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MASTER INFRASTRUCTURE REVIEW

FOR THE

BARRHAVEN CONSERVANCY DEVELOPMENT CORPORATION

BARRHAVEN CONSERVANCY

CITY OF OTTAWA

PROJECT NO.: 17-891

JULY 30, 2020
1ST SUBMISSION

EXECUTIVE SUMMARY

This Master Infrastructure Review (MIR) is prepared in support of the Barrhaven Conservancy development on behalf of Barrhaven Conservancy Development Corporation (BCDC).

The overall Barrhaven Conservancy lands are situated north of the Jock River, between Highway 416 and Greenbank Road. The subject property is approximately 103 ha and is located within the City of Ottawa urban boundary in the Barrhaven ward.

The proposed development concept consists detached single homes, townhomes, park blocks, stormwater management blocks, open space and road allowances.

The subject property is located in the Jock River watershed and is under the jurisdiction of the Rideau Valley Conservation Authority (RVCA). Per the existing topography characterized in the available City of Ottawa base mapping, all flows from the subject property are ultimately conveyed to the Jock River by a series of municipal drains and ditches. The O'Keefe Municipal Drain, the Foster Ditch, and the Fraser-Clarke Watercourse all run through the subject property.

The development area is outside of the Jock River 100-year limit as confirmed by the RVCA.

The site is subject to permissible grade raises per geotechnical recommendations, ranging from 1.4 m to 2.2 m. The site will be designed as low as possible, to have regard for the geotechnical constraints. Environmental reporting has been completed to confirm environmental constraints for the site. There are three watercourses, which are required to be maintained or enhanced.

The recommended water servicing option of those evaluated is to connect through the Nepean Town Centre development area to Zone SUC, which has recently been upgraded. The watermains will extend along the future Chapman Mills Drive extension and through the Claridge "Burnett Lands" development area.

Detailed modelling at the detailed design stage will confirm phasing of the extensions of trunk watermains and sizing of the local watermain network. The proposed water design supply will conform to all relevant City and MECP Guidelines and Policies.

Sanitary servicing will be provided to the subject property via the off-site South Nepean Collector (SNC) trunk sanitary sewer. The recommended connection to the SNC is at existing SANMH 8 at the future Chapman Mills Drive (CMD) Extension as the inverts are at the lowest, providing the optimal grading strategy on a grade raise restricted site. A sanitary pump station is proposed on the west side of the Foster Ditch due to a crossing constraint between the proposed sanitary trunk sewer and the Foster Ditch invert. With the inclusion of the subject property, and the update to current City of Ottawa design parameters for demands, the SNC sanitary sewer adequately conveys the entirety of the subject property's proposed sanitary flows without impacting downstream properties.

The basis of the stormwater design is the Jock River Subwatershed study (Jock River SWS) and a summary of existing conditions, historical review of geology, hydrogeology, geomorphology, hydraulics and hydrology is presented. As well, the guidance of the stormwater criteria for the subject lands, north of the Jock River.

Stormwater service is to be provided by capturing stormwater runoff by an internal gravity sewer system that is to convey flows to one of the oil and grit separators for quality control treatment. The oil and grit separators will discharge to naturalized wetlands prior to discharging to the Jock River. The oil and grit separators will provide an Enhanced Level of Protection for stormwater runoff from the subject property before being discharged to the Jock River. Quantity control is not required for the Jock River, notwithstanding, some quantity control by means of erosion storage will be included.

A detailed Hydraulic Grade Line (HGL) modelling analysis will be completed for the proposed system at the detailed design level. Due to the grade raise restrictions and the proposed storm and sanitary drainage schemes, the road centerlines do not allow for standard basements with a gravity connection to the storm sewer system. Because of the constraints on the subject property, sump pumps will be installed for all residential blocks, following City of Ottawa guidelines.

Erosion and sediment control measures will be implemented and maintained throughout construction. The Jock River, O'Keefe Drain, Foster Ditch and Fraser-Clarke Watercourse will all be protected from any negative impacts from construction.

The proposed servicing and grading plans will meet all City, RVCA, and MECP requirements as set out in background studies and current standards.

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1.0 INTRODUCTION

David Schaeffer Engineering Limited (DSEL) has been retained to prepare a Master Infrastructure Review (MIR) in support of the Draft Plan of Subdivision and Zoning applications for the Barrhaven Conservancy development on behalf of Barrhaven Conservancy Development Corporation (BCDC).

1.1 Study Area

The subject property is located within the City of Ottawa urban boundary in the Barrhaven ward. As illustrated in ***Figure 1***, the subject property is located north of the Jock River, east of Highway 416, west of Greenbank Road, and south of both McKenna Casey Drive and Strandherd Drive. Borrisokane Road bisects the subject property between Strandherd Drive and the Jock River. The subject property measures approximately 103.38 ha and is legally described as parts of Concessions 3 and 4, Lots 14 and 15.

The subject property is currently zoned Development Reserve (DR) Zone. The proposed development concept plan allows for the development of a mix of detached single homes, back-to-back townhomes, rear lane townhomes, park blocks, naturalized wetlands, and open space buffer blocks. It also includes a road network featuring 14 m, 16.5 m right-of-way (ROW) width local road network, 8.5 m ROW width laneways and a 24 m ROW width collector road. The proposed development concept plan is presented on ***Figure 2***.

The entirety of the subject property is within the Jock River Subwatershed and is under the jurisdiction of the Rideau Valley Conservation Authority (RVCA). The existing topography characterized in the available City of Ottawa base mapping indicates that all flows from the subject property are ultimately conveyed to the Jock River by way of the O'Keefe Municipal Drain, the Foster Ditch (former Municipal Drain), the Fraser-Clarke Watercourse (former Municipal Drain), and the Borrisokane roadside ditches, which all run through the subject property.

The development area is outside of the Jock River 100-year limit as confirmed by the Rideau Valley Conservation Authority (RVCA). Refer to the RVCA confirmation letter in ***Appendix A.***

1.2 Study Scope

The subject property has been considered as a part of the ***Official Plan*** (City of Ottawa, 2003) and the associated ***Secondary Plan*** (City of Ottawa, 2003). As presented on Schedule B of the ***Official Plan***, the subject property is considered to be primarily General Urban Area, with portions of the subject property Employment Area, and Major Open Space.

The objectives of this Master Infrastructure Review are to:

- Provide historical background information regarding the servicing of the subject property;
- Present servicing options explored while determining the recommended servicing strategy;
- Provide sufficient detail to demonstrate that development of the subject property will be adequately supported by municipal services;
- Define the course of subsequent detailed design, review, and acceptance of the proposed municipal services;
- Demonstrate how the proposed municipal services will conform with current Ministry of the Environment, Conservation and Parks (MECP) servicing design criteria and other applicable agency guidelines; and,
- Demonstrate good engineering practice for the protection of public safety, the environment, and sustainable operation.

1.3 Environmental Assessment Act

Per Ontario Regulation 345/93: Designation and Exemption Private Sector Developers under Environmental Assessment Act, works undertaken by private sector developers are exempt from the Environmental Assessment Act unless they are:

- Schedule C projects (e.g. new wastewater treatment plant, stormwater pond w. biological treatment, new well, etc.); and
- Providing the project for the residents of a municipality for roads, water or wastewater.

All works proposed as part of this MIR are to be undertaken by a private sector and are Schedule A or B projects as follows:

- Proposed Oil and Grit Separators – Schedule B;
- Proposed Sewers – Schedule A; and
- Proposed Roads – Schedule A

As such, the works described in this report are exempt from the requirements of the Environmental Assessment Act.

1.4 Development Plan

The proposed development concept is shown in ***Figure 2***. The subdivision consists of a mix of single detached homes, townhomes, park blocks, open space and a road network.

Table 1 summarizes the land use breakdown and predicted populations associated with the development concept.

Table 1: Development Statistics

Land Use - EAST	Area (ha)	Residential Population per ha	Projected Population
Residential (Low Density)	27.96	83	3926
Residential (Medium Density)	3.21	83	436
Residential (High Density)	0.59	85	119
Arterial Roads	1.87		
Collector Roads	3.72		
Local Roads	14.94		
Rear Lanes	0.86		
Foster Ditch	2.65		
Fraser-Clarke Watercourse	2.85		
Parks	3.64		
Sediment Management (K-B Pond)	0.25		
Open Space	26.50		
TOTAL	**89.29**		
Land Use - WEST	**Area (ha)**	**Residential Population per ha**	**Projected Population**
Residential	34.09	104	3546
O'Keefe Drain	3.46		
TOTAL	**37.55**		3546

The above statistics are used to inform the servicing design for the site.

2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

The following studies were utilized in the preparation of this report.

- Ottawa Sewer Design Guidelines,
  City of Ottawa, October 2012
  (City Standards)
  - Technical Bulletin ISDTB-2014-01, Revisions to Ottawa Design Guidelines - Sewer
    City of Ottawa, February 5, 2014.
    (ISDTB-2014-01)
  - Technical Bulletin PIEDTB-2016-01, Revisions to Ottawa Design Guidelines – Sewer
    City of Ottawa, September 6, 2016
    (PIEDTB-2016-01)
  - Technical Bulletin ISTB-2018-01, Revisions to Ottawa Design Guidelines – Sewer
    City of Ottawa, March 21, 2018
    (ISTB-2018-01)
  - Technical Bulletin ISTB-2018-04, Revisions to Ottawa Design Guidelines – Sewer
    City of Ottawa, June 27, 2018
    (ISTB-2018-04)
  - Technical Bulletin ISTB-2019-02, Revisions to Ottawa Design Guidelines – Sewer
    City of Ottawa, July 8, 2019
    (ISTB-2019-02)

- Ottawa Design Guidelines – Water Distribution,
  City of Ottawa, July 2010
  (Water Supply Guidelines)

  - Technical Bulletin ISD-2010-2
    City of Ottawa, December 15, 2010.
    (ISDTB-2010-2)
  - Technical Bulletin ISDTB-2014-02
    City of Ottawa, May 27, 2014.
    (ISDTB-2014-02)
  - Technical Bulletin ISTB-2018-02
    City of Ottawa, March 21, 2018
    (ISTB-2018-02)

- Design Guidelines for Sewage Works,
  Ministry of the Environment, Conservation and Parks, 2008.
  (MECP Design Guidelines)
- Stormwater Planning and Design Manual,
  Ministry of the Environment, March 2003.
  (SWMP Design Manual)
- City of Ottawa Official Plan,
  adopted by Council 2003.
  (Official Plan)
- City of Ottawa Secondary Plan – Former Nepean – South Nepean Urban Area – Areas 9 and Adopted by Council 2003.
  (Secondary Plan)
- South Nepean Collector: Phase 2 Hydraulics Review / Assessment Technical Memorandum
  Novatech, August 2015
  (Novatech SNC Memo)
- South Nepean Collector: Phase 2 Preliminary Design Report,
  Novatech, March 2016
  (Novatech SNC Design Report)
- O'Keefe Drain Environmental and Stormwater Management Plan
  CH2M Hill, May 2013
  (CH2M Hill O'Keefe Drain EMP)
- Foster Ditch Consolidated Modelling and Baseline Condition Definition for SWM Facility Design
  CH2M Hill, August 2013
  (CH2M Hill Foster Ditch Report)
- Foster Stormwater Management Facility Environmental Study Report
  CH2M Hill, October 2013
  (CH2M Hill Foster SWM Facility Report)
- Kennedy-Burnett Stormwater Management Facility Project File and Functional Design Report
  CH2M Hill, February 2017
  (CH2M Hill Kennedy-Burnett SWM Facility Report)
- Kennedy-Burnett Potable Water Master Servicing Study
  Stantec, April 2014
- Hydraulic Potable Water Assessment for Barrhaven Communities East Inc.
  Stantec, February 13, 2020
  (Stantec Hydraulic Analysis)

- Jock River Reach One Subwatershed Study
  Stantec, 2007
  (Jock River Reach 1 SWS)
- Environmental Impact Statement for Barrhaven Conservancy East
  Kilgour & Associates Ltd., July 29, 2020
  (Kilgour EIS)

3.0 EXISTING CONDITIONS AND SITE CONSTRAINTS

3.1 Geotechnical Conditions

Paterson Group (Paterson) was commissioned to complete geotechnical investigations for the Barrhaven Conservancy Lands. The following reports were prepared:

- Geotechnical Investigation – Proposed Residential Development, Conservancy Lands East (Paterson Group, September 24, 2019)
- Geotechnical Investigation – Proposed Residential Development, Conservancy Lands West (Paterson Group, September 27, 2019)

The Barrhaven Conservancy Lands East consist of vacant land and are bordered by the Foster Ditch to the west, lands under development to the north and east, and the Jock River to the south. The existing ground surface across the site is relatively level with approximate ground surface elevation varying between 91 m and 92 m. The subsurface profile generally consists of an approximate 50 mm to 460 mm thick layer of topsoil underlain by a silty clay deposit. Due to the presence of a silty clay deposit, the permissible grade raise varies between 1.4 m in the northwest and 2.2 m in the southeast. Figure PG5036-2 *Permissible Grade Raise Plan* by Paterson Group is enclosed in ***Appendix B*** for reference.

The Barrhaven Conservancy Lands West consist of vacant land and is bordered by Highway 416 to the west, a railroad to the northwest, a stormwater retention pond to the northeast, the Foster Ditch to the east, vacant City Lands to the southeast, and the Jock River to the southwest. The existing ground surface across the site is relatively level with approximate ground surface elevation varying between 91 m and 92 m. The subsurface generally consists of an approximate 50 mm to 360 mm thick layer of topsoil underlain by a silty clay deposit. Due to the presence of a silty clay deposit, the permissible grade raise varies between 1.2 m to 1.8 m. Figure 5036-5 *Permissible Grade Raise Plan* by Paterson Group is enclosed in ***Appendix B*** for reference

3.2 Drainage

The subject property is relatively flat with the existing elevations ranging from 92 m in the north to 91 m in the south. The subject property gradually slopes towards the towards the Jock River.

The subject property is within the Jock River watershed and is under the jurisdiction of the RVCA. As noted in ***Section 1.0***. The development area is outside of the Jock River 100-year limit as confirmed by the Rideau Valley Conservation Authority (RVCA). Refer to the RVCA confirmation letter in ***Appendix A***.
The O'Keefe Municipal Drain, the Foster Ditch, and the Fraser-Clarke Watercourse all run through the subject property and convey stormwater to the Jock River.

3.3 Hydrogeology

As noted in the Jock River Reach 1 SWS, the hydrogeologic conditions have been well documented in the study limits. Previous terrain analysis and hydrogeological studies within the study limits were completed by Jacques Whitford Limited (JWL) and Golder Associates Limited (Golder) and Paterson Group (Paterson).

Based on Figure 3.4.1 of the Jock River Reach 1 SWS, the surficial soils for Barrhaven Conservancy are determined to be silty clay with underlying bedrock ranging from 80.0 m to 85.0 m below original ground. As shown on Figure 3.4.3, the *Interpreted Groundwater Flow Direction* is southerly across the Barrhaven Conservancy lands, towards the Jock River. Figures 3.4.1, 3.4.2 and 3.4.3 are provided in ***Appendix B*** for reference.

3.4 Environmental Features / Natural Heritage

Kilgour & Associates Limited completed an Environmental Impact Statement for the Barrhaven Conservancy East Development dated July 29, 2020 *(Kilgour EIS)*. The purpose of the *Kilgour EIS* is to review the overall development concept for the site from a natural heritage perspective; however, as a result of pre-consultation with the City of Ottawa and RVCA, the report is more comprehensive than a typical EIS, with information and analysis that is consistent with an Environmental Management Plan (EMP). The *Kilgour EIS* was prepared for the Barrhaven Conservancy Lands East, which are situated within the larger Barrhaven Conservancy Community, bordered by the Jock River to the south, Foster Ditch to the west, and the Fraser-Clarke Watercourse to the east. An EIS will be required for the Barrhaven Conservancy Lands West when development is proposed, to determine appropriate impact assessment and mitigation. It is noted in the *Kilgour EIS* that the report is intended to determine potential impacts of proposed site development on existing natural heritage features, provide mitigation and/or design considerations to protect those elements, and highlight relevant regulations as detailed planning proceeds to allow the developer to remain compliant. Figure 3 – Current Existing Conditions from the *Kilgour EIS* is enclosed in ***Appendix C*** for reference.

3.4.1 Surface Water Features and Fish Habitat

As noted in the *Kilgour EIS,* the Jock River flows from west to east along the southern boundary of the Barrhaven Conservancy Community for approximately 3 km to its confluence with the Rideau River and the site is entirely within Reach 1 of the Jock River Subwatershed. The Jock River is classified as a warm/warm-cool water system that is home to fish habitat, as detailed in the *Kilgour EIS*.

As described in the *Kilgour EIS*, lands between 80 m and 400 m wide, adjacent to the Jock River, will be established as a Jock River open space corridor. The open space corridor will include the development of both wetland and forest cover, designed to protect or enhance aquatic life and fish habitat. The wetland facilities will receive water inputs from stormwater quality treatment units, as discussed in ***Section 6.2***. Figure 5 – Conceptual Plan for the Jock River Riparian Corridor from the *Kilgour EIS* is enclosed in ***Appendix C*** for reference.

As noted in the *Kilgour EIS,* one municipal drain and two decommissioned municipal drains occur in the overall Barrhaven Conservancy Community and flow to the Jock River: the Foster Ditch, the Fraser-Clarke Watercourse, and the O'Keefe Drain. The Foster Ditch and the Fraser-Clarke Watercourse occur within the Barrhaven Conservancy East Lands. The O'Keefe Drain is located in the Barrhaven Conservancy West Lands and will be detailed in a future EIS when those lands proceed to development.

The Foster Ditch flows approximately 800 m through the site from an existing stormwater management pond to the Jock River. The Fraser-Clarke Watercourse is a former municipal drain that was decommissioned by the City of Ottawa. The O'Keefe Drain is a municipal drain, with approximately 770 m in length abutting the western border of the Barrhaven Conservancy Lands East. The watercourses through the proposed community will be retained and protected with 30 m setbacks from their normal high-water marks. The corridors will be revegetated and re-naturalized as part of the detailed design phase of the proposed development. Existing roadside ditches will be maintained but do not require setbacks.

The *Kilgour EIS* has noted that there are no predicted negative impacts to surface water features during site development given application of conventional construction-phase mitigations.

3.4.2 Trees / Significant Woodlands

The *Kilgour EIS* has noted that the site was historically agricultural lands with treed hedgerows between fields, a tree buffer along the southern boundary of the property, and some areas of regenerating scrubland in the south west. Most of the hedgerows have been removed. The *Kilgour EIS* notes that the narrow band of trees occurring directly along the banks of the Jock River, the Foster Ditch and the Fraser-Clarke Watercourse have been fully retained. No Provincially Significant Wetlands, wetlands found in association with Significant Woodlands, Significant Valleylands, or Areas of Natural and Scientific Interest occur on or adjacent to the site. Other than the trees along the watercourses, the site currently consists of bare, flat soil, though the soil has been seeded with a grass mix to provide erosion control.

The *Kilgour EIS* has noted that there are few trees currently remaining on site, none anticipated to be impacted by development, and no unique treed habitats or tree species are present. Trees along the two watercourses were retained within the 30 m buffer surrounding them, as shown on Figure 3 – Current Existing Conditions from the *Kilgour EIS*, enclosed in ***Appendix C*** for reference. Further, riparian forest areas along the Jock River remain intact and are unlikely to be impacted by the project given conventional construction-phase mitigations.

3.4.3 Wildlife / Species at Risk

The *Kilgour EIS* has identified species at risk (SAR) with some potential to occur near, or to otherwise interact with the proposed development project (Bank Swallow, Northern Map Turtle, Snapping Turtle, and Blanding's Turtle); however, can be mitigated through appropriate and conventional mitigations. It is further noted that the proposed project is not expected to impact species at risk and the restored open space corridor has the potential to provide some additional new habitat for turtle species.

The *Kilgour EIS* notes that the site is unlikely to support wildlife. Amphibian habitats occur in the Foster Ditch and Fraser-Clarke Watercourse, which will remain within a 30 m protected corridor. Migratory birds have limited potential to occur and nest on the site. Wildlife species common to the area may continue to use or cross the site and the riparian forest along the Jock River functions as a wildlife corridor and will remain in place during and after site development. The implementation of suitable mitigation measure will minimize the risk resulting in no impact to amphibians, migratory birds and wildlife.

3.5 Existing Land Use and Adjacent Land Uses

Under existing conditions, the majority of the subject property is vacant.

For the Barrhaven Conservancy Lands West, City owned lands and a rail corridor is to the north, Highway 416 is to the west and City owned open space and the Jock River are to the south.

For the Barrhaven Conservancy Lands East, the Jock River is to the south, existing development is to the east and development underway is to the north.

Due to the proximity to existing residential developments, there are services adjacent to the proposed development area. In addition to water servicing, wastewater servicing and storm servicing, there will also be access to utility servicing. It is expected that Hydro, telecommunications, and natural gas servicing will be easily accessible.

4.0 WATER SUPPLY SERVICING

4.1 Existing Water Supply Services

The subject property is located adjacent to the City of Ottawa's Pressure Zone 3SW (previously known as Pressure Zone BARR). Pressure Zone SUC services the land found to the east of the subject property, as well as south of the Jock River.

The City of Ottawa has recently started reconfiguring the pressure zones servicing Barrhaven and the South Urban Community (SUC) in order to improve reliability and efficiency and to increase pumping capacity to accommodate for future growth in the area.

The populations and demands attributed to the Barrhaven Conservancy Lands have not been included in the recent City of Ottawa reconfiguration works.

The Fallowfield Road Pumping Station (FRPS), previously known as Barrhaven Reservoir Pumping Station and Barrhaven Pumping Station (BPS), will continue to service Zone 3SW. The new FRPS is commissioned and in operation while the BPS is currently undergoing pumping tests on the newly installed pumps as part of its commissioning process.

The BPS is changing from a single zone station to a dual zone pump station and will operate in conjunction with the Ottawa South Pumping Station (OSPS) to service the newly expanded Zone SUC. It will also continue to service the smaller / reduced Zone 3SW with one of its pumps. The OSPS is currently undergoing detailed design for its upgrade.

Future watermains in the vicinity of the subject property have been identified at the following locations, as shown on ***Figure 3***.

- 400 mm 3SW watermain trunk within Strandherd Drive ROW;
- 300 mm 3SW watermain within the future Chapman Mills Drive extension;
- 600 mm SUC watermain trunk within the future Greenbank Road realignment;
- 300 mm SUC watermain within a future local road to the east of Greenbank Road; and,
- 300 mm SUC watermains within the future road network in new developments south of the Jock River.

4.2 Water Supply Servicing Design

Stantec Consulting Limited was retained to perform a hydraulic assessment for the Barrhaven Conservancy Lands. The ***Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation (Stantec Hydraulic Analysis)*** prepared by Stantec on February 13, 2020 is enclosed in ***Appendix D*** for reference. This report is prepared for both the Conservancy East (east of the Foster Ditch) and Conservancy West (west of the Foster Ditch) and is referred to overall as the Barrhaven Conservancy Lands.

Adequacy of sizing of the trunk watermain infrastructure was considered in the ***Stantec Hydraulic Analysis***. The subject property was deemed serviceable and offered multiple servicing alternatives that could adequately service the subject property conforming to all relevant City and MECP Guidelines and Policies.

4.2.1 Water Supply Servicing Alternatives

To supply water to the entirety of the subject property, a local watermain network will follow the road network and ultimately connect to off-site trunk watermains based on one of the following alternatives, presented in the ***Stantec Hydraulic Analysis***:

<u>Alternative 1 – Servicing from Zone 3SW</u>

As shown on Figure 1 of the ***Stantec Hydraulic Analysis***, Alternative 1 is to connect at two locations to Kennedy-Burnett watermains that are fed by the future 3SW watermain trunk within Strandherd Drive.

Based on the *Kennedy-Burnett Potable Water Master Servicing Study (Stantec, 2014)*, it is likely that the Barrhaven Conservancy Lands would experience pressures greater than the City of Ottawa's objective pressure of 80 psi during basic day demands if operating at the Zone 3SW pressure. Pressure mitigation measures such as pressure reducing valves (PRVs) at individual service connections would need to be considered.

Pumping capacity upgrades at the FRPS and/or BPS would be required to service the Barrhaven Conservancy Lands from Zone 3SW on a permanent basis. Another alternative would be to service the initial phase of development (refer to Figure 1 of the ***Stantec Hydraulic Analysis*** for the boundary line) from Zone 3SW on a temporary basis, to be switched to Zone SUC at a later time. Although technically feasible, this alternative essentially borrows capacity from existing approved areas within Zone 3SW until such time that the borrowed capacity is replaced through system upgrades. Through informal discussions, the City has indicated that this is not a desirable option.

Alternative 2 – Servicing from Zone SUC

Alternative 2 is to connect at two locations to Zone SUC. Figures 2, 3 and 4 of the ***Stantec Hydraulic Analysis*** present the connections presented in Alternatives 2a, 2b and 2c, respectively.

Based on the *Barrhaven South Urban Expansion Area Master Servicing Study (Stantec, 2017),* it is likely that the Barrhaven Conservancy Lands can anticipate maximum pressures greater than 75 psi and potentially be greater than 80 psi during basic day demands if operating at Zone SUC pressure. If they were to exceed 80 psi, PRVs would need to be considered.

Alternatives 2a and 2b propose the primary feed to be a new SUC watermain running parallel to the Strandherd watermain, connecting to the Kennedy-Burnett (KB) watermains, which may require the KB subdivision to operate at SUC pressures.

Alternative 2a proposes a secondary feed from the Nepean Town Centre (NTC) as shown on Figure 2 of the ***Stantec Hydraulic Analysis***. Alternative 2b proposes a secondary feed from Barrhaven South as shown on Figure 3 of the ***Stantec Hydraulic Analysis***. Both 2a and 2b present their unique challenges with either limited land access or crossings of bodies of water.

Alternative 2c proposed both the primary and secondary feed from the NTC as shown on Figure 3 of the ***Stantec Hydraulic Analysis*** to service the first stages of development in the Barrhaven Conservancy Lands. One connection is through the future Chapman Mills Drive and one is through the future Claridge development southeast of the Kennedy-Burnett Pond. Servicing these lands with two 300 mm diameter watermains from the NTC is possible; however, ultimate optimization of sizing would have to be completed at a later phase. This option also presents challenges due to limited land access or crossing at a body of water.

Alternative 3 – Servicing from Zone SUC with an Automated Valve from Zone 3SW

Alternative 3 is to service the Barrhaven Conservancy Lands by a new Zone SUC watermain running parallel to the Strandherd Drive watermain and a secondary feed from Zone 3SW for emergency conditions. This alternative proposes a secondary feed from Zone 3SW via an automated valve off the future Strandherd Drive watermain, as shown on Figure 5 of the ***Stantec Hydraulic Analysis***. With this design, water would flow from the high-pressure Zone 3SW to the low-pressure Zone SUC if there is a pressure drop on the Zone SUC side of the valve. This alternative requires an interzonal valve connection that is not typically used or accepted in the City of Ottawa and would present both operational challenges and costs to operate and maintain.

Recommended Alternative:

Refer to Table 5: Potable Water Servicing Alternatives & Limitations of the ***Stantec Hydraulic Analysis*** for a summary of the alternatives. Through discussions with the City, it was determined that Alternative 2c was the preferred solution. This is to service from the recently configured SUC pressure zone. The water supply network will be expanded through neighbouring properties within the Zone SUC Nepean Town Centre (NTC) development area (i.e. Claridge's "Burnett Lands") development at 3370 Greenbank Road – preliminary functional design figures are provided in ***Appendix D*** for reference) with ultimate watermain concepts in line with the prior Stantec study completed titled *"Kennedy-Burnett Potable Water Master Servicing Study (April 2014)"* (excerpt provided in ***Appendix D***). Preliminary coordination with landowners has been undertaken in order to ensure appropriate watermain sizes will be available when those developments are advanced. At the time of detailed design, detailed hydraulic modelling will be undertaken to verify that the proposed on-site and off-site watermains are in conformance with all relevant criteria.

The proposed water servicing layout is presented on ***Drawing 2***. As detailed designs progress, timing, alignment, and sizing of local watermains will be confirmed. The subdivision's local watermain network will be sized to meet maximum hour and maximum day plus fire flow demands, with consideration given to proposed phasing plans. ***Table 2*** summarizes the Water Supply Design Criteria employed in the preparation of the preliminary water demand estimate

Table 2: Water Supply Design Criteria

Design Parameter	Value
Extracted from Section 4: Ottawa Design Guidelines, Water Distribution (July 2010)	
Residential - Single Family	3.4 p/unit
Residential – Townhome/ Semi	2.7 p/unit
Residential – High Density	2.1 p/unit
Minimum Watermain Size	150 mm diameter
Minimum Depth of Cover	2.4 m from top of watermain to finished grade
During normal operating conditions desired operating pressure is within	350kPa and 480kPa
During fire flow operating pressure must not drop below	140kPa
Stantec Hydraulic Analysis, Stantec, July 20, 2017 for Population Exceeding 3000 Persons	
Residential – Detached Single	180 L/cap/day
Residential – Rear Lane Town	198 L/cap/day
Residential – Back-to-Back	198 L/cap/day
Residential – High Density	219 L/cap/day
Outdoor Water Demand	1049 L/unit/day (single detached)
Basic Day	Population x Demand
Max Day	Basic Day + Outdoor Water Demand

4.2.2 Fire Flow Demand

Fire Flow requirements are to be confirmed in accordance with Local Guidelines (Fire Underwriters Survey), City of Ottawa Water Supply Guidelines, and the Ontario Building Code, upon development of detailed concepts for the detached single homes, townhouses, and the park. For planning purposes, fire flow estimates are provided in the preliminary water demand estimate (***Appendix D*** and ***Table 3***) based on the information available in the preliminary concept plan and comparable recent developments in the City of Ottawa.

4.2.3 Boundary Conditions

To support the future development of a hydraulic analysis for the subdivision, boundary conditions are expected to be provided by the City of Ottawa for the preliminary water demands.

4.2.4 Water Demand Calculations

A summary of water demands for the subject site is presented in ***Table 3***.

Table 3: Water Demand Estimate

	Unit Count			Pop	L/c/d	BSDY (MLD)	MXDY (MLD)
	Conservancy East	Conservancy West	Total				
Single Family	725	775	1,500	5,100	180	0.92	2.49
Townhouse	475	525	1,000	2,700	198	0.53	0.53
Rear-Lane Townhouse	250	-	250	675	108	0.13	0.13
High Density	50	-	50	105	219	0.02	0.02
Total	***1,500***	***1,300***	***2,800***	***8,580***		***1.60***	***3.18***

4.3 Water Supply Conclusion

Stantec was retained to evaluate water servicing options for the subject lands. Through analysis and consultation, it was determined that the preferred option is to connect through the Nepean Town Centre development area to Zone SUC, which has recently been upgraded. The watermains are recommended to extend along the future Chapman Mills Drive extension and through the Claridge "Burnett Lands" development area. Detailed modelling at the designed design stage will confirm phasing of the extensions of trunk watermains and sizing of the local watermain network. The proposed water design supply will conform to all relevant City and MECP Guidelines and Policies.

5.0 WASTEWATER SERVICING

5.1 Existing Wastewater Services

Per the ***South Nepean Collector (SNC) Wastewater Servicing Study and Functional Design Report*** by Dillon in October 2003 ***(Dillon SNC Report)***, the subject property is tributary to the South Nepean Collector (SNC) sewer as urban development land.

The SNC (previously called the Jock River Collector) sewer operates north of the subject property within Strandherd Drive prior to travelling south down Chapman Mills Drive (CMD) and then turns eastward within the future CMD right-of-way (ROW).

The SNC was designed to be constructed in three phases. Phase 1 of the SNC was completed in 2005, terminating at a 2400 mm maintenance hole located east of Longfields Drive, north of Bren-Maur Road. Phase 2 was recently extended to Strandherd Drive via the proposed extension of Chapman Mills Drive from its previous termination. Phase 3 will extend the trunk sewer along Strandherd Drive to the intersection of Maravista Drive. The wastewater is ultimately conveyed to the intersection of Jockvale Road and Longfields Drive where it then passes underneath the Jock River.

The ***South Nepean Collector Phase 2: Hydraulics Review / Assessment*** memo was prepared by Novatech Engineering Consultants on August 20, 2015 ***(Novatech SNC Memo)*** to provide an update to the sanitary design flows for Phase 2 of the South Nepean Collector, as previously documented in the ***South Nepean Collector (SNC) – Functional Design Report and Update*** by Dillon in 2012 ***(Dillon SNC Report and Update)***. In addition, Novatech is also currently the engineer of record for the design and implementation of the Phase 3 extension of the SNC, noted above.

The location of the SNC sewer is shown on ***Figure 4.***

5.2 South Nepean Collector Phase 3 – Preliminary Design

The 2015 ***Novatech SNC Memo*** contemplated that the Conservancy Phase 1 development area (north of the Fraser-Clarke Watercourse) would be serviced by the 900 mm diameter SNC sewer running adjacent to the property within the future extension of CMD. This is represented by area "A6-E" within the "*Sanitary Drainage Areas and Land Use – Fig.1"* plan within the 2015 Novatech memo (note that the actual tributary area and population varied slightly).

For the Phase 3 extension of the SNC, Novatech has prepared another review of sanitary flows within their technical memorandum titled "***Strandherd Drive Widening Project***, ***South Nepean Collector Phase 3: Sanitary Flow Calculations***" May 30, 2019 ***(2019 Novatech SNC Memo).*** The memorandum along with the design sheet calculations from the Novatech memo are provided in ***Appendix E*** for reference along with DSEL annotations on key items in the figure and design sheets. The updated "*Sanitary Drainage Areas and Land Use – Fig.1" (May 2019)* plan is essentially reflective of the same tributary information that was provided in the 2015 study (the plan has been marked up to reflect the Conservancy areas as a frame of reference). The associated design sheet also reflects updated City wastewater design criteria that was not accounted for in the 2015 study and is discussed further in the following section.

Report excerpts are provided in ***Appendix E*** for the SNC Phase 2 analysis as well as draft information associated with the Phase 3 extension.

The location of the SNC sewer is shown on ***Figure 4*** in ***Figures***.

5.3 Wastewater Design

The subject property is planned to be serviced by an internal gravity sanitary sewer system that is to generally follow the local road network, with select servicing easements identified to achieve efficiencies in servicing and grading designs. The wastewater servicing plan can be seen in ***Drawing 4***. As detailed designs progress, alignment and sizing of local sanitary sewers will be confirmed and additional servicing easements may be required, which may trigger minor amendments to the proposed fabric in the concept plan.

The ***Novatech SNC Memo*** contemplated that portions of the subject property would be serviced by the 900 mm diameter SNC sewer, running adjacent to the property within Strandherd Drive and the future extension of Chapman Mills. This ***Master Infrastructure Review*** proposes that the drainage area of the SNC sanitary sewer be expanded to include the entirety of the subject property.

Table 4 presents the wastewater design criteria applied in the design of this site.

Table 4: Wastewater Design Criteria

Design Parameter	Value
Current Design Guidelines	
Residential - Single Family	3.4 p/unit
Residential – Townhome/ Semi	2.7 p/unit
Residential – Apartment	1.8 p/unit
Average Daily Demand	350 L/d/per
Peaking Factor	Harmon's Peaking Factor. Max 4.0, Min 2.0
Commercial / Institutional Flows	50,000 L/ha/day
Commercial / Institutional Peak Factor	1.5
Infiltration and Inflow Allowance	0.28 L/s/ha
Park Flows	28,000 L/ha/d
Park Peaking Factor	1.0
Sanitary sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Minimum Sewer Size	200mm diameter
Minimum Manning's 'n'	0.013
Minimum Depth of Cover	2.5m from crown of sewer to grade
Minimum Full Flowing Velocity	0.6m/s
Maximum Full Flowing Velocity	3.0m/s
Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012, and recent residential subdivisions in City of Ottawa.	
Operational Parameters on Monitoring Data ***(Example Only, Values to be Reviewed on Case-by-Case Basis with City of Ottawa)***	
Average Daily Demand	300 L/d/per
Harmon – Correction Factor	0.4 to 0.6
Institutional / Industrial Flows	10,000 L/ha/day
Commercial Flows	17,000 L/ha/day
Commercial / Institutional Peak Factor	1 (non-coincident peak)
Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012, and recent residential subdivisions in City of Ottawa.	

5.3.1 Wastewater Design Servicing Alternatives

Alternative 1 – Connect to existing Phase 2 SNC at CMD

A total area of 107.81 ha is proposed to drain into the SNC trunk sewer from the subject property, including the Conservancy East lands and the Conservancy West lands. The sanitary drainage area information is shown in ***Drawing 4*** and the design sheets are enclosed in ***Appendix E.***

Applying the City of Ottawa's wastewater design criteria to the overall development concept, the estimated peak sanitary flow from the subject property, including external flows, is ~107.44 L/s. The proposed internal gravity sanitary trunk sewer adequately services the subject property and does not exceed 75% capacity throughout the network.

The proposed peak sanitary flow from the subject property (including Conservancy East and Conservancy West) to the existing SNC sanitary sewer (SANMH 8 in Novatech Drawing No. 20) is ~107.44 L/s. The addition of the Conservancy Land's peak flow to the peak design flows from the ***2019 Novatech SNC Memo*** results in an updated peak flow of 401.58 L/s to SNC sewer installations downstream of existing SANMH 8. With the inclusion of the subject property, the SNC sanitary sewer along the Conservancy Phase 1 frontage would be at approximately 67% capacity and can adequately handle the entirety of the Conservancy property's proposed sanitary flows.

When reviewing the projected flows to the SNC, as derived from the *Novatech Phase 2 and Phase 3* SNC data, along with Conservancy Lands design flows, the following is summarized:

Table 5: South Nepean Collector – Projected Flow Updates

Report Reference	Projected Flows at Strandherd/CMD intersection (L/s)	Flow at Conservancy Lands Connection Point (L/s)	Difference From Original SNC Design (L/s)
2015 Novatech SNC Memo	384.7(1)	423.6	0
2019 Novatech Preliminary Phase 3 Design	282.5(2)	308.6(3)	-115
DSEL inclusion of Conservancy Lands tributary of ~107.81ha	282.5	399.03(4)	-24.6

(1) See annotated Novatech design sheet "South Nepean Collector – Phase 2 & 3" (August 2015) in Appendix C and associated "Sanitary Drainage Areas and Land Use" Figure 1 dated August 2015.
(2) See annotated Novatech design sheet "South Nepean Collection Phase 3" (September 2019) in Appendix C and associated "Sanitary Drainage Areas and Land Use" Figure 1 dated May 2019
(3) Incorporating the new Phase 3 flows into the 2015 Novatech analysis
(4) See DSEL sanitary flow spreadsheet review of Novatech's SNC Phase 2 and 3 design sheet data.

The above table demonstrates that with the updates to the SNC design parameters and incorporation of the Conservancy Lands sanitary flows there is a net reduction of 24.6 L/s to the SNC sewer at this location. As such this translates into no impacts downstream of this connection point to the SNC sewer network.

<u>Alternative 2 – Connect to existing Phase 3 SNC at Strandherd</u>

In this alternative, the proposed wastewater servicing design proposes to tie into the off-site SNC sanitary sewer within Strandherd Drive at Borrisokane Road. The sanitary sewer is shown on the Strandherd Drive Widening – Maravista Drive to Jockvale Road - Grading & Drainage 7, Strandherd Drive STA 12 + 200 to STA 12+500 Drawing No.

59, Rev 4 dated 18/10/19, provided in ***Appendix E*** for reference (City contract number CP000217)

Although the capacity for the Conservancy Lands within the system can be confirmed, there are some issues with connecting to this upstream location. The invert in the SNC sanitary sewer at Borrisokane is 87.75 m, which is approximately 1.25 m higher than the invert proposed in Alternative 1. If the sanitary connection was made at this location, the proposed sanitary within the Conservancy Lands would not work with the grading. Due to the grade raise restrictions across the site, it is not feasible to raise the site further to accommodate this sanitary connection.

Recommended Alternative

Alternative 1 is recommended, which is the lower and further downstream connection to the SNC sanitary sewer at future CMD at existing manhole 'SANMH 8'. This connection is recommended as it will not lead to the requirement to lift the grades on the grade raise restricted site. Capacity in the SNC sanitary sewer has been confirmed.

The design of the gravity sewers for the Conservancy East area does not have any exceptional requirements up to the boundary of the Foster Ditch which is the westernmost limit of the East draft plan; however, the Foster Ditch does impart a constraint due to the bottom elevation of the watercourse. This constraint will necessitate the inclusion of a pump station, west of the Foster Ditch, in order to provide sanitary service upstream. The pump station overflow will connect to the downstream sewer. The upstream sanitary HGL will be controlled by the pump station failure which is controlled by the downstream HGL. Detailed design of the infrastructure for that area will be completed at the time of the advancement of the draft plan for those Conservancy lands that are west of the Foster Ditch.

The preliminary sanitary servicing design is shown on ***Drawing 2 & 4*** in ***Drawings***. The preliminary sanitary and storm trunk profiles are shown on ***Drawing 5***, ***Drawing 6*** and ***Drawing 7*** in ***Drawings***.

5.4 Wastewater Servicing Conclusion

The subject property will be serviced by local sanitary sewers, an on-site trunk sanitary sewer and the off-site existing SNC sanitary sewer as defined in previous reports. This MIR proposes the expansion of the drainage areas from the *South Nepean Collector: Phase 2 Hydraulics Review / Assessment Technical Memorandum* (Novatech, August 2015), to include the entirety of the subject property. Residual capacity exists downstream in the SNC after the addition of the subject property's wastewater flows to the SNC sanitary sewer, therefore the proposed servicing does not have a negative impact on neighbouring landowners.

Two alternatives were considered as it relates to connections to the SNC sanitary sewer, with the recommended alternative being at the existing SNC SANMH 8 at the future CMD extension. This alternative was chosen as the inverts are lower providing a better grading strategy on the grade raise restricted Conservancy Lands.

There is a requirement for a sanitary pump station to be incorporated into the design west of the Foster Ditch due to the constraint imposed by the invert elevation of the watercourse. The upstream HGL will be controlled by the pump station failure which is controlled by the downstream HGL.

6.0 STORMWATER CONVEYANCE

6.1 Existing Stormwater Drainage

The subject lands are within the Jock River Subwatershed. The existing drainage features and patterns are illustrated on ***Figure 5***. Per the existing topography characterized in available City of Ottawa base mapping, all flows from the subject property are ultimately conveyed to the Jock River by a series of watercourses. The O'Keefe Municipal Drain, the Foster Ditch (former Municipal Drain), the Fraser-Clarke Watercourse (former Municipal Drain) and the Borrisokane roadside ditches all run through the subject property and convey stormwater to the Jock River. ***Section 6.1.1*** of this report provides a summary of background information from the Jock River Reach 1 Subwatershed Study (Stantec, June 2007) as it relates to the subject site. As ***Section 6.1.1*** is based on a summary of historical information and documentation, the Fraser-Clarke Watercourse and Foster Ditch are referred to as a Municipal Drains. It is noted that the Fraser-Clarke Watercourse and Foster Ditch did previously have status as Municipal Drains under the provincial *Drainage Act* but the drains were officially abandoned, pursuant to Section 84 of the *Act*, at the request of the landowner(s). Additional information regarding the meander belt for the Jock River and municipal drains and ditches that cross the subject site is contained in ***Section 6.1.2***.

6.1.1 Jock River Reach 1 Subwatershed

The following information provides a background summary from the Jock River Subwatershed Study (Stantec, June 2007) focusing on the subject site. The Jock River Reach 1 Subwatershed study also covered the Barrhaven South Community, south of the Jock River; however, that area was subject to its own Community Design Plan (CDP) and Master Servicing Study (MSS).

In January 2005, the Jock River Reach 1 Subwatershed Study was initiated to identify the existing environmental condition of the river and associated natural resources and to recommend strategies for the management of the natural environment in order to address growing development pressure in Barrhaven and the surrounding area.

The subwatershed is approximately 2300 hectares and when the study was completed in June 2007, approximately 1070 ha (47%) was developed. The Jock River Reach 1 subwatershed study provides the environmental and conceptual stormwater management requirements for the Barrhaven South community and the undeveloped urban lands north of the Jock River. The undeveloped urban lands north of the Jock River are the Barrhaven Conservancy Lands.

The existing natural resources within the subwatershed were identified and assessed to determine significant features and functions within the study area. The main tributaries noted within the Barrhaven Conservancy Lands are the O'Keefe Drain, Foster Ditch and

Fraser-Clarke Watercourse. The O'Keefe Drain is a Municipal Drain. All the tributaries to the Jock River support fisheries and are considered fish habitat.

The holistic understanding of the health and state of the subwatershed's ecosystem led to the preparation of the preferred management strategy for the areas north and south of the Jock River. The Jock River Reach 1 management strategy consisted of three main components: Conceptual Stormwater Management Plan, Natural Environment Plan and Conceptual Fish Habitat Compensation Plan.

Stormwater Management Design Criteria

The following criteria were established for all future stormwater management facilities within Reach 1, applicable to the subject site:

Jock River:

- No quantity control storage required for flood control purposes as the hydrograph from the subwatershed will peak before the upstream peak in the Jock River.
- No erosion control storage required to maintain the pre-development in-stream erosion condition.
- Quality control volume as per the Ministry of the Environment, Conservation and Parks Enhanced Treatment (80% TSS removal), following the integrated SWM approach recommended in the Lower Rideau Watershed Strategy.

North of the Jock River:

- Quantity control storage as required to meet constraints within existing channels and/or at existing crossings (quantity control/level of control requirements to be determined through future detailed study).
- Erosion control storage as required to maintain stability and geomorphic function of the existing tributaries, as determined through further detailed study.
- Quality control storage as per the Ministry of the Environment, Conservation and Parks Enhanced Treatment (80% TSS removal).
- All stormwater management facility outlets will be designed to augment low flows to the extent possible.

6.1.1.1 Existing Conditions Summary

It is noted in the Jock River Reach 1 SWS that the area was the subject of numerous studies over many years as it was long identified for urban development. Prior to development, the subject site was primarily cropped land and wide shallow floodplain.

6.1.1.1.1 Geology and Hydrogeology

As noted in the Jock River Reach 1 SWS, the geologic and hydrogeologic conditions have been well documented in the study limits. Previous terrain analysis and hydrogeological studies within the study limits were completed by Jacques Whitford Limited (JWL) and Golder Associates Limited (Golder) and Paterson Group (Paterson).

Based on Figure 3.4.1 of the Jock River Reach 1 SWS, the surficial soils for Barrhaven Conservancy are determined to be silty clay. Based on Figure 3.4.2 of the Jock River Reach 1 SWS, the underlying bedrock ranges from 80.0 m to 85.0 m. As shown on Figure 3.4.3, the Interpreted Groundwater Flow Direction is southerly across the Barrhaven Conservancy, toward the Jock River. Figures 3.4.1, 3.4.2 and 3.4.3 from the Jock River Subwatershed Study are enclosed in ***Appendix F***.

6.1.1.1.2 Geomorphology

Reach Delineation

Parish Geomorphic Ltd evaluated the Jock River Reach 1 from a fluvial geomorphology perspective, dividing it into four distinct reaches. The reaches were delineated based on the changes in channel sinuosity, augmented by geological, topographical and land use information. The Barrhaven Conservancy lands are adjacent to Reach JR-3 and Reach JR-4, as identified on Figure 3.5.1 in the Jock River Reach 1 SWS, enclosed in ***Appendix F***. These upstream reaches flow through a well-established riparian zone, consisting of a scrubland and deciduous forest. They are controlled by underlying clay material and bedrock of low relief so that the valley is unconfined.

The following provides a summary of the two reaches adjacent to Barrhaven Conservancy, from the Jock River Reach 1 SWS.

- Reach JR-3 is located between Cedarview and the meander bend of Half Moon Bay (in the Jock River). The reach was characterized by deep, turbid, slow moving water and low sinuosity. The relief contrasts strongly with the lower reaches due to a transition from glacial till deposits to clay and exposed bedrock. This results in an unconfined valley floodplain. Approximate bankfull width is 70 – 110 m. Reach JR-3 does not demonstrate significant evidence of geomorphic instability.

- Reach JR-4 is between Highway 416 and Cedarview Road and ranges from 70 - 120 m wide, with still, turbid water and moderate sinuosity. In stream vegetation is abundant. Reach JR-4 does not demonstrate significant evidence of geomorphic instability.

Meander Belt Widths

The meander pattern for the reaches is divided in two. JR-3 and JR-4 consist of similar-shaped, low amplitude meanders. Meander belt quantification is used to identify and appropriate corridor that indicates the maximum lateral extent of the channel. Delineation of these corridors can then be used to implement specific developmental constraints at the planning level in order to avoid future remediation measures associated with channel erosion.

The following preliminary meander belt widths are determined to be conservative. For the upper reaches, JR-3 has a preliminary meander belt width of 198 m (218 m with a 10% buffer) and JR-4 has a meander belt width of 210 m (231 m with a 10% buffer).

Tributaries North of the Jock River

The presence of drains and tributaries was noted during the field reconnaissance for the Jock River Reach 1 SWS. The more defined drains were selected for geomorphic assessment and the ones through Barrhaven Conservancy (north of the Jock River) are identified as the Foster Ditch, O'Keefe Drain and the Fraser-Clarke Watercourse.

The Foster Ditch originates south of Fallowfield Road, west of Borrisokane Road and flows south until it converges with the Jock River south of McKenna Casey Drive. The ditch is approximately 3200 m long and has been artificially straightened. The surrounding land use is agricultural. Riparian vegetation is very sparse but mostly grasses with few shrubs. Due to the unnatural alignment of the ditch, a sinuosity value and the calculation of migration rates are not applicable. Top of the valley meander belt widths for the ditch derived using empirical formula are 28.16 and 37.18 m for a discharge of 0.5 and 2.0 m^3/s, respectively.

The O'Keefe Drain is located east of and runs parallel to Highway 416. The drain extends from south of Fallowfield Road and enters the Jock River south of McKenna Casey Drive. The drain is approximately 3100 m in length and has been artificially straightened to follow the depression between agricultural lands. The predominant land use is agricultural. The riparian vegetation consists mainly of grasses and some shrubs with thicker forested patches as the reach approaches the Jock River. Due to the unnatural alignment of the drain, a sinuosity value and the calculation of migration rates are not applicable. Top of the valley meander belt widths for the drain derived using empirical formula are 24.37 and 33.39 m for a discharge of 0.5 and 2.0 m^3/s, respectively.

The Fraser-Clarke Watercourse is located east of and parallel to Highway 416 and south of Strandherd Drive. The watercourse begins east of Borrisokane Road and enters the Jock River west of Greenbank Road. It is approximately 1900 m in length. Historically the land was predominantly agricultural which remained consistent throughout the time periods observed. After 1954, urban development increased north of the drain with the development of a subdivision located north of Strandherd Drive. As a result, the Kennedy-Burnett stormwater ditch was added and enters the Fraser-Clarke Watercourse, approximately 300 m from its confluence with the Jock River. Riparian vegetation consists mainly of grasses with few shrubs. A slight change in riparian vegetation is evident with a forested corridor located in the upstream limits of the watercourse. The watercourse is relatively straight with a sinuosity value of approximately 1.04. Although this watercourse is relatively natural, migration rates were unable to be calculated due to the small size of the channel.

The morphological characteristics of tributaries to the north of the Jock River are presented in Table 3.5.5 of the Jock River Reach 1 SWS.

Erosion Thresholds

Erosion thresholds established based on the particle size distribution of the bed materials. The critical depth and erosion threshold for the Foster Ditch are 0.35 m and 0.79 m^3/s, respectively. The parameters for the O'Keefe Drain are 0.49 m and 1.86 m^3/s respectively.

6.1.1.1.3 Hydrology and Hydraulics

The Jock River is a tributary of the Rideau River and the watershed is mainly rural, river slopes <0.5% and with some passive flow regulation. Its 556 km^2 drainage area forms roughly 15% of the Rideau River watershed. Although the Jock River carries high flows during the spring freshet, summer flows are documented to be quite low.

A number of drains and tributaries of the Jock River exist in Reach 1 and most are small-scale channels that tend to be less defined upstream with greater definition at the confluence with the Jock River. The tributaries collect runoff from areas north and south of the river and discharge into the Jock River during rain events and spring snowmelt; however, all drains dry up during summer months with the exception of some pools of water in the drains.

The tributary channels to the north of the Jock River, which are within the Barrhaven Conservancy Lands, are as follows:

- The Foster Ditch originates south of Fallowfield Road, west of Cedarview Road (now Borrisokane Road) and flows south until it converges with the Jock River South of McKenna Casey Drive. The ditch is approximately 3200 m long and has been artificially straightened. This non-municipal drain is a fish bearing tributary of the Jock River with approximately 335 ha of catchment area. The surrounding land use is urban, vacant lands. Riparian vegetation is very sparse consisting of mostly grasses with a few shrubs.
- The O'Keefe Drain is located east of and runs parallel to Highway 416. The drain extends from north of Fallowfield Road, with a small drainage area to the west of Highway 416 and enters the Jock River south of McKenna Casey Drive. The

drain is approximately 4620 m in length and had been artificially straightened to follow the depression between vacant lands. This municipal drain is a fish bearing tributary of the Jock River with approximately 531 ha of catchment area. The predominant land use of the drainage areas is agricultural. The riparian vegetation consists mainly of grasses and some shrubs with thicker forested patches as the reach approaches the Jock River.

- The Fraser-Clarke Watercourse (former Drain) is located north of the Jock River, south of Strandherd Drive. The watercourse begins east of Cedarview Road (now Borrisokane Road) and enters the Jock River west of Greenbank Road. It is approximately 1900 m in length. This watercourse is a fish bearing tributary of the Jock River with approximately 90 ha of catchment area. The predominant land use of the drainage area is vacant. With the urbanization of the lands north of the watercourse, the Kennedy-Burnett stormwater ditch was added and enters the Fraser-Clarke Watercourse, approximately 300 m from its confluence with the Jock River. Riparian vegetation consists mainly of grasses with a few shrubs. A slight change in riparian vegetation is evident with a forested corridor located at the upstream limits of the drain.

RVCA Hydrologic Model

As part of a flood risk mapping update, the RVCA updated the hydrology and hydraulics of the Jock River in 2004/2005.

Storm Drainage

Two major communities exist within the subwatershed north of the Jock River (Fallowfield Estates and the Barrhaven community). Ultimate modifications to the existing Foster Ditch and Kennedy-Burnett ponds have been identified in previous studies, with upgrades to better protect the Jock River and Rideau River.

Water Balance

As part of the Jock River Reach 1 SWS Study, a detailed water budget analysis was prepared. Marine clay is the predominant soil in the study area and, as such, based on the suggested permeability, it is shown that only a minor fraction (14%) of the proposed Barrhaven South Community will be suitable for infiltration practices due to the limited areas with sandy soil. It is further noted that the majority of the Reach is within tight-natured soils thereby limiting the recharge potential.

Natural Environment

There were no woodlots identified within Barrhaven Conservancy.

North of the Jock River, the existing Foster Ditch has been identified as fish habitat. The entire length of the O'Keefe Drain as well as a small unnamed tributary running parallel to the O'Keefe Drain were identified as fish habitat. The Fraser-Clarke Watercourse is also a fish bearing tributary, especially downstream of confluence with Kennedy-Burnett facility, the discharge from which contributes to the habitat.

6.1.1.1.4 Jock River Reach 1 – Subwatershed Objectives

The following represent the proposed combined objectives for Reach 1:

- Surface water quality
- Surface water quantity
- Aquatic communities and habitat
- Terrestrial communities and habitats
- Groundwater quality and quantity
- Sustainable land use and development
- Community education and awareness

6.1.1.1.5 Opportunities and Constraints to Development

<u>Jock River Flow and Drainage Network</u>

For the lands north of the Jock River, any proposed harmful alteration, disruption or destruction of fish habitat (HADD) would require DFO approval per the Fisheries Act. An integrated SWM planning approach consistent with the Lower Rideau Watershed Strategy will need to be demonstrated through further detailed study.

<u>Water Quality</u>

The proposed urban developments must ensure that net reduction in phosphorus loading to the Jock River is achieved through the combination of structural and non-structural BMPs.

<u>Meander Belt Width</u>

The meander belt widths are the limits to potential river migration; hence, future developments should not encroach into the meander belt width limits for the Jock River and the tributaries. Conservative meander belt widths for the tributaries north of the Jock River have been derived. Additional analysis of the meander belt width as part of detailed stormwater management planning is recommended for the tributaries.

6.1.2 Jock River and Municipal Drains Erosion Hazards

In 2018 a review of the meander belt widths and erosions threshold analyses from previous studies were completed for the Jock River and the three watercourses which cross the site (O'Keefe Drain, Foster Ditch and Fraser-Clarke Watercourse). The analysis is detailed in the ***Erosion Hazard Assessment and Erosion Threshold Analysis, Jock River, Barrhaven Conservancy*** by GEO Morphix, dated January 11, 2018 and contained in ***Appendix G***.

As discussed in the ***Erosion Hazard Assessment and Erosion Threshold Analysis***, most watercourses have a natural tendency to develop and maintain a meandering planform, provided there are no spatial constraints. A meander belt width assessment estimates the lateral extent that a meandering channel has historically occupied and will likely occupy in the future, which is useful to determine the potential limit of development for proposed activities in the vicinity of the stream.

It was noted that the watercourses within the study site are all within unconfined valley systems, which are those with poorly defined valleys or slopes well-outside where the channel could realistically migrate. The meander belt width is an important factor as it is one of the potential factors which could define the development setbacks from the watercourses.

Erosion threshold analyses were also completed for the reaches OKD1, FD1, and FCD2 to determine flow conditions under which channel bed and bank materials can potentially be entrained and transported. Erosion thresholds are established to provide targets for any of the stormwater management facilities or oil and grit separators which may discharge to the watercourses. This will ensure that post-development erosion rates into the receiving watercourses do not exceed natural pre-development rates.

6.1.2.1 Jock River

The Jock River meander belt widths within the ***Jock River SWS*** were reviewed to assess suitability. The meander belt widths for reaches JR-3 and JR-4 are 218 and 231 m, respectively, which includes a 10% buffer. GEO Morphix noted that they were generally in agreement with the scale of the meander belt widths. They further note that the general tendency of the watercourse generally follows the overall trend of the channel passing through riffles or runs. GEO Morphix recommended a minor refinement for the downstream reach, JR-2, as the geologic feature at Half Moon Bay is not technically a meander. The proposed meander belt for reach JR-2 is 150 m, which is smaller than that proposed in the ***Jock River SWS***.

As noted in the ***Jock River SWS***, the setback from the watercourse is to be the greatest setback limit of the following environmental factors: 1) regulatory floodplain; 2) meander belt width; 3) aquatic setback limit of 15 m from top-of-bank or 30 m from normal high water marks, whichever is greater; and 4) slope stability. In most areas along the Jock River, the greater setback requirement is defined by the regulatory floodplain or the meander belt width.

6.1.2.2 O'Keefe Drain

As noted in the ***Erosion Hazard Assessment and Erosion Threshold Analysis***, the meander belt width for reaches OKD1 and OKD2 is 34 m and 32 m, respectively.

As noted in the ***Jock River SWS***, to ensure protection of the aquatic habitat north of the Jock River, a development setback should be provided for all of the tributaries. Further studies will determine the development setback, which will be the greater of: 1) regulatory floodplain; 2) meander belt width; and 3) aquatic setback, whichever is greater.

As detailed in the GEO Morphix study, the critical discharge of the bed and bank materials for the O'Keefe Drain at reach OKD1 is 0.80 m^3/s.

6.1.2.3 Foster Ditch

As noted in the ***Erosion Hazard Assessment and Erosion Threshold Analysis***, the meander belt width for reaches FD1, FD 2 and FD3 is 32 m for all three. It is noted that since the Foster Ditch was previously ditched, the bankfull dimensions are compromised. Therefore, GEO Morphix completed a detailed assessment was completed at reach FD1, which has more accurate bankfull dimension measurements. The calculated meander belt width for reach FD1 is used for reaches FD2 and FD3.

As noted in the ***Jock River SWS***, to ensure protection of the aquatic habitat north of the Jock River, a development setback should be provided for all of the tributaries. Further studies will determine the// development setback, which will be the greater of: 1) regulatory floodplain; 2) meander belt width; and 3) aquatic setback, whichever is greater.

As detailed in the GEO Morphix study, the critical discharge of the bed and bank materials for the Foster Ditch at reach FD1 is 0.68 m^3/s.

6.1.2.4 Fraser-Clarke Watercourse

As noted in the ***Erosion Hazard Assessment and Erosion Threshold Analysis***, the Fraser-Clarke Watercourse, reaches FCD2 and FCD3, consisted of a wetland feature with no channel centerline. Therefore, there is no erosion hazard associated with these features and the same applies to the swale features for reaches FCD3-1, FCD3-2, and FCD5.

As noted in the ***Jock River SWS***, to ensure protection of the aquatic habitat north of the Jock River, a development setback should be provided for all of the tributaries. Further studies will determine the development setback, which will be the greater of: 1) regulatory floodplain; 2) meander belt width; and 3) aquatic setback, whichever is greater.

As detailed in the GEO Morphix study, the critical discharge of the bed and bank materials for the Fraser-Clarke Watercourse at reach FCD2 is 0.33 m^3/s.

6.2 Proposed Stormwater Management Strategy

Stormwater flows will be conveyed through the subject property via an underground sewer network. The stormwater runoff will be treated to provide an Enhanced Level of Protection (80% TSS removal) before ultimately being released into the Jock River as per the ***Jock River Reach 1 SWS***.

6.2.1 Stormwater Management Servicing Alternatives

The proposed stormwater management design is shown on ***Drawing 3***. Several stormwater alternatives were considered for the drainage areas, while determining the optimal strategy.

<u>Alternative 1 – Oil and Grit Separators to Naturalized Wetlands</u>

In this alternative, the stormwater management design consists of:

- A storm sewer system designed to capture at least the minimum design capture events in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01);
- Multiple oil and grit separators (OGS) designed to provide an Enhanced Level of Protection per MECP guidelines, via treatment of the stormwater captured by the storm sewer network;
- Oil and grit separators will discharge to naturalized wetlands within the flood plain, where additional quality treatment is provided prior to discharge to the Jock River;
- Inverts of outlets of oil and grit separators (OGS) are set at, or above, the 2-year summer water levels of the Jock River with a bypass design for the 100-year storm event;
- An on-site road network designed to maximize the available surface storage within ROWs for the 100-year design event; where possible, with controlled release of stormwater to the minor storm sewer system;
- An overland flow route designed to safely convey stormwater runoff flows in excess of the on-site road storage to the desired outlets;
- Quantity control is not required for the Jock River; however, the quantity of stormwater runoff existing from the subject property is to be minimized by optimizing on-site storage in the sags of the proposed road network, which in turn minimizes the size of downstream storm sewer infrastructure.

- This alternative provides a treatment train consisting OGS units discharging to naturalized wetlands within the floodplain prior to discharging to the Jock River. The implementation of OGS units has been used increasingly within Ottawa. Multiple OGS units have been proposed in order to maintain smaller storm sewer sizes, minimize standing water and keep grades low due to the presence of sensitive clay and the associated grade raise restrictions. The proposed grades will be set at a minimum of 0.50 m above the 100-year floodplain elevation. Although the OGS units can be subject to head losses, the design will include a bypass for the 100-year flow such that the head losses are negligible in the 100-year storm.
- It is expected that the OGS units will require straightforward maintenance via mobile vacuum truck units, being cleaned out regularly as part of the routine City maintenance program, as compared to traditional stormwater management ponds which requires the mobilization of heavy equipment and dedicated sediment management land areas for the handling (dewatering) of sediments removed.

With this alternative, the existing drains/watercourses will not be an outlet for the stormwater flows and will remain in their natural state, with recommended setbacks implemented for surrounding development.

<u>Alternative 2 – Stormwater Management Wetland Facilities in the Floodplain</u>

In this alternative, the stormwater management design consists of:

- A storm sewer system designed to capture at least the minimum design capture events in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01);
- Multiple Stormwater Management (SWM) Wetland facilities in the floodplain, designed to provide Enhanced Level of Protection per MECP guidelines, via treatment of the stormwater captured in the storm sewer network;
- An on-site road network designed to maximize the available storage in the on-site road network for the 100-year design event, where possible, with controlled release of stormwater to the minor storm system; and,
- An overland flow route designed to safely convey stormwater runoff flows in excess of the on-site road storage.
- Quantity control is not required for the Jock River; however, the quantity of stormwater runoff exiting from the subject property is to be minimized by optimizing on-site storage in the sags of the proposed road network, which in turn minimizes the size of downstream storm sewer infrastructure.

This alternative provides separate stormwater management wetland facilities within the regulatory floodplain with the provision of traditional forebays. Multiple facilities have been proposed in order to maintain smaller storm sewer sizes, minimize standing water and keep grades low due to the presence of sensitive clay and the associated grade raise restrictions. The multiple facilities impose additional maintenance requirements. Although this is an efficient use of land for the facilities themselves, any required sediment management areas would have to be outside of the floodplain area as is typically desired by the City of Ottawa. Additional challenges are encountered when proposing infrastructure within the floodplain.

With this alternative, it is anticipated that there would be minimal standing water within the proposed storm sewers.

With this alternative, the existing drains/watercourses will not be an outlet for the stormwater flows and will remain in their natural state, with recommended setbacks implemented for surrounding development.

<u>Alternative 3 – Stormwater Management Wetland Facilities outside of the Floodplain</u>

In this alternative, the stormwater management design consists of:

- A storm sewer system designed to capture at least the minimum design capture events in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01);
- Multiple Stormwater Management (SWM) facilities, designed to provide Enhanced Level of Protection per MECP guidelines, via treatment of the stormwater captured in the storm sewer network;
- An on-site road network designed to maximize the available storage in the on-site road network for the 100-year design event, where possible, with controlled release of stormwater to the minor storm system; and,
- An overland flow route designed to safely convey stormwater runoff flows in excess of the on-site road storage.
- Quantity control is not required for the Jock River; however, the quantity of stormwater runoff exiting from the subject property is to be minimized by optimizing on-site storage in the sags of the proposed road network, which in turn minimizes the size of downstream storm sewer infrastructure.

This alternative provides multiple traditional stormwater management facilities and dedicated sediment management areas situated outside of the regulatory floodplain. Multiple facilities have been proposed in order to maintain smaller storm sewer sizes, minimize standing water and keep grades low due to the presence of sensitive clay and the associated grade raise restrictions. This option is the least efficient use of developable land and creates multiple facilities requiring extensive maintenance requirements.

As with the other alternatives, it is anticipated that there would be minimal standing water within the proposed storm sewers. Multiple stormwater management facilities would have a significant impact on efficient land usage.

With this alternative, the existing drains/watercourses will not be an outlet for the stormwater flows and will remain in their natural state, with recommended setbacks implemented for surrounding development.

Recommended Alternative

The recommended alternative is Alternative 1, where there are several OGS units discharging to naturalized wetlands and the Jock River. This is determined to provide the best treatment strategy for the stormwater, prior to release to the Jock River. While providing the best treatment strategy, it also presents an efficient use of land and conservation of the existing drains/watercourse in their natural state.

The OGS units will require regular, simple maintenance that will be greatly reduced compared to the maintenance requirements of multiple stormwater management facilities. This strategy will be desirable to the City of Ottawa from a maintenance perspective. To enhance the treatment, the OGS units will discharge to naturalized wetlands within the floodplain. The naturalized wetlands will have minimal stormwater management function and are expected to be low maintenance.

Head losses through the units are negligible during the 100-year storm as they will be designed with a bypass for the 100-year storm. Multiple units are proposed in order to minimize storm sewer size, standing water within the sewers, the reliance on sump pumps for foundation drainage and to keep the grades as low as possible, which is important due to the presence of sensitive clays and associated grade raise restrictions.

For the remainder of this document, it is assumed that the recommended Alternative 1 is to be implemented.

6.3 Post-Development Stormwater Management Targets

Stormwater management requirements for the proposed alternative Stormwater management scheme have been adopted from the ***Jock River Reach 1 Subwatershed SWS***, City of Ottawa ***Sewer Design Guidelines*** and the ***MECP SWMP Manual***.

Given the general criteria mentioned above, the following specific standards are applied for stormwater management within the subject property:

- Enhanced quality treatment will be provided for stormwater runoff from the subject property, corresponding to a long-term average Total Suspended Solid removal efficiency of 80%, as defined by the MECP prescribed treatment levels.

- Downstream receiving watercourses will be assessed for responses to planned stormwater management outflows, and stabilization mitigation measures will be planned as required.
- Storm sewers on local roads are to be designed to provide at least a 2-year level of service without any ponding per the City's latest Technical Bulletin PIEDTB-2016-01.
- Storm sewers on collector roads are to be designed to provide at least a 5-year level of service without any ponding per the City's latest Technical Bulletin PIEDTB-2016-01.
- For less frequent storms (i.e. larger than 2-year or 5-year), the minor system sewer capture will be restricted with the use of inlet control devices to prevent excessive hydraulic surcharges.
- Under full flow conditions, the allowable velocity in storm sewers is to be no less than 0.80 m/s and no greater than 6.0 m/s.
- For the 100-year storm and for all roads, the maximum depth of water (static and/or dynamic) on streets, rear yards, public space and parking areas shall not exceed 0.35 m at the gutter.
- The major system shall be designed with sufficient capacity to allow the excess runoff of a 100-year storm to be conveyed within the public ROW or adjacent to the right-of-way provided that the water level must not touch any part of the building envelope, must remain below all building openings during the stress test event (100-year + 20%), and must maintain 15 cm vertical clearance between spill elevation on the street and the ground elevation at the nearest building envelope.
- Flow across road intersections shall not be permitted for minor storms (generally 5-year or less).
- When catch basins are installed in rear yards, safe overland flow routes are to be provided to allow the release of excess flows from such areas. A minimum of 30 cm of vertical clearance is required between the rear yard spill elevation and the ground elevation at the adjacent building envelope.
- The product of the maximum flow depths on streets and maximum flow velocity must be less than 0.60 m^2/s on all roads.

6.3.1 Quality Control

Per the ***Jock River Reach 1 SWS***, prior to discharge to the Jock River, quality treatment of stormwater runoff from the subject property is to be provided to meet the MECP Enhanced Protection criteria, corresponding to a long-term average Total Suspended Solid removal efficiency of 80%.

6.3.2 Quantity Control

As noted in the ***Jock River SWS***, quantity control is not required for the Jock River; however, some quantity control may be provided by erosion storage, as erosion thresholds for any watercourses/outlets will be respected where required.

6.4 Stormwater Management Designs

The preferred stormwater management approach is comprised of multiple oil and grit separators (OGS) throughout the site, discharging to the Jock River via naturalized wetlands. By way of an MECP Certificate of Technology Assessment and manufacturer's design report, the OGS units must prove compliance with Enhanced Level of Protection requirements, with specific drainage area parameters for each area.

The manufacturer's reported efficiency of TSS removal of the oil/grit separator is expected to be based on a 'fine distribution' particle size distribution in conformance with ***Table 5*** below, unless otherwise approved by DSEL, City of Ottawa, RVCA, and MECP. The particle size distribution in ***Table 6*** is the generic particle size distribution accepted by the City of Toronto per the *Wet Weather Flow Management Guidelines* (City of Toronto, 2006) as a typical average stormwater particle size distribution, and is an excerpt from Table 3.3 of the *Stormwater Management Practices Planning and Design Manual* (MOECC, 1994).

Table 6: Typical Stormwater Particle Size Distribution & Settling Velocities (Source: *Stormwater Management Practices Planning and Design Manual,* MOECC, 1994)

Particle Size (microns) (NURP 1983)	% of Particle Mass	Average Settling Velocities (m/s)
< 20	0 - 20	0.00000254
20 - 40	20 - 30	0.00001300
40 - 60	30 - 40	0.00002540
60 - 130	40 - 60	0.00012700
130 - 400	60 - 80	0.00059267
400 - 4000	80 - 100	0.00550333

To allow for flexibility as detailed design advances, it is proposed that any OGS unit can be selected, given that it:

- Meets the requirements set out in Section 6.3 – 6.4;
- Ensures no significant negative impact on the upstream storm sewer system – to be determined via hydraulic modelling at detailed design; and

- Demonstrates suitability for meeting Enhanced water quality targets via a MECP Certificate of Technology Assessment.

The preliminary OGS units proposed in the ***Table 7*** have been sized to treat the stormwater runoff for the tributary areas noted in order to meet MECP Enhanced Level of Protection criteria prior to discharge to the Jock River via naturalized wetlands as shown on ***Drawing 3***. The OGS total suspended solids removal rates and unit details have been attached for reference in ***Appendix H***.

Table 7: OGS Unit ID and Design Characteristics

Area and Unit ID (2)	Drainage Area Target (ha)	Estimated Weighted C Value	Unit Treatment Capacity (L/s)	Unit Model (1)
Area 1 – OGS1	6.24	0.65	170	CDS Model 4040
Area 2 – OGS2	5.82	0.65	170	CDS Model 4040
Area 3 – OGS3	2.63	0.65	68	CDS Model 3025
Area 4 – OGS4	6.66	0.65	170	CDS Model 4040
Area 5 – OGS5	8.66	0.65	255	CDS Model 5640
Area 6 – OGS6	5.92	0.65	170	CDS Model 4040
Area 7 – OGS7	9.30	0.65	396	CDS Model 5653
Area 8 – OGS8	5.42	0.65	170	CDS Model 4040
Area 9 – OGS9	4.18	0.65	108	CDS Model 3035
Area 10 – OGS10	3.91	0.65	108	CDS Model 3035
Area 11 – OGS 11	4.50	0.65	127	CDS Model 4030
Area 12 – OGS 12	11.11	0.65	396	CDS Model 5653
Area 13 – OGS 13	8.22 ha	0,65	212	CDS Model 4045
Area 14 – OGS 14	6.91	0.65	170	CDS Model 4045
Area 15 – OGS 15	6.39	0.65	170	CDS Model 4040
Area 16 – OGS 16	4.72	0.65	127	CDS Model 4030

(1) Providing at minimum 80% TSS removal
(2) See ***Drawing 3*** for OGS unit locations

6.5 Proposed Minor System

The subject property will be serviced by an internal gravity storm sewer system that will generally follow the local road network and proposed servicing easements. The internal gravity storm sewer will be conveyed to the proposed OGS units, which discharge to naturalized wetlands and ultimately to the Jock River.

Street catch basins will collect drainage from the streets and front yards, while rear yard catch basins will capture drainage from backyards. Perforated catch basin leads will be provided in rear yards, except the last segment where it connects to the right-of-way which will be solid pipe, per current City standards.

The preliminary rational method design of the minor system captures drainage for storm events up to and including the 2-year (local), 5-year (collector) and 10-year (arterial) event assuming the use of inlet control devices (ICD) for all catch basins within the subject property. ***Table 8*** summarizes the standards that will be employed in the detailed design of the storm sewer network, meeting the requirements in ***Section 6.3***. The drainage area plans and rational method design sheets are provided in ***Appendix H***.

Table 8: Storm Sewer Design Criteria

Design Parameter	Value
Minor System Design Return Period	1:2 year (PIEDTB-2016-01) for local roads, without ponding 1:5 year (PIEDTB-2016-01) for collector roads, without ponding 1:100 year (PIEDTB-2016-01) for arterial road, without ponding
Major System Design Return Period	1:100 year
Intensity Duration Frequency Curve (IDF) 2-year storm event: A=732.951 | B=6.199 | C=0.810 5-year storm event: A = 998.071 | B = 6.053 | C = 0.814	$i = \frac{A}{(t_c + B)^C}$
Minimum Time of Concentration	10 minutes
Rational Method	$Q = CiA$
Storm sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} AR^{2/3} S^{1/2}$
Runoff coefficient for paved and roof areas	0.9
Runoff coefficient for landscaped areas	0.2
Minimum Sewer Size	250 mm diameter
Minimum Manning's 'n' for pipe flow	0.013
Minimum Depth of Cover	1.5 m from crown of sewer to grade
Minimum Full Flowing Velocity	0.8 m/s
Maximum Full Flowing Velocity	6.0 m/s
Clearance from 100-Year Hydraulic Grade Line to Building Opening	0.30 m
Max. Allowable Flow Depth on Municipal Roads	35 cm above gutter (PIEDTB-2016-01)
Extent of Major System	To be contained within the municipal right-of-way or adjacent to the right-of-way provided that the water level must not touch any part of the building envelope and must remain below the lowest building opening during the stress test event (100-year + 20%) and 15cm vertical clearance is maintained between spill elevation on the street and the ground elevation at the nearest building envelope (PIEDTB-2016-01)
Stormwater Management Model	DDSWMM (release 2.1), SWMHYMO (v. 5.02) and XPSWMM (v. 10)
Model Parameters	Of = 76.2 mm/hr, Fc = 13.2 mm/hr, DCAY = 4.14/hr, D.Stor.Imp. = 1.57 mm, D.Stor.Per. = 4.67 mm
Imperviousness	Based on runoff coefficient (C) where Percent Imperviousness = (C - 0.2) / 0.7 x 100%.
Design Storms	Chicago 3-hour Design Storms and 24-hour SCS Type II Design Storms. Maximum intensity averaged over 10 minutes.
Historical Events	July 1st, 1979, August 4th, 1988 and August 8th, 1996
Climate Change Street Test	20% increase in the 100-year, 3-hour Chicago storm

Extracted from City of Ottawa Sewer Design Guidelines, October 2012, and ISSU, based on recent residential subdivisions in City of Ottawa.

The peak design flows are calculated based on an average predicted runoff coefficient (C-value) of 0.67 and 0.75 for the development areas and 0.25 for the grassed areas. As detailed design progresses, the runoff coefficients will be refined to reflect the proposed building envelopes, driveways and other details.

There are several trunk sewers proposed and the peak flows are described for the trunk sewers which correspond to the stormwater management design areas as presented in ***Table 9***:

Table 9: Minor System Trunk Sewer Outlets

Area	OGS Unit	Trunk Sewer Outlet to OGS	Peak Flow (L/s)
1	OGS 1	900 mm diameter @ 0.15%	612
2	OGS 2	900 mm diameter @ 0.15%	595
3	OGS 3	675 mm diameter @ 0.15%	264
4	OGS 4	975 mm diameter @ 0.15%	641
5	OGS 5	1050 mm diameter @ 0.15%	820
6	OGS 6	900 mm diameter @ 0.15%	571
7	OGS 7	1050 mm diameter @ 0.25%	1363
8	OGS 8	900 mm diameter @ 0.20%	659
9	OGS 9	825 mm diameter @ 0.15%	421
10	OGS 10	825 mm diameter @ 0.15%	408
11	OGS 11	825 mm diameter @ 0.15%	382
12	OGS 12	1050 mm diameter @ 0.20%	1066
13	OGS 13	1050 mm diameter @ 0.20%	689
14	OGS 14	975 mm diameter @ 0.15%	409
15	OGS 15	1050 mm diameter @ 0.20%	763
16	OGS 16	975 mm diameter @ 0.15%	258

The storm sewers tributary to the OGS units and associated peak flows are detailed in the rational method design sheet, enclosed in ***Appendix H***.

The peak design flows are calculated based on an average predicted runoff coefficient (C-value) of 0.65 for the development areas and 0.40 for the grassed areas. As detailed design progresses, the runoff coefficients will be refined to reflect the proposed building envelopes, driveways and other details.

The preliminary *Conceptual Servicing Plan* is shown on ***Drawing 2*** in ***Drawings***. As detailed design progresses, alignments and sizing of local storm sewers will be confirmed and additional servicing easements may be required, which may trigger amendments to the proposed lot fabric in the concept plan. The preliminary sanitary and storm trunk plan and profiles are shown on ***Drawing 5***, ***Drawing 6*** and ***Drawing 7*** in ***Drawings***.

6.6 Hydraulic Grade Line Analysis

A detailed hydraulic gradeline (HGL) modelling analysis will be completed for the proposed system at the detailed design level, based on the 100-year 3-hour Chicago, 12-hour SCS, and 24-hour SCS design storms, including climate change stress test, as required. Detailed grading design and storm sewer design will be modified as required to achieve the freeboard requirements set out in ***Section 5.3*** (per PIEDTB-2016-01).

6.7 Proposed Major System

Major system conveyance, or overland flow (OLF), will be provided to accommodate flows in excess of the minor system capacity. OLF is accommodated by generally storing stormwater up to the 100-year design event in road sags then routing additional surface flow along the road network and service easements towards the proposed naturalized wetlands, discharging to the Jock River, as shown on ***Drawing 1*** in ***Drawings***.

The grading design described shown on ***Drawing 1*** includes a saw-toothed-road design with 0.10 % minimum grade from highpoint to highpoint, in order to maximize available surface storage for management of flows up to the 100-year design event where possible.

Given the elements above, the proposed drainage systems are expected to safely capture and convey all storms up to and including the 100-year event in accordance with the requirements of the City Standards.

6.8 Proposed Grading and Foundation Drainage

A site grading scheme has been developed to optimize earthworks and provide major system conveyance to the receiving outlets – the proposed SWM wetland facilities, which outlet to the existing Jock River drainage network. The proposed grading plan can be seen on ***Drawing 1*** in ***Drawings***.

Paterson completed geotechnical investigations for the subject site, east lands and west lands as follows:

- Geotechnical Investigation – Conservancy Lands East (Paterson Group, September 24, 2019); and
- Geotechnical Investigation – Conservancy Lands West (Paterson Group, September 27, 2019)

The geotechnical conditions are described in detail in ***Section 3.1.*** For the Barrhaven Conservancy Lands east, the grade raise restriction varies between 1.4 m and 2.2 m. For the Barrhaven Conservancy Lands West, the grade raise restriction varies between

1.2 m to 1.8 m. Paterson's permissible grade raise plans are contained in ***Appendix B*** for reference. At the time of detailed design, detailed review and signoff by a licensed Geotechnical Engineer will be required.

The following additional grading criteria and guidelines will be applied to detailed design, per ***City of Ottawa Guidelines***:

- Driveway slopes will have a maximum slope of 6%;
- Grading in grassed/landscaped areas to range from 2% to 3:1, with terracing required for slopes larger than 7%;
- Swales are to be 0.15m deep with 3:1 side slopes unless otherwise indicated on the drawings; and,
- Perforated pipe will be required for drainage swales if they are less than 1.5% in slope.

6.8.1 Sump Pumps

Due to the grade raise restrictions and the proposed storm and sanitary drainage schemes, the road centerlines do not allow for standard basements with a gravity connection to the storm sewer system. Because of the constraints on the subject property, sump pumps are proposed for all residential blocks and residential lots.

The City of Ottawa issued Technical Bulletin *ISTB-2018-04* and *2019-02* for the amendment of the *Ottawa Design Guidelines – Sewer, Second Edition,* October 2012 with respect to the screening criteria for the use of sump pump systems for foundation drainage in Greenfield developments on sites with clay soils. Similar to the development of Conservancy Phase 1, the Conservancy East site has also been assessed as meeting the required criteria for the use of sump pumps.

One of the screening criteria is with respect to the hydraulic grade line (HGL) for the development wherein the system should be reviewed to demonstrate that the HGL cannot reasonably be lowered any further due to outlet restrictions. The site grading is constrained by the close proximity of the Jock River, which is the receiver of stormwater outflows, and is also constrained by grade raise restrictions for the property.

For the Barrhaven Conservancy Lands east, the grade raise restriction varies between 1.4 m and 2.2 m. For the Barrhaven Conservancy Lands west, the grade raise restriction varies between 1.2 m to 1.8 m. Paterson's permissible grade raise plans are contained in ***Appendix B*** for reference. Further investigation of site and potential surcharging or lightweight fill (LWF) underneath garages could increase the permissible grade raise and is being investigated further.

The functional grading plan for the subdivision have been prepared with the grade raise restrictions in mind, with grades being kept as low as possible.

The proposed centerline of road grades, and subsequently the house grades, do not allow for standard basements with a gravity connection to the storm sewer system. As such, the subdivision will be serviced entirely by sump pumps due to site constraints imposed by grade raise restrictions, HGL elevations and the proximity to the Jock River stormwater outlet.

6.9 Infiltration

The following Low Impact Development techniques should be considered for implementation, where possible, as part of detailed design:

- Rear-yard swales should be designed with minimum grades where possible, to promote infiltration;
- Rear-yard catchbasin leads should be perforated (except for the last segment connecting to the storm sewer within the right-of-way), to promote infiltration; and,
- Where eavestroughs are provided on residential units, they are to be directed to landscaped surfaces, to promote infiltration.
- Furthermore, the following techniques can be examined as part of detailed landscaping design of the park block:
- Amended topsoil (minimum 300mm thick) can be considered for use;
- Micro-grading can be considered to promote infiltration; and
- Although Best Management Practices (BMPs) should be implemented, where feasible, the site is not conducive for infiltration based on the soil type being predominantly marine clay with limited sandy soil. This was stated in the Jock River Reach 1 SWS, summarized in ***Section 6.1.1.1.2 – Water Balance*** of this report.

6.10 Stormwater Servicing Conclusions

The stormwater runoff is designed to be captured by an internal gravity sewer system, conveying flows to multiple OGS units for quality control treatment. An Enhanced Level of Protection will be provided for stormwater runoff from the subject property before being discharged to the Jock River via naturalized wetlands. Quantity control is not required for the Jock River. Notwithstanding, some quantity control by means of erosion storage will be included.

A detailed Hydraulic Grade Line (HGL) modelling analysis will be completed for the proposed system at the detailed design level. Due to the grade raise restrictions and the proposed storm and sanitary drainage schemes, the road centerlines do not allow for standard basements with a gravity connection to the storm sewer system. As such, because of the constraints on the subject property, sump pumps are proposed to be installed for all residential blocks and residential lots.

7.0 UTILITIES

Utility services extending to the site may require connections to multiple existing infrastructure points: consultation with Enbridge gas, Hydro Ottawa, Rogers, and Bell is required as part of the development process to confirm the servicing plan for the subject lands.

8.0 EROSION AND SEDIMENT CONTROL

Soil erosion occurs naturally and is a function of soil type, climate and topography. The extent of erosion losses is exaggerated during construction where vegetation has been removed and the top layer of soil becomes agitated.

Erosion and sediment controls are currently in place will be monitored and maintained throughout construction.

The following specific recommendations to the Contractor will be included in contract documents.

- Limit extent of exposed soils at any given time.
- Re-vegetate exposed areas as soon as possible.
- Minimize the area to be cleared and grubbed.
- Protect exposed slopes with plastic or synthetic mulches.
- Install silt fence to prevent sediment from leaving the site and entering existing watercourses, and clean and maintain throughout construction.
- Install catchbasin inserts during construction to protect from silt entering the storm sewer system.
- Install mud mat in order to prevent mud tracking onto adjacent roads.
- No refueling or cleaning of equipment near existing watercourses.
- No material stockpiles within 30 m of existing watercourses, unless otherwise permitted by RVCA and City of Ottawa.
- Provide sediment traps and basins during dewatering.
- Plan construction at proper time to avoid flooding.
- The Contractor will, at every rainfall, complete inspections and guarantee proper performance.
- Erosion and sediment control will remain in place until the working areas have been stabilized and re-vegetated.

9.0 CONCLUSIONS AND RECOMMEDATIONS

This Master Infrastructure Review (MIR) provides historical background information regarding the servicing of the subject property and presents servicing options explored while determining the recommended servicing strategy. Sufficient detail is provided to demonstrate that the development of the subject property will be adequately supported by municipal services and demonstrate how the municipal services will conform to current guidelines and design criteria. The conclusions from this report are as follows:

- Paterson Group has completed geotechnical investigations of the site and has noted that the site is subject to grade raise restrictions varying from 1.4 m to 2.2 m.

- The development area is outside of the Jock River 100-year limit as confirmed by the Rideau Valley Conservation Authority (RVCA).

- The recommended water servicing preferred option of those evaluated is to connect through the Nepean Town Centre development area to Zone SUC, which has recently been upgraded. The watermains are recommended to extend along the future Chapman Mills Drive extension and through the Claridge “Burnett Lands” development area.

- Detailed modelling at the designed design stage will confirm phasing of the extensions of trunk watermains and sizing of the local watermain network. The proposed water design supply is to conform to all relevant City and MECP Guidelines and Policies.

- Sanitary service will be provided to the subject property via the off-site South Nepean Collector (SNC) trunk sanitary sewer. A new sanitary pump station is proposed, west of the Foster Ditch, where the sanitary trunk sewer is constrained by the bottom of ditch elevation. With the inclusion of the subject property, the SNC sanitary sewer can adequately handle the entirety of the subject properties proposed sanitary flows.

- Stormwater service is to be provided by capturing stormwater runoff by an internal gravity sewer system that is to convey flows to multiple OGS units for quality control treatment. An Enhanced Level of Protection will be provided for stormwater runoff from the subject property before being discharged to the Jock River via constructed wetlands. Quantity control is not required for the Jock River. Notwithstanding, some quantity control by means of erosion storage will be included.

- The storm outlets will be set at, or above, the 2-year summer water level and bypasses will be provided for the 100-year rain on snow event for the Jock River.

- A detailed Hydraulic Grade Line (HGL) modelling analysis will be completed for the proposed system at the detailed design level. Due to the grade raise restrictions and the proposed storm and sanitary drainage schemes, the road centerlines do not allow for standard basements with a gravity connection to the storm sewer system. As such, because of the constraints on the subject property, sump pumps are proposed to be installed for all residential blocks following City of Ottawa guidelines.

- Erosion and sediment control measures will be implemented and maintained throughout construction. The Jock River and all municipal drains/watercourses will be projected from any negative impacts from during construction.

- The proposed servicing and grading plans are expected to meet all City, RVCA, and MECP requirements as set out in background studies and current standards.

Prepared by,
David Schaeffer Engineering Ltd.

LICENSED PROFESSIONAL ENGINEER
J. AILEY
100079299
2020/07/31
PROVINCE OF ONTARIO

Per: Jennifer Ailey, P.Eng.

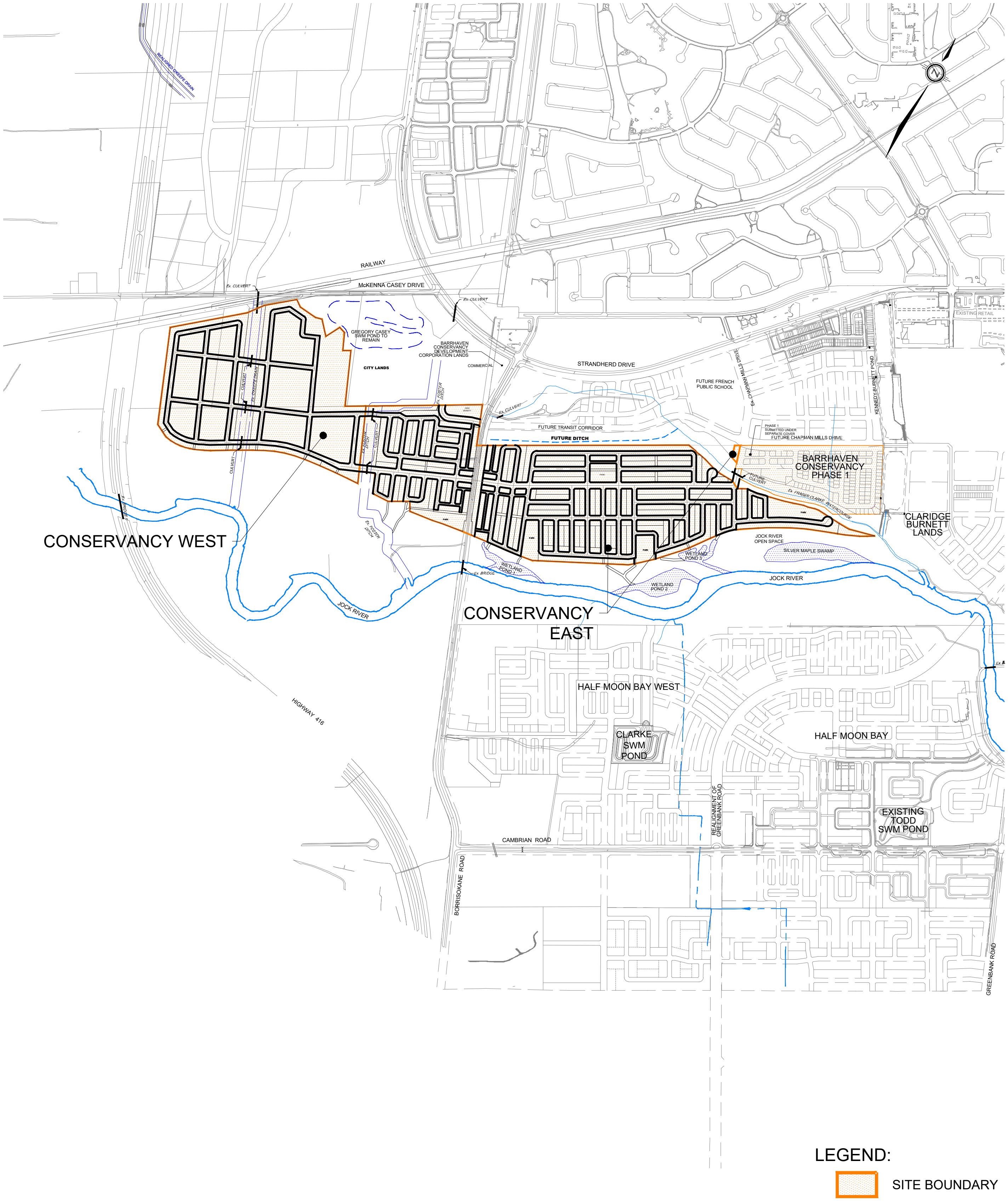
Reviewed by,
David Schaeffer Engineering Ltd.

LICENSED PROFESSIONAL ENGINEER
K.L. MURPHY
90475369
July 31/20
PROVINCE OF ONTARIO

Per: Kevin L. Murphy, P.Eng.

Z:\Projects\16-891_Barrhaven_Conservancy_East_Inc\B_Design\B3_Reports\B3-2_Servicing (DSEL)\2020-07-30_891_MIR\2020-07-30_barrhaven_conservancy_1st_submission.doc

FIGURES & DRAWINGS



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FAX: (613) 836-7183
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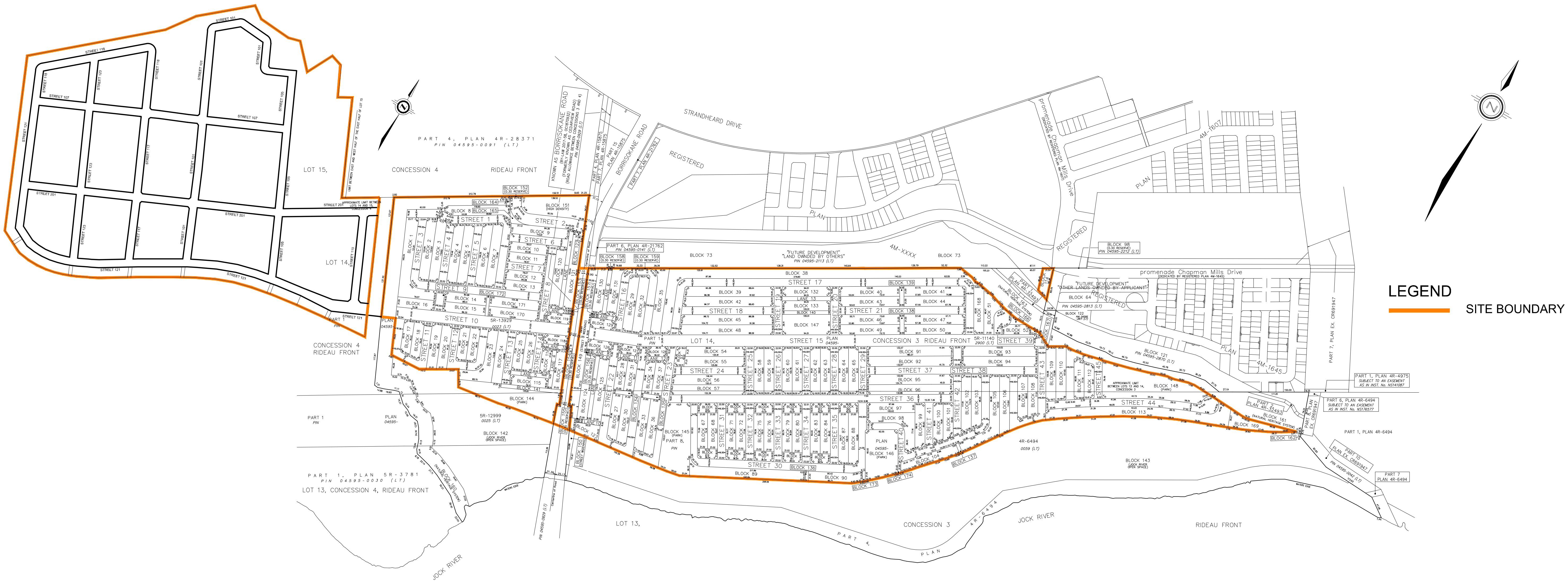
BARRHAVEN CONSERVANCY

KEY PLAN

CITY OF OTTAWA

DATE:	JUNE 2020
SCALE:	1:20000
PROJECT No.:	16-891
FIGURE:	1



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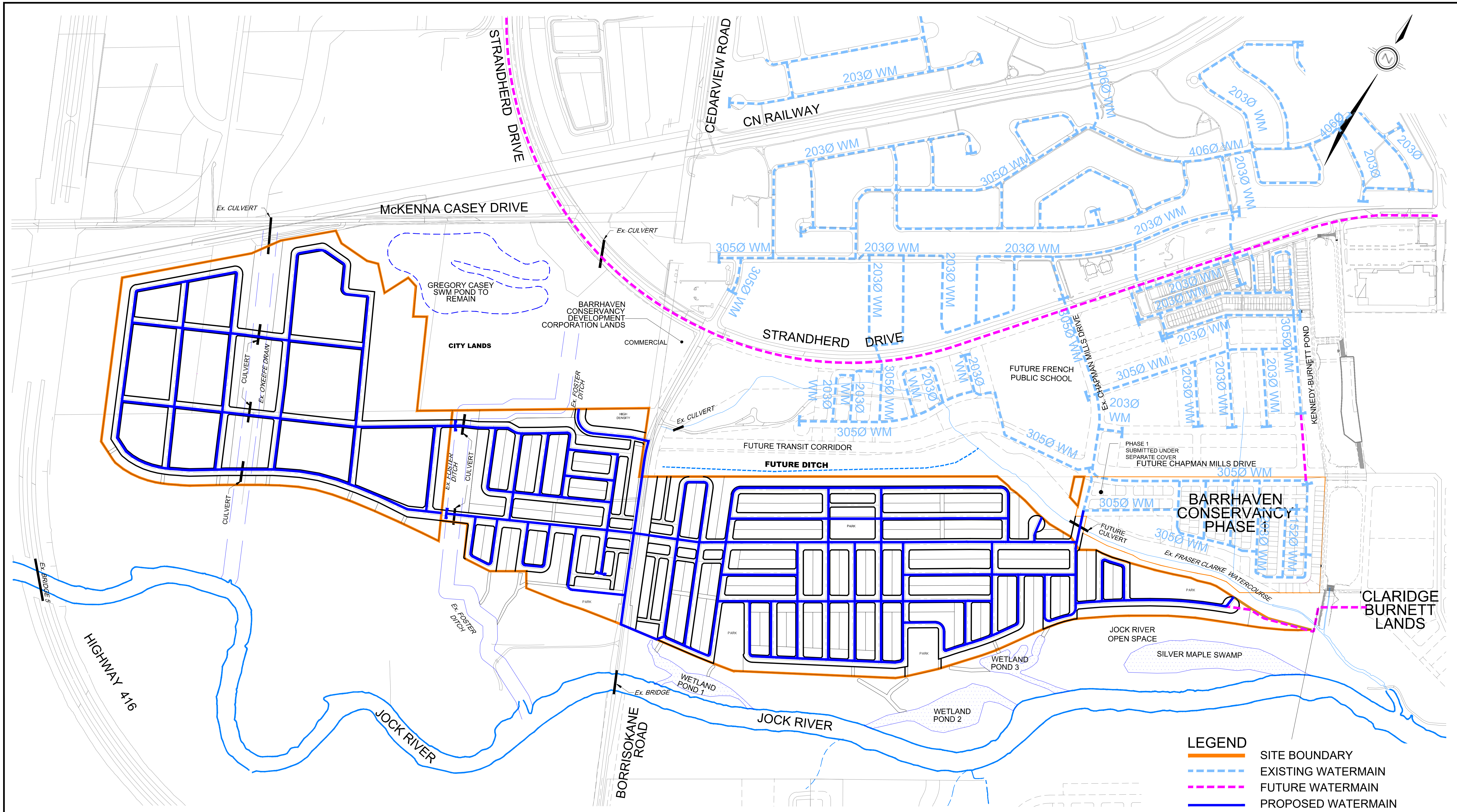
BARRHAVEN CONSERVANCY
SUBDIVISION PLAN
CITY OF OTTAWA

PROJECT No.:	16-891
SCALE:	NTS
DATE:	JULY 2020
FIGURE:	2



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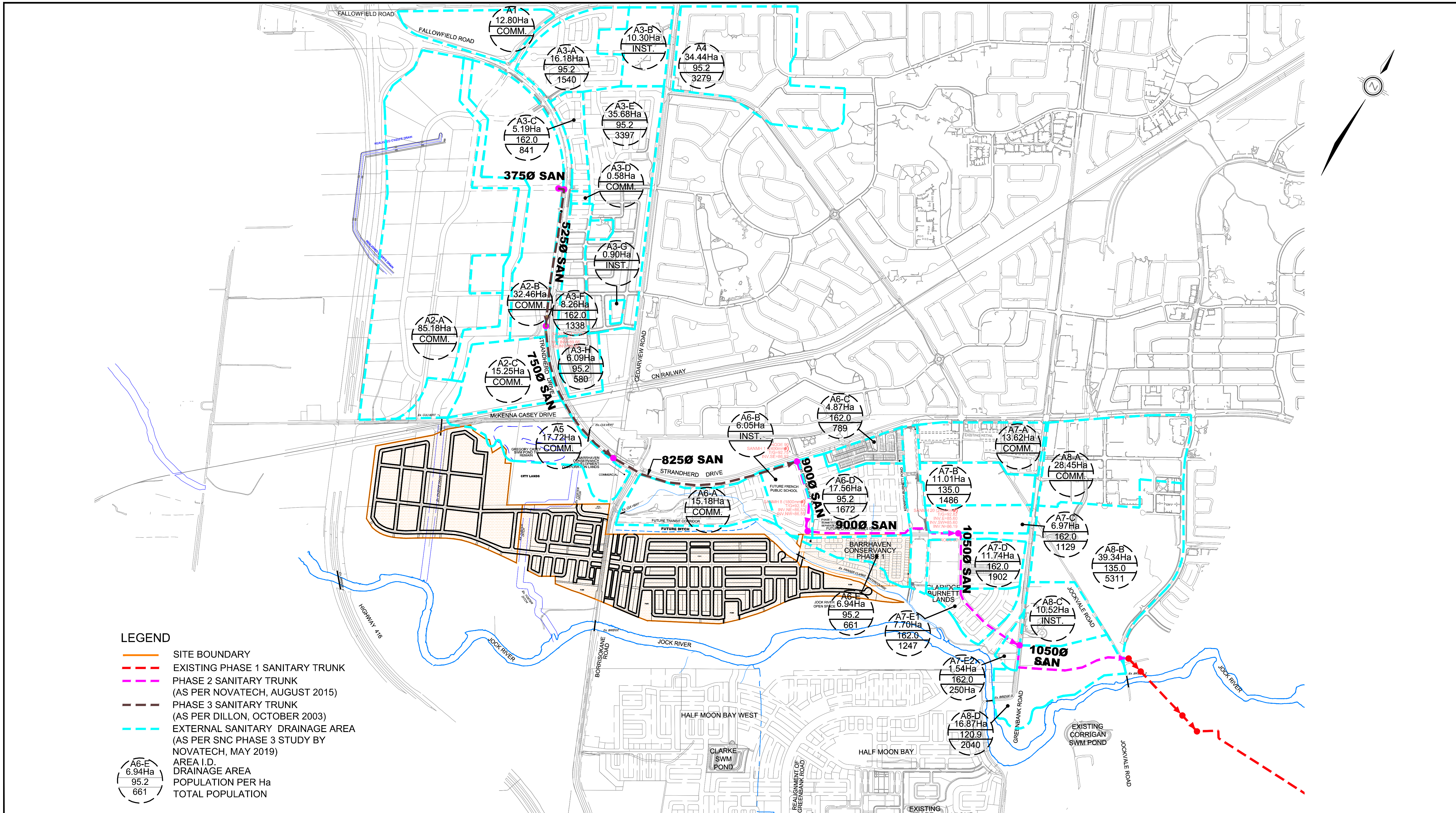
BARRHAVEN CONSERVANCY
WATERMAIN SERVICING PLAN
CITY OF OTTAWA

PROJECT No.:	16-891
SCALE:	1:8000
DATE:	JULY 2020
FIGURE:	3



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BARRHAVEN CONSERVANCY
EXTERNAL SANITARY SERVICING
CITY OF OTTAWA

PROJECT No.:	16-891
SCALE:	1:18000
DATE:	JULY 2020
FIGURE:	4

LEGEND

- SITE BOUNDARY
- STORM OVERLAND FLOW ARROW
- 192.85 PROPOSED CENTERLINE ELEVATION
- 193.50 PROPOSED ELEVATION
- 193.50 EXISTING ELEVATION
- 244.50 EXISTING CONTOUR ELEVATION

CUT-FILL DEPTH ALONG CENTER LINE:

CUT DEPTH (m)		FILL DEPTH (m)	
0 - 1	white	0 - 1	white
1 - 2	yellow	1 - 2	light cyan
2 - 3	orange	2 - 3	blue
> 3	red	> 3	dark blue

NOTES:
1. LOW FLOW CHANNEL ELEVATION TO BE VERIFIED IN THE FIELD AT ALL ROAD AND SEWER CROSSING LOCATIONS.
2. DETAILED DESIGN ROAD GRADES WILL BE NO LOWER THAN THE ELEVATIONS ILLUSTRATED ON THIS PLAN, AND WILL RISE AND FALL BY APPROXIMATELY 0.4m ABOVE THE TROUGH GRADES PRESENTED ON THIS PLAN.
3. EARTHWORKS VOLUMES ARE BASED ON THE MEDIAN ROAD GRADES, WHICH ARE ESTIMATED TO BE 0.2m HIGHER THAN THE TROUGH GRADES PRESENTED ON THIS PLAN.
4. ENGINEERED FILL VOLUMES ARE BASED ON THE MEDIAN ROAD GRADES, WHICH ARE ESTIMATED TO BE 0.2m HIGHER THAN THE TROUGH GRADES PRESENTED ON THIS PLAN.
5. MAXIMUM GRADE RAISE IS BASED ON THE CREST ROAD GRADES, WHICH ARE ESTIMATED TO BE O.4m HIGHER THAN THE TROUGH GRADES PRESENTED ON THIS PLAN.
6. EXISTING ELEVATIONS SHOWN ARE FROM TOPOGRAPHIC SURVEY PROVIDED BY JD BARNES, DATED NOVEMBER 2019. HOWEVER, ALL LIGHTWEIGHT FILL TO DETERMINED FROM TOPOGRAPHIC SURVEY PROVIDED BY JD BARNES, DATED APRIL 2019.

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BARRHAVEN CONSERVANCY
CONCEPTUAL GRADING PLAN
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:4000
DATE:	JULY 2020
DRAWING No.	1

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BARRHAVEN CONSERVANCY
CONCEPTUAL SERVICING PLAN
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:4000
DATE:	JULY 2020
DRAWING No.	2

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BARRHAVEN CONSERVANCY
STORM TRIBUTARY AREA
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:4000
DATE:	JULY 2020
DRAWING No.	3

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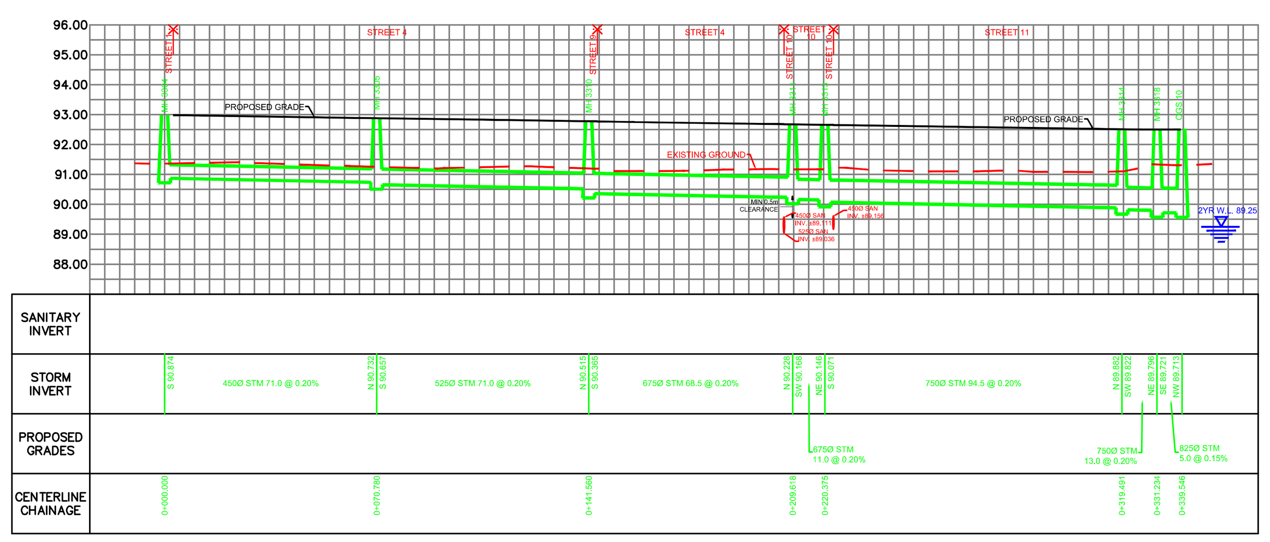
BARRHAVEN CONSERVANCY
SANITARY TRIBUTARY AREA
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:4000
DATE:	JULY 2020
DRAWING No.	4

SANITARY TRUNK 1

STORM TRUNK 10



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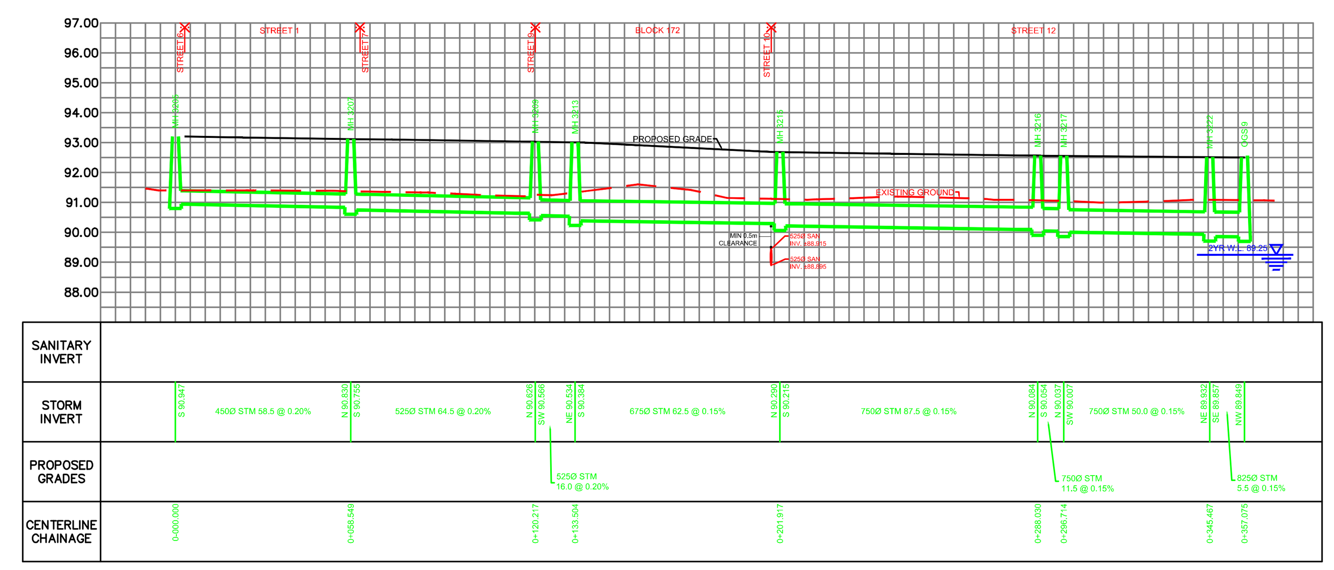

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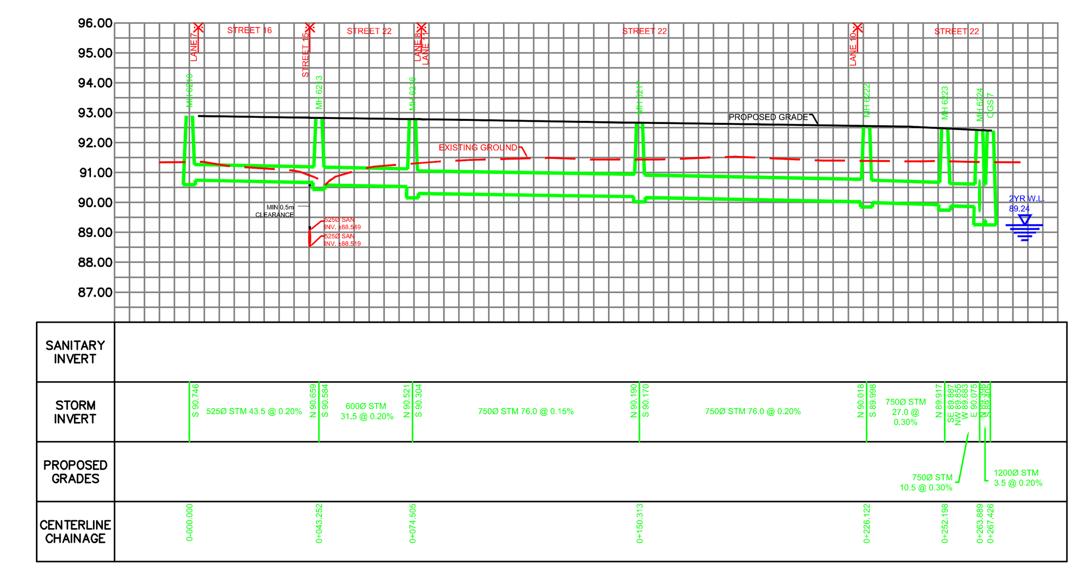

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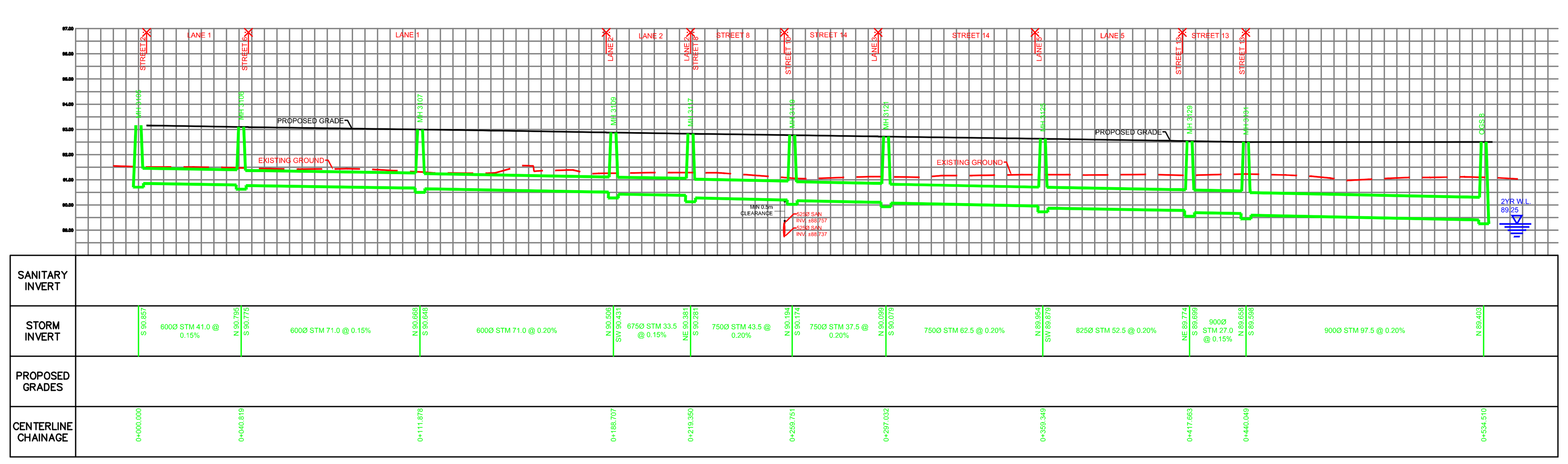
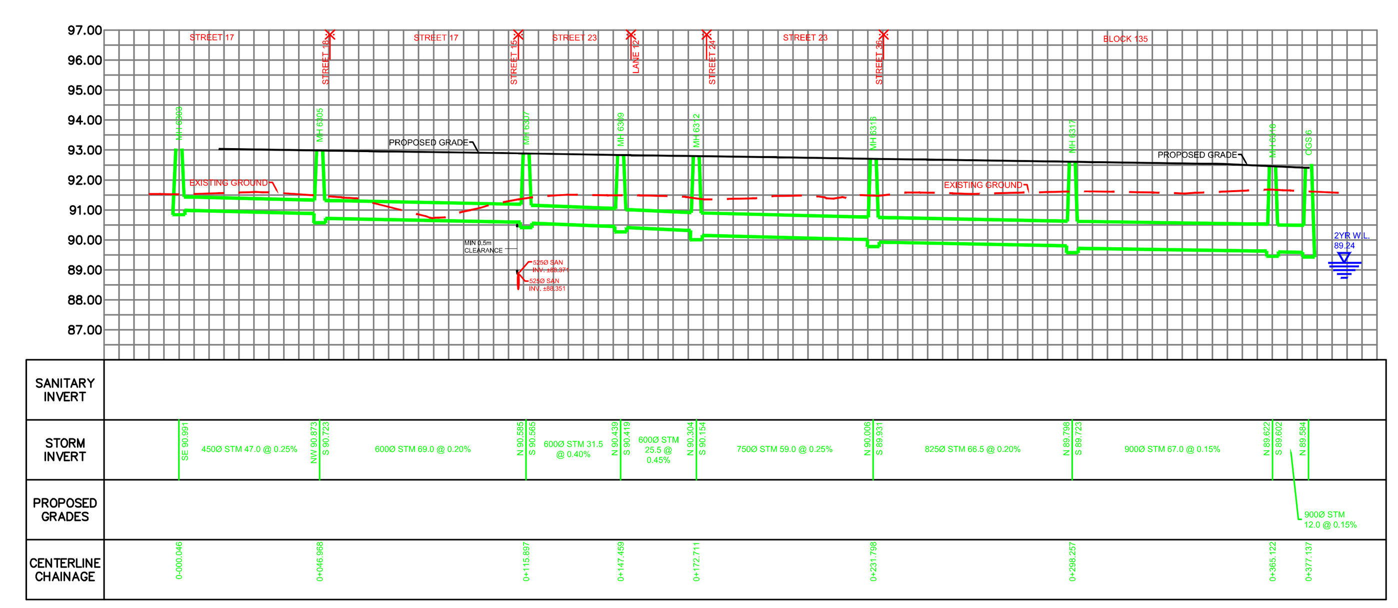
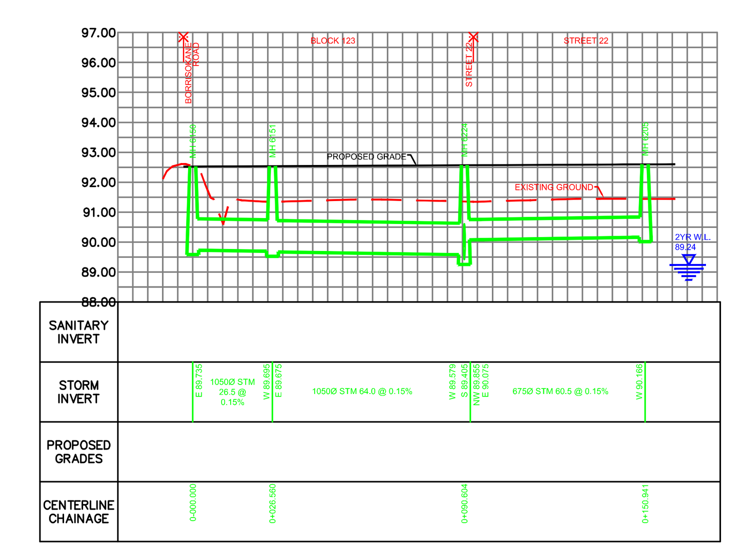


STORM TRUNK 6



STORM TRUNK 7A



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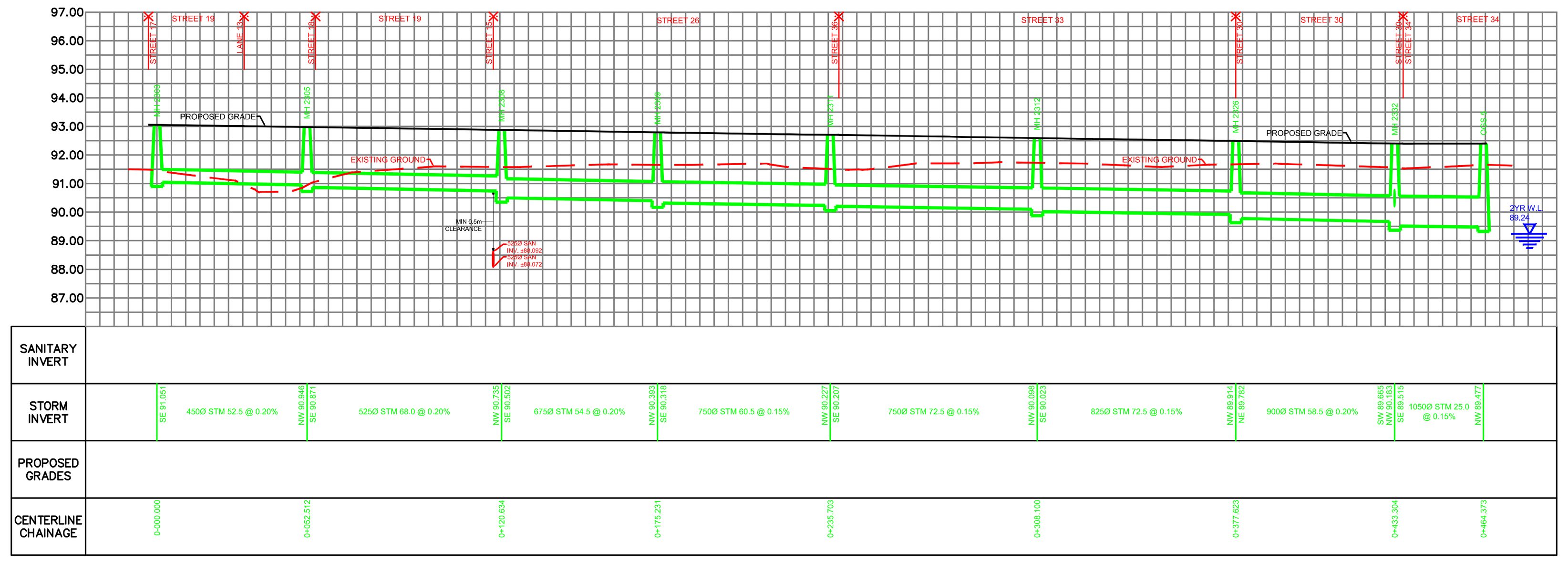
BARRHAVEN CONSERVANCY
SANITARY AND STORM TRUNK PROFILES
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:2000
DATE:	JULY 2020
DRAWING No.	5

STORM TRUNK 5



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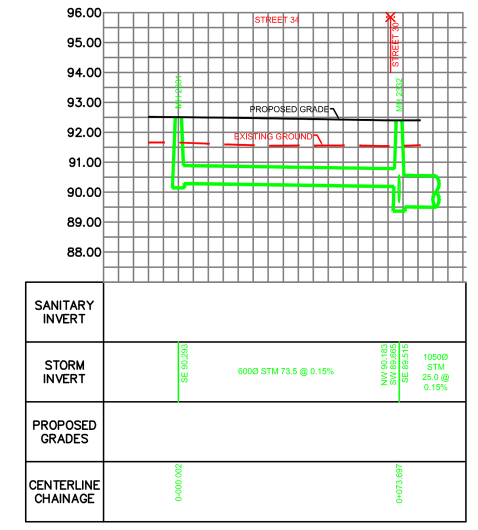

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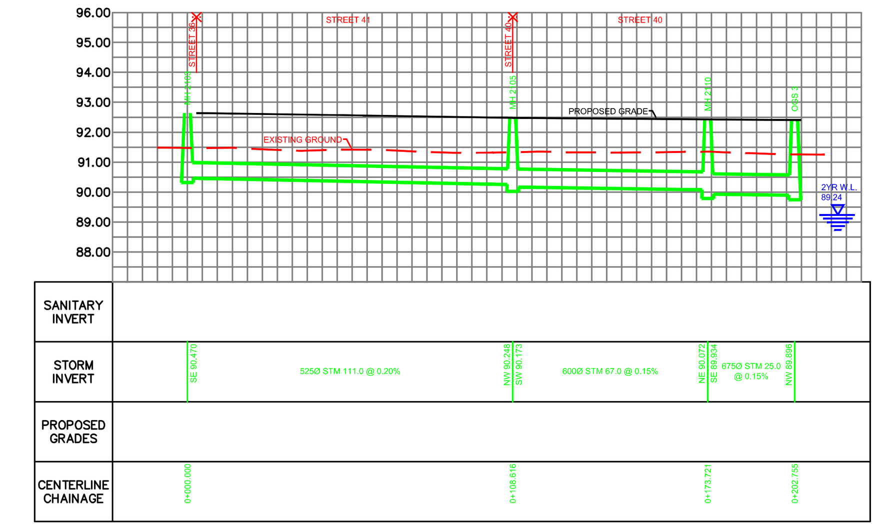

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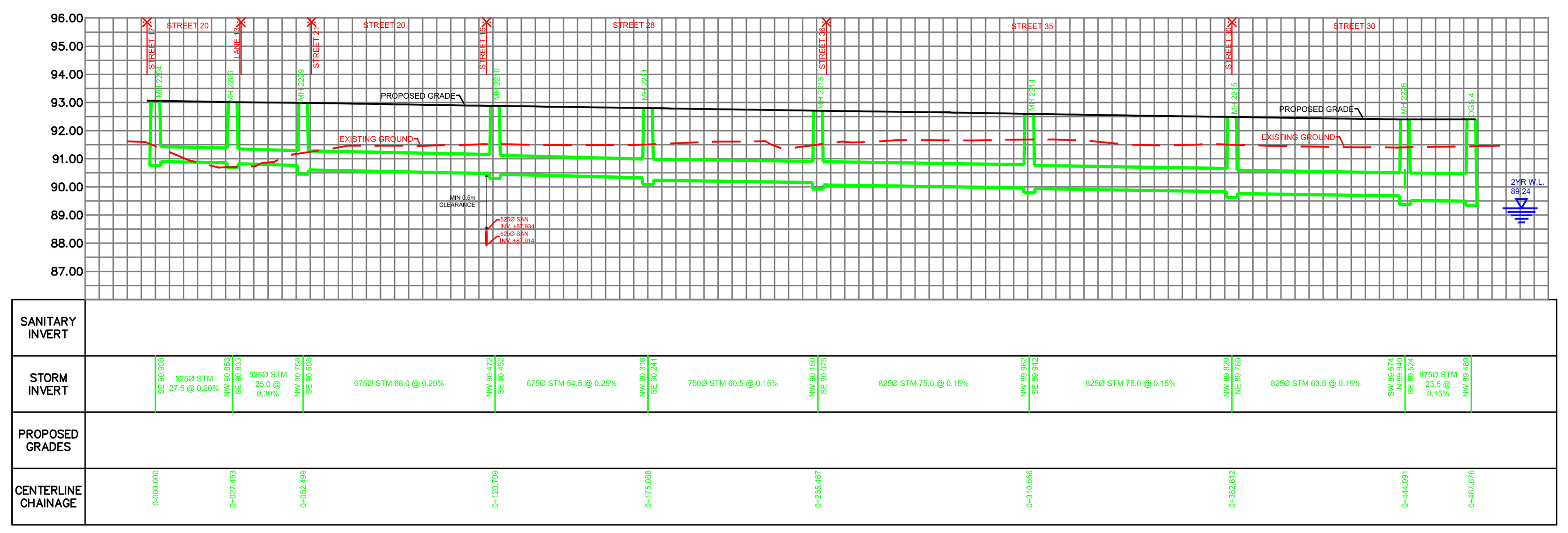

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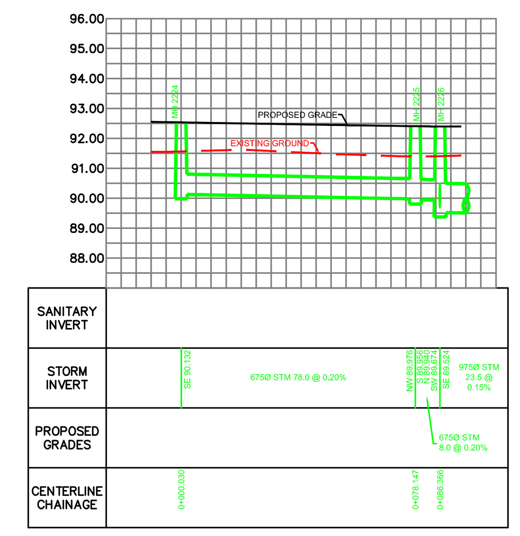

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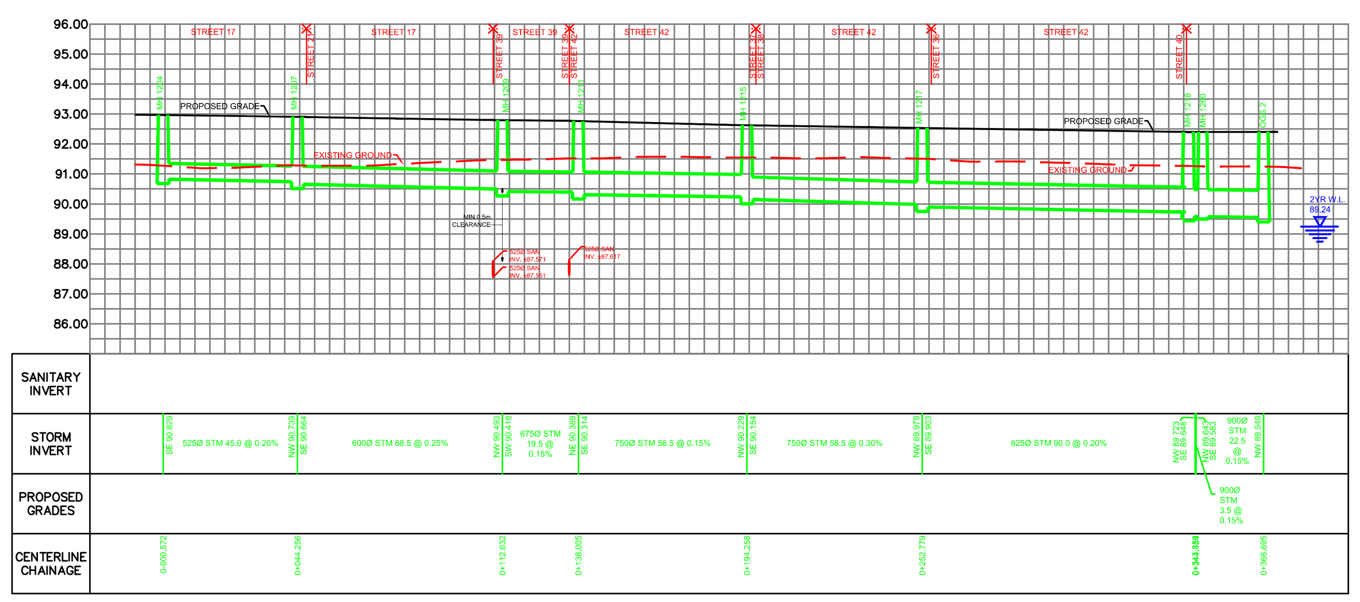

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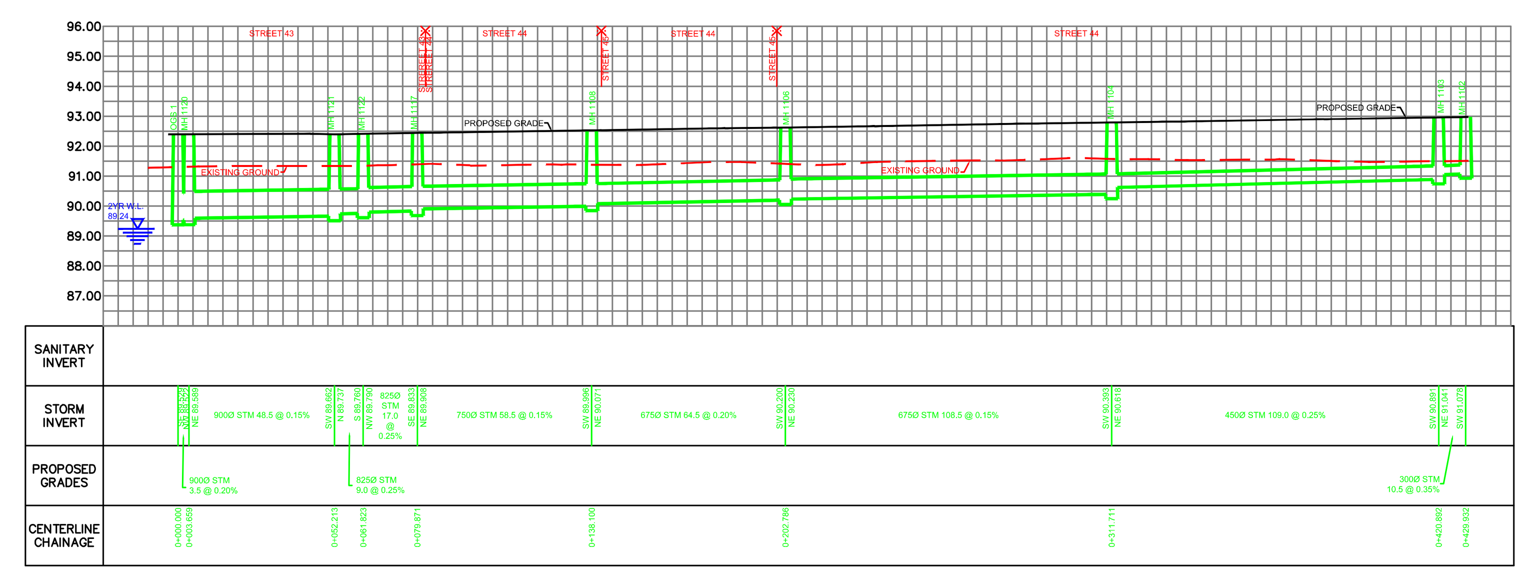

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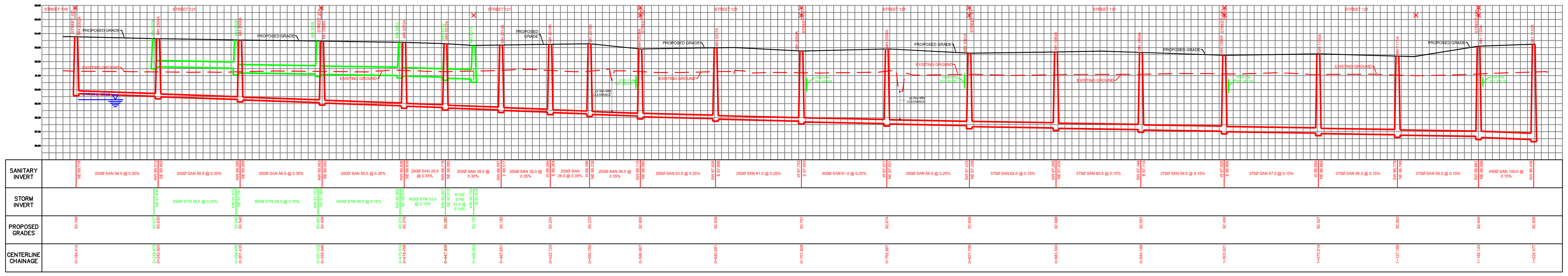
BARRHAVEN CONSERVANCY
SANITARY AND STORM TRUNK PROFILES
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:2000
DATE:	JULY 2020
DRAWING No.	6

SANITARY TRUNK 2 AND STORM TRUNK 16 & 12A



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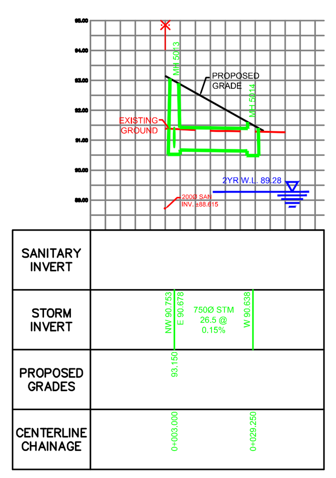

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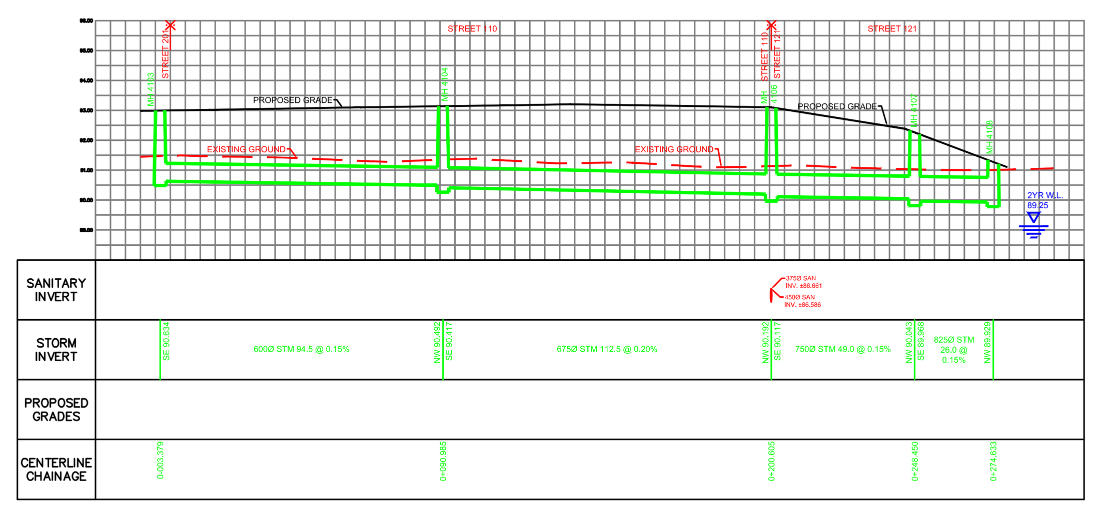

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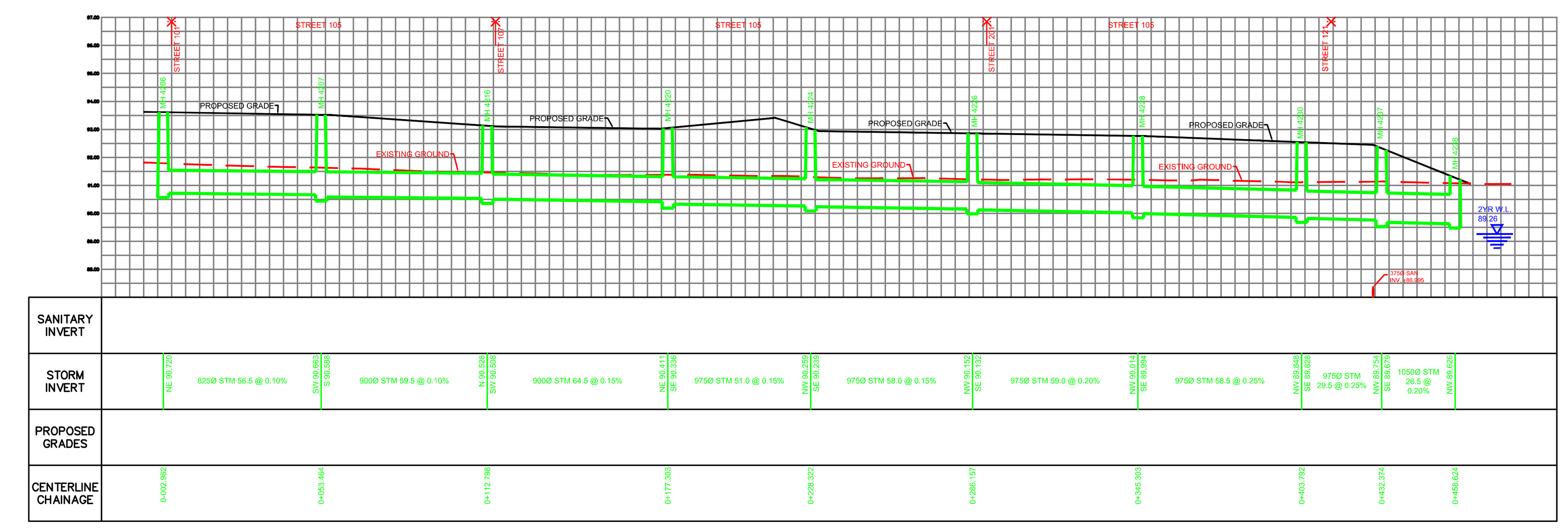

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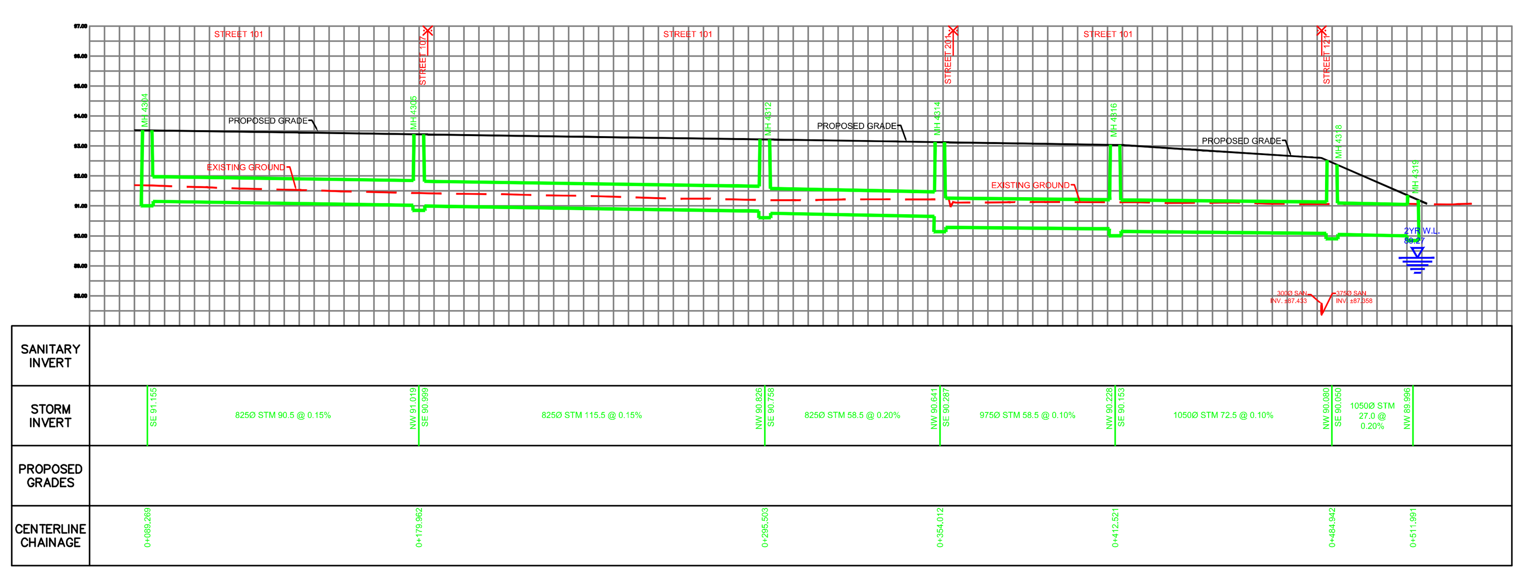

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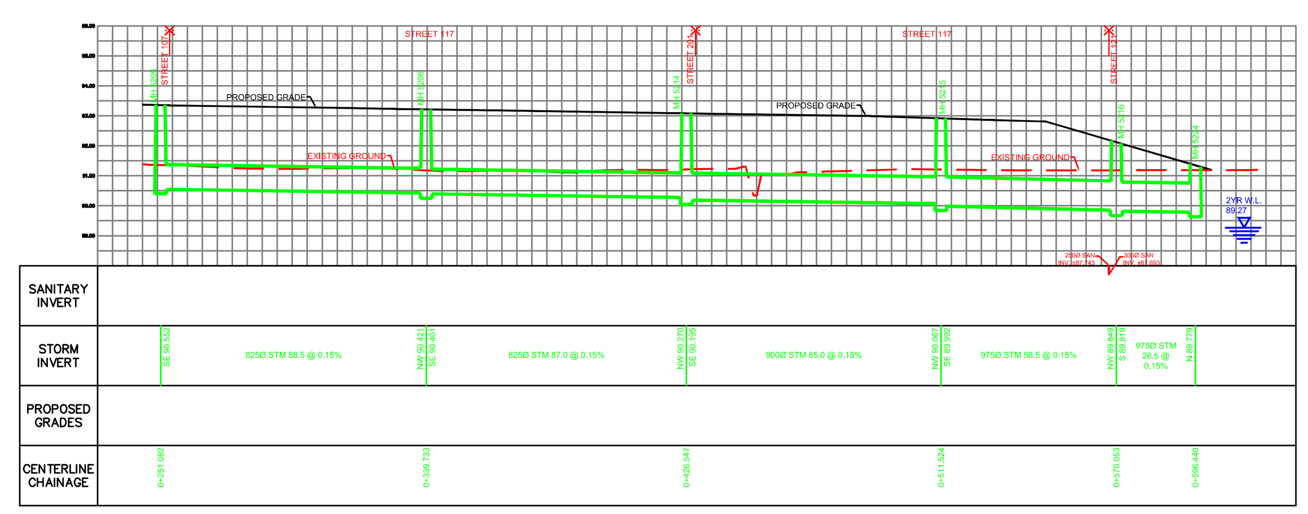

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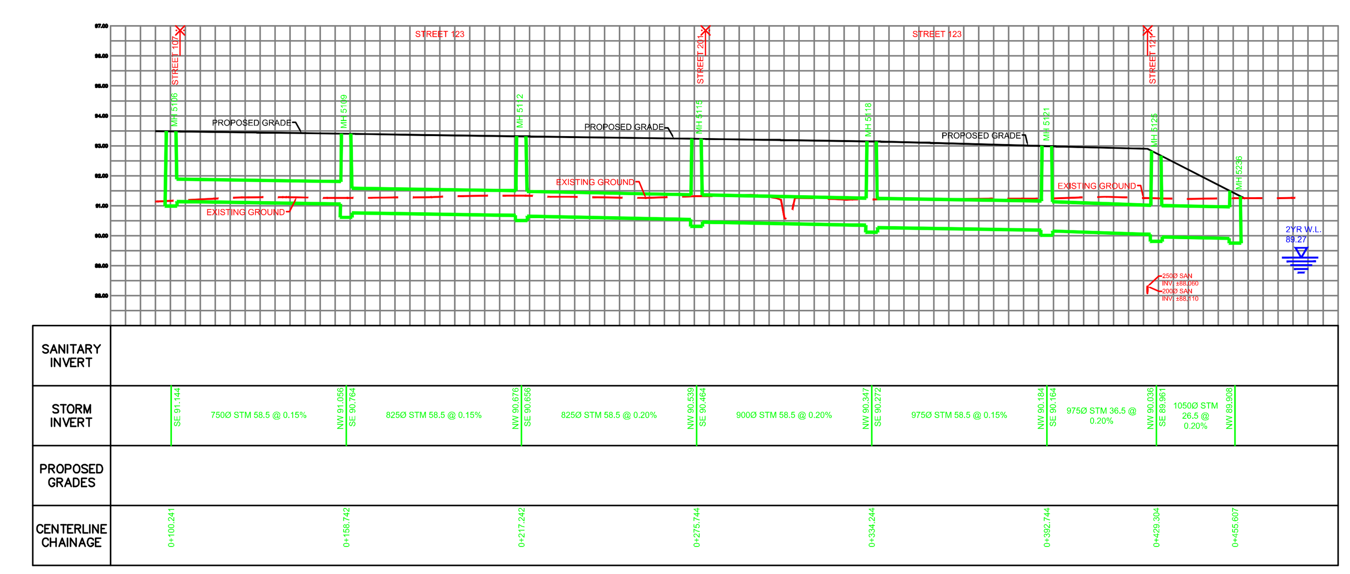

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BARRHAVEN CONSERVANCY
SANITARY AND STORM TRUNK PROFILES
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:2000
DATE:	JULY 2020
DRAWING No.	7

APPENDIX A

RVCA CONFIRMATION

May 31, 2020

City of Ottawa
110 Laurier Avenue,
Ottawa, ON K1P 1J1

Attention: Doug James

Subject: **Barrhaven Conservancy Development Corporation**
Status of As-Built Grading
Related: RVCA Permit # RV5-4419 and RV5-1718)
Vacant land on the north side of the Jock River generally bounded by Highway 416 and the Fraser Clarke Creek, City of Ottawa

Dear Mr. James:

The RVCA has reviewed information recently submitted by David Schaeffer Engineering Ltd. including as-built grades in support of works approved by the Rideau Valley Conservation Authority under Section 28 of the Conservation Authorities Act (Permit File Number: RV5-4419 and RV5-1718). The RVCA offers the following comments related to future development proposed for the area within the scope of approved the permits.

The subject lands as identified as part of Lots 11, 12, 13, 14, 15 former geographic Township of Nepean, Concessions 3 & 4, now in the City of Ottawa have been addressed through the general placement of fill and the formal construction of a berm around the perimeter of four blocks within the subject lands. The site specific elevations of the berm have been reviewed by the RVCA and are generally accepted as being appropriate as removing these lands from the floodplain in accordance with the aforementioned approved permits.

The detailed grading plans submitted by David Schaeffer Engineering Ltd. titled As Constructed plan of Berms and Cut Areas – Barrhaven Conservancy", dated May 27, 2020, prepared by Adam Fobert, P.Eng. of DSEL, DSEL File Number 16891 using the following resources:

- Orthoimagery Survey, dated April 20, 2020, acquired and processed by First Base Solutions a division of JD Barnes Ltd and certified by Chris Fox, O.L.S., A.L.S., P. Eng. of JD Barnes Ltd, file reference number 2037OTTA0001;
- Topographic Detail of Part of Lot 13, 14,&15 Concession 3&4, dated May 6, 2020, certified by Chris Fox, O.L.S., A.L.S., P. Eng. of JD Barnes Ltd, file reference number 16-10-127-00;

- Contractor as-built collected by the Tomlinson Group of Companies of Phase 1 dated May 15, 2020, reviewed by Jeremy Chouindard, EIT and certified by Stephen Pichette, P.Eng. of DSEL

The above information indicates that land within the berm have generally been raised to exceed the flood elevation cross sections throughout the project area. However, it is noted that as this is considered an active construction site the presence of lower areas to manage construction, on-site erosion and sediment control show lower elevations. These areas will be addressed through the construction process, as sufficient material is presently stockpiled for this purpose to ensure. For the purposes of the floodplain, these areas are considered removed by virtue of the berm.

Conclusion:

The grade modifications, including construction of the berm and filling behind the berm, as documented in the above noted "as constructed" plans, have been completed in accordance with the plans approved by the RVCA under permits RV5-4419 and RV5-1718.

Please feel free to contact our office with any questions or comments you may have.

Respectfully,

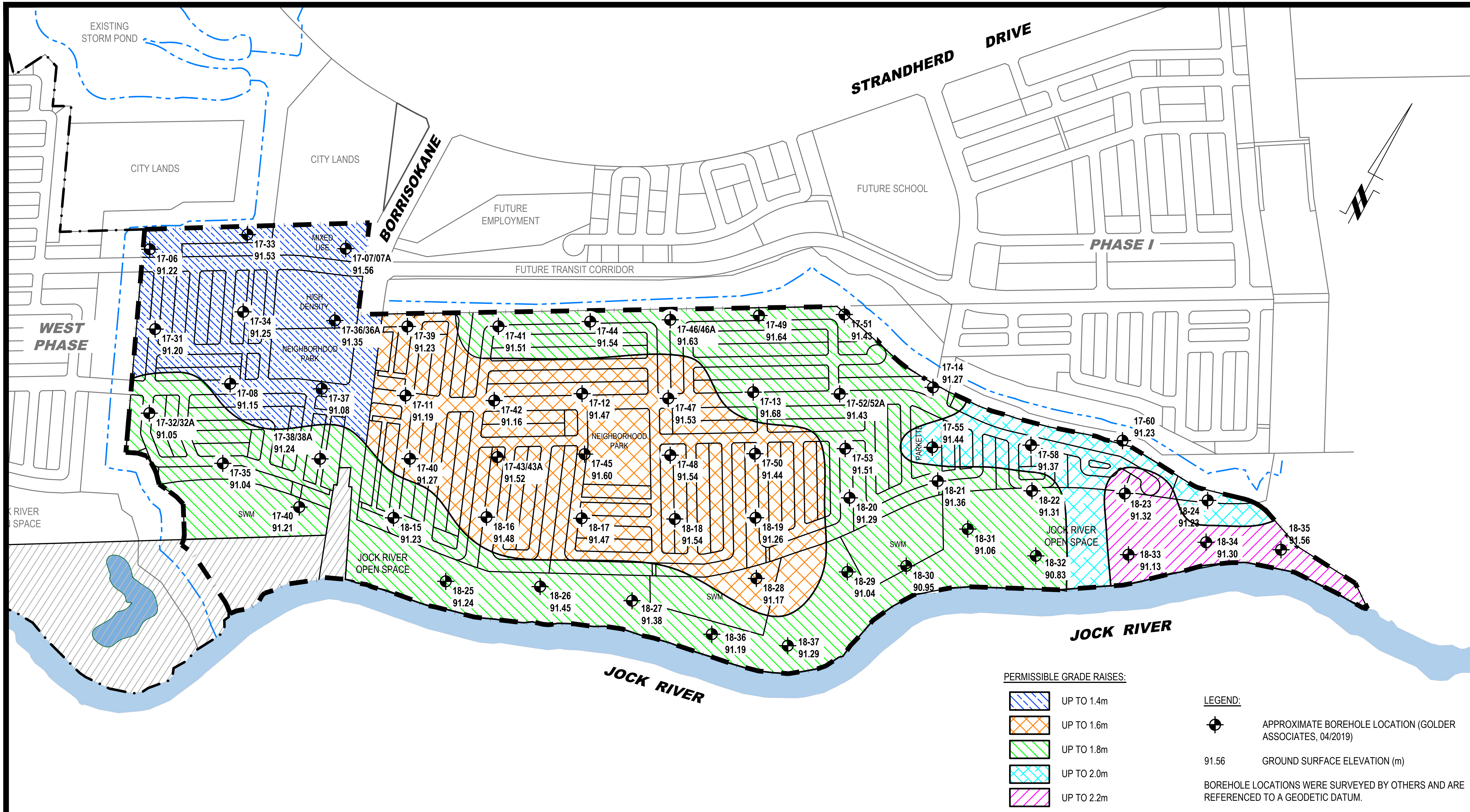
Terry K. Davidson

Terry Davidson, P.Eng
Director of Engineering and Regulations
Rideau Valley Conservation Authority
613-692-3571 x1107
terry.davidson@rvca.ca

attach: Technical memorandum by Evelyn Liu, M.Asc., P.Eng. Water Resources Engineer, RVCA dated May 29, 2020

APPENDIX B

GEOTECHNICAL



patersongroup
consulting engineers

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Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
0			

CAIVAN COMMUNITIES

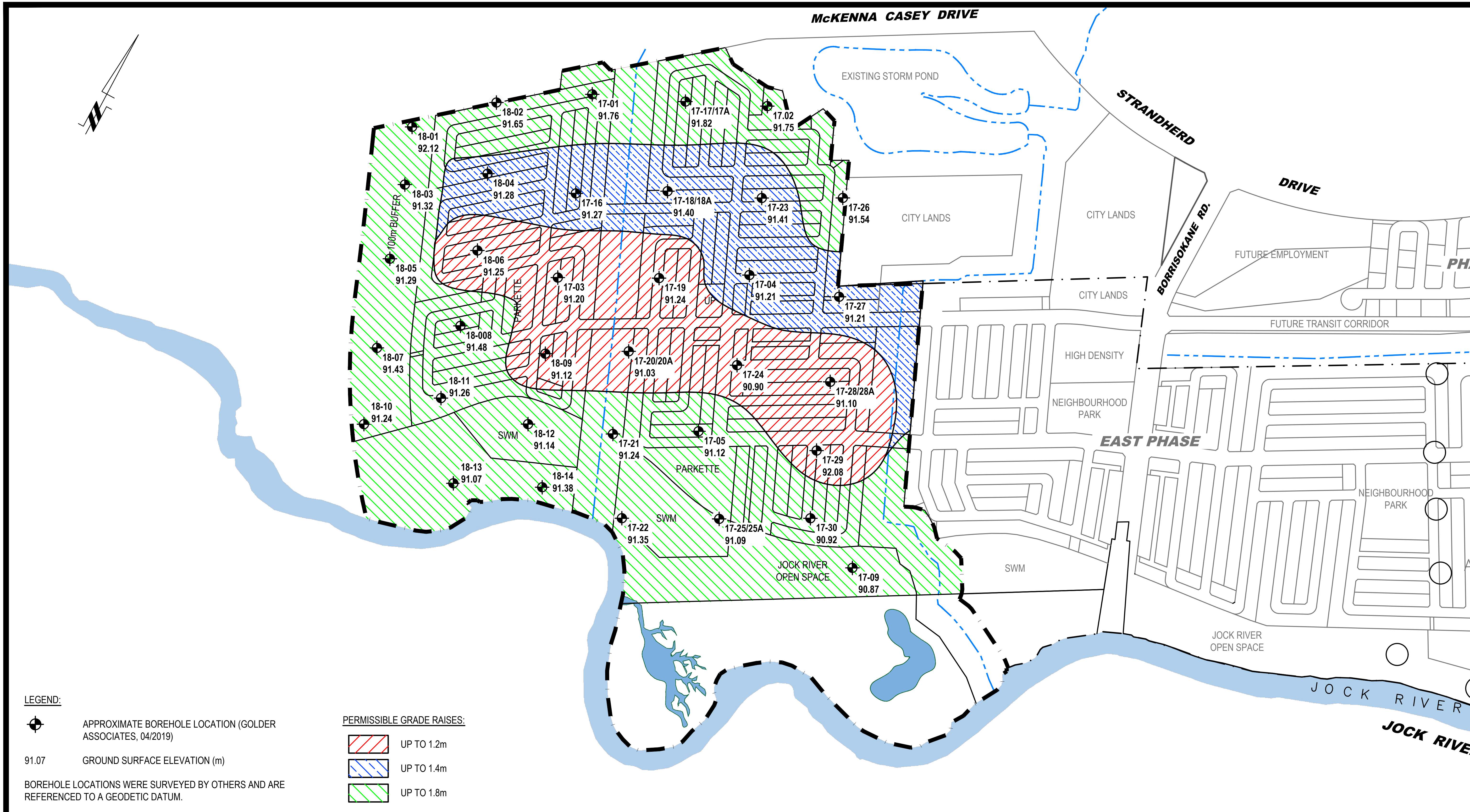
GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - CONSERVANCY LANDS EAST
OTTAWA, ONTARIO

Title:
PERMISSIBLE GRADE RAISE PLAN

Scale: 1:6000	Date: 09/2019
Drawn by: MPG	Report No.: PG5036-1
Checked by: SD	**PG5036-2**
Approved by: SD	Revision No.:

p:\autocad drawings\geotechnical\pg50xx\pg5036\pg5035-1 thlp east land.dwg

11x17



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NO.	REVISIONS	DATE	INITIAL
0			

CAIVAN COMMUNITIES
GEOTECHNICAL INVESTIGATION
PROP. RESIDENTIAL DEVELOPMENT - CONSERVANCY LANDS WEST
OTTAWA, ONTARIO

Title:
PERMISSIBLE GRADE RAISE PLAN

Scale: 1:5000	Date: 09/2019
Drawn by: MPG	Report No.: PG5036-2
Checked by: SD	**PG5036-5**
Approved by: SD	Revision No.:

11x17

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APPENDIX C

ENVIRONMENTAL

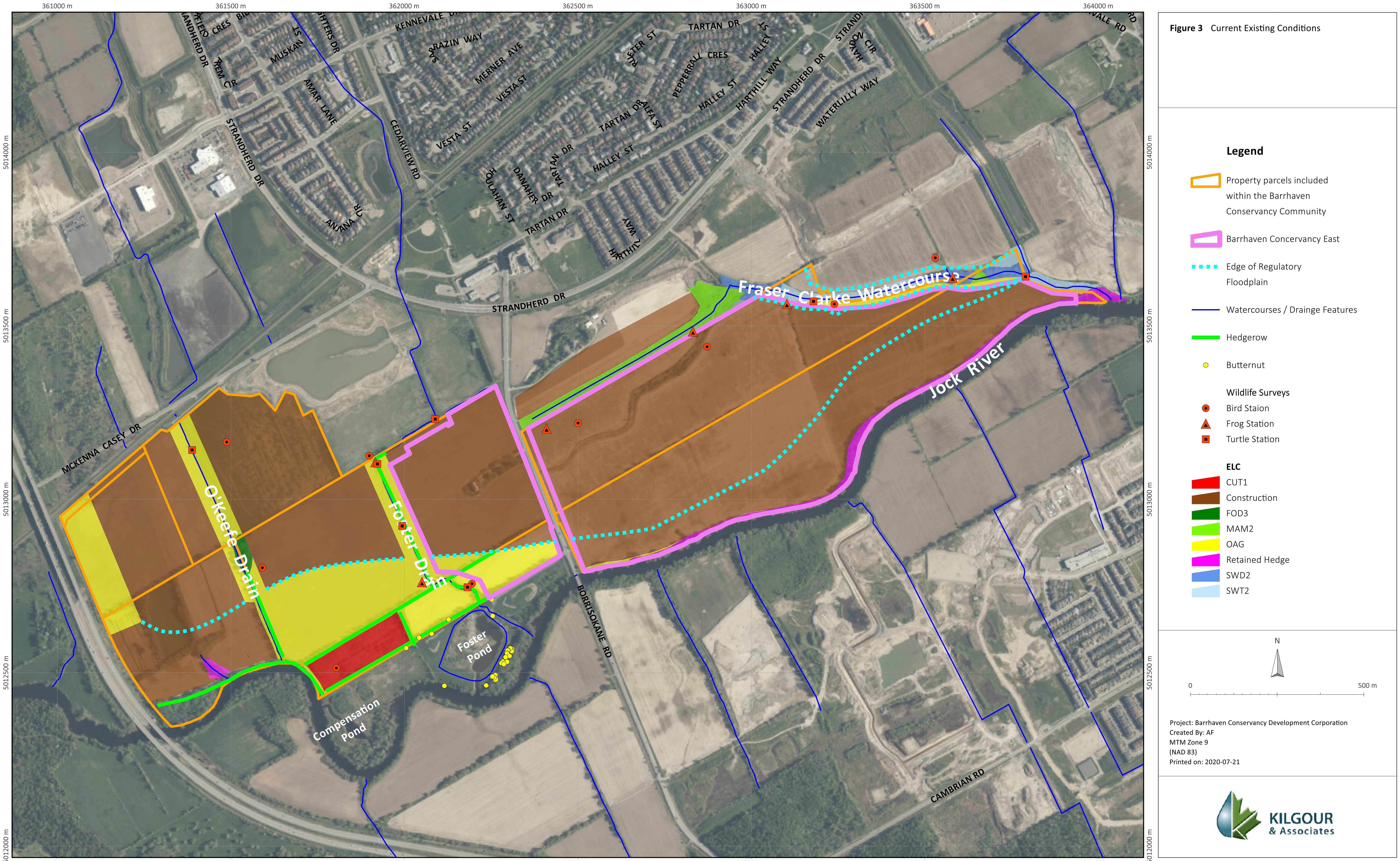

Figure 3 Current Existing Conditions

Figure 5 Conceptual Plan for the Jock River Riparian Corridor

Notes: Figure provided by NAK Design based on input by Kilgour & Associates Ltd.

APPENDIX D

WATER SERVICING

Stantec

Memo

To:	Hugo Lalonde / Kevin Murphy (DSEL) Barrhaven Conservancy Development Corporation	From:	Jasmin Sidhu / Kevin Alemany Stantec Consulting Ltd.
File:	1634-01437	Date:	February 13, 2020

Reference: Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation

OVERVIEW

Stantec Consulting Ltd. (Stantec) was retained by Barrhaven Conservancy Development Corporation to perform a hydraulic assessment for a land parcel located adjacent to Pressure Zone (PZ) 3SW (previously known as PZ BARR). This technical memo reviews and assesses the limitations/opportunities associated with servicing the parcel in question as it is located near the Jock River. The parcel in question, which is divided into east (Conservancy East) and west (Conservancy West) portions, is herein referred to as the Barrhaven Conservancy Lands.

BACKGROUND REVIEW

As part of the assessment, the following reports were reviewed:

- City of Ottawa 2013 Water Master Plan, Stantec Consulting Ltd., September 2013;
- Kennedy-Burnett Potable Water Master Servicing Study, Stantec Consulting Ltd., April 2014;
- SUC Water Infrastructures Upgrades – Hydraulic Assessment, Stantec Consulting Ltd., July 2015; and,
- Barrhaven Master Servicing Study Addendum – Revised Potable Water and Sanitary Servicing Analysis for the Barrhaven South Urban Expansion Area, Stantec Consulting Ltd., March 2017.

ZONE 3SW AND ZONE SUC

ZONAL WATER DEMANDS & POPULATION PROJECTIONS

Zone 3SW services the lands adjacent to the proposed Barrhaven Conservancy Lands development. In 2015, the City embarked on a large initiative to reconfigure the pressure zones servicing Barrhaven and the southern reaches of Ottawa, and area called the South Urban Community (SUC). The purpose of the zone reconfiguration was to improve reliability, to improve efficiencies and to provide increased pumping capacity for future growth.

Table 1 shows the projected water demands and **Table 2** shows the projected populations of Zone 3SW and Zone SUC before and after the pressure zone reconfiguration. These values were adapted from the City of Ottawa 2013 Water Master Plan (Stantec, 2013) and the SUC Water Infrastructure Upgrades – Hydraulic Assessment (Stantec, 2015) reports.

Reference: **Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation**

Table 1: Water Demand Projections

Zone	Existing Pre-Zone Reconfiguration (MLD)			2018 Post-Zone Reconfiguration (MLD)			2031 Post-Zone Reconfiguration (MLD)			2060 Post-Zone Reconfiguration (MLD)		
	BSDY	MXDY	PKHR	BSDY	MXDY	PKHR	BSDY	MXDY	PKHR	BSDY	MXDY	PKHR
3SW	12.0	26.2	52.3	5.7	11.7	27.0	6.3	12.8	29.5	6.4	12.9	29.8
SUC	3.4	7.3	14.6	24.7	47.6	90.8	44.4	78.7	148.9	63.3	107.6	207.1

Table 2: Population Projections

Zone	Existing Pre-Zone Reconfiguration	2018 Post-Zone Reconfiguration	2031 Post-Zone Reconfiguration	2060 Post-Zone Reconfiguration
3SW	48,917	29,995	30,363	31,183
SUC	5,737	137,909	175,073	234,538

PUMPING CAPACITY

The newly installed pumps for Zone 3SW are sized based on population/demand projections for lands within current approved growth areas. They do not include demands attributed to the Barrhaven Conservancy Lands. As such, the current pumping capacity into Zone 3SW is not sufficient to supply these additional lands along with the growth already planned for in Zone 3SW up to 2060 projections.

The Fallowfield Road Pumping Station (FRPS) (previously known as Barrhaven Reservoir Pumping Station) and Barrhaven Pumping Station (BPS) will continue to service Zone 3SW post pressure zone reconfiguration; however, both pump stations are being equipped with new pumps that were sized for the post pressure zone reconfiguration water demands in Zone 3SW.

The new FRPS is already commissioned and in operation while the BPS is currently undergoing pumping tests on the newly installed pumps as part of its commissioning process.

The BPS is changing from a single zone station to a dual zone pump station and will operate in conjunction with Ottawa South Pumping Station (OSPS) to service the newly expanded Zone SUC. It will also continue to service the smaller/reduced Zone 3SW with one of its pumps.

The Ottawa South Pumping Station is the second pumping station that will feed Zone SUC. It is currently undergoing a detailed design for its upgrade. It may be possible to make some provisions to account for the additional demands in SUC however it is recommended that this be considered as soon as possible through discussions with the City.

Table 3 provides the pumping capacities into each pressure zone post zone reconfiguration upgrades.

Reference: **Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation**

Table 3: Pumping Capacity Post-Zone Reconfiguration

Zone	Firm Pumping Capacity (MLD)	Total Pumping Capacity (MLD)
3SW	14	21
SUC	113	173

Due to the elevated balancing storage provided by Moodie Tank, the firm capacity of the 3SW pumps must be able to supply the future 2060 maximum day demand of 12.9 MLD as shown in **Table 1**. The 3SW pumps were sized based on 2060 demands as they do not increase significantly compared to 2018 post zone reconfiguration demands.

In Zone SUC, without elevated storage, the firm capacity of the pumps must be able to supply the greater demand of peak hour (90.8 MLD) or maximum day plus fire flow (66.3 MLD; FF = 18.7 MLD) for post zone reconfiguration demands. It should be noted that pumping capacity at the SUC pump stations will be further increased in the future to meet 2031 and 2060 projected demands.

The above shows that both the 3SW and SUC pumps have been sized to meet the existing and future demands within the previously established growth areas.

HYDRAULIC ASSESSMENT

WATER DEMANDS

Following the 2013 Water Master Plan “Design Criteria and Levels of Service”, when projected population exceeds 3,000 persons, basic unit demands for Zone/System Levels are to be used. For residential land-uses, single family and semi-detached homes were considered to have similar demands, with both types of residential home categorized under “single family home” or SFH. All townhomes were categorized under “multi-level townhomes” or MLT and all apartments or high-density units were categorized under APT. Consumption rates for SFH, MLT and APT are presented in **Table 4**.

To determine the MXDY demand, an outdoor water demand (OWD) of 1,049 L/SFH/d is allocated to all SFH units. This is a fixed value and does not change with zone demand. This outdoor water demand is added to the basic day (BSDY) demand to obtain the MXDY demand.

The unit counts were provided by David Schaeffer Engineering Ltd. (DSEL) via email on January 21, 2020. The estimated water demands are presented in **Table 4**. This additional demand is not within the current capacity of the new pumps within Zone 3SW.

Reference: Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation

Table 4: Estimated Water Demands of the Barrhaven Conservancy Lands

Unit Types	Unit Count			PPU	Persons	L/c/d	BSDY (MLD)	MXDY (MLD)
	Conservancy East	Conservancy West	Total					
Single Family	725	775	1,500	3.4	5,100	180	0.92	2.49
Townhouse	475	525	1,000	2.7	2,700	198	0.53	0.53
Rear-Lane Townhouse	250	-	250	2.7	675	198	0.13	0.13
High Density	50	-	50	2.1	105	219	0.02	0.02
Total	***1,500***	***1,300***	***2,800***		***8,580***		***1.60***	***3.18***

POTABLE WATER SERVICING ALTERNATIVES

Figures 1 to **5** and **Table 5** present alternatives to service the Barrhaven Conservancy Lands with potable water and discusses limitations of each alternative. It should be noted that the alignments shown in **Figures 1** to **5** are approximate with the intent to show general locations for possible connections.

All alternatives are anticipated to satisfy the City’s objective minimum pressure of 40 psi during peak hour demand and achieve a typical planning level fire flow value 10,000 L/min or greater.

Alternative 1 – Servicing from 3SW

Figure 1 shows the connection points to the Kennedy-Burnett watermains that are fed by the future Strandherd Drive watermain.

Based the Kennedy-Burnett Potable Water Master Servicing Study (Stantec, 2014), which is a subdivision adjacent to the Barrhaven Conservancy Lands, it is likely the Barrhaven Conservancy Lands will experience pressures greater than the City of Ottawa’s objective pressure of 80 psi during basic day demands if operating at Zone 3SW pressure. Pressure mitigation measures would need to be considered (i.e. pressure reducing valves (PRVs) at individual service connections).

Pumping capacity upgrades at FRPS and/or BPS would be required to service the Barrhaven Conservancy Lands from Zone 3SW on a permanent basis. As an example of costs, recent upgrades to the FRPS totaled approximately $1.5 million. Additional works at FRPS and BPS to service the Conservancy Lands could include retrofitting the pump(s), piping, valving and supporting infrastructures as well as instrumentation, electrical and mechanical aspects. A more in-depth assessment would be required to determine the potential costs.

Another alternative to service the Barrhaven Conservancy Lands from Zone 3SW would be on a temporary basis. As shown in **Figure 1**, the initial phase of development (estimated boundary shown) could be serviced at 3SW pressure and switched over to SUC pressure at a later time as development takes place. While this alternative is likely to be technically feasible, the extent of development within the Barrhaven Conservancy Lands that can operate at 3SW pressure in the interim will depend on the City’s planning and approvals currently in place. This alternative essentially borrows capacity from existing approved areas within Zone 3SW until such time that the borrowed capacity is replaced through system upgrades. Through informal discussions between DSEL and City staff, the City has indicated that this is not a desirable option.

Reference: **Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation**

Alternative 2 – Servicing from SUC

Figures 2, **3** and **4** show the Barrhaven Conservancy Lands being serviced by new SUC watermains and include two options for a secondary feed.

Based on findings from the Barrhaven South Urban Expansion Area Master Servicing Study (Stantec, 2017), the Barrhaven Conservancy Lands can anticipate maximum pressures greater than 75 psi and potentially be greater than 80 psi during basic day demands if operating at Zone SUC pressure. If they were to exceed 80 psi, PRVs would need to be considered.

A new SUC watermain running parallel to the Strandherd watermain, as proposed as the primary feed for Alternatives 2a and 2b, could connect to the Kennedy-Burnett (KB) watermains and this may require the KB subdivision to operate at SUC pressures. Alternative 2a proposes a secondary feed from Nepean Town Centre (NTC). Alternative 2b proposes a secondary feed from Barrhaven South. Both options present their own unique challenges with either limited land access or crossings of bodies of water.

Alternative 2c proposes both primary and secondary feeds from the NTC (one along future Chapman Mills Drive and one through the future Claridge development from southeast of the KB pond) to service the first stages of development in the Conservancy Lands. The Kennedy-Burnett Potable Water Master Servicing Study (Stantec, 2014) looked at servicing this area from the NTC in the future SUC pressure zone. Based on findings of this study, servicing the Conservancy Lands with two 300 mm diameter watermains from the NTC is possible, however ultimate optimization of sizing would have to be completed at a later phase. Similar to Alternatives 2a and 2b, this option presents challenges due to limited land access or crossings of a body of water.

Alternative 3 – Servicing from SUC with an Automated Valve from 3SW

Figure 5 shows the Barrhaven Conservancy Lands being serviced by a new SUC watermain running parallel to the Strandherd Drive watermain and a secondary feed from 3SW for emergency conditions.

This alternative proposes a secondary feed from 3SW via an automated valve off the future Strandherd Drive watermain. Water would flow from the high pressure Zone 3SW into the low pressure Zone SUC if there is a pressure drop on the SUC side of the valve. This alternative requires an interzonal valve connection that is not typically used/accepted in the City of Ottawa and would present both operational challenges and costs to operate and maintain.

Table 5: Potable Water Servicing Alternatives & Limitations

Alternative		Zone	Max Pressures	Min Pressures	Available Fire Flow at 20 psi	Limitations
1	Connect to the future 3SW 406 mm dia. WM along Strandherd Drive at two locations	3SW	> 80 psi	> 40 psi (ok)	> 10,000 L/min	Requires additional pumping capacity in Zone 3SW. Will require individual pressure reducing valves (PRVs) at each service connection.
2a	Connect to a future SUC WM that will run parallel to the future Strandherd WM and connect to a 2nd future SUC WM from the NTC	SUC	> 75 psi; could potentially be > 80 psi	> 40 psi (ok)	> 10,000 L/min	Requires crossing water way east of the Barrhaven Conservancy Lands. Land around ponds may not be accessible.

Reference: Hydraulic Potable Water Assessment for Barrhaven Conservancy Development Corporation

Alternative		Zone	Max Pressures	Min Pressures	Available Fire Flow at 20 psi	Limitations
	(north of the Jock River)					Potentially requires operating Kennedy-Burnett Lands at SUC pressure. Likely requires PRVs at each service connection.
2b	Connect to a future SUC WM that will run parallel to the future Strandherd WM and connect to a 2nd future SUC WM from Barrhaven South (south of the Jock River – crossing river)	SUC	> 75 psi; could potentially be > 80 psi	> 40 psi (ok)	> 10,000 L/min	Requires crossing the Jock River. Potentially requires operating Kennedy-Burnett Lands at SUC pressure. Likely requires PRVs at each service connection.
2c	Connect to future SUC WMs in the NTC (north of the Jock River) at two locations	SUC	> 75 psi; could potentially be > 80 psi	> 40 psi (ok)	> 10,000 L/min	Requires crossing water way at one location east of the Barrhaven Conservancy Lands. Land around ponds may not be accessible. Potentially requires operating Kennedy-Burnett Lands at SUC pressure. Likely requires PRVs at each service connection.
3	Connect to a future SUC WM that will run parallel to the future Strandherd WM and connect to the Strandherd 3SW WM using an automated valve to feed from 3SW under emergency conditions	SUC	> 75 psi; Could potentially be > 80 psi	> 40 psi (ok)	> 10,000 L/min	Requires crossing water way east of the Barrhaven Conservancy Lands. Land around ponds may not be accessible. Requires operating Kennedy-Burnett Lands at SUC pressure. May possibly require PRVs at each service connection. An automated 3SW/SUC valve presents operational challenges and costs.

SUMMARY & RECOMMENDATIONS

The recent pump station upgrades at the Zone 3SW pump stations are nearing completion. Alternative 1 for servicing the Conservancy Lands would eventually require changing the recently commissioned pumps at the Fallowfield Road Pumping and Station and one of the new pumps at the Barrhaven Pump Station and potentially some of the associated piping, valving, instrumentation, electrical and mechanical appurtenances for higher capacity pumps and appurtenances. Due to the anticipated maximum pressures exceeding 80 psi during basic day demands, individual PRVs will be required at each service connection if the lands operate at Zone 3SW pressure. It is understood from informal discussions between DSEL and City staff that this is not a desirable option.

Servicing the Conservancy Lands from Zone SUC requires either a crossing of a stormwater pond and/or the Jock River to complete a looping network. All three alternatives present their own challenges with either limited land access or crossing of bodies of water. City staff have indicated through informal discussions with DSEL a preference for Alternative 2c. Based on findings of the Kennedy-Burnett Potable Water Master Servicing Study, servicing the Conservancy Lands with two 300 mm diameter watermains from the NTC is possible, however ultimate optimization of sizing would have to be completed at a later phase.

An automated 3SW/SUC valve could potentially be considered for interim conditions, as discussed in Alternative 3, however inter-zonal automated valve connections are not typically used/accepted in the City of Ottawa and would present both operational challenges and costs to operate and maintain.

Sincerely,

Stantec Consulting Ltd.

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Attachment:
Figure 1: Alternative 1 – Servicing from Zone 3SW
Figure 2: Alternative 2a – Servicing from Zone SUC (from Strandherd) w/ Secondary Feed from NTC
Figure 3: Alternative 2b – Servicing from Zone SUC (from Strandherd) w/ Secondary Feed from Barrhaven South
Figure 4: Alternative 2c – Servicing from Zone SUC (from NTC) w/ Secondary Feed from NTC
Figure 5: Alternative 3 – Servicing from Zone SUC w/ Automated Valve from 3SW for Emergency Conditions

Figure 1: Alternative 1 - Servicing from Zone 3SW

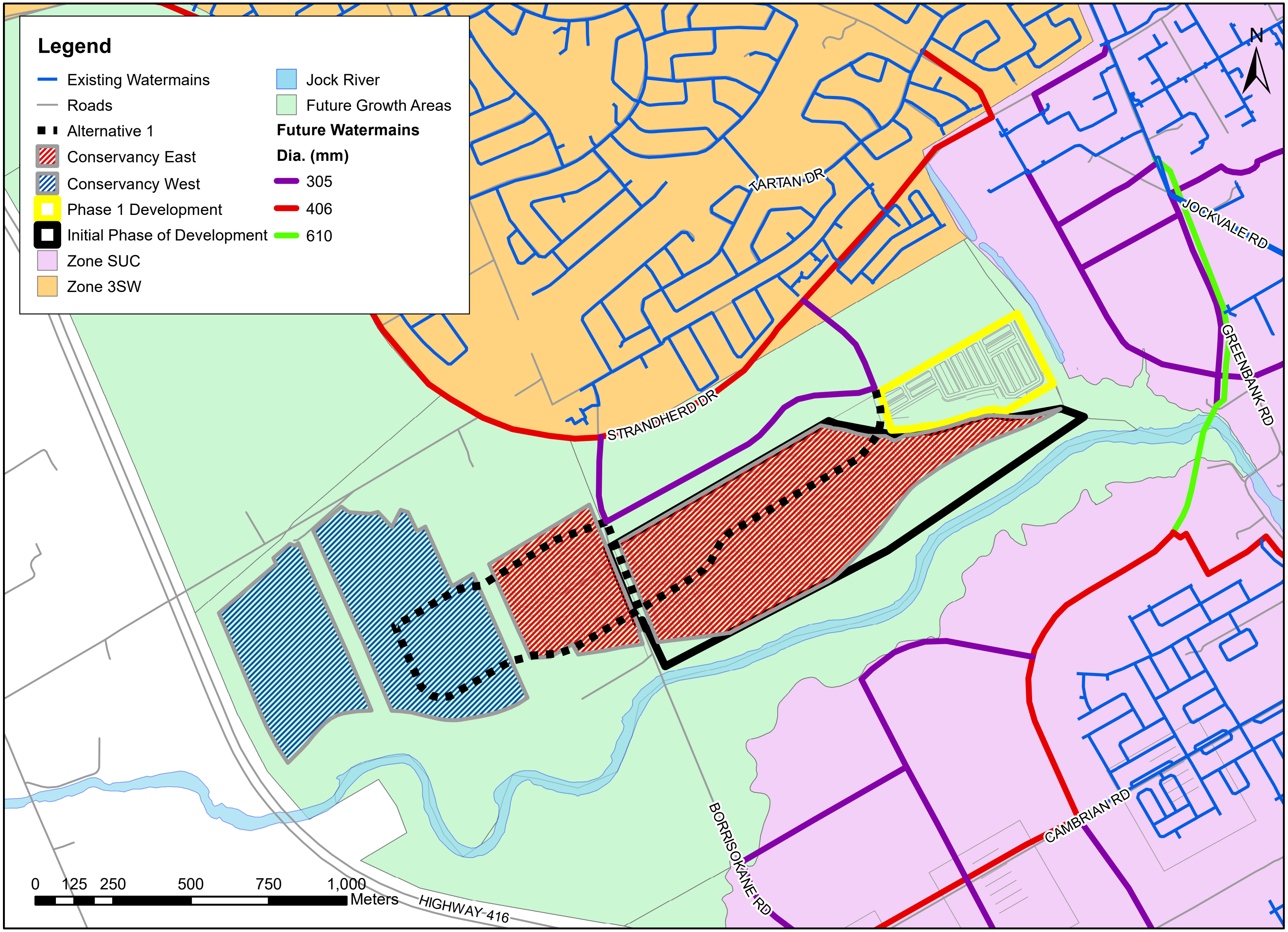


Figure 2: Alternative 2a - Servicing from Zone SUC (from Strandherd) w/ Secondary Feed from NTC

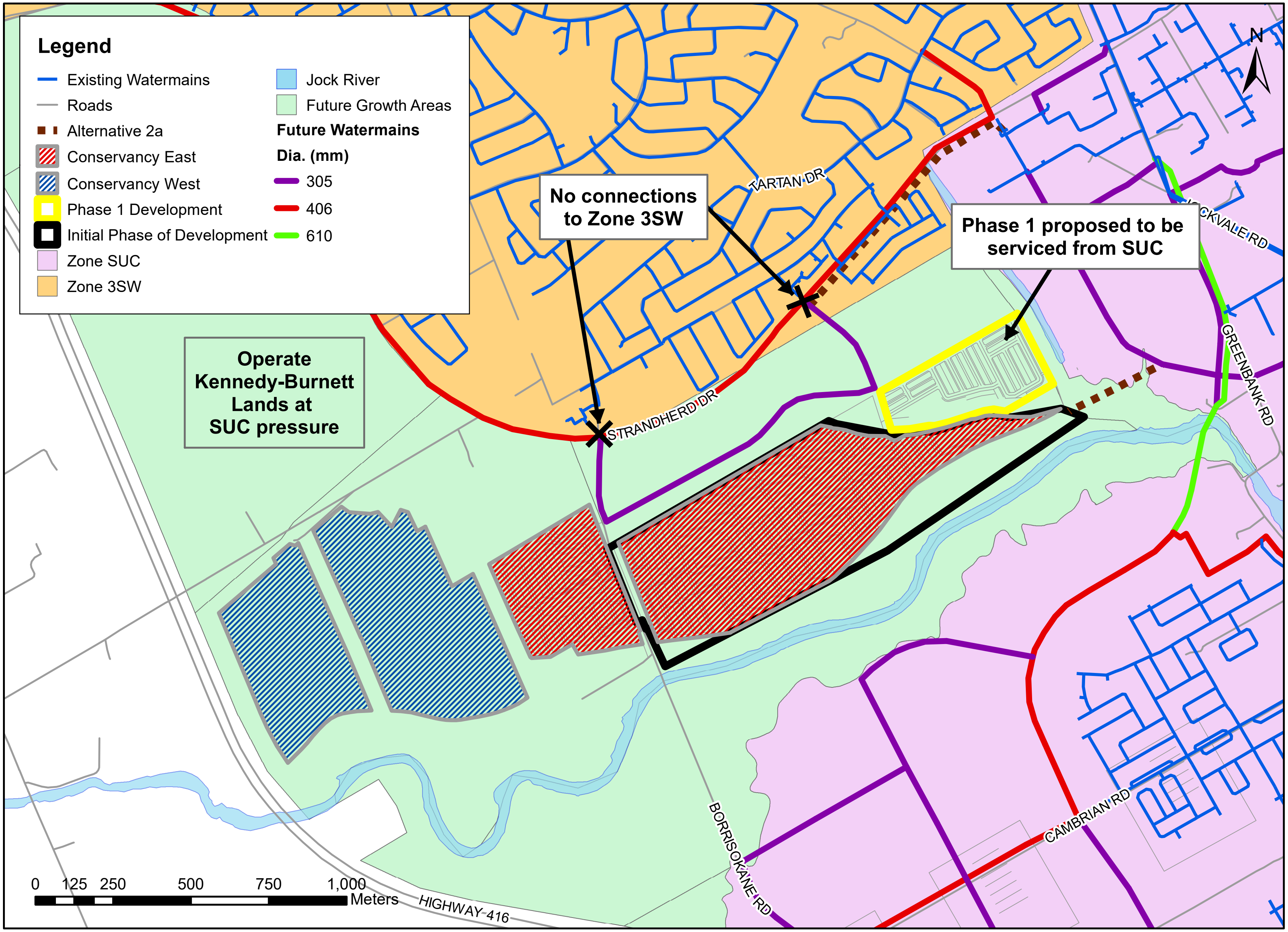


Figure 3: Alternative 2b - Servicing from Zone SUC (from Strandherd) w/ Secondary Feed from Barrhaven South

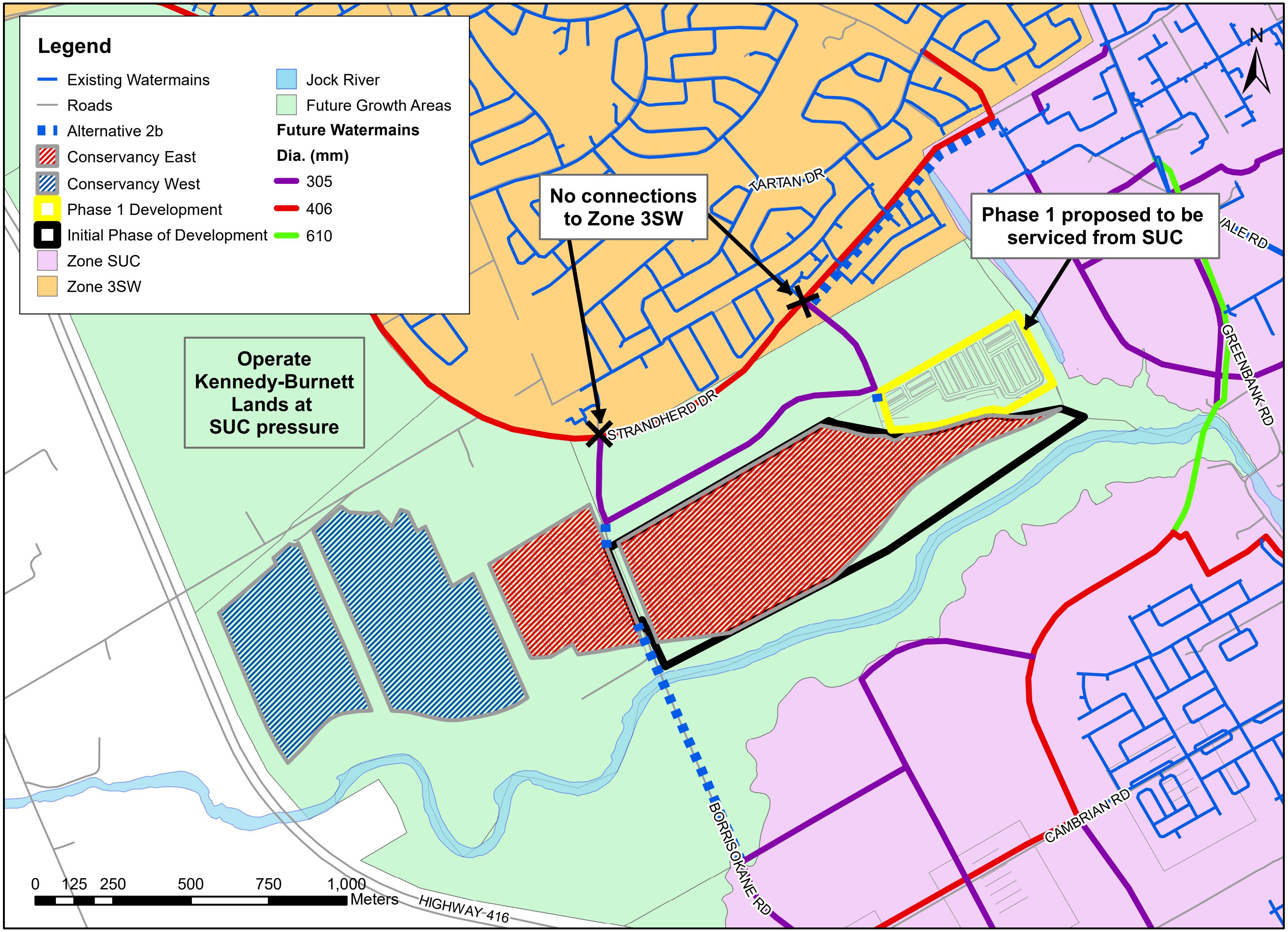


Figure 4: Alternative 2c - Servicing from Zone SUC (from NTC) w/ Secondary Feed from NTC

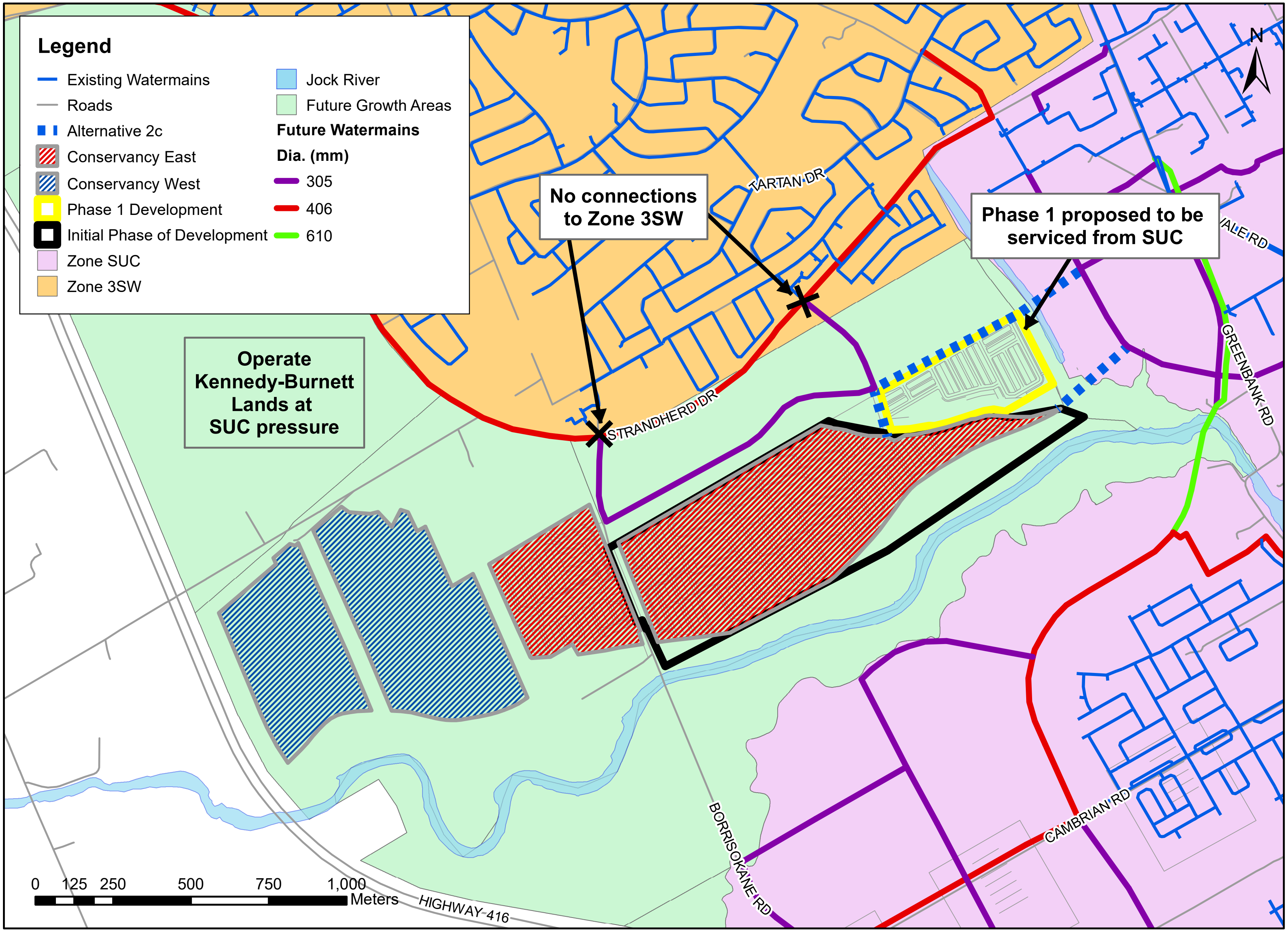
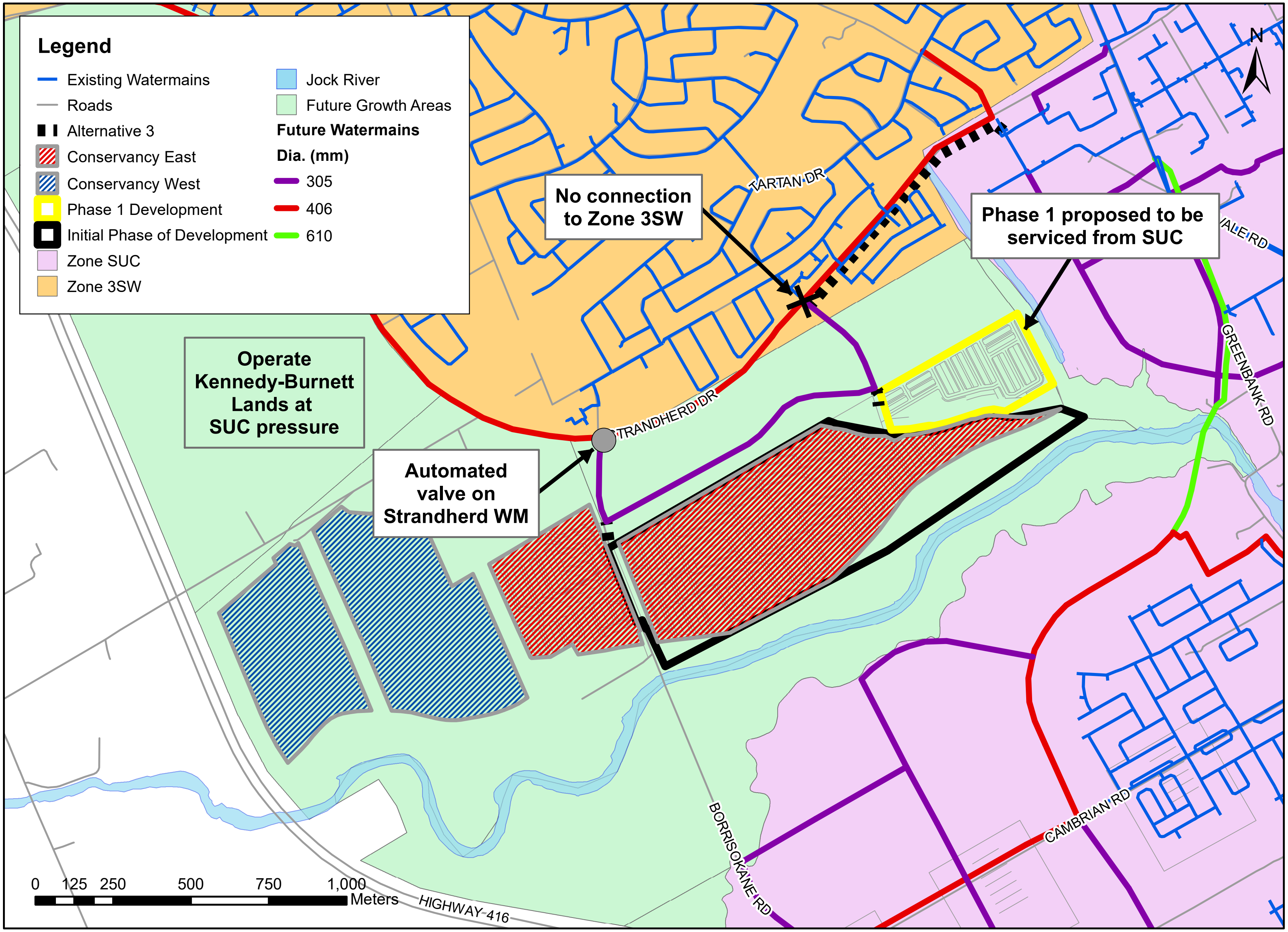


Figure 5: Alternative 3 - Servicing from Zone SUC w/ Automated Valve from 3SW for Emergency Conditions



Kennedy-Burnett Potable Water Master Servicing Study

Prepared for:
City of Ottawa
100 Constellation Crescent
Ottawa, ON K2G 6G8

Prepared by:
Stantec Consulting Ltd.
400-1331 Clyde Avenue
Ottawa, ON K2C 3G4

File No. 1634-01221

April 29, 2014

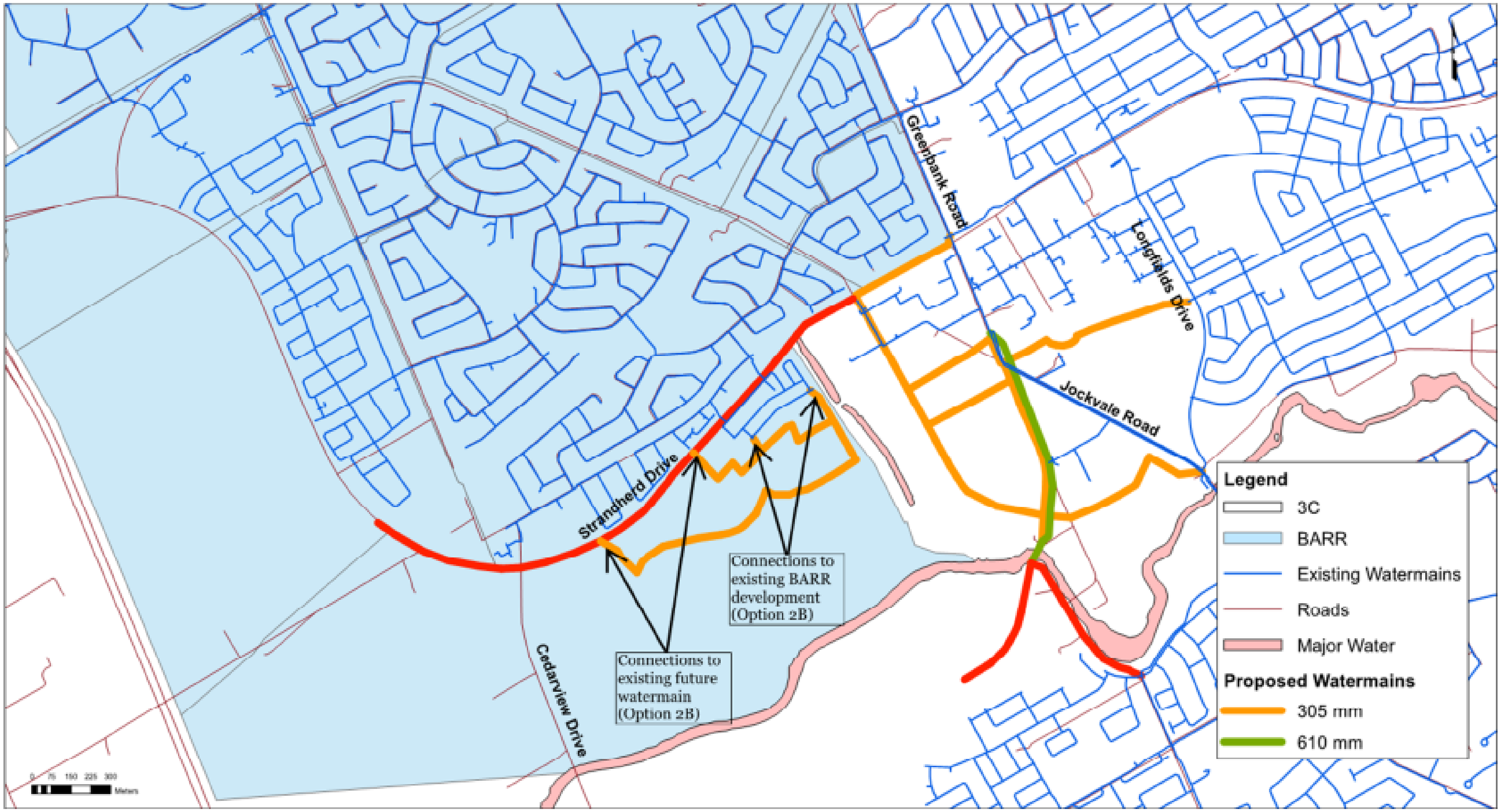
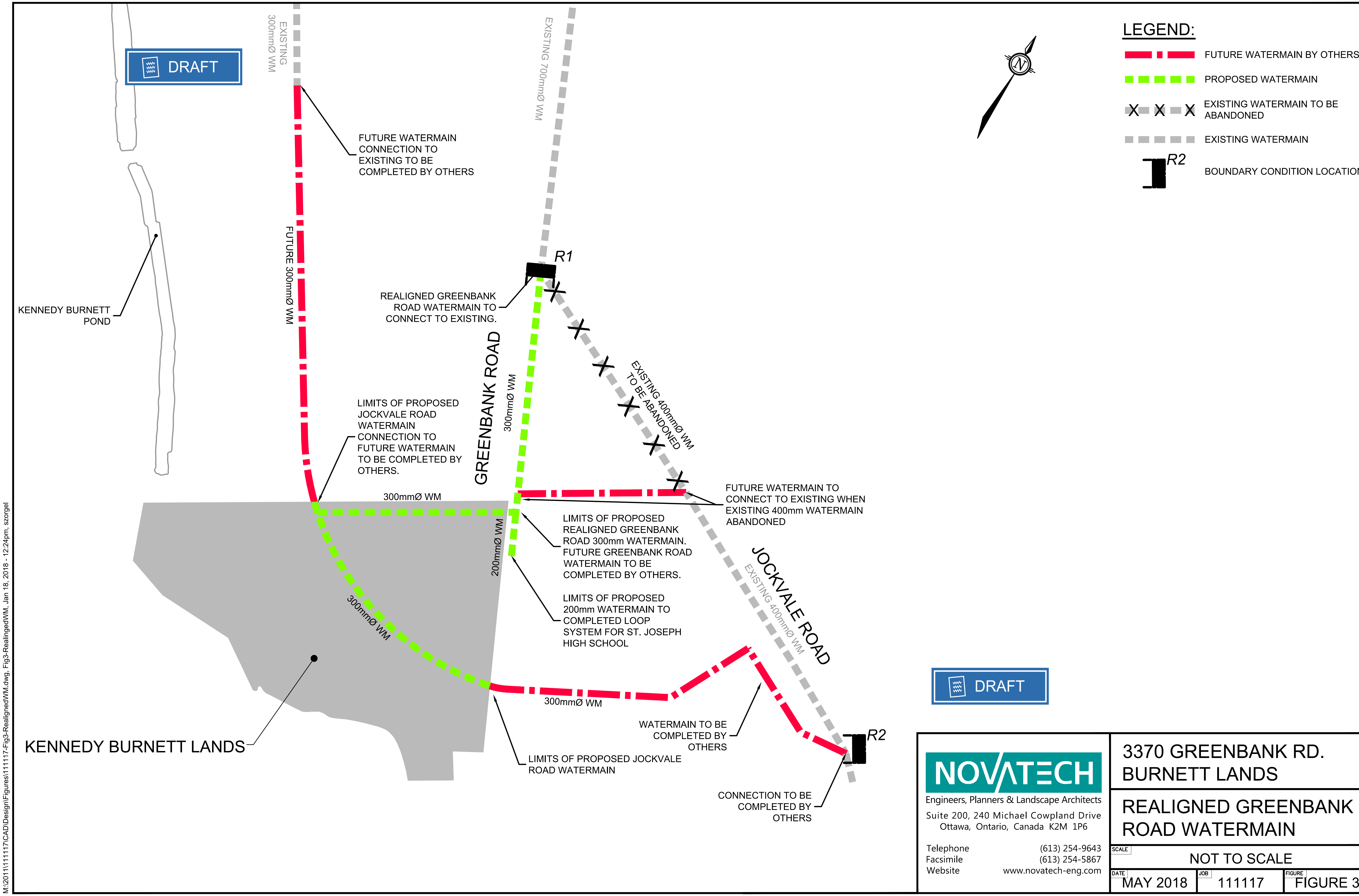


Figure 2-6: Proposed Pipe Layout Post Zone Reconfiguration – Scenario 2B



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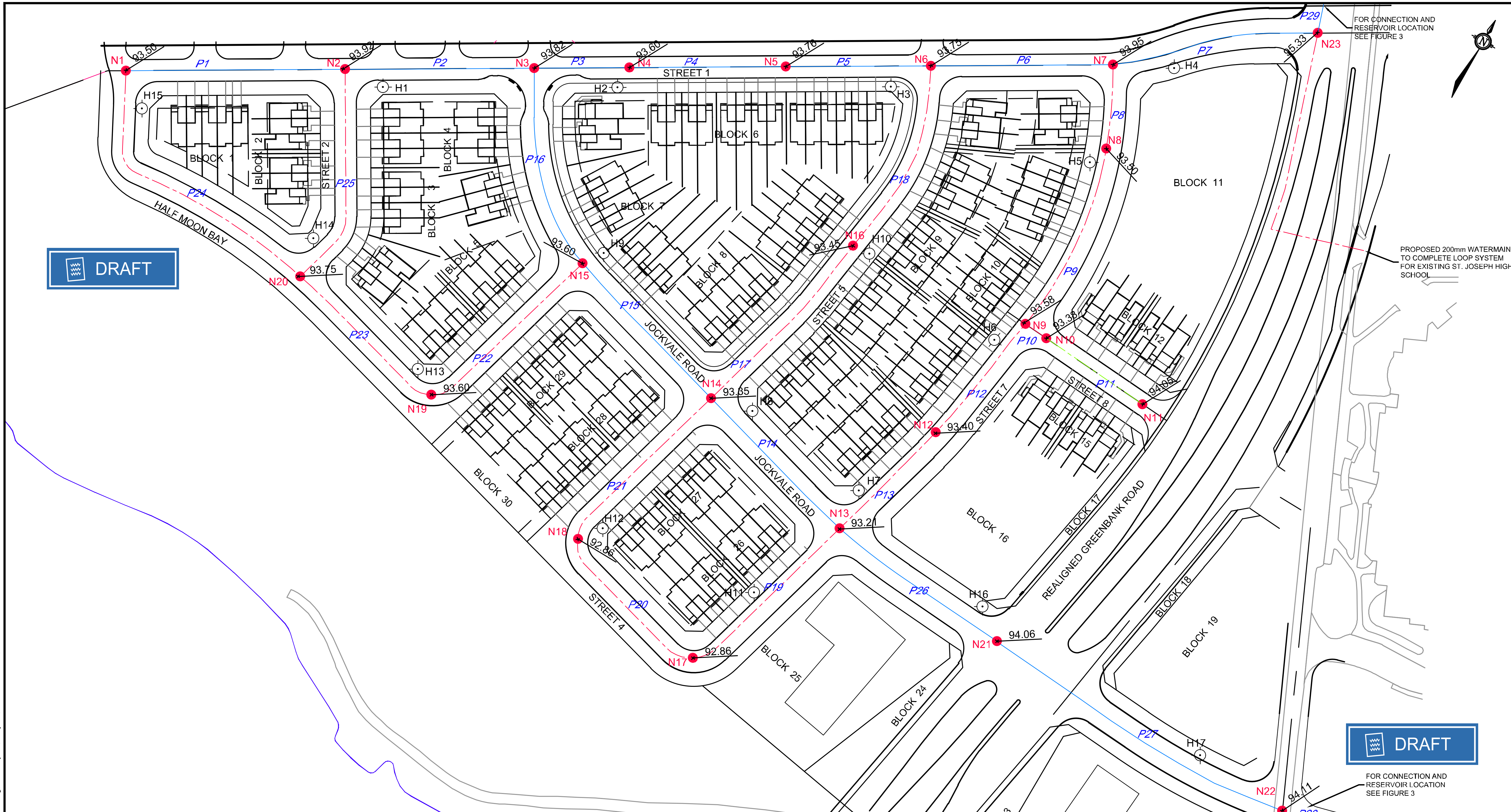
3370 GREENBANK RD.
BURNETT LANDS

REALIGNED GREENBANK ROAD WATERMAIN

SCALE		
NOT TO SCALE		
DATE MAY 2018	JOB 111117	FIGURE FIGURE 3



LEGEND

12	PROPOSED 50mmØ WATERMAIN PIPE
12	PROPOSED 200mmØ WATERMAIN PIPE
4	PROPOSED 300mmØ WATERMAIN PIPE
4	WATERMAIN NODE
	RESERVOIR
	HYDRANT
97.75	GROUND ELEVATION

FIREFLOWS CAN'T BE CAPPED

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3370 GREENBANK RD. BURNETT LANDS

WATERMAIN LAYOUT

SCALE	DATE	JOB	FIGURE
1:1500	MAY 2018	111117	FIGURE 4

APPENDIX E

SANITARY SERVICING

NOVATECH
Engineers, Planners & Landscape Architects

M E M O R A N D U M

DATE: MAY 30, 2019

TO: JOSÉE VALLEE – CITY OF OTTAWA

FROM: CONRAD STANG – NOVATECH

RE: STRANDHERD DRIVE WIDENING PROJECT
SOUTH NEPEAN COLLECTOR PHASE 3: SANITARY FLOW CALCULATIONS

CC: EDSON DONNELLY – NOVATECH

1.0 PURPOSE

This memorandum provides the sanitary sewer flow calculations and design sheet for Phase 3 of the proposed South Nepean Collector (SNC), as part of the Strandherd Drive Widening Project. Sanitary design flows have been estimated for both current-day operational flows and future development peak design flows. They are based on the latest available planning information for the vacant lands within the SNC sewershed.

2.0 BACKGROUND

In January 1998, the Master Servicing Study for the South Nepean Urban Area provided a conceptual plan for water, wastewater and stormwater infrastructure. The preferred alternative for wastewater servicing was an east/west trunk sewer alignment that was to be completed in several phases. The proposed sanitary trunk sewer was initially called the Jock River Collector, but was renamed the South Nepean Collector during the original functional design study completed in 2003.

Phase 1 of the South Nepean Collector was completed in 2005 and currently terminates at a 2400mm maintenance hole located east of Longfields Drive, north of Bren-Maur Road. Phase 2 was completed in 2016 and currently terminates at a 2400mm maintenance hole located at the intersection of Strandherd Drive and Fraser Fields Way.

Phase 3 will extend the trunk sewer along Strandherd Drive to the intersection of Kennevale Drive. Here it will connect with the existing sanitary trunk sewer that was constructed as part of the 2014 works to improve Strandherd Drive and develop the CitiGate Lands.

The sanitary sewer flows were previously documented in the *South Nepean Collector – Functional Design Report and Update* (Dillon, 2012). Novatech (2016) completed a Hydraulics Review / Assessment of the sanitary flows presented in the Dillion Report (attached). This was based on the latest planning information for the vacant lands within the SNC sewershed. The results of the Hydraulics Review / Assessment (Novatech, 2016) were similar to the results from the Dillion (2012) analysis.

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3.0 DESIGN PARAMETERS AND POPULATION ESTIMATES

3.1 Design Parameters

The sanitary design flow were calculated using the parameters from the City of Ottawa Sewer Design Guidelines (October 2012), revised per Technical Bulletin ISTB-2018-01 (March 2018). These parameters are summarized in **Table 1** and **Table 2**.

Table 1: Peak Design Flow Parameters

Land Use	Average Daily Flow	Peaking Factor	Peak Extraneous Flows
Residential	280 L/cap/day	Harmon Equation, K=0.8 (1.6 min – 3.2 max)	0.33 L/s/ha
Commercial	28,000 L/ha/day	1.0 – 1.5*	
Institutional	28,000 L/ha/day	1.0 – 1.5*	
Other†	0 L/ha/day	N/A	

**Peak Factor = 1.5 if contributing area is >20%; Peak Factor = 1.0 if contributing area is <20%*
†Open Space, Arterial ROW, SWM Blocks, etc. with no sanitary flow contribution (extraneous flow only)

Table 2: Operational Design Flow Parameters

Land Use	Average Daily Flow	Peaking Factor	Peak Extraneous Flows
Residential	200 L/cap/day	Harmon Equation, K=0.6 (1.2 min – 2.4 max)	0.30 L/s/ha
Commercial	17,000 L/ha/day	1.0 (non-coincident peak)	
Institutional	17,000 L/ha/day	1.0 (non-coincident peak)	

**There are no industrial areas identified within the tributary area.*

Harmon Equation $= 1 + \frac{14}{4+\left(\frac{P}{1000}\right)^{\frac{1}{2}}} \times K$

Where:
P = Population
K = Correction Factor:
- Peak Flow = 0.8
- Operational = 0.6

3.2 Land Use Designations & Population Estimates

Population densities and unit counts for future residential development are based on the Novatech (2016) Hydraulics Review / Assessment; refer to **Table 3**. They are based on the concept plans provided by the developers of the future residential areas.

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Table 3: Residential Land Use Population Densities

Residential Land Use	Units per ha	Persons per Unit	Persons per ha
Low Density (singles and semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row/townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

The land use designations shown in **Table 4** have been applied for the areas within Phases 2 & 3 of the SNC (Node 70 to 130). The Hydraulics Analysis / Review delineated the sewershed areas and land use designations using aerial photos (existing development) and conceptual site plans (future development).

Table 4: Land Use Designations

Land Use Designation	
Secondary Plan	**SNC Design**
Residential	Residential (Low / Medium / High Density)
Institutional / Office	Institutional
Commercial	Commercial
Recreational	
Business Park	
Prestige Business Park	
Park/Open Space Area	Other*
Ex. Snow Disposal Facility (future commercial)	
Stormwater Management Facility	
Conservation Lands	
Arterial Right-of-Ways	

** No sanitary flow contribution - extraneous flows (inflow/infiltration) only.*

The overall residential population estimate and sewershed area for Phases 2 and 3 of the SNC is provided in **Table 5** below. It is assumed that the snow dump facility at the Stranderd Drive and McKenna Casey Drive will ultimately be re-zoned for commercial development.

Table 5: Population Estimates and Areas

Existing / Future	Estimated Population / Area	Novatech (2015)
Existing	Estimated Population	6,944 persons
	Gross Residential Area	60.09 ha
	Gross Commercial / Institutional Area	64.37 ha
	Total Sewershed Area	124.5 ha
Future (full service)	Estimated Population	27,312 persons
	Gross Residential Area	248.48 ha
	Gross Commercial / Institutional Area	228.82 ha
	Total Sewershed Area	477.3 ha

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4.0 SANITARY DESIGN FLOWS

The sanitary flow allocations for Phases 2 and 3 of the SNC are provided in **Table 6**. The corresponding sanitary drainage area plan is provided as **Figure 1**. Sanitary sewer flow calculations for Phases 2 and 3 and detailed sanitary sewer design sheets for Phase 3 are attached to this memorandum.

The estimated sanitary design flows from Phase 3 of the SNC (entering Node 90) are as follows:

- Present-Day Operational Design Flows (Theoretical) = 55.1 L/s
- Future Peak Design Flows = 282.5 L/s

The outlet for Phase 3 of the SNC is the existing 900mm outlet pipe at the 2400mm maintenance hole (Node 90) located at the intersection of Strandherd Drive and Fraser Fields Way. Given a minimum design slope of 0.10%, this 900mm sanitary trunk sewer would have a full flow capacity of 597.2 L/s. Therefore, the downstream sanitary trunk sewer would be at 64% capacity, based on the future peak design flow being 282.5 L/s.

ATTACHMENTS:

- Figure 1: Sanitary Drainage Areas and Land Use
- Sanitary Sewer Flow Calculations
- Sanitary Sewer Design Sheets (Phase 3)
- South Nepean Collector Phase 2: Hydraulics Review / Assessment (Novatech, 2016)
- Excerpts from Dillion (2012)

LICENSED PROFESSIONAL ENGINEER
C. M. STANG
100125708
May 30/19
PROVINCE OF ONTARIO

Table 6: Updated Allocation of Commercial, Institutional and Residential Demands to Phases 2 & 3 (Nodes 70 – 130) of the SNC by Collection Area

Collection Area	Upstream Node	Existing / Proposed Development	Existing / Proposed Land Use	Area (ha)	Estimated Number of Residential Units	Population Density (persons / ha)	Comment	Reference
A1	130	Proposed	Commercial	12.80	-	-	O'Keefe Court – Conceptual site plan shows proposed commercial.	Conceptual Plans for O'Keefe Court
A2-A	130	Proposed	Commercial	85.18	-	-	CitiGate – Analysis uses same approach as the design for CitiGate.	Detailed Servicing and SWM Report (Phase 1) (Novatech, 2014)
A2-B	130	Proposed	Commercial	32.46	-	-		
A2-C	120	Proposed	Commercial (ex. Snow dump)	15.25	-	-	Existing snow dump facility assumed to be future commercial.	Functional Design Report and Update – SNC Phase 2 and 3 (Dillon, 2012)
A3-A	130	Proposed	Low Density Residential	16.18	461	95.2	Havencrest – Existing single family units.	Havencrest Design Report (IBI, 2013)
A3-B	130	Existing	Institutional	10.30	-	-	Cedarview Middle School and Cedarview Alliance Church.	Aerial Photos / Site Visits
A3-C	130	Existing	Medium Density Residential	5.19	311	162	Existing townhouse units.	
A3-D	130	Existing	Commercial	0.58	-	-	Existing commercial buildings.	
A3-E	130	Existing	Low Density Residential	35.68	999	95.2	Existing single family units.	
A3-F	130	Existing	Medium Density Residential	8.26	496	162.0	Existing townhouse units.	
A3-G	130	Existing	Institutional	0.90	-	-	Ottawa Torah Centre Chibad.	
A3-H	120	Existing	Low Density Residential	6.09	171	95.2	Existing single family units.	
A4	130	Existing	Low Density Residential	34.44	964	95.2	Existing single family units currently serviced by Jockvale pump station; to be redirected to SNC.	Functional Design Report and Update – SNC Phase 2 and 3 (Dillon, 2012); based on 2011 Census.
A5	110	Proposed	Commercial	17.72	-	-	Proposed commercial south of McKenna Casey Drive.	Site Visits
A6-A	100	Proposed	Commercial	15.18	-	-	Proposed commercial south of Srandherd Drive; east of Borrisokane Road.	Conceptual Plan for Lands Adjacent the Kennedy-Burnett SWMF provided by Minto (2015)
A6-B	100	Proposed	Institutional	6.05			Proposed school site on Minto property.	
A6-C	90	Existing	Medium Density Residential	4.87	292	162.0	Existing townhouse units.	Aerial Photos / Site Visits
A6-D	90	Proposed	Low Density Residential	17.56	492	95.2	Proposed single family units on lands owned by Minto / Mion.	Conceptual Plans for Lands Adjacent the Kennedy-Burnett SWMF provided by land owners.
A6-E	90	Proposed	Low Density Residential	6.94	203	95.2	Proposed single family units on lands owned by Pavic / Braovac.	
A7-A	80	Existing	Commercial	13.62	-	-	Existing large retail stores (commercial).	Aerial Photos
A7-B	80	Proposed	High Density Residential	11.01	826	135.0	Proposed high density units on lands owned by Richcraft / Trinity.	Conceptual Plans for Lands Adjacent the Kennedy-Burnett SWMF provided by land owners.
A7-C	80	Proposed	Medium Density Residential	6.97	418	162.0	Proposed Medium density units on lands owned by Mion.	
A7-D	80	Proposed	Medium Density Residential	11.74	704	162.0	Proposed Medium density units on lands owned by Caivan.	
A7-E1/E2	80	Proposed	Medium Density Residential	9.24	554	162.0	Proposed Medium density units on lands owned by Claridge.	
A8-A	80	Existing	Commercial	28.45	-	-	Existing Barrhaven Market Place (commercial).	Aerial Photos / Site Visits
A8-B	80	Proposed	High Density Residential	39.34	2951	135.0	Future development similar to Ampersands development.	Site Visits
A8-C	80	Existing	Institutional	10.52	-	-	Existing St. Joseph High School.	Aerial Photos / Site Visits
A8-D	80	Proposed	Low Density Residential	16.87	1012	162.0	Proposed 600 low density residential units.	Functional Design Report and Update – SNC Phase 2 and 3 (Dillon, 2012)

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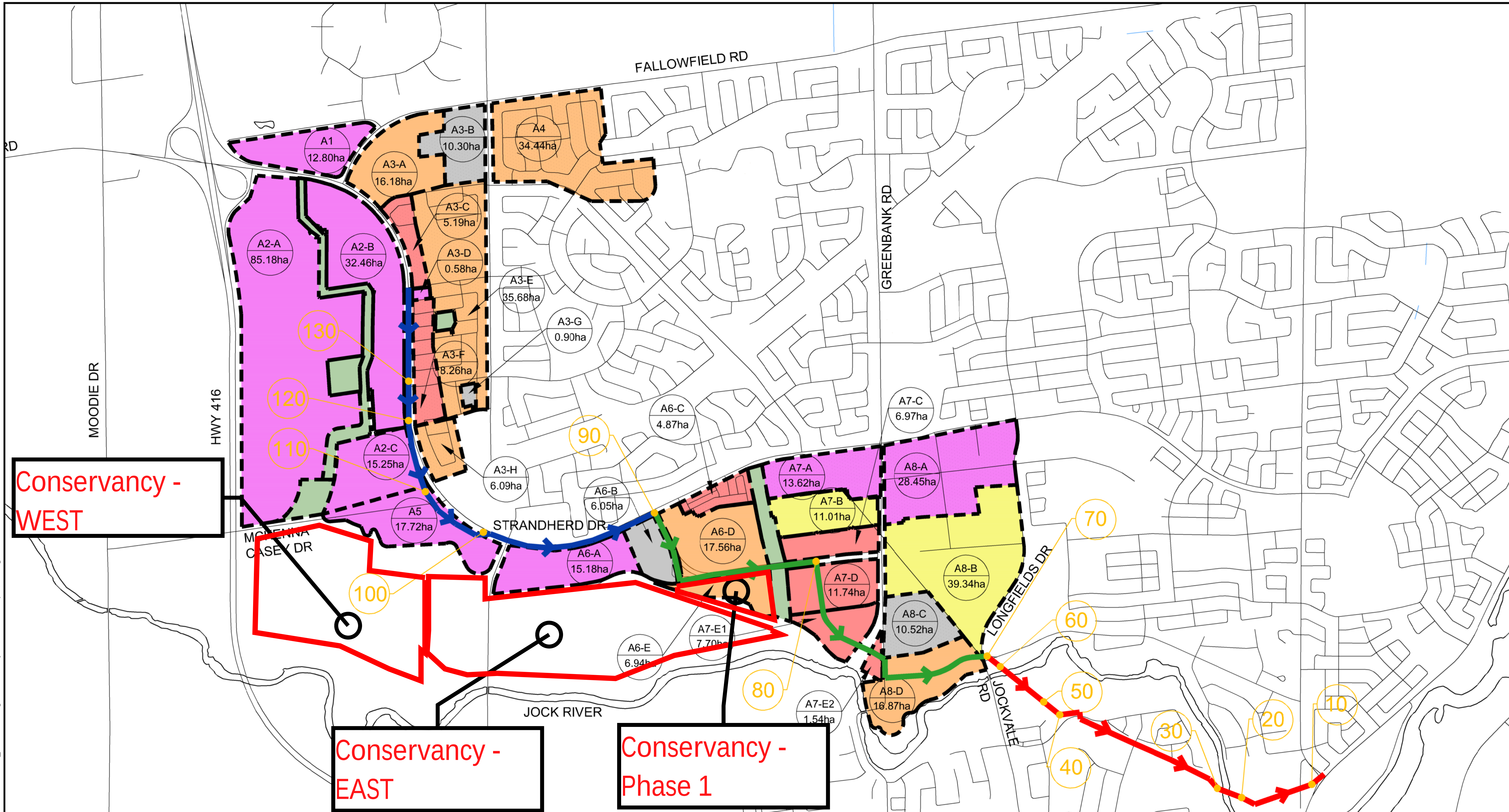

LEGEND

- EXISTING / PROPOSED HIGH DENSITY RESIDENTIAL
- EXISTING / PROPOSED MEDIUM DENSITY RESIDENTIAL
- EXISTING / PROPOSED LOW DENSITY RESIDENTIAL
- EXISTING / PROPOSED COMMERCIAL
- EXISTING / PROPOSED INSTITUTIONAL
- OTHER LANDS (OPEN SPACE, PARKS, AND SWMFS)
- SOUTH NEPEAN COLLECTOR PHASE 1
- SOUTH NEPEAN COLLECTOR PHASE 2
- SOUTH NEPEAN COLLECTOR PHASE 3
- 80 SOUTH NEPEAN COLLECTOR NODE ID

NOVATECH
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Website www.novatech-eng.com

SOUTH NEPEAN COLLECTOR SEWER

SANITARY DRAINAGE AREAS AND LAND USE

SCALE 1:20 000

DATE MAY 2019 | JOB 117190 | FIGURE FIG. 1

PROJECT #:	117190		**SANITARY SEWER DESIGN SHEET**	NOVATECH
DESIGNED BY:	CMS		**South Nepean Collector - Phase 2 & 3**	Engineers, Planners & Landscape Architects
CHECKED BY:	RJD			
DATE:	December 5, 2018		*Theoretical Current Operational Peak Wastewater Flow*	

Location			Areas				Population				Individual Design Flows			Cumulative Design Flows				
Area I.D.	Existing Land Use	Upstream Node	Gross Commercial Area (ha)	Gross Institutional Area (ha)	Gross Residential Area (ha)	Total Gross Area (ha)	Residential Popultation Density (people / ha)	Individual Residential Population	Cumulative Residential Population	Residential Peaking Factor (Harmon Eqn[1])	Commercial Peak Flow Rate[2] (17,000 L/ha/d) (L/s)	Institutional Peak Flow Rate[2] (17,000 L/ha/d) (L/s)	Infiltration / Inflow Rate (0.3 L/s/ha) (L/s)	Commercial (L/s)	Institutional (L/s)	Infiltration / Inflow (L/s)	Residential Peak Flow Rate (200 L/cap/d) (L/s)	Cumulative Peak Design Flow (L/s)
A1	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A2-A	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A2-B	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A3-A	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A3-B	Institutional	130		10.30		10.30					0.0	2.0	3.1	0.0	2.0	3.1	0.0	5.1
A3-C	Medium Density Residential	130			5.19	5.19	162.0	841	841	2.40	0.0	0.0	1.6	0.0	2.0	4.6	4.7	11.3
A3-D	Commercial	130	0.58			0.58			841	2.40	0.1	0.0	0.2	0.1	2.0	4.8	4.7	11.6
A3-E	Low Density Residential	130			35.68	35.68	95.2	3397	4238	2.39	0.0	0.0	10.7	0.1	2.0	15.5	23.4	41.1
A3-F	Medium Density Residential	130			8.26	8.26	162	1338	5576	2.32	0.0	0.0	2.5	0.1	2.0	18.0	29.9	50.1
A3-G	Institutional	130		0.90		0.90			5576	2.32	0.0	0.2	0.3	0.1	2.2	18.3	29.9	50.5
A4	Low Density Residential*	130				0.00			5576	2.32	0.0	0.0	0.0	0.1	2.2	18.3	29.9	50.5
A2-C	Snow Dump Facility	120				0.00			5576	2.32	0.0	0.0	0.0	0.1	2.2	18.3	29.9	50.5
A3-H	Low Density Residential	120			6.09	6.09	95.2	580	6155	2.30	0.0	0.0	1.8	0.1	2.2	20.1	32.7	55.1
A5	Open Space	110				0.00			6155	2.30	0.0	0.0	0.0	0.1	2.2	20.1	32.7	55.1
A6-A	Open Space	100				0.00			6155	2.30	0.0	0.0	0.0	0.1	2.2	20.1	32.7	55.1
A6-B	Open Space	100				0.00			6155	2.30	0.0	0.0	0.0	0.1	2.2	20.1	32.7	55.1
A6-C	Medium Density Residential	90			4.87	4.87	162.0	789	6944	2.27	0.0	0.0	1.5	0.1	2.2	21.6	36.4	60.3
A6-D	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	0.1	2.2	21.6	36.4	60.3
A6-E	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	0.1	2.2	21.6	36.4	60.3
A7-A	Commercial	90	13.62			13.62			6944	2.27	2.7	0.0	4.1	2.8	2.2	25.6	36.4	67.1
A7-B	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	2.2	25.6	36.4	67.1
A7-C	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	2.2	25.6	36.4	67.1
A7-D	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	2.2	25.6	36.4	67.1
A7-E1/E2	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	2.2	25.6	36.4	67.1
A8-A	Commercial	80	28.45			28.45			6944	2.27	5.6	0.0	8.5	8.4	2.2	34.2	36.4	81.2
A8-B	Open Space	80				0.00			6944	2.27	0.0	0.0	0.0	8.4	2.2	34.2	36.4	81.2
A8-C	Institutional	80		10.52		10.52			6944	2.27	0.0	2.1	3.2	8.4	4.3	37.3	36.4	86.4
A8-D	Open Space	80				0.00			6944	2.27	0.0	0.0	0.0	8.4	4.3	37.3	36.4	86.4
ROW Along SNC Sewer Alignment	-	80				14.34			6944	2.27	0.0	0.0	4.3	8.4	4.3	41.6	36.4	90.7
TOTAL		***80***	***42.65***	***21.72***	***60.09***	***138.80***	***-***	***6944***	***6944***	***2.27***	***8.4***	***4.3***	***41.6***	***8.4***	***4.3***	***41.6***	***36.4***	***90.7***

Residential Land Use	Population Density (Units / ha)	Persons per Unit	Persons per ha
Low Density (singles and semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row/townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

Notes:

1. Harmon Equation = 1 + [14 / (4+$(P/1000)^{1/2}$)] x K

Where: P = population; K = correction factor = 0.6

2. Instituional / Commercial Peaking Factor = 1.0

Reported Design Flows / Assumptions:

1. Area A4: Existing single family units currently serviced by Jockvale pump station; currently not directed to SNC

PROJECT #: 117190
DESIGNED BY: CMS
CHECKED BY: RJD
DATE: December 5, 2018

SANITARY SEWER DESIGN SHEET

South Nepean Collector - Phase 2 & 3

Theoretical Future Full Service Peak Wastewater Flow

NOVATECH
Engineers, Planners & Landscape Architects

Location			Areas				Population				Individual Design Flows			Cumulative Design Flows				
Area I.D.	Existing / Proposed Land Use	Upstream Node	Gross Commercial Area (ha)	Gross Institutional Area (ha)	Gross Residential Area (ha)	Total Gross Area (ha)	Residential Popultation Density (people / ha)	Individual Residential Population	Cumulative Residential Population	Residential Peaking Factor (Harmon Eqn[1])	Commercial Peak Flow Rate[2] (28,000 L/ha/d) (L/s)	Institutional Peak Flow Rate[2] (28,000 L/ha/d) (L/s)	Infiltration / Inflow Rate (0.33 L/s/ha) (L/s)	Commercial (L/s)	Institutional (L/s)	Infiltration / Inflow (L/s)	Residential Peak Flow Rate (280 L/cap/d) (L/s)	Cumulative Peak Design Flow (L/s)
A1	Commercial	130	12.80			12.80					6.2	0.0	4.2	6.2	0.0	4.2	0.0	10.4
A2-A	Commercial	130	85.18			85.18					41.4	0.0	28.1	47.6	0.0	32.3	0.0	80.0
A2-B	Commercial	130	32.46			32.46					15.8	0.0	10.7	63.4	0.0	43.0	0.0	106.5
A3-A	Low Density Residential	130			16.18	16.18	95.2	1540	1540	3.14	0.0	0.0	5.3	63.4	0.0	48.4	15.7	127.5
A3-B	Institutional	130		10.30		10.30			1540	3.14	0.0	3.3	3.4	63.4	3.3	51.8	15.7	134.2
A3-C	Medium Density Residential	130			5.19	5.19	162.0	841	2381	3.02	0.0	0.0	1.7	63.4	3.3	53.5	23.3	143.6
A3-D	Commercial	130	0.58			0.58			2381	3.02	0.3	0.0	0.2	63.7	3.3	53.7	23.3	144.0
A3-E	Low Density Residential	130			35.68	35.68	95.2	3397	5778	2.75	0.0	0.0	11.8	63.7	3.3	65.5	51.5	184.0
A3-F	Medium Density Residential	130			8.26	8.26	162	1338	7116	2.68	0.0	0.0	2.7	63.7	3.3	68.2	61.8	197.0
A3-G	Institutional	130		0.90		0.90			7116	2.68	0.0	0.3	0.3	63.7	3.6	68.5	61.8	197.6
A4	Low Density Residential	130			34.44	34.44	95.2	3279	10395	2.55	0.0	0.0	11.4	63.7	3.6	79.9	85.9	233.1
A2-C	Commercial (ex. snow dump)	120	15.25			15.25			10395	2.55	7.4	0.0	5.0	71.1	3.6	84.9	85.9	245.5
A3-H	Low Density Residential	120			6.09	6.09	95.2	580	10974	2.53	0.0	0.0	2.0	71.1	3.6	86.9	90.0	251.7
A5	Commercial	110	17.72			17.72			10974	2.53	8.6	0.0	5.8	79.7	3.6	92.7	90.0	266.1
A6-A	Commercial	100	15.18			15.18			10974	2.53	7.4	0.0	5.0	87.1	3.6	97.7	90.0	278.5
A6-B	Institutional	100		6.05		6.05			10974	2.53	0.0	2.0	2.0	87.1	5.6	99.7	90.0	282.5
A6-C	Medium Density Residential	90			4.87	4.87	162.0	789	11763	2.51	0.0	0.0	1.6	87.1	5.6	101.4	95.6	289.6
A6-D	Low Density Residential	90			17.56	17.56	95.2	1672	13435	2.46	0.0	0.0	5.8	87.1	5.6	107.1	107.2	307.0
A6-E	Low Density Residential	90			6.94	6.94	95.2	661	14096	2.44	0.0	0.0	2.3	87.1	5.6	109.4	111.7	313.8
A7-A	Commercial	90	13.62			13.62			14096	2.44	6.6	0.0	4.5	93.7	5.6	113.9	111.7	324.9
A7-B	High Density Residential	90			11.01	11.01	135.0	1486	15582	2.41	0.0	0.0	3.6	93.7	5.6	117.6	121.7	338.5
A7-C	Medium Density Residential	90			6.97	6.97	162.0	1129	16711	2.38	0.0	0.0	2.3	93.7	5.6	119.9	129.2	348.3
A7-D	Medium Density Residential	90			11.74	11.74	162.0	1902	18613	2.35	0.0	0.0	3.9	93.7	5.6	123.7	141.6	364.6
A7-E1/E2	Medium Density Residential	90			9.24	9.24	162.0	1497	20110	2.32	0.0	0.0	3.0	93.7	5.6	126.8	151.2	377.3
A8-A	Commercial	80	28.45			28.45			20110	2.32	13.8	0.0	9.4	107.5	5.6	136.2	151.2	400.5
A8-B	High Density Residential	80			39.34	39.34	135.0	5311	25421	2.24	0.0	0.0	13.0	107.5	5.6	149.2	184.4	446.7
A8-C	Institutional	80		10.52		10.52			25421	2.24	0.0	3.4	3.5	107.5	9.0	152.6	184.4	453.6
A8-D	Low Density Residential	80			16.87	16.87	120.9	2040	27461	2.21	0.0	0.0	5.6	107.5	9.0	158.2	196.9	471.6
ROW Along SNC Sewer Alignment	-	80				14.34			27461	2.21	0.0	0.0	4.7	107.5	9.0	162.9	196.9	476.3
TOTAL		***80***	***221.24***	***27.77***	***230.38***	***493.73***	***-***	***27461***	***27461***	***2.21***	***107.5***	***9.0***	***162.9***	***107.5***	***9.0***	***162.9***	***196.9***	***476.3***

Residential Land Use	Population Density (Units / ha)	Persons per Unit	Persons per ha
Low Density (singles and semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row/townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

Notes:

1. Harmon Equation = $1 + [14 / (4+(P/1000)^{1/2})] \times K$

Where: P = population; K = correction factor = 0.8

2. Commercial Peaking Factor = 1.5; Institutional Peaking Factor = 1.0

Reported Design Flows / Assumptions:

1. Area A4: Existing single family units currently serviced by Jockvale pump station to be redirected to SNC

2. Area A8-D: proposed 600 medium density residential units

See Note (2) in the DSEL "Barrhaven Conservancy - Evaluation of SNC Flows" design sheet

THE PRIOR NOVATECH SNC DESIGN SHEET HAD FLOWS AT **423.6 L/s** AFTER AREA ID "A6-E".

THIS UPDATED NOVATECH 'PHASE 3' EVALUATION HAS A FLOW OF **313.8 L/s**.

THE DSEL EVALUATION OF SANITARY FLOWS WITH THE NEW CITY DESIGN PARAMETERS AT THIS SAME NODE (WITH CONSERVANCY WEST AND EAST INCLUDED) IS **~401.58 L/s** (WHICH IS LESS THAN THE PRIOR **423.6 L/s** NOTED ABOVE)

SOUTH NEPEAN COLLECTOR (PHASE 3)
SANITARY SEWER DESIGN SHEET

DECEMBER 5 2018
JOB# 117190

NOVATECH
Engineers, Planners & Landscape Architects

LOCATION			Area				Population		Cumulative Design Flows					PROPOSED SEWER						
From MH	To MH	Upstream Node	Gross Commercial Area (ha)	Gross Institutional Area (ha)	Gross Residential Area (ha)	Total Gross Area (ha)	Cumulative Residential Population	Residential Peaking Factor (Harmon Eqn[1])	Commercial (L/s)	Institutional (L/s)	Infiltration / Inflow (L/s)	Residential Peak Flow Rate (280 L/cap/d) (L/s)	Cumulative Peak Design Flow (L/s)	Length (m)	Pipe Size (mm)	Type	Slope %	Capacity (L/s)	Full Flow Velocity (m/s)	Ratio (Q/Qfull)
SA 22	SA 21	120	146.27	11.20	105.84	263.31	10974	2.53	71.1	3.6	86.9	90.0	251.7	131.9	750	CONC	0.10	367.3	0.81	69%
SA 21	SA 20	120											251.7	90.6	750	CONC	0.10	367.3	0.81	69%
SA 20	SA 19	120											251.7	90.0	750	CONC	0.10	367.3	0.81	69%
SA 19	SA 18	120											251.7	72.1	750	CONC	0.10	367.3	0.81	69%
SA 18	SA 17	120											251.7	71.9	750	CONC	0.10	367.3	0.81	69%
SA 17	SA 16	120											251.7	71.4	750	CONC	0.10	367.3	0.81	69%
SA 16	SA 15	110	163.99	11.20	105.84	281.03	10974	2.53	79.7	3.6	92.7	90.0	266.1	73.2	750	CONC	0.10	367.3	0.81	72%
SA 15	SA 14	110											266.1	67.5	750	CONC	0.10	367.3	0.81	72%
SA 14	SA 13	110											266.1	56.6	750	CONC	0.10	367.3	0.81	72%
SA 13	SA 12	110											266.1	133.5	750	CONC	0.10	367.3	0.81	72%
SA 12	SA 11	110											266.1	150.0	750	CONC	0.10	367.3	0.81	72%
SA 11	SA 10	100	179.17	17.25	105.84	302.26	10974	2.53	87.1	5.6	99.7	90.0	282.5	97.8	750	CONC	0.10	367.3	0.81	77%
SA 10	SA 9	100											282.5	76.7	750	CONC	0.10	367.3	0.81	77%
SA 9	SA 8	100											282.5	79.7	750	CONC	0.10	367.3	0.81	77%
SA 8	SA 7	100											282.5	75.3	750	CONC	0.10	367.3	0.81	77%
SA 7	SA 6	100											282.5	84.9	750	CONC	0.10	367.3	0.81	77%
SA 6	SA 5	100											282.5	77.1	750	CONC	0.10	367.3	0.81	77%
SA 5	SA 4	100											282.5	78.9	750	CONC	0.10	367.3	0.81	77%
SA 4	SA 3	100											282.5	80.5	750	CONC	0.10	367.3	0.81	77%
SA 3	SA 2	100											282.5	150.0	750	CONC	0.10	367.3	0.81	77%
SA 2	SA 1	100											282.5	114.6	750	CONC	0.10	367.3	0.81	77%
SA 1	*EX 80*	100											282.5	12.4	750	CONC	0.10	367.3	0.81	77%

Design Parameters:

Residential Land Use	Population Density (Units / ha)	Persons per Unit	Persons per ha
Low Density (singles / semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row / townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

Notes:

1. Harmon Equation = 1 + [14 / (4+(P/1000)$^{1/2}$)] x K

Where: P = population; K = correction factor = 0.8

2. Commercial Peaking Factor = 1.5; Institutional Peaking Factor = 1.0

Reported Design Flows / Assumptions:

1. Area A4: Existing single family units currently serviced by Jockvale pump station to be redirected to SNC

2. Area A8-D: proposed 600 medium density residential units

NOVATECH
Engineers, Planners & Landscape Architects

M E M O R A N D U M

DATE: MAY 26, 2016

TO: JONATHAN KNOYLE – CITY OF OTTAWA

FROM: CONRAD STANG – NOVATECH

RE: SOUTH NEPEAN COLLECTOR PHASE 2: SANITARY FLOW CALCULATIONS

CC: EDSON DONNELLY – NOVATECH

1.0 PURPOSE

This memorandum provides the sanitary sewer flow calculations and design sheet for Phase 2 of the proposed South Nepean Collector (SNC). Sanitary design flows have been estimated for both current-day operational flows and future development peak design flows, based on the latest available planning information for the vacant lands within the SNC sewershed.

2.0 BACKGROUND

In January 1998, the Master Servicing Study for the South Nepean Urban Area provided a conceptual plan for water, wastewater and stormwater infrastructure. The preferred alternative for wastewater servicing was an east/west trunk sewer alignment that was to be completed in several phases. The proposed sanitary trunk sewer was initially called the Jock River Collector, but was renamed the South Nepean Collector during the original functional design study completed in 2003.

Phase 1 of the South Nepean Collector was completed in 2005 and currently terminates at a 2400mm maintenance hole located east of Longfields Drive, north of Bren-Maur Road. Phase 2 will extend the trunk sewer to Strandherd Drive at the intersection of the proposed transitway along the proposed extension to Chapman Mills Drive. Phase 3 will extend the trunk sewer along Strandherd Drive to the intersection of Maravista Drive.

The sanitary sewer flows were previously documented in the *South Nepean Collector – Functional Design Report and Update* (Dillon, 2012). A review of the sanitary flows provided in the Dillion Report based on the latest planning information for the vacant lands within the SNC sewershed was documented in the technical memorandum titled South Nepean Collector Phase 2: Hydraulics Review / Assessment (Novatech, 2015), which is attached to this memorandum. The results of the Hydraulics Review / Assessment (Novatech, 2015) were very similar to the results from the Dillion (2012) analysis.

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3.0 DESIGN PARAMETERS AND POPULATION ESTIMATES

3.1 Design Parameters

The sanitary design flow were calculated using the parameters from the City of Ottawa Sewer Design Guidelines (October 2012), and are summarized in **Table 1** and **Table 2**.

Table 1: Peak Design Flow Parameters

Land Use	Average Daily Flow	Peaking Factor	Peak Extraneous Flows
Residential	350 L/cap/day	Harmon Equation, K=1 (2.0 min – 4.0 max)	0.28 L/s/ha
Commercial	50,000 L/ha/day	1.5	
Institutional	50,000 L/ha/day	1.5	
Other*	0 L/ha/day	N/A	

**Open Space, Arterial ROW, SWM Blocks, etc. with no sanitary flow contribution (extraneous flow only)*

Table 2: Operational Design Flow Parameters

Land Use	Average Daily Flow	Peaking Factor	Peak Extraneous Flows
Residential	300 L/cap/day	Harmon Equation, K=0.6 (1.2 min – 2.4 max)	Dry weather 0.05-0.08 L/s/ha Wet Weather 0.15 - 0.20 L/s/ha (typical events) 0.28 L/s/ha (large/annual events) 0.30 - 0.50 L/s/ha (extreme events)
Commercial	17,000 L/ha/day	1.0 (non-coincident peak)	
Institutional	10,000 L/ha/day	1.0 (non-coincident peak)	

**There are no industrial areas identified within the tributary area.*

$$\text{Harmon Equation} = 1 + \frac{14}{4 + \left(\frac{P}{1000}\right)^{\frac{1}{2}}} \times K$$

Where:

P = Population

K = Correction Factor:

- Peak Flow = 1
- Operational = between 0.4 to 0.6 (0.6 used)

3.2 Land Use Designations & Population Estimates

Population densities and unit counts for future residential development are based on the current concept plans for these areas, and are presented in **Table 3**.

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Table 3: Residential Land Use Population Densities

Residential Land Use	Units per ha	Persons per Unit	Persons per ha
Low Density (singles and semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row/townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

The land use designations shown in **Table 4** have been applied for the areas within Phases 2 and 3 of the SNC (Node 70 to 130). The sewershed areas and land use designations were delineated using aerial photos (existing development) and conceptual site plans (future development).

Table 4: Land Use Designations

Land Use Designation	
Secondary Plan	**SNC Design**
Residential	Residential (Low / Medium / High Density)
Institutional / Office	Institutional
Commercial	Commercial
Recreational	
Business Park	
Prestige Business Park	
Park/Open Space Area	Other*
Ex. Snow Disposal Facility (future commercial)	
Stormwater Management Facility	
Conservation Lands	
Arterial Right-of-Ways	

** No sanitary flow contribution - extraneous flows (inflow/infiltration) only.*

The overall residential population estimate and sewershed area for Phases 2 and 3 of the SNC is provided in **Table 5** below. It is assumed that the snow dump facility at the Stranderd Drive and McKenna Casey Drive will ultimately be re-zoned for commercial development.

Table 5: Population Estimates and Areas

Existing / Future	Estimated Population / Area	Novatech (2015)
Existing	Estimated Population	6,944 persons
	Gross Residential Area	60.09 ha
	Gross Commercial / Institutional Area	64.37 ha
	Total Sewershed Area	124.5 ha
Future (full service)	Estimated Population	27,312 persons
	Gross Residential Area	248.48 ha
	Gross Commercial / Institutional Area	228.82 ha
	Total Sewershed Area	477.3 ha

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4.0 SANITARY DESIGN FLOWS

The sanitary flow allocations for Phases 2 and 3 of the SNC are provided in **Table 6**. The corresponding sanitary drainage area plan is provided as **Figure 1**. Sanitary sewer flow calculations for Phases 2 and 3 and detailed sanitary sewer design sheets for Phase 2 are attached to this memorandum.

The estimated sanitary design flows from Phases 2 and 3 of the SNC (entering Node 70) are as follows:

- Present-Day Operational Design Flows (Theoretical) = 72.5 L/s
- Future Peak Design Flows = 634.2 L/s

The outlet for Phase 2 of the SNC is the existing 1050mm outlet pipe at the 2400mm maintenance hole (Node 70) located east of Longfields Drive, north of Bren-Maur Road. Given a minimum design slope of 0.10%, this sanitary trunk sewer would have a full flow capacity of 900.5 L/s. Therefore, the downstream sanitary trunk sewer would be at 70% capacity, based on the future peak design flow being 634.2 L/s.

ATTACHMENTS:

- Figure 1: Sanitary Drainage Areas and Land Use
- Sanitary Sewer Flow Calculations
- Sanitary Sewer Design Sheets (Phase 2)
- South Nepean Collector Phase 2: Hydraulics Review / Assessment (Novatech, 2015)

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Table 6: Updated Allocation of Commercial, Institutional and Residential Demands to Phases 2 & 3 (Nodes 70 – 130) of the SNC by Collection Area

Collection Area	Upstream Node	Existing / Proposed Development	Existing / Proposed Land Use	Area (ha)	Estimated Number of Residential Units	Population Density (persons / ha)	Comment	Reference
A1	130	Proposed	Commercial	12.80	-	-	O'Keefe Court – Conceptual site plan shows proposed commercial.	Conceptual Plans for O'Keefe Court
A2-A	130	Proposed	Commercial	85.18	-	-	CitiGate – Analysis uses same approach as the design for CitiGate.	Detailed Servicing and SWM Report (Phase 1) (Novatech, 2014)
A2-B	130	Proposed	Commercial	32.46	-	-		
A2-C	120	Proposed	Commercial (ex. Snow dump)	15.25	-	-	Existing snow dump facility assumed to be future commercial.	Functional Design Report and Update – SNC Phase 2 and 3 (Dillon, 2012)
A3-A	130	Proposed	Low Density Residential	16.48	461	95.2	Havencrest – Existing single family units.	Havencrest Design Report (IBI, 2013)
A3-B	130	Existing	Institutional	10.30	-	-	Cedarview Middle School and Cedarview Alliance Church.	Aerial Photos / Site Visits
A3-C	130	Existing	Medium Density Residential	5.19	311	162	Existing townhouse units.	
A3-D	130	Existing	Commercial	0.58	-	-	Existing commercial buildings.	
A3-E	130	Existing	Low Density Residential	35.68	999	95.2	Existing single family units.	
A3-F	130	Existing	Medium Density Residential	8.26	496	162.0	Existing townhouse units.	
A3-G	130	Existing	Institutional	0.90	-	-	Ottawa Torah Centre Chibad.	
A3-H	120	Existing	Low Density Residential	6.09	171	95.2	Existing single family units.	
A4	130	Existing	Low Density Residential	34.44	964	95.2	Existing single family units currently serviced by Jockvale pump station; to be redirected to SNC.	Functional Design Report and Update – SNC Phase 2 and 3 (Dillon, 2012); based on 2011 Census.
A5	110	Proposed	Commercial	17.72	-	-	Proposed commercial south of McKenna Casey Drive.	Site Visits
A6-A	100	Proposed	Institutional	20.70	-	-	Proposed school site on Minto property.	Conceptual Plan for Lands Adjacent the Kennedy-Burnett SWMF provided by Minto (2015)
A6-B	90	Existing	Medium Density Residential	4.87	292	162.0	Existing townhouse units.	Aerial Photos / Site Visits
A6-C	90	Proposed	Low Density Residential	10.11	283	95.2	Proposed single family units on lands owned by Minto.	Conceptual Plans for Lands Adjacent the Kennedy-Burnett SWMF provided by land owners.
A6-D	90	Proposed	Low Density Residential	5.59	157	95.2	Proposed single family units on lands owned by Mion.	
A6-E	90	Proposed	Low Density Residential	7.24	203	95.2	Proposed single family units on lands owned by Pavic / Braovac.	
A7-A	80	Existing	Commercial	13.62	-	-	Existing large retail stores (commercial).	Aerial Photos
A7-B	80	Proposed	High Density Residential	11.01	826	135.0	Proposed high density units on lands owned by Richcraft / Trinity.	Conceptual Plans for Lands Adjacent the Kennedy-Burnett SWMF provided by land owners.
A7-C	80	Proposed	Medium Density Residential	6.97	418	162.0	Proposed Medium density units on lands owned by Mion.	
A7-D	80	Proposed	Medium Density Residential	11.74	704	162.0	Proposed Medium density units on lands owned by Caivan.	
A7-E1/E2	80	Proposed	Medium Density Residential	9.24	554	162.0	Proposed Medium density units on lands owned by Claridge.	
A8-A	80	Existing	Commercial	28.45	-	-	Existing Barrhaven Market Place (commercial).	Aerial Photos / Site Visits
A8-B	80	Proposed	High Density Residential	39.34	2951	135.0	Future development similar to Ampersands development.	Site Visits
A8-C	80	Existing	Institutional	10.52	-	-	Existing St. Joseph High School.	Aerial Photos / Site Visits
A8-D	80	Proposed	Low Density Residential	16.87	1012	162.0	Proposed 600 low density residential units.	Functional Design Report and Update – SNC Phase 2 and 3 (Dillon, 2012)

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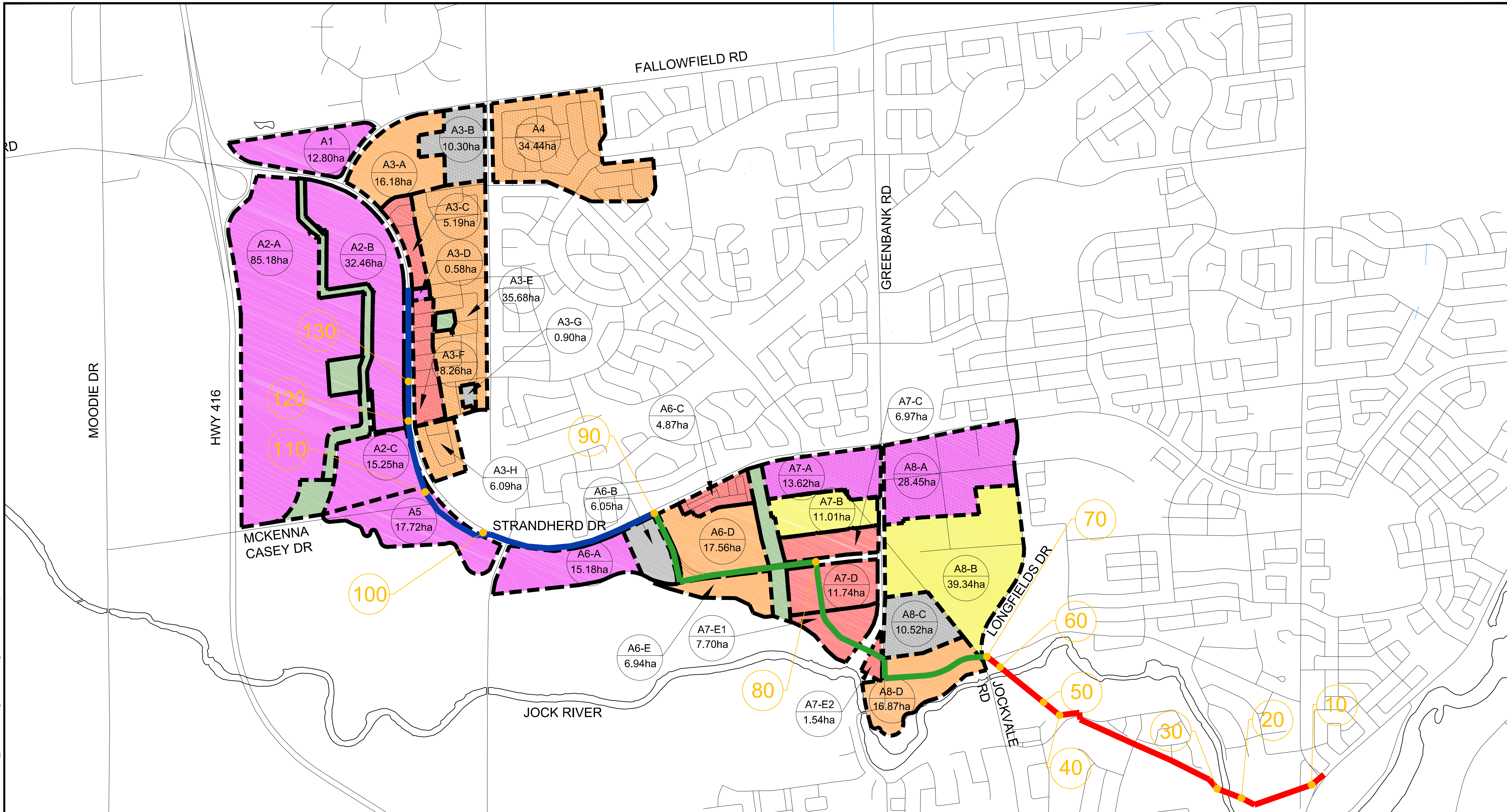
Attachment 1

Sanitary Drainage Areas and Land Use



LEGEND

- EXISTING / PROPOSED HIGH DENSITY RESIDENTIAL
- EXISTING / PROPOSED MEDIUM DENSITY RESIDENTIAL
- EXISTING / PROPOSED LOW DENSITY RESIDENTIAL
- EXISTING / PROPOSED COMMERCIAL
- EXISTING / PROPOSED INSTITUTIONAL
- OTHER LANDS (OPEN SPACE, PARKS, AND SWMFS)
- SOUTH NEPEAN COLLECTOR PHASE 1
- SOUTH NEPEAN COLLECTOR PHASE 2
- SOUTH NEPEAN COLLECTOR PHASE 3
- 80 SOUTH NEPEAN COLLECTOR NODE ID

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SOUTH NEPEAN COLLECTOR SEWER

SANITARY DRAINAGE AREAS AND LAND USE

SCALE	DATE	JOB	FIGURE
1:20 000	MAY 2016	115075	FIG. 1

Attachment 2

Sewer Flow Calculations

PROJECT #: 115075
DESIGNED BY: CMS
CHECKED BY: MJP
DATE: August 20, 2015

SANITARY SEWER DESIGN SHEET

South Nepean Collector - Phase 2 & 3

Theoretical Current Operational Peak Wastewater Flow

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Location			Areas				Population				Individual Design Flows			Cumulative Design Flows				
Area I.D.	Existing Land Use	Upstream Node	Gross Commercial Area (ha)	Gross Institutional Area (ha)	Gross Residential Area (ha)	Total Gross Area (ha)	Residential Popultation Density (people / ha)	Individual Residential Population	Cumulative Residential Population	Residential Peaking Factor (Harmon Eqn[1])	Commercial Peak Flow Rate[2] (17,000 L/ha/d) (L/s)	Institutional Peak Flow Rate[2] (10,000 L/ha/d) (L/s)	Infiltration / Inflow Rate (0.05 L/s/ha) (L/s)	Commercial (L/s)	Institutional (L/s)	Infiltration / Inflow (L/s)	Residential Peak Flow Rate (300 L/cap/d) (L/s)	Cumulative Peak Design Flow (L/s)
A1	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A2-A	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A2-B	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A3-A	Open Space	130				0.00					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A3-B	Institutional	130		10.30		10.30					0.0	1.2	0.5	0.0	1.2	0.5	0.0	1.7
A3-C	Medium Density Residential	130			5.19	5.19	162.0	841	841	2.71	0.0	0.0	0.3	0.0	1.2	0.8	7.9	9.9
A3-D	Commercial	130	0.58			0.58			841	2.71	0.1	0.0	0.0	0.1	1.2	0.8	7.9	10.0
A3-E	Low Density Residential	130			35.68	35.68	95.2	3397	4238	2.39	0.0	0.0	1.8	0.1	1.2	2.6	35.1	39.0
A3-F	Medium Density Residential	130			8.26	8.26	162	1338	5576	2.32	0.0	0.0	0.4	0.1	1.2	3.0	44.9	49.2
A3-G	Institutional	130		0.90		0.90			5576	2.32	0.0	0.1	0.0	0.1	1.3	3.0	44.9	49.4
A4	Low Density Residential*	130				0.00			5576	2.32	0.0	0.0	0.0	0.1	1.3	3.0	44.9	49.4
A2-C	Snow Dump Facility	120				0.00			5576	2.32	0.0	0.0	0.0	0.1	1.3	3.0	44.9	49.4
A3-H	Low Density Residential	120			6.09	6.09	95.2	580	6155	2.30	0.0	0.0	0.3	0.1	1.3	3.4	49.1	53.8
A5	Open Space	110				0.00			6155	2.30	0.0	0.0	0.0	0.1	1.3	3.4	49.1	53.8
A6-A	Open Space	100				0.00			6155	2.30	0.0	0.0	0.0	0.1	1.3	3.4	49.1	53.8
A6-B	Open Space	100				0.00			6155	2.30	0.0	0.0	0.0	0.1	1.3	3.4	49.1	53.8
A6-C	Medium Density Residential	90			4.87	4.87	162.0	789	6944	2.27	0.0	0.0	0.2	0.1	1.3	3.6	54.6	59.6
A6-D	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	0.1	1.3	3.6	54.6	59.6
A6-E	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	0.1	1.3	3.6	54.6	59.6
A7-A	Commercial	90	13.62			13.62			6944	2.27	2.7	0.0	0.7	2.8	1.3	4.3	54.6	63.0
A7-B	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	1.3	4.3	54.6	63.0
A7-C	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	1.3	4.3	54.6	63.0
A7-D	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	1.3	4.3	54.6	63.0
A7-E1/E2	Open Space	90				0.00			6944	2.27	0.0	0.0	0.0	2.8	1.3	4.3	54.6	63.0
A8-A	Commercial	80	28.45			28.45			6944	2.27	5.6	0.0	1.4	8.4	1.3	5.7	54.6	70.0
A8-B	Open Space	80				0.00			6944	2.27	0.0	0.0	0.0	8.4	1.3	5.7	54.6	70.0
A8-C	Institutional	80		10.52		10.52			6944	2.27	0.0	1.2	0.5	8.4	2.5	6.2	54.6	71.8
A8-D	Open Space	80				0.00			6944	2.27	0.0	0.0	0.0	8.4	2.5	6.2	54.6	71.8
ROW Along SNC Sewer Alignment	-	80				14.34			6944	2.27	0.0	0.0	0.7	8.4	2.5	6.9	54.6	72.5
TOTAL		***80***	***42.65***	***21.72***	***60.09***	***138.80***	***-***	***6944***	***6944***	***2.27***	***8.4***	***2.5***	***6.9***	***8.4***	***2.5***	***6.9***	***54.6***	***72.5***

Residential Land Use	Population Density (Units / ha)	Persons per Unit	Persons per ha
Low Density (singles and semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row/townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

Notes:

1. Harmon Equation = 1 + [14 / (4+(P/1000)$^{1/2}$)] x K

Where: P = population; K = correction factor = 0.6

2. Instituional / Commercial Peaking Factor = 1.0

Reported Design Flows / Assumptions:

1. Area A4: Existing single family units currently serviced by Jockvale pump station; currently not directed to SNC

PROJECT #: 115075
DESIGNED BY: CMS
CHECKED BY: MJP
DATE: August 20, 2015

SANITARY SEWER DESIGN SHEET

South Nepean Collector - Phase 2 & 3

Theoretical Future Full Service Peak Wastewater Flow

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Location			Areas				Population				Individual Design Flows			Cumulative Design Flows				
Area I.D.	Existing / Proposed Land Use	Upstream Node	Gross Commercial Area (ha)	Gross Institutional Area (ha)	Gross Residential Area (ha)	Total Gross Area (ha)	Residential Popultation Density (people / ha)	Individual Residential Population	Cumulative Residential Population	Residential Peaking Factor (Harmon Eqn[1])	Commercial Peak Flow Rate[2] (50,000 L/ha/d) (L/s)	Institutional Peak Flow Rate[2] (50,000 L/ha/d) (L/s)	Infiltration / Inflow Rate (0.28 L/s/ha) (L/s)	Commercial (L/s)	Institutional (L/s)	Infiltration / Inflow (L/s)	Residential Peak Flow Rate (350 L/cap/d) (L/s)	Cumulative Peak Design Flow (L/s)
A1	Commercial	130	12.80			12.80					11.1	0.0	3.6	11.1	0.0	3.6	0.0	14.7
A2-A	Commercial	130	85.18			85.18					73.9	0.0	23.9	85.1	0.0	27.4	0.0	112.5
A2-B	Commercial	130	32.46			32.46					28.2	0.0	9.1	113.2	0.0	36.5	0.0	149.8
A3-A	Low Density Residential	130			16.18	16.18	95.2	1540	1540	3.67	0.0	0.0	4.5	113.2	0.0	41.1	22.9	177.2
A3-B	Institutional	130		10.30		10.30			1540	3.67	0.0	8.9	2.9	113.2	8.9	43.9	22.9	189.0
A3-C	Medium Density Residential	130			5.19	5.19	162.0	841	2381	3.53	0.0	0.0	1.5	113.2	8.9	45.4	34.0	201.6
A3-D	Commercial	130	0.58			0.58			2381	3.53	0.5	0.0	0.2	113.7	8.9	45.6	34.0	202.2
A3-E	Low Density Residential	130			35.68	35.68	95.2	3397	5778	3.19	0.0	0.0	10.0	113.7	8.9	55.5	74.6	252.8
A3-F	Medium Density Residential	130			8.26	8.26	162	1338	7116	3.10	0.0	0.0	2.3	113.7	8.9	57.9	89.4	269.9
A3-G	Institutional	130		0.90		0.90			7116	3.10	0.0	0.8	0.3	113.7	9.7	58.1	89.4	270.9
A4	Low Density Residential	130			34.44	34.44	95.2	3279	10395	2.94	0.0	0.0	9.6	113.7	9.7	67.8	123.7	314.9
A2-C	Commercial (ex. snow dump)	120	15.25			15.25			10395	2.94	13.2	0.0	4.3	127.0	9.7	72.0	123.7	332.4
A3-H	Low Density Residential	120			6.09	6.09	95.2	580	10974	2.91	0.0	0.0	1.7	127.0	9.7	73.7	129.6	340.0
A5	Commercial	110	17.72			17.72			10974	2.91	15.4	0.0	5.0	142.4	9.7	78.7	129.6	360.3
A6-A	Commercial	100	15.18			15.18			10974	2.91	13.2	0.0	4.3	155.5	9.7	82.9	129.6	377.8
A6-B	Institutional	100		6.05		6.05			10974	2.91	0.0	5.3	1.7	155.5	15.0	84.6	129.6	384.7
A6-C	Medium Density Residential	90			4.87	4.87	162.0	789	11763	2.88	0.0	0.0	1.4	155.5	15.0	86.0	137.4	393.9
A6-D	Low Density Residential	90			17.56	17.56	95.2	1672	13435	2.83	0.0	0.0	4.9	155.5	15.0	90.9	153.8	415.2
A6-E	Low Density Residential	90			6.94	6.94	95.2	661	14096	2.81	0.0	0.0	1.9	155.5	15.0	92.9	160.2	423.6
A7-A	Commercial	90	13.62			13.62			14096	2.81	11.8	0.0	3.8	167.4	15.0	96.7	160.2	439.2
A7-B	High Density Residential	90			11.01	11.01	135.0	1486	15582	2.76	0.0	0.0	3.1	167.4	15.0	99.8	174.3	456.4
A7-C	Medium Density Residential	90			6.97	6.97	162.0	1129	16711	2.73	0.0	0.0	2.0	167.4	15.0	101.7	184.9	468.9
A7-D	Medium Density Residential	90			11.74	11.74	162.0	1902	18613	2.68	0.0	0.0	3.3	167.4	15.0	105.0	202.4	489.7
A7-E1/E2	Medium Density Residential	90			9.24	9.24	162.0	1497	20110	2.65	0.0	0.0	2.6	167.4	15.0	107.6	215.9	505.8
A8-A	Commercial	80	28.45			28.45			20110	2.65	24.7	0.0	8.0	192.0	15.0	115.5	215.9	538.5
A8-B	High Density Residential	80			39.34	39.34	135.0	5311	25421	2.55	0.0	0.0	11.0	192.0	15.0	126.6	262.4	596.0
A8-C	Institutional	80		10.52		10.52			25421	2.55	0.0	9.1	2.9	192.0	24.1	129.5	262.4	608.1
A8-D	Low Density Residential	80			16.87	16.87	120.9	2040	27461	2.52	0.0	0.0	4.7	192.0	24.1	134.2	279.8	630.2
ROW Along SNC Sewer Alignment	-	80				14.34			27461	2.52	0.0	0.0	4.0	192.0	24.1	138.2	279.8	634.2
TOTAL		***80***	***221.24***	***27.77***	***230.38***	***493.73***	***-***	***27461***	***27461***	***2.52***	***192.0***	***24.1***	***134.2***	***192.0***	***24.1***	***138.2***	***279.8***	***634.2***

Residential Land Use	Population Density (Units / ha)	Persons per Unit	Persons per ha
Low Density (singles and semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row/townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

Notes:

1. Harmon Equation = $1 + [14 / (4+(P/1000)^{1/2})] \times K$

Where: P = population; K = correction factor = 1.0

2. Instituional / Commercial Peaking Factor = 1.5

Reported Design Flows / Assumptions:

1. Area A4: Existing single family units currently serviced by Jockvale pump station to be redirected to SNC
2. Area A8-D: proposed 600 medium density residential units

THIS PRIOR NOVETECH SNC DESIGN SHEET HAD DESIGN FLOWS AT 423.6 L/S AFTER AREA ID "A6-E'.

THE DSEL EVALUATION WITH NEW PARAMTERS AT THIS SAME NODE WITH CONSERVANCY WEST AND EAST INCLUDED IS ~**401.58 < 423.6 L/S**

Attachment 3

Sanitary Sewer Design Sheets (Phase 2)

SOUTH NEPEAN COLLECTOR (PHASE 2)
SANITARY SEWER DESIGN SHEET

MAY 26, 2016
JOB# 115075

NOVATECH
Engineers, Planners & Landscape Architects

LOCATION			Area					Population				Individual Design Flows			Cumulative Design Flows					PROPOSED SEWER						
From MH	To MH	Upstream Node	Gross Commercial Area (ha)	Gross Institutional Area (ha)	Gross Residential Area (ha)	Right-of-Way (ha)	Total Gross Area (ha)	Residential Popultation Density (people / ha)	Individual Residential Population	Cumulative Residential Population	Residential Peaking Factor (Harmon Eqn[1])	Commercial Peak Flow Rate[2] (50,000 L/ha/d) (L/s)	Institutional Peak Flow Rate[2] (50,000 L/ha/d) (L/s)	Infiltration / Inflow Rate (0.28 L/s/ha) (L/s)	Commercial (L/s)	Institutional (L/s)	Infiltration / Inflow (L/s)	Residential Peak Flow Rate (350 L/cap/d) (L/s)	Cumulative Peak Design Flow (L/s)	Length (m)	Pipe Size (mm)	Type	Slope %	Capacity (L/s)	Full Flow Velocity (m/s)	Ratio (Q/Qfull)
MHSA 1	MHSA 2	90	192.79	17.25	174.17	0.00	384.21	1678	20110	20110	2.65	167.352	14.97	107.58	167.4	15.0	107.6	215.9	505.8	57.3	900	CONC	0.10	597.2	0.91	85%
MHSA 2	MHSA 3	90																	505.8	57.3	900	CONC	0.10	597.2	0.91	85%
MHSA 3	MHSA 4	90																	505.8	73.9	900	CONC	0.10	597.2	0.91	85%
MHSA 4	MHSA 5	90																	505.8	34.6	900	CONC	0.10	597.2	0.91	85%
MHSA 5	MHSA 6	90																	505.8	42.8	900	CONC	0.10	597.2	0.91	85%
MHSA 6	MHSA 7	90																	505.8	84.4	900	CONC	0.10	597.2	0.91	85%
MHSA 7	MHSA 8	90																	505.8	16.5	900	CONC	0.10	597.2	0.91	85%
MHSA 8	MHSA 9	90																	505.8	85.4	900	CONC	0.10	597.2	0.91	85%
MHSA 9	MHSA 10	90																	505.8	70.6	900	CONC	0.10	597.2	0.91	85%
MHSA 10	MHSA 11	90																	505.8	70.6	900	CONC	0.10	597.2	0.91	85%
MHSA 11	MHSA 12	90																	505.8	77.8	900	CONC	0.10	597.2	0.91	85%
MHSA 12	MHSA 13	90																	505.8	77.8	900	CONC	0.10	597.2	0.91	85%
MHSA 13	MHSA 14	90																	505.8	77.8	900	CONC	0.10	597.2	0.91	85%
MHSA 14	MHSA 15	90																	505.8	25.4	900	CONC	0.10	597.2	0.91	85%
MHSA 15	MHSA 16	90																	505.8	34.2	900	CONC	0.10	597.2	0.91	85%
MHSA 16	MHSA 17	90																	505.8	86.7	900	CONC	0.10	597.2	0.91	85%
MHSA 17	MHSA 18	90																	505.8	34.3	900	CONC	0.10	597.2	0.91	85%
MHSA 18	MHSA 19	90																	505.8	68.6	900	CONC	0.10	597.2	0.91	85%
MHSA 19	MHSA 20	90																	505.8	65.5	900	CONC	0.10	597.2	0.91	85%
MHSA 20	MHSA 21	80	221.24	27.77	230.38	14.34	493.73	256	7351	27461	2.52	192.049	24.11	138.24	192.0	24.1	138.2	279.8	634.2	18.2	1050	CONC	0.10	900.9	1.01	70%
MHSA 21	MHSA 22	80																	634.2	81.9	1050	CONC	0.10	900.9	1.01	70%
MHSA 22	MHSA 23	80																	634.2	84.7	1050	CONC	0.10	900.9	1.01	70%
MHSA 23	MHSA 24	80																	634.2	77.4	1050	CONC	0.10	900.9	1.01	70%
MHSA 24	MHSA 25	80																	634.2	45.5	1050	CONC	0.10	900.9	1.01	70%
MHSA 25	MHSA 26	80																	634.2	35.8	1050	CONC	0.10	900.9	1.01	70%
MHSA 26	MHSA 27	80																	634.2	83.3	1050	CONC	0.10	900.9	1.01	70%
MHSA 27	MHSA 28	80																	634.2	74.4	1050	CONC	0.10	900.9	1.01	70%
MHSA 28	MHSA 29	80																	634.2	77.3	1050	CONC	0.10	900.9	1.01	70%
MHSA 29	MHSA 30	80																	634.2	83.8	1050	CONC	0.10	900.9	1.01	70%
MHSA 30	MHSA 31	80																	634.2	42.3	1050	CONC	0.10	900.9	1.01	70%
MHSA 31	MHSA 32	80																	634.2	100.6	1050	CONC	0.10	900.9	1.01	70%
MHSA 32	MHSA 33	80																	634.2	13.9	1050	CONC	0.10	900.9	1.01	70%
MHSA 33	MHSA 34	80																	634.2	99.9	1050	CONC	0.10	900.9	1.01	70%
MHSA 34	MHSA 35	80																	634.2	99.9	1050	CONC	0.10	900.9	1.01	70%
MHSA 35	MHSA 36	80																	634.2	88.7	1050	CONC	0.10	900.9	1.01	70%
MHSA 36	MHSA 37	80																	634.2	88.8	1050	CONC	0.10	900.9	1.01	70%
MHSA 37	MHSA 38	80																	634.2	90.3	1050	CONC	0.10	900.9	1.01	70%
MHSA 38	MHSA 39	80																	634.2	87.5	1050	CONC	0.10	900.9	1.01	70%

Design Parameters:

Residential Land Use	Population Density (Units / ha)	Persons per Unit	Persons per ha
Low Density (singles / semis)	26 – 28 (28 used)	2.7 – 3.4 (3.4 used)	95.2
Medium Density (row / townhouse)	50 – 60 (60 used)	2.7	162.0
High Density (apartments)	60 – 75 (75 used)	1.8	135.0

Notes:

1. Harmon Equation = 1 + [14 / (4+(P/1000)$^{1/2}$)] x K

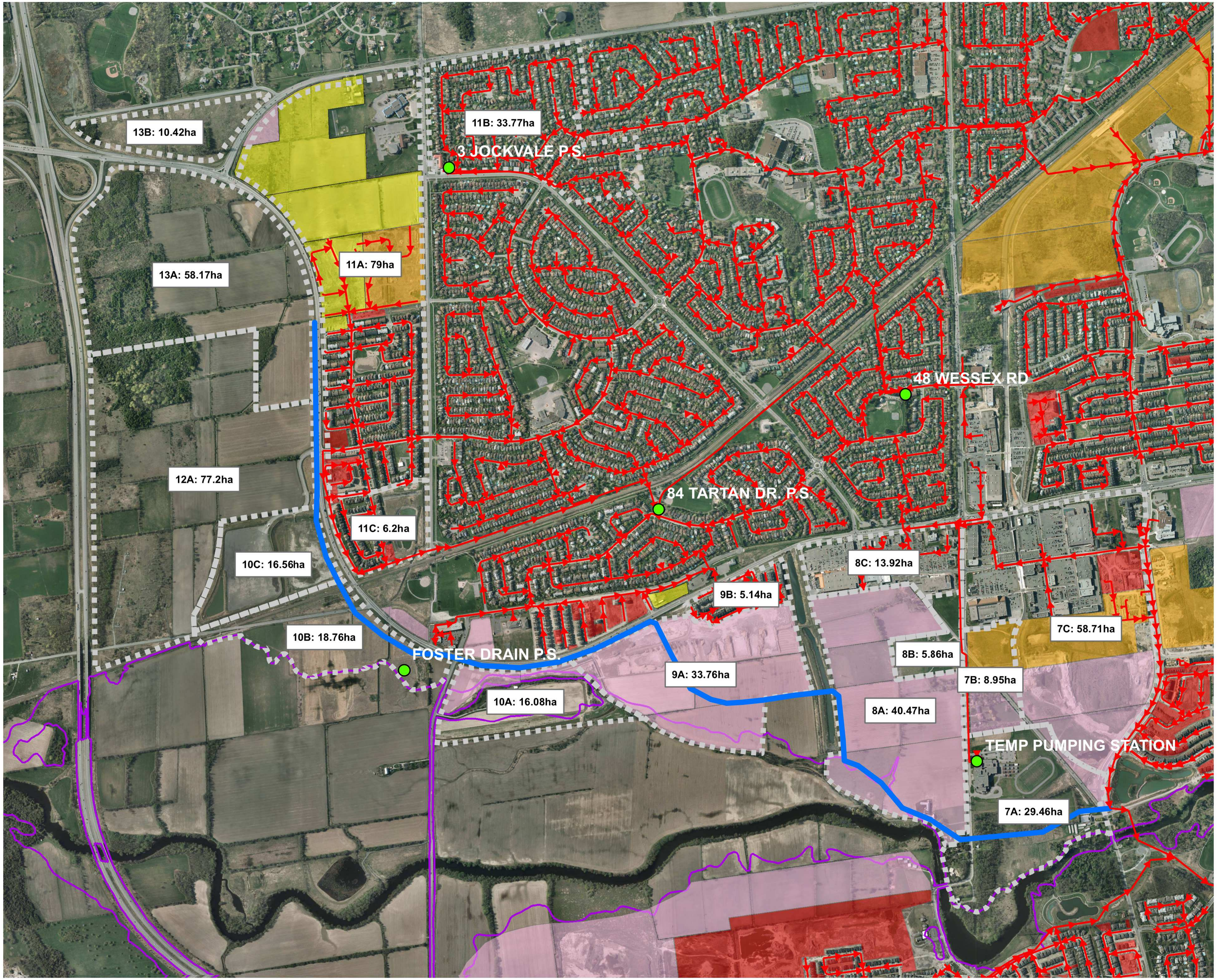
Where: P = population; K = correction factor = 1.0

2. Instituional / Commercial Peaking Factor = 1.5

Reported Design Flows / Assumptions:

1. Area A4: Existing single family units currently serviced by Jockvale pump station to be redirected to SNC

2. Area A8-D: proposed 600 medium density residential units



Ottawa

City of Ottawa
South Nepean Collector

Figure 01
Existing Sanitary Network and Collection Areas

- Pump Station
- Existing Sanitary Main (With Flow Direction)
- Proposed Alignment for South Nepean Collector
- Collection Area

DEVELOPMENT STATUS
- Registered
- Draft Approved
- Pending
- No Plan
- Floodplain

NOT TO SCALE

MAP DRAWING INFORMATION:
DATA PROVIDED BY THE CITY OF OTTAWA

MAP CREATED BY: BC
MAP CHECKED BY: MBM
MAP PROJECTION: NO PROJECTION

FILE LOCATION: \\Dillon.ca\dillon_dfs\Ottawa\Ottawa CA\CAD\2011\115681\Design_GIS\MXD\Figure01c_ExistingSanitaryNetwork.mxd

DILLON CONSULTING

PROJECT: 11-5681
STATUS: FINAL
DATE: 18/07/12

Table 5.1: Allocation of Commercial/Institutional and Residential Demands to SNC by Collection Area

Collection Area	Discharging Node	Estimated from GIS			City of Ottawa VURL Data			Other Space [1] (ha)	Population (PE)	Residential Density (PE/net ha)	Comments	Additional Source(s)
		Gross Institutional/Commercial (ha)	Gross Residential (ha)	Gross Area (ha)	Net Residential (ha)	Units (#)	Unit Density (#/ha)					
7A	70	13.5	7.4	29.5	4.0	605	0.3	9.1	1637	4.25	Flow calculations include St Joseph H.S. Pump Station firm capacity of 7.0 L/s Additional 600 units (TAC)	3.4ppu (TAC)
7B	70	0.0	9.24	9.24	6.23	1474	136.7	3.0	3321	638.8	Population from split VURL allocated by area. VURL parcel id 323 - inconsistency between net and gross reported area.	2.7ppu (TAC)
8A	70	0.0	40.0	40.0	24.1	4462	185.1	15.9	12047.4	499.9		2.7ppu (TAC)
8B	70	5.9	0.0	5.9	0.0	0	0	0.0			Future Commercial area	
8C	70	13.9	0.0	13.9	0.0	0	0	0.0			Commercial area includes Home Depot	
9A	80	0.0	33.8	33.8	18.6	635	34.1	15.2	2210	116.2		3.4ppu (TAC)
10A	90	0.0	16.1	16.1	9.7	451	28.0	6.4	1533.4	158.0	Assume net population = 60% gross.	3.4ppu (TAC)
10B	100	18.8	0.0	35.3	0.0	0	0	16.5			Allocated as potential future I/C use as directed by TAC	
10C	110	16.6	0.0	35.3	0.0	0	0	18.7			Area includes current Municipal Snow Dump. Flow allowance is made for potential future I/C use	
11C	110	0.0	6.2	6.2	Note 2			2.5	306	82.7	This area is south of '11 block' in the existing development	From IBI Apr 2010 Report Figure 1
11A	120	12.5	66.5	79.0	Note 2			26.6	3923	98.3	Institutional includes 4.38ha church site and 6.89 ha institution at northeast corner, as well and Claridge Commercial (0.56ha) and DCR/Phoenix Commercial (0.64ha)	From IBI Apr2010 Report Figure 1
11B	120	0.0	37.0	37.0	Note 2			14.8	1550	69.8	Presently serviced by Jockvale pump station; to be redirected to SNC.	Estimated from 2011 Census Block data
12A	120	77.2	0.0	77.2	Note 2			0.0			Allow sanitary peak flow 79.0 L/s	Novatech, Employment Lands Report, Revised Jan 2012
13A	130	58.5	0.0	58.5	Note 2			0.0			Allow sanitary peak flow 62.8 L/s plus Collection Area 13B, total 82.2 L/s	Novatech, Employment Lands Report, Revised Jan 2012
13B	130	12.5	0.0	12.5	Note 2			0.0			Allow sanitary peak flow 19.4 L/s; gravity discharge to Collection Area 13A	IBI/Novatech

Notes:
1. Other space includes other residential space accounting for the difference between gross area (measured with GIS) and net area (provided in VURL data), such as sidewalks, roads, greenspace, etc.
2. Collection Area 11A and 11B population and land use as identified under Additional Source(s). Other space reported as 60% of gross residential area, consistent with VURL average.

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2012 Operational current day

CITY OF OTTAWA
SOUTH NEPEAN COLLECTOR SEWER
SANITARY SEWER DESIGN SHEET - Operational Service (Average Flow Design Parameters)

Sheet 1 of 1

TRIBUTARY AREA		LOCATION		AREA (ha)							INDIVIDUAL		CUMULATIVE		RESIDENTIAL		COMMERCIAL & INSTITUTION			INFIL. INFLOW	PEAK DESIGN
	Design Factors	FROM	TO	Gross ICI	Net ICI	Other ICI space (Green, Sidewalks, roads)	Gross RESIDENTIAL Area	Net Residential Area	Other Res (Green, Sidewalks, roads)	TOTAL AREA (Gross ICI plus Gross Residential)	POP	DENSITY	POP	AREA	PEAKING FACTOR	RESIDENT. FLOW	PEAKING FACTOR	CUM. AREA	I.C.I. FLOW (l/s)	Q(p)	FLOW Q(d)
												(po./ha.)		(ha.)		(L/s)				(L/s)	(L/s)
13A	1			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		0	0.0	4.50	0.00	1.00	0.00	0.00	0.00	0.00
13B	1		Node 130	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		0	0.0	4.50	0.00	1.00	0.00	0.00	0.00	0.00
12A	1	Node 130		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		0	0.0	4.50	0.00	1.00	0.00	0.00	0.00	0.00
11A	1			12.5	9.4	3.1	66.5	8.0	58.5	79.0	1196	148.76	1196	79.0	3.75	15.57	1.00	12.50	2.00	3.95	21.52
11B	1		Node 120	0.0	0.0	0.0	37.0	22.2	14.8	37.0	1550	69.82	2746	116.0	3.47	33.13	1.00	12.50	2.00	5.80	40.93
11C	1	Node 120		0.0	0.0	0.0	6.2	3.7	2.5	6.2	306	82.26	3052	122.2	3.44	36.41	1.00	12.50	2.00	6.11	44.52
10C	1		Node 110	16.6	12.5	4.2	0.0	0.0	0.0	16.6	0		3052	138.8	3.44	36.41	1.00	29.10	4.66	6.94	48.01
10B	1	Node 110	Node 100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		3052	138.8	3.44	36.41	1.00	29.10	4.66	6.94	48.01
10A	1	Node 100	Node 90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		3052	138.8	3.44	36.41	1.00	29.10	4.66	6.94	48.01
9A	1	Node 90	Node 80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		3052	138.8	3.44	36.41	1.00	29.10	4.66	6.94	48.01
8A	1	Node 80		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		3052	138.8	3.44	36.41	1.00	29.10	4.66	6.94	48.01
8B	1			5.9	4.4	1.5	0.0	0.0	0.0	5.9	0		3052	144.7	3.44	36.41	1.00	35.00	5.60	7.24	49.25
8C	1			13.9	10.4	3.5	0.0	0.0	0.0	13.9	0		3052	158.6	3.44	36.41	1.00	48.90	7.82	7.93	52.17
7A	1			13.5	10.1	3.4	16.0	1.4	14.6	29.5	17	12.14	3069	188.1	3.43	36.59	1.00	62.40	9.98	9.41	55.93
7B	1		Node 70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		3069	188.1	3.43	36.59	1.00	62.40	9.98	9.41	55.93
										188.1											

TRIBUTARY AREA	PROPOSED SEWER											OPERATIONAL DESIGN	
	LENGTH (m)	GROUND ELEVATION (m)	DEPTH OF COVER (m)	PIPE SIZE (m)	INVERT 1 (m)	INVERT 2 (m)	PIPE TYPE	GRADE	CAPACITY (L/s)	Q(d)/Q(c)	VELOCITY at capacity (m/s)	DEPTH (m)	VELOCITY (m/s)
13A													
13B		95.14	5.43	0.750		88.96							
12A													
11A													
11B	531.89	93.60	4.42	0.750	88.96	88.43	Conc.	0.10%	353.24	0.13	0.80	0.20	0.58
11C													
10C	497.82	93.44	4.76	0.750	88.43	87.93	Conc.	0.10%	353.24	0.14	0.80	0.20	0.58
10B	603.17	93.03	4.95	0.750	87.93	87.33	Conc.	0.10%	353.24	0.14	0.80	0.20	0.58
10A	430.49	93.75	6.03	0.825	87.33	86.90	Conc.	0.10%	455.17	0.11	0.85	0.21	0.61
9A	1268.65	92.37	5.84	0.900	86.90	85.63	Conc.	0.10%	573.71	0.08	0.90	0.18	0.56
8A													
8B													
8C													
7A													
7B	1448.98	91.24	6.01	1.050	85.63	84.18	Conc.	0.10%	864.51	0.06	1.00	0.18	0.56

DEFAULTS		
q=AVERAGE DAILY FLOW	300	L/CAP.D
I=UNIT OF PEAK EXTR.FLOW	0.050	L/Ha.s
Mannings 'n'	0.013	
q=AVERAGE COMMERCIAL AND INSTITUTIONAL	0.16	L/Ha.s

DESIGN: DJG

CHECKED:

TODAY: 7/18/2012

DILLON CONSULTING

Project 11-5681

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2012 Full Service (Peak)

CITY OF OTTAWA

SOUTH NEPEAN COLLECTOR SEWER

SANITARY SEWER DESIGN SHEET - Full Service (Peak Flow Design Parameters)

Sheet 1 of 1

TRIBUTARY AREA		LOCATION		AREA (ha)							INDIVIDUAL		CUMULATIVE		RESIDENTIAL		COMMERCIAL & INSTITUTION			INFIL. INFLOW	PEAK DESIGN
	Design Factors	FROM	TO	Gross ICI	Net ICI	Other ICI space (Green, Sidewalks, roads)	Gross RESIDENTIAL Area	Net Residential Area	Other Res (Sidewalks, roads)	TOTAL AREA (Gross ICI plus Gross Residential)	POP	DENSITY	POP	Total I/C and Res AREA	PEAKING FACTOR	RESIDENT. FLOW	PEAKING FACTOR	I/C CUM. AREA	I/C FLOW (l/s)	Q(p)	FLOW Q(d)
												(pers/net ha.)		(ha.)		(L/s)				(L/s)	(L/s)
13A	1			58.5	43.9	14.6	0.0	0.0	0.0	58.5	0		0	58.5	4.50	0.00	1.50	58.50	50.90	16.38	67.28
13B	1		Node 130	12.5	9.4	3.1	0.0	0.0	0.0	12.5	0		0	71.0	4.50	0.00	1.50	71.00	61.77	19.88	81.65
12A	1	Node 130		77.2	57.9	19.3	0.0	0.0	0.0	77.2	0		0	148.2	4.50	0.00	1.50	148.20	128.93	41.50	170.43
11A	1			12.5	9.4	3.1	66.5	39.9	26.6	79.0	3923	98.32	3923	227.2	3.34	53.09	1.50	160.70	139.81	63.62	256.52
11B	1		Node 120	0.0	0.0	0.0	37.0	22.2	14.8	37.0	1550	69.82	5473	264.2	3.21	71.13	1.50	160.70	139.81	73.98	284.92
11C		Node 120		0.0	0.0	0.0	6.2	3.7	2.5	6.2	306	82.26	5779	270.4	3.19	74.59	1.50	160.70	139.81	75.71	290.11
10C	1		Node 110	16.6	12.5	4.2	0.0	0.0	0.0	16.6	0		5779	287.0	3.19	74.59	1.50	177.30	154.25	80.36	309.20
10B	1	Node 110	Node 100	18.8	14.1	4.7	0.0	0.0	0.0	18.8	0		5779	305.8	3.19	74.59	1.50	196.10	170.61	85.62	330.82
10A	1	Node 100	Node 90	0.0	0.0	0.0	16.1	9.7	6.4	16.1	1533	158.04	7312	321.9	3.09	91.48	1.50	196.10	170.61	90.13	352.22
9A	1	Node 90	Node 80	0.0	0.0	0.0	33.8	18.6	15.2	33.8	2161	116.18	9473	355.7	2.98	114.28	1.50	196.10	170.61	99.60	384.48
8A	1	Node 80		0.0	0.0	0.0	40.0	24.1	15.9	40.0	12047	499.88	21520	395.7	2.62	228.45	1.50	196.10	170.61	110.80	509.85
8B	1			5.9	4.4	1.5	0.0	0.0	0.0	5.9	0		21520	401.6	2.62	228.45	1.50	202.00	175.74	112.45	516.64
8C	1			13.9	10.4	3.5	0.0	0.0	0.0	13.9	0		21520	415.5	2.62	228.45	1.50	215.90	187.83	116.34	532.62
7A	1			13.5	10.1	3.4	16.5	5.2	11.3	30.0	1637	314.81	23157	445.5	2.59	242.84	1.50	229.40	199.58	124.74	567.16
7B	1		Node 70	0.0	0.0	0.0	9.2	6.2	3.0	9.2	3980	638.84	27137	454.7	2.52	277.05	1.50	229.40	199.58	127.32	603.94
							225.3	129.7		454.7	27,137.0										

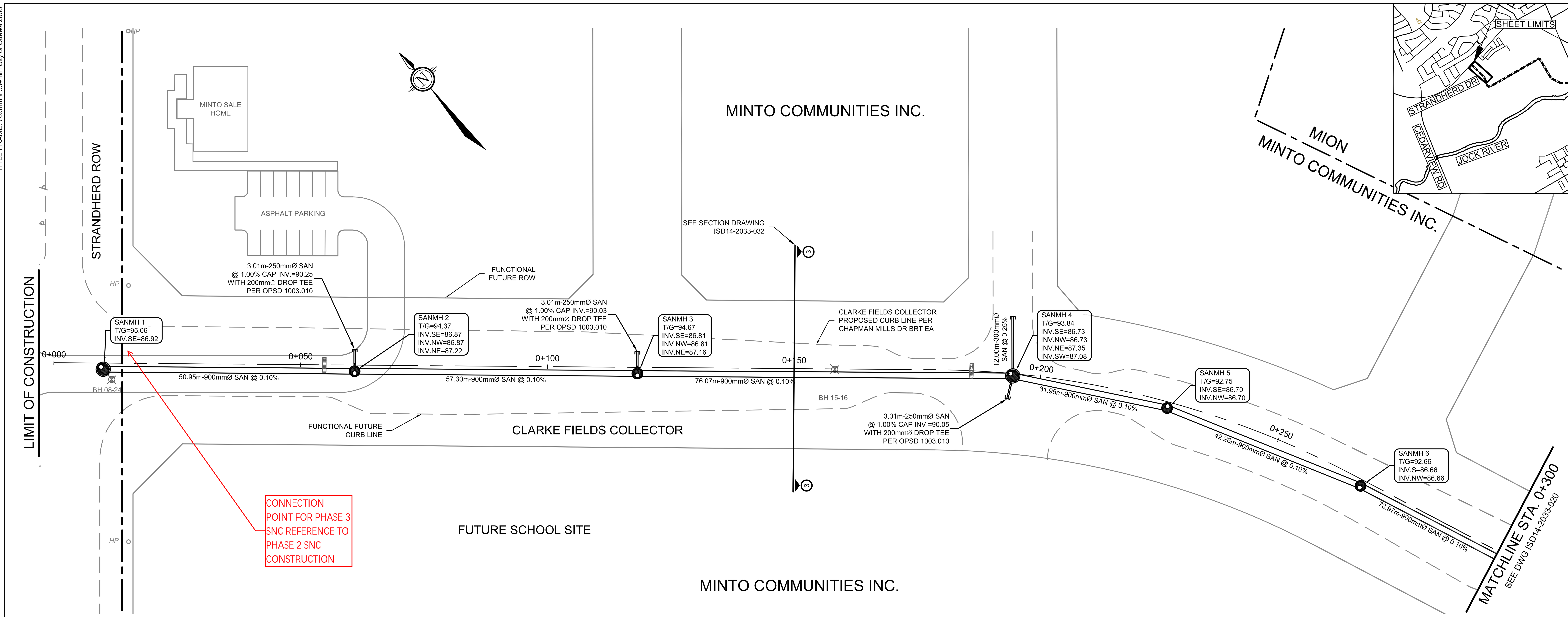
TRIBUTARY AREA						PROPOSED SEWER					PEAK DESIGN		
	LENGTH	GROUND ELEVATION	DEPTH OF COVER	PIPE SIZE	INVERT 1	INVERT 2	PIPE TYPE	GRADE	CAPACITY	Q(d)/Q(c)	VELOCITY at capacity	DEPTH	VELOCITY
	(m)	(m)	(m)	(m)	(m)	(m)			(L/s)		(m/s)	(m)	(m/s)
13A													
13B		95.14	5.43	0.750		88.96							
12A													
11A													
11B	531.89	93.60	4.42	0.750	88.96	88.43	Conc.	0.10%	353.24	0.81	0.80	0.53	0.90
11C													
10C	497.82	93.44	4.76	0.750	88.43	87.93	Conc.	0.10%	353.24	0.88	0.80	0.55	0.91
10B	603.17	93.03	4.95	0.750	87.93	87.33	Conc.	0.10%	353.24	0.94	0.80	0.58	0.92
10A	430.49	93.75	6.03	0.825	87.33	86.90	Conc.	0.10%	455.17	0.77	0.85	0.55	0.95
9A	1268.65	92.37	5.84	0.900	86.90	85.63	Conc.	0.10%	573.71	0.67	0.90	0.55	0.97
8A													
8B													
8C													
7A													
7B	1448.98	91.24	6.01	1.050	85.63	84.18	Conc.	0.10%	864.51	0.70	1.00	0.64	1.07
	4,781.0												

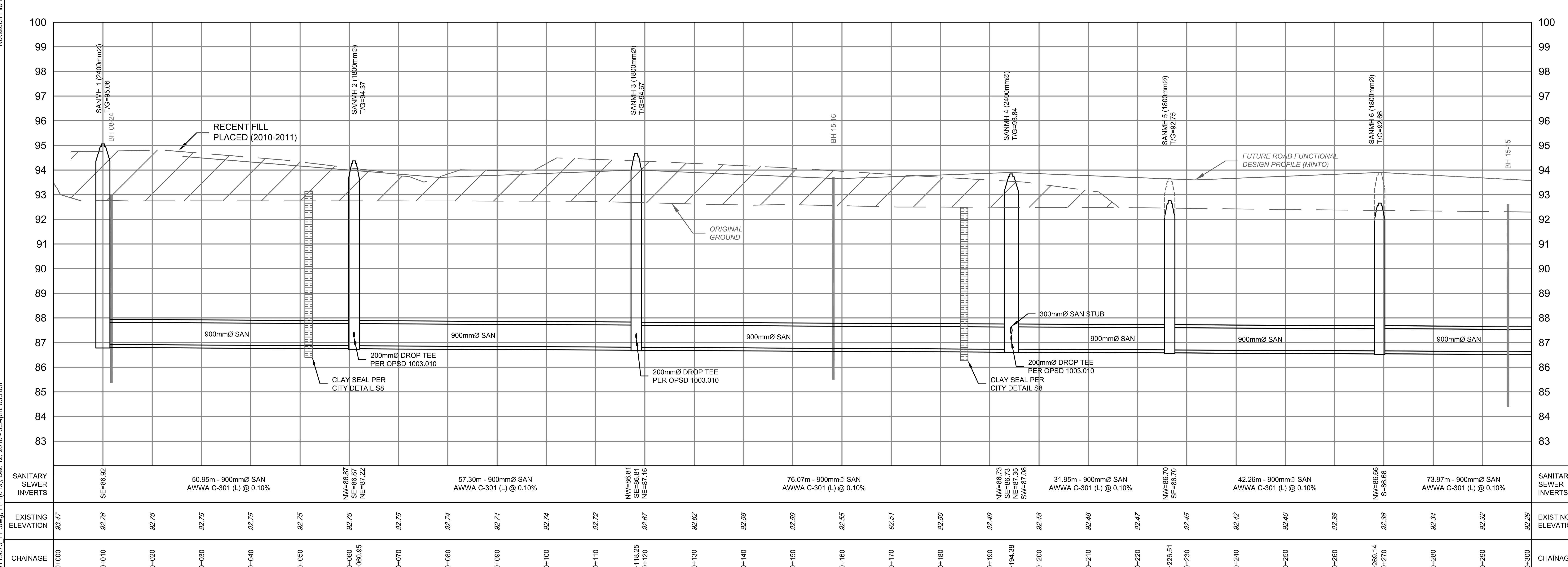
DEFAULTS		
q=AVERAGE DAILY FLOW	350	L/CAP.D
I=UNIT OF PEAK EXTR.FLOW	0.280	L/Ha.s
Mannings 'n'	0.013	
q=AVERAGE COMMERCIAL AND INSTITUTIONAL	0.58	L/Ha.s

DESIGN	DJG
CHECKED	
TODAY:	7/18/2012

DILLON CONSULTING

Project 11-5681





CITY OF OTTAWA

SOUTH NEPEAN COLLECTOR (SNC)
SEWER PHASE 2 - STRANDHERD DRIVE TO JOCKVALE ROAD

PLAN AND PROFILE
STA. 0+000 TO 0+300

WAYNE NEWELL, P.Eng.	JONATHAN KNOYLE, P.Eng.
General Manager	*Senior Engineer*

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Kanata, Ontario, Canada, K2M 1P6
Telephone: (613) 254-9643
Facsimile: (613) 254-5867
Email: novainfo@novatech-eng.com

LICENSED PROFESSIONAL ENGINEER
M.A. BISSETT
PROVINCE OF ONTARIO

Contract No. ISD14-2033	Dwg. No. 019
Sheet 19 of 51	
Asset No.	
Asset Group ISD	
Des. RJD	Chk'd. ERD
Dwn. NCS	Chk'd. RJD
Utility Circ. No.	Index No.
Const. Inspector	
Scale: HORIZONTAL 1:500, VERTICAL 1:100	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1.	ISSUED FOR PRELIMINARY DESIGN CIRCULATION	ERD	21/12/15
2.	CHANGES TO ORIENTATION ACROSS KB SWM FACILITY	ERD	16/02/16
3.	ISSUED FOR PRELIMINARY DESIGN REPORT	ERD	02/03/16
4.	ISSUED FOR FINAL DESIGN CIRCULATION	ERD	29/04/16
5.	ISSUED FOR MOECC ECA APPLICATION	ERD	26/05/16
6.	ISSUED FOR TENDER	ERD	20/06/16
7.	ISSUED FOR CONSTRUCTION	ERD	30/08/16
8.	SEWER ALIGNMENT SHIFT ON GREENBANK	ERD	16/09/16
9.	REVISED PER MION SERVICING	ERD	08/12/16

LEGEND

EXISTING ITEMS
- WATERMAIN
- WATERMAIN VALVE
- STORM SEWER
- STORM MH (STM)
- CATCH BASIN & LEAD (CB)
- CULVERT
- STORM STRUCTURE
- SANITARY SEWER
- SANITARY MH (SAN)

PROPOSED ITEMS
- SANITARY SEWER
- SANITARY MH & LID
- CULVERT
- FUTURE STRUCTURE T/G ADJUSTMENT

NOTES:

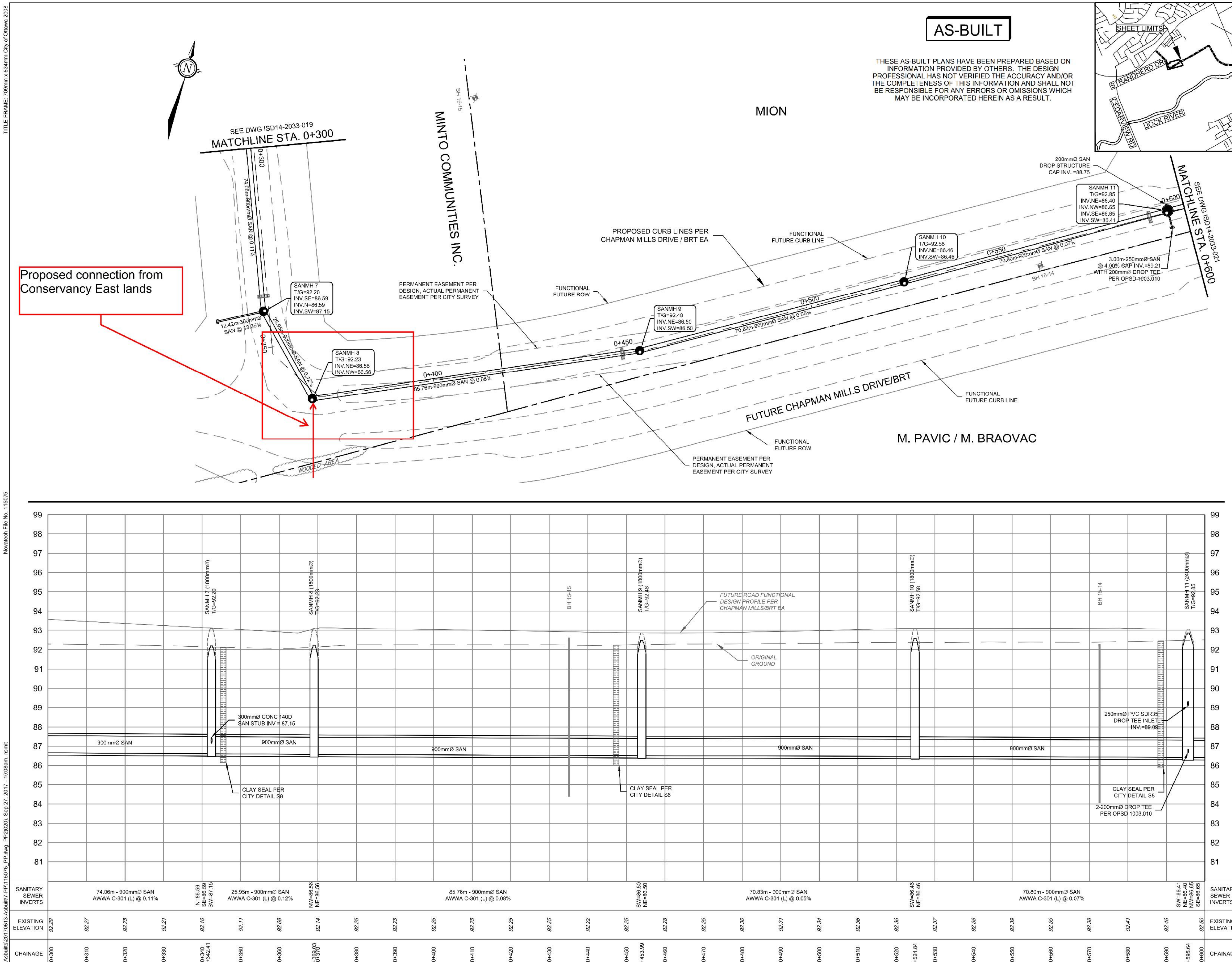
1. CONCRETE PRESSURE PIPE SHALL BE AWWA C301 (L) CL-16. FITTING SHALL BE DESIGNED TO THE SAME CRITERIA AS THE ADJACENT PIPE.
2. CONTRACTOR TO PROVIDE PIPE CLASS CALCULATIONS, AS PER AWWA C304 (DESIGN OF PRESTRESSED CONCRETE CYLINDER PIPE), BY THE PIPE MANUFACTURER, SIGNED AND SEALED BY A PROFESSIONAL ENGINEER LICENSED IN THE PROVINCE OF ONTARIO.
3. PIPE EMBEDMENT SHALL BE AS PER CITY OF OTTAWA DETAIL S6. SAND MAY BE USED AS PIPE COVER MATERIAL ABOVE THE SPRINGLINE.
4. A CLOTH DIAPER APPROVED BY THE PIPE MANUFACTURE SHALL BE PLACED AROUND EACH EXTERIOR JOIN RECESS AND FASTENED IN PLACE WITH EITHER WIRE OR STEEL STRAPPING STITCHED INTO ITS EDGES.
5. THE JOINT SHALL BE FILLED WITH MORTAR IN ONCE CONTINUOUS OPERATION AND PATTED OR MANIPULATED TO SETTLE THE MORTAR AND EXPEL AND ENTRAPPED AIR.
6. INTERIOR JOINTS SHALL BE FILLED WITH MORTAR AFTER BACKFILLING AND FINISHED SMOOTH WITH A TROWEL. CEMENT USED SHALL MEET THE REQUIREMENTS OF TYPE HS CEMENT (HIGH-SULPHATE-RESISTANCE), OR APPROVED EQUIVALENT.
7. THE INTERIOR OF THE JOINTS SHALL BE PROTECTED FROM CORROSION WITH EPOXY AND ZINC COATING APPLIED DURING FABRICATION.
8. THE INTERIOR STRUCTURAL CONCRETE CORE SHALL BE MANUFACTURED WITH TYPE HS CEMENT (HIGH-SULPHATE-RESITANCE), OR APPROVED EQUIVALENT.
9. SEE MANHOLE DETAIL DRAWINGS ISD14-2033-36 TO ISD14-2033-45 FOR ADDITIONAL DETAILS

MAINTENANCE HOLE DATA

MH ID	STATION	OFFSET	STRUCTURE	COVER	T/G ELEV	LOW. INV.
1	0+010.00	1.25R	OPSD 701.013	S24/S25	95.06	86.92
2	0+060.95	1.25R	OPSD 701.012	S24/S25	94.37	86.87
3	0+118.25	1.25R	OPSD 701.012	S24/S25	94.67	86.81
4	0+194.38	0.46R	OPSD 701.013	S24/S25	93.84	86.73
5	0+226.51	1.25R	OPSD 701.012	S24/S25	92.75	86.70
6	0+269.14	1.25R	OPSD 701.012	S24/S25	92.66	86.66

SANITARY SEWER PIPE DATA

CONNECTED STRUCTURES & INVERTS	DIA (mm)	LENGTH (m)	MATERIAL
SANMH 1 = 86.92 SANMH 2 = 86.87	900	50.95	AWWA C-301 (L)
SANMH 2 = 86.87 SANMH 3 = 86.81	900	57.30	AWWA C-301 (L)
SANMH 3 = 86.81 SANMH 4 = 86.73	900	76.07	AWWA C-301 (L)
SANMH 5 = 86.70 SANMH 4 = 86.73	900	31.95	AWWA C-301 (L)
SANMH 5 = 86.70 SANMH 6 = 86.66	900	42.26	AWWA C-301 (L)
SANMH 6 = 86.66 SANMH 7 = 86.59	900	73.97	AWWA C-301 (L)



CITY OF OTTAWA

SOUTH NEPEAN COLLECTOR (SNC) SEWER PHASE 2 - STRANDHERD DRIVE TO JOCKVALE ROAD

PLAN AND PROFILE
STA. 0+300 TO 0+600

Contract No. ISD14-2033	Dwg. No. 020
Sheet 20 of 51	
Asset No.	
Asset Group	ISD
Des. RJD	Chk'd. ERD
Dwn. NCS	Chk'd. RJD
Utility Circ. No.	Index No.
Const. Inspector	

Scale: HORIZONTAL 1:500, VERTICAL 1:100

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8.	SEWER ALIGNMENT SHIFT ON GREENBANK	ERD	16/09/16
9.	REVISED PER MION SERVICING	ERD	08/12/16
10.	MINTO LANDS MANHOLE UPDATE	ERD	24/04/17
11.	ISSUED FOR AS-BUILT	ERD	28/09/17

LEGEND

EXISTING ITEMS
- WATERMAIN
- WATERMAIN VALVE
- STORM SEWER
- STORM MH
- CATCH BASIN & LEAD
- CULVERT
- STORM STRUCTURE
- SANITARY SEWER
- SANITARY MH

PROPOSED ITEMS
- SANITARY SEWER
- SANITARY MH & LID
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9. SEE MANHOLE DETAIL DRAWINGS ISD14-2033-36 TO ISD14-2033-45 FOR ADDITIONAL DETAILS

MAINTENANCE HOLE DATA

MH ID	STATION	OFFSET	STRUCTURE	COVER	T/G ELEV	LOW. INV.
7	0+342.41	1.41R	OPSD 701.012	S24/S25	92.20	86.59
8	0+369.03	1.50R	OPSD 701.012	S24/S25	92.23	86.56
9	0+453.99	0.07L	OPSD 701.012	S24/S25	92.48	86.50
10	0+524.84	0.04L	OPSD 701.012	S24/S25	92.58	86.46
11	0+595.64	0.41L	OPSD 701.013	S24/S25	92.85	86.40

SANITARY SEWER PIPE DATA

CONNECTED STRUCTURES & INVERTS	DIA (mm)	LENGTH (m)	MATERIAL
SANMH 6 = 86.68 SANMH 7 = 86.59	900	74.06	AWWA C-301 (L)
SANMH 7 = 86.59 SANMH 8 = 86.56	900	25.95	AWWA C-301 (L)
SANMH 8 = 86.56 SANMH 9 = 86.50	900	85.76	AWWA C-301 (L)
SANMH 10 = 86.46 SANMH 9 = 86.50	900	70.83	AWWA C-301 (L)
SANMH 10 = 86.46 SANMH 11 = 86.41	900	70.80	AWWA C-301 (L)
SANMH 11 = 86.40 SANMH 12 = 86.32	900	78.15	AWWA C-301 (L)

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

Ottawa

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK				I+C+I+P	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	ICI Ratio	ICI Peaking Factor	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
rue Moonbeam Street																															
	9A	10A	0.49	11	11		38	0.49	38	3.67	0.45										0.49	0.49	0.16	0.61	56.5	200	0.65	26.44	0.02	0.84	0.35
	10A	11A	0.38	9	9		31	0.87	69	3.63	0.81										0.38	0.87	0.29	1.10	73.0	200	1.35	38.11	0.03	1.21	0.53
To promenade Albion Falls Drive, Pipe 11A - 12A								0.87	69													0.87									
rue Douglas Fir Street																															
	7A	8A	0.73	17	17		58	0.73	58	3.64	0.68										0.73	0.73	0.24	0.93	114.0	200	0.80	29.34	0.03	0.93	0.42
To promenade Albion Falls Drive, Pipe 8A - 11A								0.73	58													0.73									
promenade Beatrice Peak Drive																															
	1A	2A	0.48	11		11	30	0.48	30	3.68	0.36										0.48	0.48	0.16	0.52	85.5	200	0.65	26.44	0.02	0.84	0.33
	2A	4A	0.40	12		12	33	0.88	63	3.63	0.74										0.40	0.88	0.29	1.03	103.5	200	0.35	19.40	0.05	0.62	0.33
To promenade Albion Falls Drive, Pipe 4A - 5A								0.88	63													0.88									
promenade Albion Falls Drive																															
	3A	4A	0.23	5	5		17	0.23	17	3.71	0.20										0.23	0.23	0.08	0.28	53.0	200	1.25	36.67	0.01	1.17	0.34
Contribution From promenade Beatrice Peak Drive, Pipe 2A - 4A								0.88	63												0.88	1.11									
	4A	5A	0.15	3	3		11	1.26	91	3.60	1.06										0.15	1.26	0.42	1.48	34.5	200	0.35	19.40	0.08	0.62	0.36
PARK	Ctrl MH 500A	5A														0.67	0.67			0.11	0.67	0.67	0.22	0.33	11.0	200	0.65	26.44	0.01	0.84	0.28
	5A	6A	0.13	2	2		7	1.39	98	3.60	1.14						0.67			0.11	0.13	2.06	0.68	1.93	14.0	200	0.35	19.40	0.10	0.62	0.39
	6A	8A	0.22	4	4		14	1.61	112	3.58	1.30						0.67			0.11	0.22	2.28	0.75	2.16	55.5	200	0.35	19.40	0.11	0.62	0.41
Contribution From rue Douglas Fir Street, Pipe 7A - 8A								0.73	58												0.73	3.01									
	8A	11A	0.22	4	4		14	2.56	184	3.53	2.10						0.67			0.11	0.22	3.23	1.07	3.28	60.0	200	0.35	19.40	0.17	0.62	0.46
Contribution From rue Moonbeam Street, Pipe 10A - 11A								0.87	69												0.87	4.10									
	11A	12A	0.15	2	2		7	3.58	260	3.48	2.94						0.67			0.11	0.15	4.25	1.40	4.45	32.5	200	0.35	19.40	0.23	0.62	0.50
	12A	24A	0.04					3.62	260	3.48	2.94						0.67			0.11	0.04	4.29	1.42	4.46	28.5	200	0.35	19.40	0.23	0.62	0.50
To croissant Point Prim Crescent, Pipe 24A - 25A								3.62	260								0.67					4.29									
voie Horseshoe Falls Way																															
	14A	18A	0.22	7		7	19	0.22	19	3.71	0.23										0.22	0.22	0.07	0.30	58.5	200	1.00	32.80	0.01	1.04	0.32
To rue Coppermine Street, Pipe 18A - 19A								0.22	19													0.22									
	18A	25A	0.22	7		7	19	0.22	19	3.71	0.23										0.22	0.22	0.07	0.30	58.0	200	0.65	26.44	0.01	0.84	0.27
To Unknown Road6 - 06, Pipe 25A - 26A								0.22	19													0.22									
rue Coppermine Street																															
Contribution From voie Horseshoe Falls Way, Pipe 14A - 18A								0.22	19												0.22	0.22									
	18A	19A	0.41	12	12		41	0.63	60	3.64	0.71										0.41	0.63	0.21	0.92	74.5	200	0.35	19.40	0.05	0.62	0.31
	19A	20A	0.38	9	9		31	1.01	91	3.60	1.06										0.38	1.01	0.33	1.40	74.5	200	0.75	28.40	0.05	0.90	0.47
To croissant Point Prim Crescent, Pipe 20A - 21A								1.01	91													1.01									
croissant Point Prim Crescent																															
	13A	14A	0.28	5	5		17	0.28	17	3.71	0.20										0.28	0.28	0.09	0.30	53.5	200	0.95	31.97	0.01	1.02	0.31
	14A	15A	0.41	11	11		38	0.69	55	3.64	0.65										0.41	0.69	0.23	0.88	69.0	200	0.95	31.97	0.03	1.02	0.43
	15A	16A	0.41	9	9		31	1.10	86	3.61	1.01										0.41	1.10	0.36	1.37	72.5	200	0.35	19.40	0.07	0.62	0.35
	16A	17A	0.13	2	2		7	1.23	93	3.60	1.09										0.13	1.23	0.41	1.49	11.0	200	0.35	19.40	0.08	0.62	0.36
	17A	20A	0.22	4	4		14	1.45	107	3.59	1.24										0.22	1.45	0.48	1.72	52.0	200	0.35	19.40	0.09	0.62	0.38
Contribution From rue Coppermine Street, Pipe 19A - 20A								1.01	91												1.01	2.46									
	20A	21A	0.06					2.52	198	3.52	2.26										0.06	2.52	0.83	3.09	35.5	200	0.35	19.40	0.16	0.62	0.45

LICENSED PROFESSIONAL ENGINEER
W. LIU
100187932
PROVINCE OF ONTARIO

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da
Average Daily Flow =	280	l/p/day
Comm/Inst Flow =	28000	L/ha/da
Industrial Flow =	35000	L/ha/da
Max Res. Peak Factor =	4.00	
Park Peak Factor =	1.50	

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.330 L/s/ha
Minimum Velocity = 0.600 m/s
Manning's n = (Conc) 0.013 (Pvc) 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

Designed: P.P.	PROJECT: **BARRHAVEN CONSERVANCY PHASE 1**
Checked: W.L.	LOCATION: **City of Ottawa**
Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 33	File Ref: 16-891 · Date: January, 2019 · Sheet No. 1 of 2

891_San3.xlsx

SANITARY SEWER CALCULATION SHEET

Ottawa

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION									COMM		INSTIT		PARK				I+C+I+P	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	UNITS Singles	UNITS Townhouse	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	ICI Ratio	ICI Peaking Factor	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
	21A	22A	0.04					2.56	198	3.52	2.26										0.04	2.56	0.84	3.10	21.0	200	0.35	19.40	0.16	0.62	0.45
	22A	23A	0.01					2.57	198	3.52	2.26										0.01	2.57	0.85	3.11	8.0	200	0.35	19.40	0.16	0.62	0.45
	23A	24A	0.26	6	6		21	2.83	219	3.51	2.49										0.26	2.83	0.93	3.42	42.0	200	0.80	29.34	0.12	0.93	0.62
Contribution From promenade Albion Falls Drive, Pipe 12A - 24A								3.62	260								0.67				4.29	7.12									
	24A	25A	0.49	12	12		41	6.94	520	3.37	5.68						0.67			0.11	0.49	7.61	2.51	8.30	91.5	200	0.35	19.40	0.43	0.62	0.59
Contribution From voie Horseshoe Falls Way, Pipe 18A - 25A								0.22	19												0.22	7.83									
Upper Pipe	26A	25A	0.30	5	5		17														0.30	0.30	0.10	0.10	66.5	200	0.65	26.44	0.00	0.84	0.19
Lower Pipe	25A	26A						7.46	556	3.36	6.05						0.67			0.11	0.00	8.13	2.68	8.85	66.5	200	0.35	19.40	0.46	0.62	0.60
To promenade Chapman Mills Drive, Pipe 26A - Ex. MH 13								7.46	556								0.67					8.13									
promenade Chapman Mills Drive																															
	28A	29A	0.41	7		7	19	0.41	19	3.71	0.23										0.41	0.41	0.14	0.36	42.0	200	0.65	26.44	0.01	0.84	0.29
	29A	30A	0.28	6		6	17	0.69	36	3.67	0.43										0.28	0.69	0.23	0.66	60.0	200	0.35	19.40	0.03	0.62	0.29
	30A	31A	0.44	9		9	25	1.13	61	3.64	0.72										0.44	1.13	0.37	1.09	120.0	200	0.35	19.40	0.06	0.62	0.33
	31A	*Ex. MH 11*						1.13	61	3.64	0.72										0.00	1.13	0.37	1.09	18.5	200	3.40	60.48	0.02	1.93	0.72
To Existing Sanitary Trunk, *Ex. Pipe 11 - 12*								1.13	61													1.13									
	27A	26A	0.50	14		14	38	0.50	38	3.67	0.45						0.00			0.00	0.50	0.50	0.17	0.62	98.0	200	0.65	26.44	0.02	0.84	0.35
Contribution From croissant Point Prim Crescent, Pipe 25A - 26A								7.46	556								0.67				8.13	8.13									
	26A	*Ex. MH 13*						7.96	594	3.35	6.44						0.67			0.11	0.00	8.63	2.85	9.40	23.5	200	0.35	19.40	0.48	0.62	0.61
To Existing Sanitary Trunk, *Ex. Pipe 13 - 14*								7.96	594								0.67					8.63									

Conservancy Phase 1 - Flows and population tributary to South Nepean Collector

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
PROVINCE OF ONTARIO

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da
Average Daily Flow =	280	l/p/day
Comm/Inst Flow =	28000	L/ha/da
Industrial Flow =	35000	L/ha/da
Max Res. Peak Factor =	4.00	
Park Peak Factor =	1.50	

Industrial Peak Factor = as per MOE Graph

Extraneous Flow =		0.330	L/s/ha	
Minimum Velocity =		0.600	m/s	
Manning's n =	(Conc)	0.013	(Pvc)	0.013
Townhouse coeff=		2.7		
Single house coeff=		3.4		

Designed:	P.P.
Checked:	W.L.
Dwg. Reference: Sanitary Drainage Plan, Dwg. No: 33	
PROJECT:	BARRHAVEN CONSERVANCY PHASE 1
LOCATION:	City of Ottawa
File Ref:	16-891
Date:	January, 2019
Sheet No.	2 of 2

891_San3.xlsx

SANITARY SEWER CALCULATION SHEET

104 people/Ha	Population Density (Conservancy West)
83 people/Ha	Population Density (Conservancy East)

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION						COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
										0.00				0.00	0.00	0.00	0.00	0.000	0.00							
Extracted from SNC Novatech Ph3 design		EX SANMH1(1)	105.8	10974	105.8	10974.0	2.53	89.98	179.17	179.17	17.25	17.25		0.00	92.69	302.22	302.22	99.73	282.40	165.0	914.4	0.10	597.22	0.47	0.91	0.89
at Strandherd & CMD intersection		See Note (2)	31.5	3116	137.3	14090	2.44	111.42		179.17				0.00	87.10	31.50	333.7	110.12	308.64	50.0	914.4	0.10	597.22	0.52	0.91	0.91
CONSERVANCY WEST (3)		EX SANMH8	38.4	3913	175.7	18003	2.36	137.69		179.17				0.00	87.10	38.40	372.10	122.79	347.58	125.0	914.4	0.10	597.22	0.58	0.91	0.94
CONSERVANCY EAST (3)		EX SANMH8	61.7	4839	237.4	22842	2.28	168.78		179.17				0.00	87.10	61.70	433.80	143.15	399.03	260.0	914.4	0.10	597.22	0.67	0.91	0.97
					237.4	22842	2.28	168.78		179.17				0.00	87.10	0.00	433.80	143.15	399.03		914.4	0.10	597.22	0.67	0.91	0.97

NOTES:

(1) Refer to Novatech Drawing No. 19 - South Nepean Collector (SNC) Sewer Phase 2 - Strandherd Rive to Jockvale Road (ISD14-2033) in Appendix C

(2) Derived from Tributary areas "A6-C" and "A6-D" from Novatech's "Sanitary Drainage Areas and Land Use - Fig. 1" plan dated August 2015 (See Appendix C of DSEL report) = 4.87ha and 17.56ha and derived from Barrhaven Conservancy Phase 1 design sheet (see Appendix C of DSEL report) = 1.13ha + 7.96ha

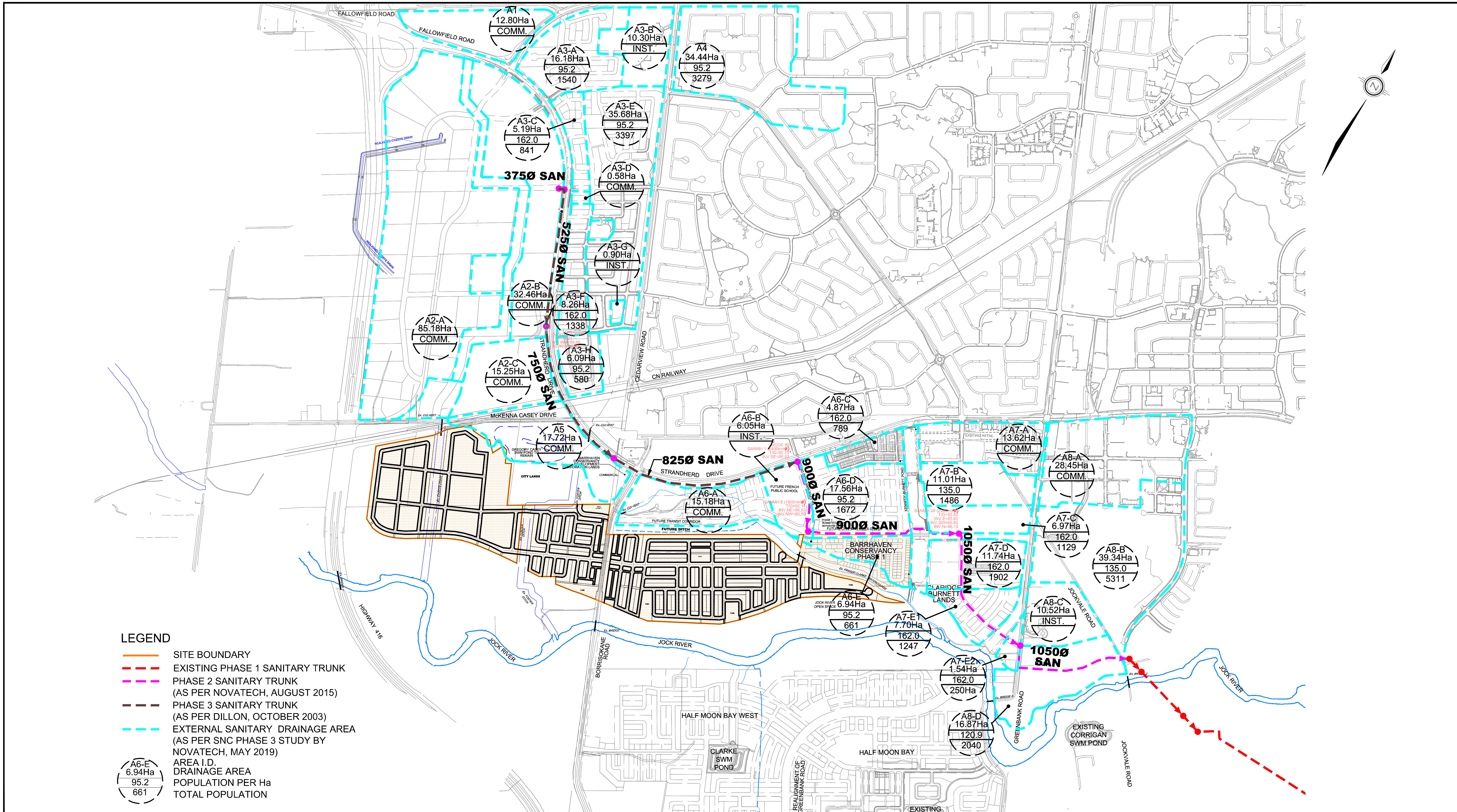
(3) Based on population densities of 104 people/ha for WEST and 83 people/ha for EAST. See Conservancy East sanitary design sheet

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da			
Average Daily Flow =	280	l/p/day	Industrial Peak Factor = as per MOE Graph		
Comm/Inst Flow =	28000	L/ha/da	Extraneous Flow =	0.330	L/s/ha
Industrial Flow =	35000	L/ha/da	Minimum Velocity =	0.600	m/s
Max Res. Peak Factor =	4.00		Manning's n =	0.000	
Commercial/Inst./Park Peak Factor =	1.50		Townhouse coeff=	2.7	
Institutional	0.32	l/s/Ha	Single house coeff=	3.4	

Designed: KLM	PROJECT: **Barrhaven Conservancy - Evaluation of SNC Flows**
Checked: KLM	LOCATION: **City of Ottawa**
Dwg. Reference:	File Ref: 16-891 / Date: June 2020 / Sheet No. 1 of 1

TOTAL FLOW INCLUDING CONSERVANCY LANDS IS 399.03 L/S WHICH IS LESS THAN THE PRIOR 423.6 L/S DETERMINED IN THE 2015 NOVATECH ASSESSMENT OF FLOWS AT THE SAME LOCATION IN THE SOUTH NEPEAN COLLECTOR DESIGN.



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BARRHAVEN CONSERVANCY
EXTERNAL SANITARY SERVICING
CITY OF OTTAWA

PROJECT No.:	16-891
SCALE:	1:18000
DATE:	JULY 2020
FIGURE:	4

DSEL
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www.DSEL.ca

BARRHAVEN CONSERVANCY
SANITARY TRIBUTARY AREA
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:4000
DATE:	JULY 2020
DRAWING No.	4

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	PPHA*	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
SANITARY TRUNK 2																											
	2002A	2004A	0.56	104	58	0.56	58	3.6	0.69		0.00		0.00		0.00	0.00	0.56	0.56	0.18	0.87	58.5	200	0.35	19.40	0.04	0.62	0.31
	2004A	2006A	0.22	104	23	0.78	81	3.6	0.95		0.00		0.00		0.00	0.00	0.22	0.78	0.26	1.21	58.5	200	0.35	19.40	0.06	0.62	0.34
	2006A	2008A	0.21	104	22	0.99	103	3.6	1.20		0.00		0.00		0.00	0.00	0.21	0.99	0.33	1.53	58.5	200	0.35	19.40	0.08	0.62	0.36
	2008A	2010A	0.22	104	23	1.21	126	3.6	1.46		0.00		0.00		0.00	0.00	0.22	1.21	0.40	1.86	58.5	200	0.35	19.40	0.10	0.62	0.39
	2010A	2012A	0.12	104	12	1.33	138	3.6	1.60		0.00		0.00		0.00	0.00	0.12	1.33	0.44	2.04	29.5	200	0.35	19.40	0.10	0.62	0.40
	2012A	2013A	0.17	104	18	1.50	156	3.5	1.79		0.00		0.00		0.00	0.00	0.17	1.50	0.50	2.29	39.5	200	0.35	19.40	0.12	0.62	0.41
	2013A	2014A	0.15	104	16	1.65	172	3.5	1.97		0.00		0.00		0.00	0.00	0.15	1.65	0.54	2.51	35.0	200	0.35	19.40	0.13	0.62	0.42
	2014A	2015A	0.11	104	11	1.76	183	3.5	2.09		0.00		0.00		0.00	0.00	0.11	1.76	0.58	2.67	28.0	200	0.35	19.40	0.14	0.62	0.43
	2015A	2036A	0.14	104	15	1.90	198	3.5	2.25		0.00		0.00		0.00	0.00	0.14	1.90	0.63	2.88	36.0	200	0.35	19.40	0.15	0.62	0.44
	2036A	2037A	7.40	104	770	9.30	967	3.2	10.18		0.00		0.00		0.00	0.00	7.40	9.30	3.07	13.25	53.5	250	0.25	29.73	0.45	0.61	0.59
	2037A	2038A	0.23	104	24	9.53	991	3.2	10.41		0.00		0.00		0.00	0.00	0.23	9.53	3.14	13.56	61.0	250	0.25	29.73	0.46	0.61	0.59
	2038A	2058A	4.24	104	441	13.77	1432	3.2	14.64		0.00		0.00		0.00	0.00	4.24	13.77	4.54	19.19	61.0	300	0.20	43.25	0.44	0.61	0.59
	2058A	1061A	0.16	104	17	13.93	1449	3.2	14.80		0.00		0.00		0.00	0.00	0.16	13.93	4.60	19.40	59.0	300	0.20	43.25	0.45	0.61	0.59
	1061A	1063A	6.64	104	691	20.57	2139	3.1	21.15		0.00		0.00		0.00	0.00	6.64	20.57	6.79	27.94	62.0	375	0.15	67.91	0.41	0.61	0.58
	1063A	1064A	0.22	104	23	20.79	2162	3.0	21.35		0.00		0.00		0.00	0.00	0.22	20.79	6.86	28.21	60.5	375	0.15	67.91	0.42	0.61	0.58
	1064A	1096A	0.22	104	23	21.01	2185	3.0	21.56		0.00		0.00		0.00	0.00	0.22	21.01	6.93	28.49	59.5	375	0.15	67.91	0.42	0.61	0.59
	1096A	1105A	9.80	104	1019	30.81	3204	2.9	30.47		0.00		0.00		0.00	0.00	9.80	30.81	10.17	40.64	67.0	375	0.15	67.91	0.60	0.61	0.64
	1105A	1111A	0.25	104	26	31.06	3230	2.9	30.69		0.00		0.00		0.00	0.00	0.25	31.06	10.25	40.94	56.5	375	0.15	67.91	0.60	0.61	0.64
	1111A	1120A	0.12	104	12	31.18	3243	2.9	30.80		0.00		0.00		0.00	0.00	0.12	31.18	10.29	41.09	58.5	375	0.15	67.91	0.61	0.61	0.64
			0.24	104	25	31.42	3268	2.9	31.01		0.00				0.00	0.00	0.24	31.42	10.37	41.38	58.5	375	0.15	67.91	0.61	0.61	0.64
			4.32	85	367	35.74	3635	2.0	23.56		0.00		0.00		0.00		4.32	35.74									
	1120A	1122A	2.67	104	278	38.41	3913	2.9	36.44		0.00		0.00		0.00	0.00	2.67	38.41	12.68	49.11	100.0	450	0.15	110.42	0.44	0.69	0.67
To Barrhaven Conservancy East:						38.41	3913				0.00		0.00		0.00			38.41									

* PPHA calculated based on a weighted average across the site, using the single house and townhouse coefficents of 3.4 and 2.7 people per unit respectively

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha				
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph			
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s
Max Res. Peak Factor =	4.00				Manning's n =	(Conc)	0.013	(Pvc) 0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4	

Designed: R.B.	PROJECT: **BARRHAVEN CONSERVANCY WEST**		
Checked: D.A.	LOCATION: **City of Ottawa**		
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 4	File Ref: 16-891	Date: July 2020	Sheet No. 1 of 1

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

Ottawa

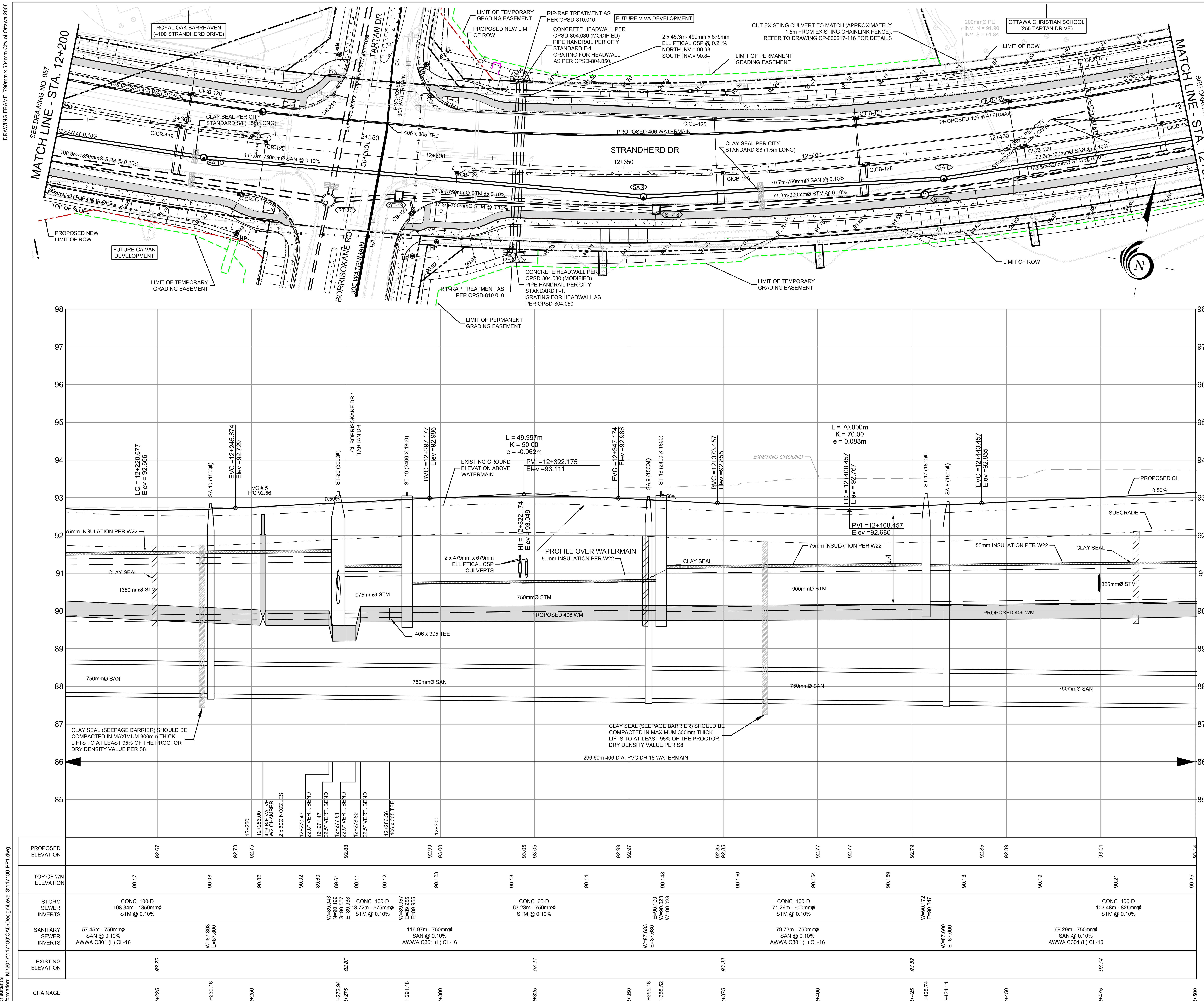
LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	PPHA*	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
SANITARY TRUNK 1																											
Contribution From Barrhaven Conservancy West:						38.41	3913				0.00		0.00		0.00		0.00	38.41									
	1122A	1124A	0.63	83	53	39.04	3966	2.9	36.88		0.00		0.00		0.00	0.00	0.63	39.04	12.88	49.76	58.5	450	0.15	110.42	0.45	0.69	0.68
	1124A	1134A	0.63	83	53	39.67	4019	2.9	37.31		0.00		0.00		0.00	0.00	0.63	39.67	13.09	50.41	16.5	450	0.15	110.42	0.46	0.69	0.68
	1134A	1135A	2.73	83	227	42.40	4246	2.8	39.19		0.00		0.00		0.00	0.00	2.73	42.40	13.99	53.18	42.0	525	0.10	136.00	0.39	0.63	0.59
	1135A	1141A	0.70	83	59	43.10	4305	2.8	39.67		0.00		0.00		0.00	0.00	0.70	43.10	14.22	53.89	58.5	525	0.10	136.00	0.40	0.63	0.59
	1141A	1144A	1.06	83	88	44.16	4393	2.8	40.39		0.00		0.00		0.00	0.00	1.06	44.16	14.57	54.96	58.5	525	0.10	136.00	0.40	0.63	0.59
	1144A	1174A	0.85	83	71	45.01	4464	2.8	40.97		0.00		0.00		0.00	0.00	0.85	45.01	14.85	55.82	58.5	525	0.10	136.00	0.41	0.63	0.60
			0.03	83	3	45.04	4467				0.00		0.00		0.00		0.03	45.04									
	1174A	1175A	4.94	83	411	49.98	4878	2.8	44.32		0.00		0.00		0.00	0.00	4.94	49.98	16.49	60.82	69.5	525	0.10	136.00	0.45	0.63	0.61
From External			4.21	85	358	54.19	5236				0.00		0.00	0.93	0.93		5.14	55.12									
			0.97	83	81	55.16	5317				0.00		0.00		0.93		0.97	56.09									
			1.43	83	119	56.59	5436				0.00		0.00		0.93		1.43	57.52									
			1.65	83	137	58.24	5573				0.00		0.00		0.93		1.65	59.17									
	1175A	1186A	0.44	83	37	58.68	5610	2.8	50.15		0.00		0.00		0.93	0.10	0.44	59.61	19.67	69.92	87.5	525	0.10	136.00	0.51	0.63	0.63
	1186A	1190A	2.31	83	192	60.99	5802	2.7	51.66		0.00		0.00		0.93	0.10	2.31	61.92	20.43	72.19	58.5	525	0.10	136.00	0.53	0.63	0.64
	1190A	1200A	2.29	83	191	63.28	5993	2.7	53.15		0.00		0.00		0.93	0.10	2.29	64.21	21.19	74.44	59.0	525	0.10	136.00	0.55	0.63	0.64
	1200A	1201A	3.69	83	307	66.97	6300	2.7	55.54		0.00		0.00	0.85	1.78	0.19	4.54	68.75	22.69	78.42	79.5	525	0.10	136.00	0.58	0.63	0.65
	1201A	1204A	0.50	83	42	67.47	6342	2.7	55.86		0.00		0.00		1.78	0.19	0.50	69.25	22.85	78.91	79.5	525	0.10	136.00	0.58	0.63	0.65
	1204A	1223A	1.26	83	105	68.73	6447	2.7	56.67		0.00		0.00		1.78	0.19	1.26	70.51	23.27	80.13	58.5	525	0.10	136.00	0.59	0.63	0.65
	1223A	1228A	5.84	83	485	74.57	6932	2.7	60.39		0.00		0.00	0.43	2.21	0.24	6.27	76.78	25.34	85.97	58.5	525	0.10	136.00	0.63	0.63	0.66
	1228A	1237A	1.78	83	148	76.35	7080	2.7	61.52		0.00		0.00		2.21	0.24	1.78	78.56	25.92	87.68	58.5	525	0.10	136.00	0.64	0.63	0.67
	1237A	1249A	3.36	83	279	79.71	7359	2.7	63.64		0.00		0.00		2.21	0.24	3.36	81.92	27.03	90.91	58.5	525	0.10	136.00	0.67	0.63	0.67
	1249A	1250A	3.08	83	256	82.79	7615	2.7	65.56		0.00		0.00	0.67	2.88	0.31	3.75	85.67	28.27	94.15	98.5	525	0.10	136.00	0.69	0.63	0.68
	1250A	1272A				82.79	7615	2.7	65.56		0.00		0.00		2.88	0.31	0.00	85.67	28.27	94.15	98.5	525	0.10	136.00	0.69	0.63	0.68
	1272A	1278A	5.86	83	487	88.65	8102	2.6	69.21		0.00		0.00		2.88	0.31	5.86	91.53	30.20	99.72	25.5	525	0.10	136.00	0.73	0.63	0.69
	1278A	1281A				88.65	8102	2.6	69.21		0.00		0.00		2.88	0.31	0.00	91.53	30.20	99.72	58.5	525	0.10	136.00	0.73	0.63	0.69
	1281A	1297A				88.65	8102	2.6	69.21		0.00		0.00		2.88	0.31	0.00	91.53	30.20	99.72	91.5	525	0.10	136.00	0.73	0.63	0.69
	1297A	1298A	7.70	83	640	96.35	8742	2.6	73.94		0.00		0.00	0.76	3.64	0.39	8.46	99.99	33.00	107.33	14.5	525	0.15	166.56	0.64	0.77	0.82
	1298A	1299A	0.12	83	10	96.47	8752	2.6	74.01		0.00		0.00		3.64	0.39	0.12	100.11	33.04	107.44	79.0	525	0.15	166.56	0.65	0.77	0.82
	1299A	1300A				96.47	8752	2.6	74.01		0.00		0.00		3.64	0.39	0.00	100.11	33.04	107.44	79.0	525	0.15	166.56	0.65	0.77	0.82
To Existing Sanitary Trunk:						96.47	8752				0.00		0.00		3.64			100.11									

* PPHA calculated based on a weighted average across the site, using the single house and townhouse coefficents of 3.4 and 2.7 people per unit respectively

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha					
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph				
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha	
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s	
Max Res. Peak Factor =	4.00				Manning's n =	(Conc)	0.013	(Pvc)	0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7		
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4		

Designed: R.B.	PROJECT: **BARRHAVEN CONSERVANCY EAST**		
Checked: D.A.	LOCATION: **City of Ottawa**		
Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 4	File Ref: 16-891	Date: July 2020	Sheet No. 1 of 1



STRANDHERD DRIVE WIDENING

MARAVISTA DRIVE TO JOCKVALE ROAD

Ottawa

Contract No. CP000217
Dwg. No. 059
Sheet 059 of XX

GRADING & DRAINAGE 7
STRANDHERD DRIVE
STA. 12+200 TO STA. 12+500

A. C. GONTHIER, P.Eng. — Director
J. VALLEE, P.Eng. — Project Manager

PARSONS NOVATECH — Engineers, Planners & Landscape Architects

Asset No.
Asset Group

Des.	TPB	Chk'd.	RJD
Dwn.	TPB	Chk'd.	RJD
Utility Circ. No.		Index No.	

Const. Inspector

Scale: 1:500 H, 1:50 V

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

REVISIONS

No.	Description	By	Date (dd/mm/yy)
1.	PRELIMINARY DESIGN CIRCULATION	RJD	31/05/18
2.	ISSUED FOR CONTRACTOR PRE-QUALIFICATION	RJD	24/10/18
3.	ISSUED FOR MOE ECA APPROVAL	RJD	13/03/19
4.	ISSUED FOR TENDER	ERD	18/10/19

NOT FOR CONSTRUCTION

DRAWING FRAME: 790mm x 534mm City of Ottawa 2008

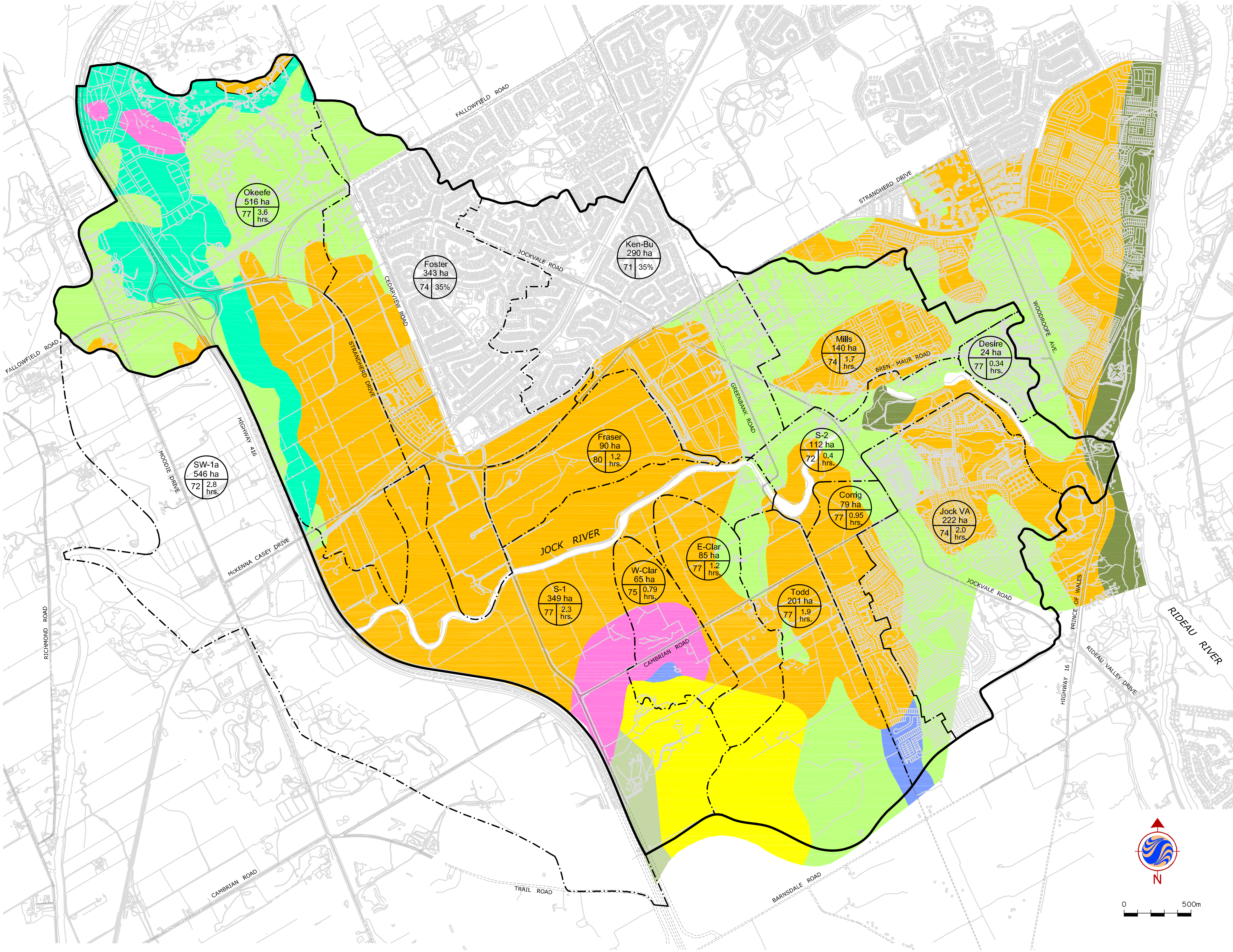
Consultant's Information: M:\2017\117190\CAD\Design\Level 3\117190-PP1.dwg

APPENDIX F

JOCK RIVER SUBWATERSHED STUDY

JOCK RIVER REACH ONE
SUBWATERSHED STUDY

SURFICIAL SOILS



Desire 24 ha 77 50% hrs. — Sub-drainage Area Name; Sub-drainage Area Size; % Impervious or Time to Peak (hours); SCS Curve Number

Sub-drainage Area Limit

WATERSHED BOUNDARY

SILTY CLAY

GLACIAL TILL

FLUVIOGLACIAL DEPOSIT

ORGANIC DEPOSITS

RIVER CHANNEL DEPOSITS

MARINE SAND

BEACH SAND

BEDROCK

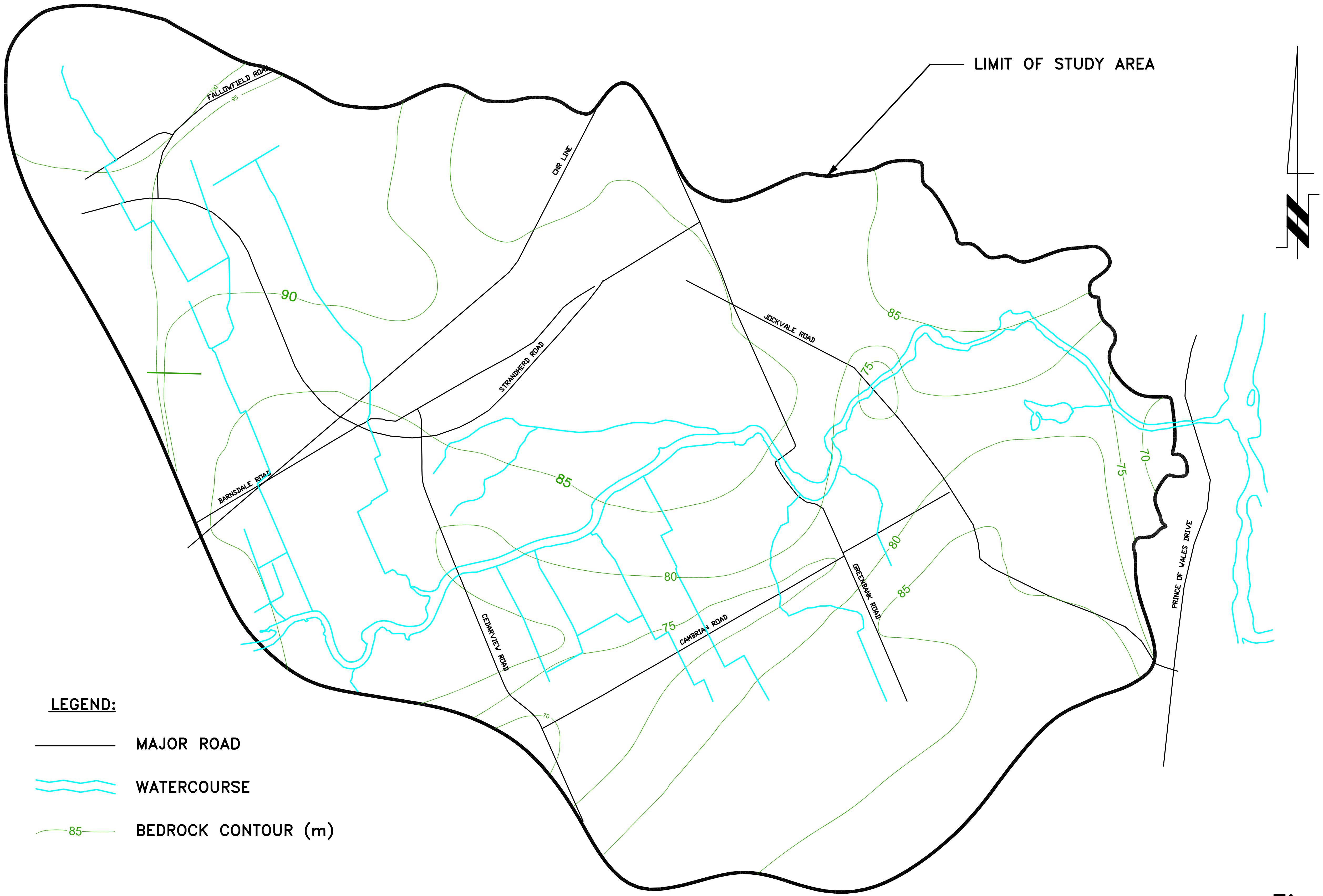
Source :
South Nepean Urban Area Master Servicing Study.
Environmental Study Report, Volume 1
(J.L.Richards & Ainley Graham, 1998)

JUNE 2007

Stantec

Ottawa

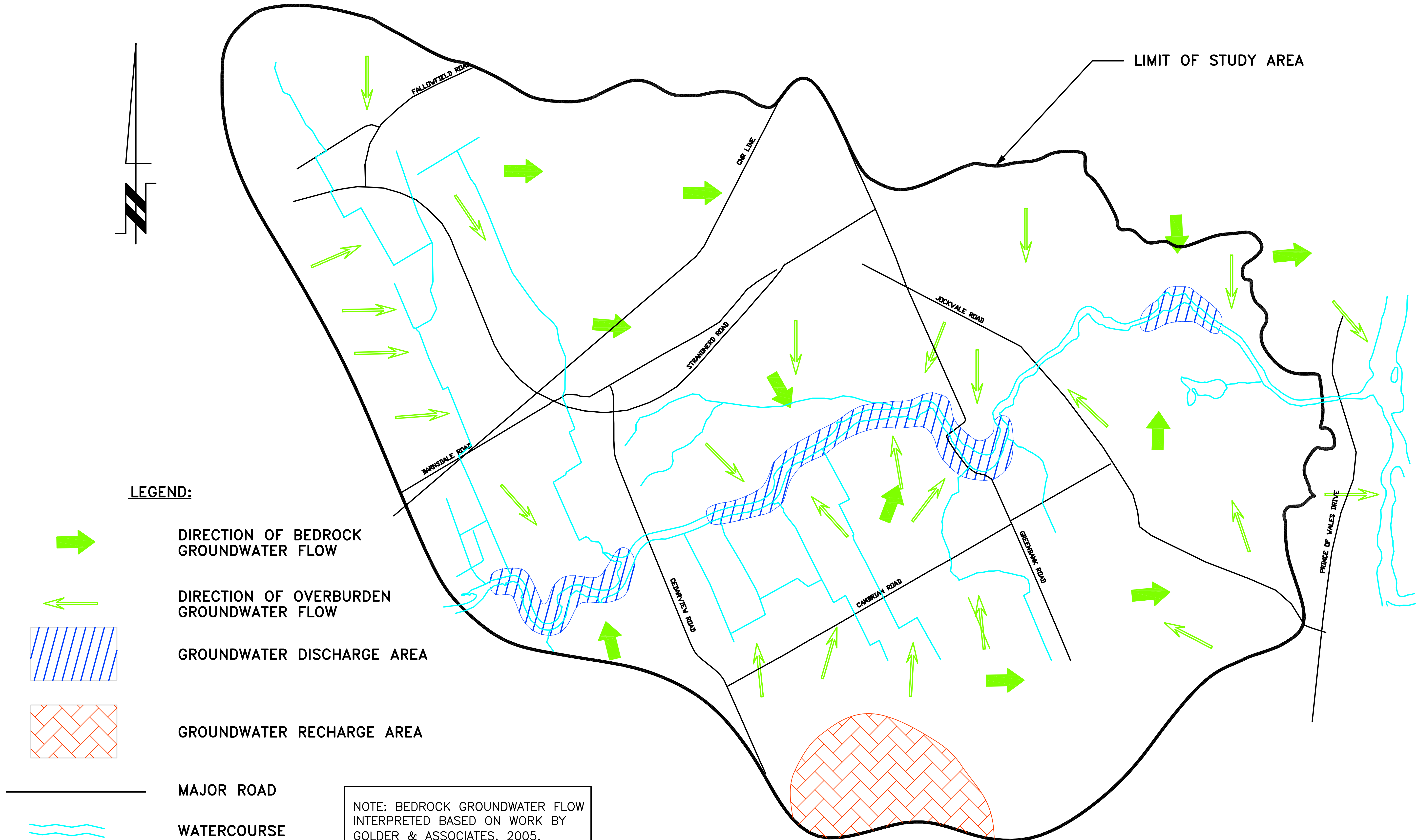
Figure 3.4.1



JUNE 2007

Fig: 3.4.2

patersongroup **consulting engineers** **28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7**	**Scale:** N.T.S. **Des.:** RAP **Dwn:** MPG **Chkd:** RAP	STANTEC CONSULTING LTD. JOCK RIVER SUBWATERSHED STUDY OTTAWA (NEPEAN), ONTARIO	BEDROCK CONTOURS	**Dwg. No.** PH0299-3 **Report No.:** PH0299-01 **Date:** 11/2005



NOTE: BEDROCK GROUNDWATER FLOW INTERPRETED BASED ON WORK BY GOLDER & ASSOCIATES, 2005.

JUNE 2007

Fig: 3.4.3

paterson group
consulting engineers
28 Concourse Gate, Unit 1, Ottawa, Ontario K2E 7T7

Scale:	N.T.S.
Des.:	RAP
Dwn:	MPG
Chkd:	RAP

STANTEC CONSULTING LTD.
JOCK RIVER SUBWATERSHED STUDY
OTTAWA (NEPEAN), ONTARIO

INTERPRETED GROUNDWATER FLOW DIRECTION

Dwg. No.	PH0299-2
Report No.:	PH0299-01
Date:	11/2005

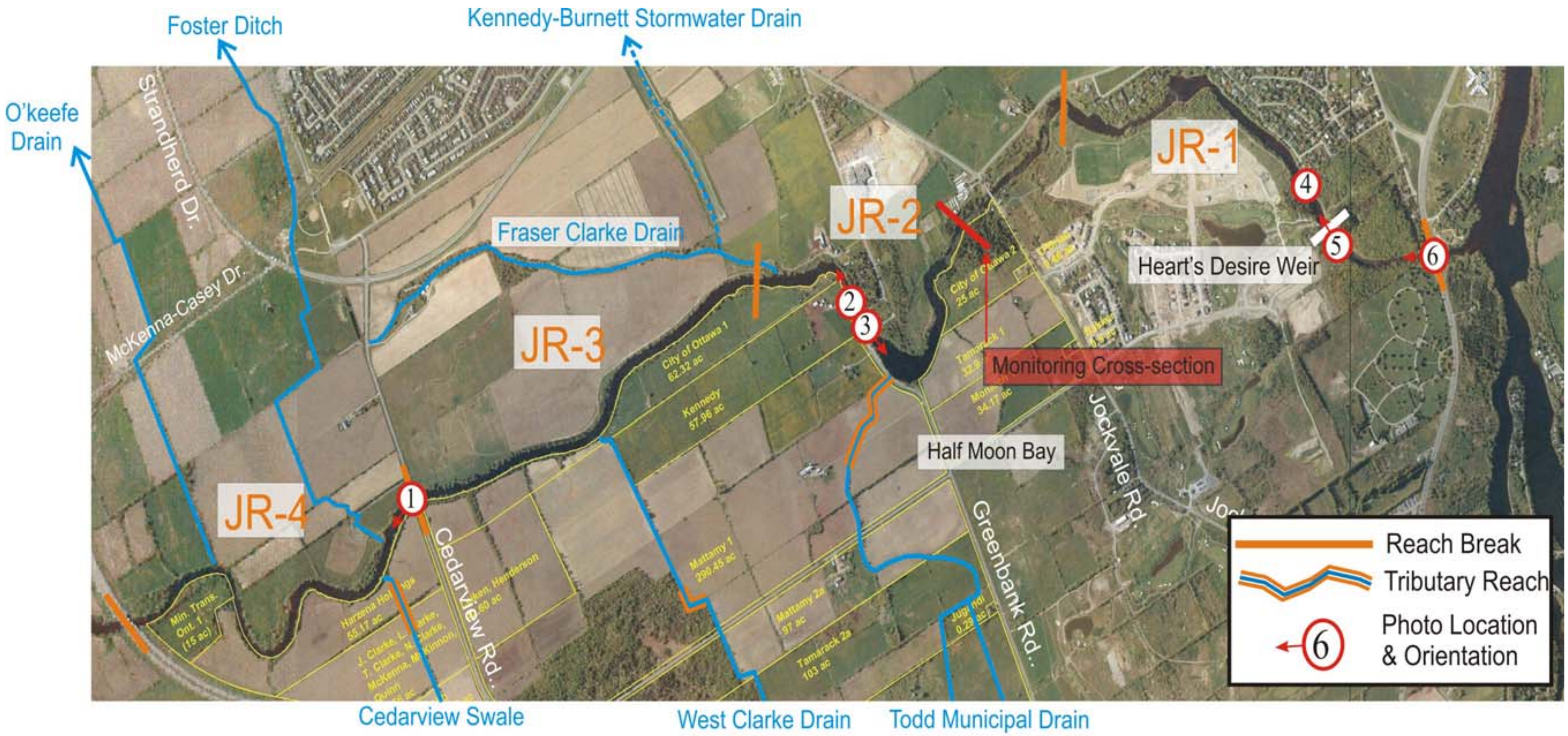


Figure 3.5.1: Delineation of reaches in R1 Study Area: JR-1, JR-2, JR-3 and JR-4 along the main Jock River, the Monitoring Cross Section and the six main tributaries contributing to the Jock River.

APPENDIX G

EROSION HAZARD ASSESSMENT &
EROSION THRESHOLD ANALYSIS

Jock River, Barrhaven Conservancy

Erosion Hazard Assessment and Erosion Threshold Analysis

Prepared for:
David Schaeffer Engineering Ltd.
120 Iber Road, Unit 103
Stittsville, ON
K2S 1E9

January 11, 2018
PN17071

GEO MORPHIX
Geomorphology
Earth Science
Observations

Report Prepared by:	GEO Morphix Ltd. 2800 High Point Drive Suite 100A Milton, ON L9T 6P4
Report Title:	Jock River, Barrhaven Conservancy – Erosion Hazard Assessment and Erosion Threshold Analysis
Project Number:	PN17071
Status:	Final
Version:	2.0
First Submission Date:	August 4, 2017
Revision Date:	January 11, 2018
Prepared by:	Cara Hutton, M.Sc.
Approved by:	Paul Villard, Ph.D., P.Geo.
Approval Date:	January 11, 2018

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List of Tables

Appendices

1 Introduction

This report provides support in addressing meander belt width requirements for the Jock River and its tributaries and erosion threshold analyses for the Fraser Clark, Foster Ditch, and O'Keefe municipal drains. The property of the assessed reaches is located between Highway 416 to the west, Greenbank Road to the east, Strandherd Drive to the north, and Jock River to the South.

To delineate the hazard land associated with Jock River and the three (3) municipal drains and to determine the erosion thresholds analysis in support of the proposed stormwater management, the following activities were completed:

- Background review of existing documents related to the study area, including topography, physiography, and geology mapping;
- Review of the meander belt widths associated with the subwatershed study and subsequent analysis on the adjacent tributaries;
- Updated and confirm reach delineation for all three drains;
- Review of historical and recent aerial photographs;
- Completion of rapid geomorphic assessments of the three drains to document channel condition;
- Delineation of the hazard area adjacent to the Jock River and 3 drains based on the results of the updated belt width assessment where warranted;
- Complete a detailed geomorphic assessment of each municipal drain to determine a critical discharge or confirm existing erosion thresholds; and
- Modelling of erosion indices based on post- to pre-development synthetic storage or continuous modelling.

2 Background Review

A review of the meander belt widths and erosion threshold analyses from previous studies were completed for the Jock River and the three adjacent municipal drains. The following studies were reviewed:

- CH2M Hill Canada Limited. 2013. O'Keefe Drain Environmental and Stormwater Management Plan. Prepared for the City of Ottawa;
- CH2M Hill Canada Limited. 2013. Foster Stormwater Management Facility Environmental Study Report. Prepared for the City of Ottawa;
- Parish Aquatic Services, A Division of Matrix Solutions. 2016. Clarke Drain Erosion Threshold Assessment. Prepared for Minto Communities Inc.; and
- Stantec Consulting Ltd. 2007. Jock River Reach One Subwatershed Study Final Report: Volume 1 of 2. Prepared for the City of Ottawa.

3 Historical Assessment

Historical aerial photographs were reviewed to determine changes to the channel and surrounding land use/cover. This information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. The 1976 and 1991 aerials were provided by the City of Ottawa and the 2016 was provided by Google Earth Pro. A summary of the historical changes to the three drains are provided in **Table 1**. Historical aerial photographs are provided in **Appendix A**.

Table 1. Historical assessment

Watercourse	1976	1991	2014
Fraser Clark Drain	Agricultural fields surround associated reaches with little to no riparian buffer. Land use within the study site remains consistent to 2014. Reaches FCD2 and FCD3 consist of wetland features. Reach FCD3-3 was not present on the aerial photograph. Reaches FCD3-1, FCD3-2, and FCD5 consist of swale features.	Residential development extends to McKenna Drive and Borrisokane Road. A localized residential property present adjacent to Reach FCD4. Tree growth within the narrow riparian areas. Reach FCD5 was ditched and straightened. No changes to the form of the remainder of the reaches since 1976. Two elongated storm water ponds are constructed, extending east from McKenna Drive parallel to Reach FD1-1.	Residential development extends to Strandherd Drive. Residential and commercial properties present along Strandherd Drive. Riparian buffers increase in width and an increase in tree cover. No changes to the form of the reaches since 1991. A storm water pond was constructed between Strandherd Drive and Reach FCD4**.** Reach FCD4-1 was built to convey flows from the pond to FCD4.
Foster Ditch	Agricultural fields surround associated reaches with no riparian buffer. Land use within the study site remains consistent to 2014. Reaches FD1, FD2, FD3 are narrow features. Reach FD3 was ditched, Reaches FD1 and FD2 were unmodified.	Residential properties extend to the east side of Borrisokane Road. Riparian buffers are narrow and fragmented. Reaches FD1, FD2, FD3, and upstream of Reach FD3 have been noticeably widened. A stormwater pond and Reach FCD1-1 was constructed adjacent to Reach FD1. A flow structure was present at the pond inlet and an access road crosses Reach FD1.	Riparian buffers widen slightly and some tree establishment was noted. Residential areas extend west to Strandherd Drive and north towards Fallowfield Road. Stormwater pond along reach FD1 was reshaped, given a new outlet flowing into Jock River. The flow structure and access road are removed Upstream of the study site stormwater ponds were constructed. Reaches FD4 and FD5 were created as inlet and outlet reaches to the ponds. Further upstream, reaches FD6 to FD14 were re-aligned for development purposes.

Watercourse	1976	1991	2014
O'Keefe Drain	Agricultural fields surround associated reaches. Land use within the study site remains consistent to 2014. A narrow, established riparian buffer zone was only present along Reach OKD1. All other reaches possess little to no riparian area. All reaches were previously straightened and ditched	No notable changes to land use, riparian coverage, and channel formation since 1976.	Riparian tree growth noted upstream of the study site. No changes to riparian coverage and channel formation to reaches OKD1 and OKD2. Commercial development extends east of Strandherd Drive. Reaches OKD3 to OKD8 were re-aligned. Stormwater ponds were constructed along reaches OKD3, and OKD5.
Jock River	Agricultural fields surround associated reaches. Narrow riparian zones along both banks of all reaches. Reach JR-4 more sinuous than reach JR-3. No other morphology apparent in aerial.	No notable changes to land use, riparian coverage, and channel formation since 1976.	No notable changes to riparian coverage and channel formation since 1991. Residential development just south of reach JR-3. Highway 416 was built intersection reach JR-4.

4 Existing Conditions

4.1 Watershed Characteristics

Channel morphology and planform are largely governed by the flow regime and the availability and type of sediments (i.e., surficial geology) within the stream corridor. Physiography, riparian vegetation and land use also physically influence the channel. These factors provide insight into existing conditions and perception to the future potential changes as they relate to a proposed activity.

Physiographically, the project site is located within an area dominated by glaciofluvial deposits comprised of alluvial deposits and topset facies. Within the project site, surficial deposits also include modern alluvium ranging from clay to gravel with organic deposits as well as glaciolacustrine sediments composed of massive to laminated silt and clay with minor sand and gravel (OGS, 2010).

4.2 Confirmation of Reach Delineation

Reaches are homogeneous segments of channel used in geomorphological investigations. They are studied semi-independently as each is expected to function in a manner that is at least slightly different from adjoining reaches. This allows for a meaningful characterization of a watercourse as the aggregate of reaches, or an understanding of a particular reach, for example, as it relates to a proposed activity.

Reaches are delineated based on changes in the following:

- Channel planform;
- Channel gradient;
- Physiography;
- Land cover (land use or vegetation);
- Flow, due to tributary inputs;
- Soil type and surficial geology; and
- Certain types of anthropogenic channel modifications.

This follows scientifically defensible methodology proposed by Montgomery and Buffington (1997), Richards et al. (1997), Brierley and Fryirs (2005), and the Toronto and Region Conservation Authority (2004).

Thirteen reaches were delineated within the study area in a desktop exercise using available data and background reports. These reaches were then field verified. Seven reaches of Fraser Clark Drain (FCD), two reaches of O'Keefe Drain (OKD), and four reaches of Foster Ditch (FD) were defined in the subject lands. The reaches for the Jock River remain the same from the Subwatershed Study (Stantec, 2007). A reach map is provided in **Appendix B**. Reach mapping extends north of the study site.

4.3 Channel Characteristics

Reach observations and channel measurements were collected in June 2017. These field investigations were used to gain insight into the conditions and general characteristics of each reach in the subject property. A photographic record is included in **Appendix C** and documents the conditions from all observed reaches. Field notes and observations are provided in **Appendix D**.

Rapid geomorphological assessments were completed and included the following reach-by-reach observations:

- Characterization of stream form, process, and evolution using the Rapid Geomorphological Assessment (RGA) (MOE, 2003, VANR, 2007);
- Assessment of the ecological function of the watercourse using the Rapid Stream Assessment Technique (RSAT) (Galli, 1996);
- Stream classification following a modified Downs (1995) and a modified Brierley and Fryirs (2005) River Styles Classification approach;
- Reach-scale habitat sketch maps based on Newson and Newson (2000) outlining channel substrate, flow behaviour, geomorphological units, and riparian vegetation on the day;
- Instream estimates of bankfull channel dimensions; and
- Bed and bank material composition and structure.

4.4 Rapid Geomorphological Assessments

Channel stability and susceptibility to erosion were objectively assessed through the application of the Ontario Ministry of the Environment's (2003) Rapid Geomorphic Assessment (RGA). The RGA evaluates degradation, aggradation, widening, and planimetric form adjustment at the reach scale. The end result of the RGA is to produce a score, or stability index, which evaluates the degree to which a stream has departed from its equilibrium condition. A stream with a score of less than 0.20 is in regime, indicating minimal changes to its shape or processes over time. A score of 0.21 to 0.40 indicates that a stream is in transition or stress and is experiencing major change to process and form outside the natural range of variability. A score of greater than 0.41

indicates that a stream is in extreme adjustment, exhibiting a new stream type, or in the process of adjusting to a new equilibrium (MOE, 2003; VANR, 2007).

The Rapid Stream Assessment Technique (RSAT) was also employed to provide a broader view of the system and consider the ecological functioning of the watercourses (Galli, 1996). Observations were made of channel stability, channel scouring or sediment deposition, instream and riparian habitats, and water quality. The RSAT score ranks the channel as maintaining a poor (<13), fair (13-24), good (25-34), or excellent (35-42) degree of stream health.

Reaches were also classified according to a modified Downs (1995) Channel Evolution Model and the River Styles Framework (Brierley and Fryirs, 2005). The Down's Model describes successional stages of a channel as a result of a perturbation, namely hydromodification. Understanding the current stage of the system is beneficial as this allows one to predict how the channel will continue to evolve, or respond to an alteration to the system. The River Styles Framework (Brierley and Fryirs, 2005) provides a geomorphological approach to examining river character, behaviour, condition, and recovery potential.

Field observations are provided in **Table 2** and **Table 3** below.

4.4.1 Fraser Clark Drain

Reach FCD2 exists as an unconfined wetland between agricultural fields. The reach flows south east with low gradient and entrenchment to the Jock River. Riparian vegetation was comprised of trees and grasses. In the upstream portion of the reach, riparian cover was continuous and tree dominated. The downstream was grass dominated and entirely encroached with reeds. Average feature width and depth were 9.3, and 0.4 m, respectively. Bed and bank material were soft and comprised of clay, silt, and sand. There was no development of geomorphic units. Approximately 0.30 to 0.40 m deep of loose bed material and organics were present on the bed at the time of assessment.

Reach FCD3 exists as an unconfined wetland. Riparian vegetation was fragmented containing scattered trees and dominated by grasses. Approximately 75% of upstream is heavily encroached with reeds, containing no notable flow. Bed and bank materials consisted of clay, silt, and sand. Average feature width and depth were 12.3 m, and 0.2 m, respectively. There was no riffle-pool development throughout the reach.

Reach FCD3-1 is an unconfined swale feature surrounded by active agricultural fields. The riparian zone was fragmented and consisted of grasses with scattered trees and shrubs. The swale was heavily encroached with grasses and reeds. The reach had no defined channel banks and no riffle-pool features. Bed material consisted of clay, silt, and sand.

Reach FCD3-2 starts approximately 25 m east of Borrisokane Road and flows intermittently over a low gradient. There was no surface water present at the time of assessment. The riparian area was grass dominated, with reeds fully encroaching the bed. The reach had no defined channel banks and no riffle-pool features. Bed material consisted of clay, silt, and sand.

Reach FCD3-3 was not present at the time of assessment.

Reach FCD5 exists as an unconfined swale feature with a low gradient. The reach begins on the western side of Borrisokane Road, and concludes at a culvert at Borrisokane Road. No surface water was present at the time of assessment. The bank angles were low with no evidence of erosion. Riparian vegetation consisted of mainly grasses with scattered trees. Bed and bank material consisted of clay, silt, sand. The reach was absent of geomorphic development.

4.4.2 Foster Ditch

Reach FD1 consists as a sinuous, unconfined channel that perennially flows into Jock River. The reach flows over a low gradient surrounded by agricultural fields. Riparian coverage was dominated by grass, with trees present at the upstream and downstream breaks. The banks were highly entrenched and undercutting was present in the downstream portion of the reach. Bank angles were high and extent of bank erosion included 30-60% of the reach. Bankfull width and depth were 4.7 m and 0.7 m, respectively. No riffle-pool features were present. Grasses encroached minimally into the channel and a low density of woody debris was present. The bed and banks of the channel were both comprised of clay and silt, with sand and scattered rip rap present in the heavily modified areas. Bed materials were soft and were 0.05 to 0.20 m deep.

Reach FD2 consisted of a low gradient, perennial channel surrounded by agricultural fields. The reach exhibits a sinuous planform and was slightly entrenched. The riparian area was narrow and consisted of trees, shrubs, and grasses. Reeds were extensively encroaching the channel at the downstream reach break. A moderate density of woody debris was present. High bank angles at 60-90 degrees and undercutting up to 0.10 m was present. Average bankfull width and depth were 7.6 m and 0.6 m, respectively. No riffle-pool features were present. The bed and banks were composed of clay and silt.

Reach FD3 is straight, ditched, and unconfined channel with a low gradient. The reach was surrounded by a narrow riparian buffer dominated by grasses with scattered trees. Reeds were moderately encroaching the channel. The banks had high angles of 60-90 degrees and were highly entrenched. A large woody debris jam at the downstream portion of the reach was causing substantial backwatering. Undercutting was present upstream and downstream of a large woody debris jam. Average bankfull width and depth were 6.9 m and 0.5 m, respectively. The reach was absent of riffle-pool features. Bed and bank material consisted of clay, silt, and sand. Approximately 0.3 to 0.4 m deep of fines were present on the bed upstream of the woody debris jam.

4.4.3 O'Keefe Drain

Reach OKD1 is a previously straightened and ditched channel flowing between agricultural fields. The reach had a low gradient and was unconfined. Riparian vegetation was continuous and dominated by trees and grasses. The channel was highly entrenched, with high bank angles between 60-90 degrees. Fluvial entrainment and exposed tree roots were commonly observed, with an extent of 60-100% of the reach exhibiting erosion. Encroachment was minimal. Woody debris was high in density with two woody debris jams per 50 m. Average bankfull width and depth were 4.6 and 0.7 m, respectively. The reach had no riffle-pool features. Substrate of the bed and bank ranged between clay, silt, sand, and organics. At the time of assessment, approximately 0.2 – 0.3 m of loose bed material was present on the bed.

Reach OKD2 was previously straightened and ditched. Riparian vegetation was narrow and consisted of grasses. Reed encroachment was moderate. The banks were highly entrenched with high angles of 60-90 degrees. Erosion was present in 30-60% of the reach. Two erosion scars were observed along the right bank. Average bankfull width and depth were 4.4 m and 0.7 m, respectively. Riffle-pool features were not observed. Bed and bank material included clay and silt. A low density of woody debris was present in the channel.

General reach characteristics are summarized below in **Table 2**, and results from the rapid assessments are summarized in **Table 3**.

Table 2. General reach characteristics

Reach	Average Bankfull Width (m)	Average Bankfull Depth (m)	Substrate		Valley Type	Riparian Vegetation	Notes
			Riffle	Pool			
FCD2	N/A: wetland feature		No riffle-pool development: clay, silt, organics		Unconfined	Trees and grasses, fragmented	Wetland feature. Heavy reed encroachment. Soft bed materials.
FCD3	N/A: wetland feature		No riffle-pool development: clay, silt, organics		Unconfined	Trees and grasses, fragmented	Wetland feature. Heavy reed encroachment. No flow.
FCD3-1	N/A: swale feature		No riffle-pool development: clay, silt, organics		Unconfined	Trees and grasses, fragmented	Swale feature. Channel dry at time of assessment. Heavy reed encroachment.
FCD3-2	N/A: swale feature		No riffle-pool development: clay, silt, organics		Unconfined	Trees and grasses, fragmented	Swale feature. Channel dry at time of assessment. Heavy reed encroachment.
FCD3-3	N/A: no feature at the time of assessment						
FCD5	N/A: swale feature		No riffle pool development: clay, silt, sand		Unconfined	Trees and grasses, fragmented	Swale feature. Channel dry at time of assessment. Heavy reed encroachment.
FD1	4.3	0.4	No riffle pool development: clay, silt		Unconfined	Trees and grasses, fragmented	Sinuous and entrenched. Undercutting. Soft bed materials.
FD2	7.6*	0.4	No riffle pool development: clay, silt		Unconfined	Trees shrubs and grasses, continuous	Sinuous and slightly entrenched. Undercutting. Heavy reed encroachment.
FD3	6.9*	0.4	No riffle pool development: clay, silt, sand		Unconfined	Trees and grasses, fragmented	Straightened and ditch feature. Backwatering due to a large woody debris jam.
OKD1	4.6	1.0	No riffle pool development: clay, silt, sand, organics		Unconfined	Trees shrubs and grasses, fragmented	Straightened and ditch feature. Highly entrenched. Soft bed materials.
OKD2	4.4	0.7	No riffle pool development: clay, silt		Unconfined	Trees and grasses, fragmented	Straightened and ditch feature. Highly entrenched. Erosion scars observed.

*feature width

Table 3. Rapid assessment results

Reach	RGA (MOE, 2003)			RSAT (Galli, 1996)			Down's Channel Evolution Model (1995)	River Styles Framework (Brierley and Fryirs, 2005)
	Score	Condition	Dominant Systematic Adjustment	Score	Condition	Limiting Features		
FCD2	0	In Regime	N/A	31	Good	Riparian Habitat	S – stable	Straight, suspended load
FCD3	0	In Regime	N/A	29.5	Good	Riparian Habitat	S – stable	Straight, suspended load
FCD3-1	0	In Regime	N/A	N/A	N/A	N/A	S – stable	Meandering, suspended load
FCD3-2	0	In Regime	N/A	N/A	N/A	N/A	S – stable	Meandering, suspended load
FCD3-3	N/A, Channel non-existent at time of assessment.							
FCD5	0	In Regime	N/A	N/A	N/A	N/A	S – stable	Straight, suspended load
FD1	0.09	In Regime	Evidence of Aggradation	30.5	Good	Riparian Habitat	S – stable	Meandering, suspended load
FD2	0.12	In Regime	Evidence of Widening	31	Good	Riparian Habitat	S – stable	Meandering, suspended load
FD3	0.11	In Regime	Evidence of Widening	30	Good	Riparian Habitat	S – stable	Straight, suspended load
OKD1	0.12	In Regime	Evidence of Widening	30	Good	Channel Stability	e - enlarging	Straight, suspended load
OKD2	0	In Regime	N/A	29	Good	Riparian Habitat	C – Compound	Straight, suspended load

4.4.4 Jock River

Reach JR-2 is just downstream and east of the study site. Site reconnaissance was completed at the Borrisokane Road crossing at the reach break between JR-3 and JR-4. Photographs are provided in **Appendix C**. Both reaches are unconfined with narrow riparian buffer zones. Bank erosion was not observed in the vicinity of the crossing. This was consistent with Stantec's observations.

4.5 Detailed Geomorphological Assessments

A detailed geomorphological assessment was completed for each drain: OKD1, FD1, and FCD2 in June 2017. As these reaches are downstream of the proposed SWM facility, Wet Ponds, and Oil and Grit Separator. The extent of the detailed assessments areas are provided in **Appendix F**. As such, defining an erosion threshold is necessary to mitigate negative post-development impacts.

The detailed assessment includes the following:

- Longitudinal profile of the channel;
- Eight detailed cross-sectional surveys of the watercourse;
- Detailed instream measurements at each cross-section location including bankfull channel geometry, riparian conditions, bank material, bank height/angle, and bank root density;
- Bed material sampling at each cross-section following a modified Wolman's (1954) Pebble Count Technique or substrate sample; and
- Velocity, discharge and observations of active/inactive sediment transport at select representative cross-sections.

Bankfull characteristics, based on the results of the detailed assessments for each drain are presented in **Table 5** in **Section 6.1**. A summary of the detailed assessment results for Reach OKD1, FCD1, and FCD2 are provided in **Appendix G**.

5 Meander Belt Width Assessment

Most watercourses in southern Ontario have a natural tendency to develop and maintain a meandering planform, provided there are no spatial constraints. A meander belt width assessment estimates the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. This assessment is therefore useful for determining the potential limit of development for proposed activities in the vicinity of a stream.

When defining the meander belt width for a creek system, the Ministry of Natural Resources and Forestry (MNRF) treats unconfined and confined systems differently. Unconfined systems are those with poorly defined valleys or slopes well-outside where the channel could realistically migrate. Confined systems are those where the watercourse in contained within a defined valley, where valley wall contact is possible.

In unconfined systems, the meander belt width can be graphically defined using orthorectified aerial imagery by determining the channel centreline and the channel's central tendency (i.e. meander belt axis). In cases where the channel has been previously modified or the location cannot be determined in the imagery – due to tree cover or poor photograph resolution, for example – a modelling approach is employed. More specifically, empirical models by Williams (1986). These models are scientifically-defensible and have been verified in past projects as suitable for use in southern Ontario. This modelling approach also serves as a preliminary, or planning level, meander belt width assessment.

All watercourses within the study site are within unconfined valley systems. Since the drainage features have been heavily modified, the meander belt width cannot be determined using orthorectified aerial imagery. Therefore, the modelling approach was used for all the drainage feature within the study site.

Meander belt widths were calculated using empirical models, as these reaches showed signs of previous modification. The results are outlined in **Table 4** and a map is provided in **Appendix H**.

Meander belt widths were proposed using a modified Williams (1986) model, based on field measurements of channel geometries. The modified model also accounts for the average bankfull width of a given reach and an additional 20% factor of safety. These empirical relations are outlined below:

$$B_w = 4.3{W_b}^{1.12} + W_b \qquad \text{[Eq. 1]}$$

where B_w is meander belt width (m) and W_b is bankfull channel width (m).

Table 4. Meander belt width estimates

Reach	#CH2MHILL (2013)	##Stantec (2007)	GEO Morphix Ltd.	
			*Williams – Width (1986) (m)	Proposed Meander Belt Width (m)
FCD2	No previous meander belt widths given for the Fraser Clark Drain		N/A: wetland feature; no erosion hazard	
FCD3			N/A: wetland feature; no erosion hazard	
FCD3-1			N/A: wetland feature; no erosion hazard	
FCD3-2			N/A: wetland feature; no erosion hazard	
FCD3-3			N/A: wetland feature; no erosion hazard	
FCD5			N/A: wetland feature; no erosion hazard	
FD1	18.9	32.7	32	32
FD2	18.9		32^	32
FD3	Not determined		32^	32
OKD1	45.6	28.8	34	34
OKD2	45.6		32	32

*includes a 20% factor of safety
#O'Keefe and Foster Drain Report
##No reach specified, average given
^Using the bankfull width from reach FD1

The Fraser Clark Drain, reaches FCD2 and FCD3, consisted of a wetland feature with no channel centreline. Therefore, there is no erosion hazard associated with these features. The same applies to the swale features for reaches FCD3-1, FCD3-2, and FCD5.

Since the Foster Ditch was previously ditched, the bankfull dimensions are comprised. The detailed assessment completed at reach FD1 has more accurate bankfull dimension measurements. Therefore, the meander belt with calculation for reach FD1 are used for reaches FD2 and FD3.

The Jock River meander belt widths within the Subwatershed Study (Stantec, 2007) were reviewed to assess suitability. The meander belt widths provided by the Subwatershed Study for reaches JR-3 and JR-4 are 218 and 231 m, respectively (Stantec, 2007). These meander belt widths include a 10% buffer. We are generally in agreement with the scale of the meander belt widths. The central tendency of the watercourse generally follows the overall trend of the channel passing through riffles or runs. Although there may be an opportunity for minor adjustments to the central tendencies for reaches JR-3 and JR-4. This does not fundamentally adjust the meander belt width from the location illustrated in the subwatershed study.

We have a minor refinement for the downstream reach, JR-2. The geologic feature at Half Moon bay is not technically a meander. Half Moon bay was formed by reworking the underlying glaciomarine deposits (OGS, 2010). Therefore, the meander belt width for reach JR-2 is 130 m plus a 10% buffer plus a 7 m setback. The proposed meander belt width for reach JR-2 is 150 m. This is smaller than that proposed in the subwatershed study.

6 Erosion Analysis

6.1 Erosion threshold Analysis

Erosion threshold analyses were completed for reaches OKD1, FD1, and FCD2 to determine the flow conditions under which channel bed and bank materials can potentially be entrained and transported. Erosion thresholds are established to provide targets for the proposed SWM facility, Wet Ponds, and Oil and Grit Separator discharges to ensure that post-development erosion rates into the receiving watercourses do not exceed natural pre-development rates.

The erosion threshold analysis provides a depth, velocity, or discharge at which sediments of a particular size may potentially be entrained. The results of the detailed geomorphic assessments were used to inform the erosion threshold analysis. Detailed geomorphic assessment locations were completed downstream of the proposed SWM facility, Wet Ponds, and Oil and Grit Separators. We note that even under the most typical conditions, due to natural variability of channel morphology and sediment characteristics within the reach, the computed flow characteristics would only provide first approximations of erosion thresholds.

Erosion thresholds are determined using different methods that are dependent on channel and sediment characteristics. For example, erosion thresholds for non-cohesive sediments may be estimated using either a shear stress or a velocity approach. An erosion threshold, in the form of a critical discharge, is then calculated based on the bed and bank materials and local channel geometry. Theoretically, above this discharge, entrainment and transport of sediment can occur.

Threshold targets are determined using different methods that are dependent on channel and sediment characteristics. An erosion threshold was quantified based on the bed and bank materials and local channel geometry in the form of a critical discharge. Theoretically, above this discharge, entrainment and transport of sediment can occur. The velocity, U (m/s) is iteratively calculated at various depths, until the average velocity in the cross section slightly exceeds the critical velocity of the bed material. The velocity is determined using a Manning's approach, where the Manning's n value is visually estimated, a method proposed by Cowan (1956). This is mathematically represented as

$$U = \frac{1}{n} d^{2/3} S^{1/2} \qquad \text{[Eq. 2]}$$

where, d is depth of water (m), S is channel slope, and n is the Manning's roughness. The discharge is then calculated using the area of a typical cross section at that depth. Results of the erosion threshold analysis are provided below in **Table 5**.

Table 5. Erosion thresholds for each drain

Channel parameter	O'Keefe Drain Reach OKD1	Foster Ditch Reach FD1	Fraser Clark Drain Reach FCD2
Measured			
Average bankfull channel width (m)	4.59	4.69	9.33
Average bankfull channel depth (m)	0.98	0.70	0.39
Bankfull channel gradient (%)	0.05	0.17	0.0001
D_{50} (m)	0.000002	0.000002	0.000002
Average bankfull velocity (m/s)	0.51	0.52	0.05
Bankfull discharge (m^3/s)	1.69	1.21	0.10
Bankfull shear stress (N/m^2)	3.53	8.33	1.46
Calculated for Bed Materials			
Critical velocity (m/s)	0.53*	0.53*	0.15
Critical discharge (m^3/s)	0.80	0.68	0.33
Apparent shear stress (N/m^2)	3.80	11.60	2.5
Conditions at Time of Assessment			
Water depth (m)	0.14	0.21	0.23
Average velocity (m/s)	0.26	0.20	0.05
Average discharge (m^3/s)	0.08	0.13	0.04
Sediment Transport Observations	No transport	No transport	No transport
Critical Discharges from Previous Reports			
Critical discharge (m^3/s)	1.86# (Stantec, 2007) 0.08## (CH2MHILL, 2013)	0.79# (Stantec, 2007) 0.82 (CH2MHILL, 2013)	1.70 (PARISH, 2013)

* Based on Fischenich (2001) for sandy loam
\# Not given for a specific reach
\#\# calculated for reach OKD2

Since both bed and bank material are similar in all three reaches and bank erosion thresholds are a proportion of thresholds for bed material, erosion thresholds for bank materials would be higher. Therefore, using the thresholds for bed materials would keep the bank erosion thresholds values conservative.

The critical discharge of the bed and bank materials for the O'Keefe Drain at reach OKD1 is 0.80 m^3/s. The critical discharge of the bed and bank materials for the Foster Ditch at reach FD1 is 0.68 m^3/s. The critical discharge of the bed and bank materials for the Fraser Clark Drain at reach FCD2 is 0.33 m^3/s.

7 Summary and Conclusions

The purpose of this report was to provide support in addressing meander belt width requirements and erosion threshold analyses for the Frazer Clark drain, the Foster Ditch, and the O'Keefe Drain. To delineate the limit of development, the meander belt width was calculated for the 2 reaches of the O'Keefe Drain and the 3 reaches of the Foster Ditch. The Frazer Clark Drain does not have a centre line of channel as the drain consisted of a wetland feature and therefore does not require and meander belt width. The meander belt widths for the O'Keefe Drain are 34 m for reach OKD1 and 32 m for reach OKD2. The meander belt widths for the reaches within the Foster Ditch are 32 m. The meander belt widths for the Jock River reaches JR-2, JR-3, and JR-4 are 150 m, 218 m, and 231 m, respectively.

The erosion threshold analyses provide targets for the proposed SWM facility, Wet Ponds, and Oil and Grit Separator discharge to ensure that post-development erosion rates into the receiving drains do not exceed the natural pre-development rates. The critical discharge of the bed and bank materials for reach OKD1, FD1, and FCD2 are 0.80 m^3/s, 0.68 m^3/s, and 0.33 m^3/s respectively.

We trust this report meets your requirements. Should you have any questions please contact the undersigned.

Respectfully submitted,

Cara Hutton

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Cara Hutton, M.Sc.
Senior Environmental Technician

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Appendix A Historical Aerial Photographs

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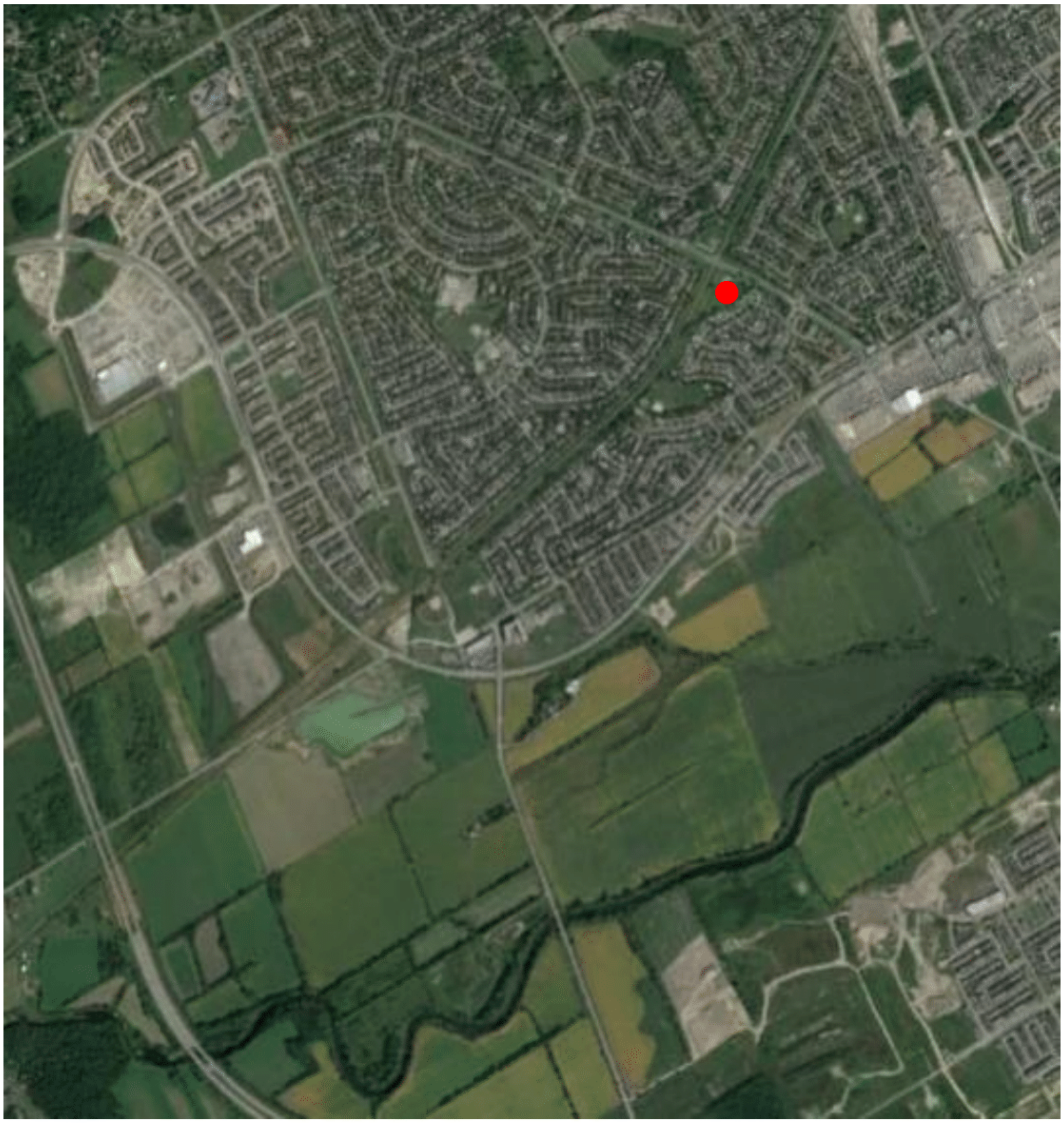
Location: Barrhaven, ON (denoted by red circle)
Year: 1976
Source: City of Ottawa, Teranet

Location: Barrhaven, ON
Year: 1991
Source: City of Ottawa, Teranet



Location: Barrhaven, ON
Year: 2016
Source: Google Earth Pro

Appendix B Reach Delineation


GEO MORPHIX
Reach Delineation
Jock River,
O'Keefe Drain, Foster Drain,
and Fraser-Clarke Drain
Barrhaven, Ottawa
Jock River
Jock River
JR-2
JR-3
JR-4
Legend
1:12,000
N
Reach break
Drainage Feature
O'Keefe Drain (OKD)
Foster Drain (FD)
Fraser-Clarke Drain (FCD)
Not present at time
of assessment
Reach break: Stantec, 2007, PARISH Geomorphic Ltd., 2013, and GEO Morphix Ltd., 2017.
Drainage Feature: MNRF, 2010, City of Ottawa, 2016, and GEO Morphix Ltd., 2017.
Imagery: Google Earth Pro, 2016.

Appendix C Photographic Record

Photo 1 Reach FCD2	
	Photograph taken facing west. Bed material was 30 to 40cm deep consisted of fines and organics.
Photo 2 Reach FCD2	
	Photograph taken facing east. Wetland feature fully encroached with reeds.

<table>
<tr><td rowspan="2">Photo
3

Reach
FCD3</td><td>
</td></tr>
<tr><td>Photograph taken facing east.
Heavily encroaching reeds in the wetland feature was observed.</td></tr>
<tr><td rowspan="2">Photo
4

Reach
FCD3</td><td>
</td></tr>
<tr><td>Photograph taken facing east.
Fragmented riparian buffer was dominated by grass.</td></tr>
</table>

Photo 5 Reach FCD3-1	
	Photograph taken facing east. Riparian buffer composed of trees, grasses and shrubs.
Photo 6 Reach FCD3-1	
	Photograph taken in the middle of the feature, facing east. Swale was primarily composed of reeds and was dry at the time of assessment.

Photo 7 Reach FCD3-2	
	Photograph taken facing south east. Center of swale was encroached with reeds, with a primarily grass buffer.
Photo 8 Reach FCD3-2	
	Photograph taken facing south east. No water was present in the feature at the time of assessment.

Photo 9 Reach FD3-3	
	Photograph taken facing south east. Feature not present at time of assessment.

Photo 10 Reach FCD5	
	Photograph taken facing downstream towards left bank. Channel dry at time of assessment.
Photo 11 Reach FCD5	
	Photograph taken facing upstream. Heavy encroachment of tall reeds was observed.

Photo 12 Reach FD1	
	Photograph taken facing downstream towards left bank. Channel was entrenched. Rip rap was observed along the banks in some areas.
Photo 13 Reach FD1	
	Photograph taken facing downstream towards right bank. Minor undercutting observed on right bank.

Photo 14 Storm -water Pond at FD1	
	Photograph taken facing south from Reach FD1.
Photo 15 Reach FD1-1	
	Photograph taken facing west from overflow channel FD1-1.

Photo 16 Reach FD2	 Photograph taken facing upstream. The channel was slightly entrenched and large woody debris was observed.
Photo 17 Reach FD2	 Photograph taken facing upstream from Reach FD1 break. Reeds heavily encroached the channel near the downstream reach break.

Photo 18 Reach FD3	
	Photograph taken facing upstream towards left bank. Channel was a straightened and ditched feature.
Photo 19 Reach FD3	
	Photograph taken facing downstream. Extensive backwatering observed upstream of large woody debris jam.

Photo 20 Reach OKD1	
	Photograph taken facing downstream. Channel was a straightened and ditched feature.
Photo 21 Reach OKD1	
	Photograph taken facing left bank. Channel was highly entrenched, woody debris was commonly observed.

Photo 22 Reach OKD2	 Photograph taken facing upstream. Channel exists as a highly entrenched, straightened and ditched feature.
Photo 23 Reach OKD2	 Photograph taken facing right bank. Erosion scarring was observed.

Photo 24 Reach JR-4	
	Photograph taken facing upstream, west, from Borrisokane Road.
Photo 25 Reach JR-4	
	Photograph taken facing right bank, south, from Borrisokane Road. The reach was unconfined.

Photo 26 Reach JR-3	
	Photograph taken facing downstream, east, from Borrisokane Road.
Photo 27 Reach JR-3	
	Photograph taken facing the left bank, north, from Borrisokane Road. The reach was unconfined with a narrow riparian buffer zones.

Appendix D Field Observations

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PO Box 336 Woodlawn PO
Dunrobin, Ontario, Canada K0A 1T0

T 613.979.7303

Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD2
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Rain 18C	Watershed:	Jock River

Location

lat=45.260226245331054, long=-75.75114652679375, alt=94.27012027340467, accuracy=48.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	11 - Straight suspended load
Flow Type:	Perennial
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Trees, Grasses
Dominant Species:	Grass dominant in downstream portion, trees dominant upstream portion
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Moderate
Notes:	Fully encroached in downstream portion of reach.

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Emergent
Coverage of Reach (%):	70
Presence of Woody Debris:	Present in Channel
Density of Woody Debris:	Low
Number of WDJs per 50 m:	0
Notes:	

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Low (>2.2)
Bank Failures (Brierley and Fryirs, 2005):	None
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt, Organics
Bank Material:	Clay, Silt, Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	< 5%

Notes:

Channel Measurements

Additional Measurements

Is riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes:

Water Quality

Odour:	None
Turbidity:	Clear
Notes:	

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General Site Characteristics

Project Code: 17071

Date:	June 21 2017	**Stream/Reach:**	FCD2
Weather:	Sunny 25°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

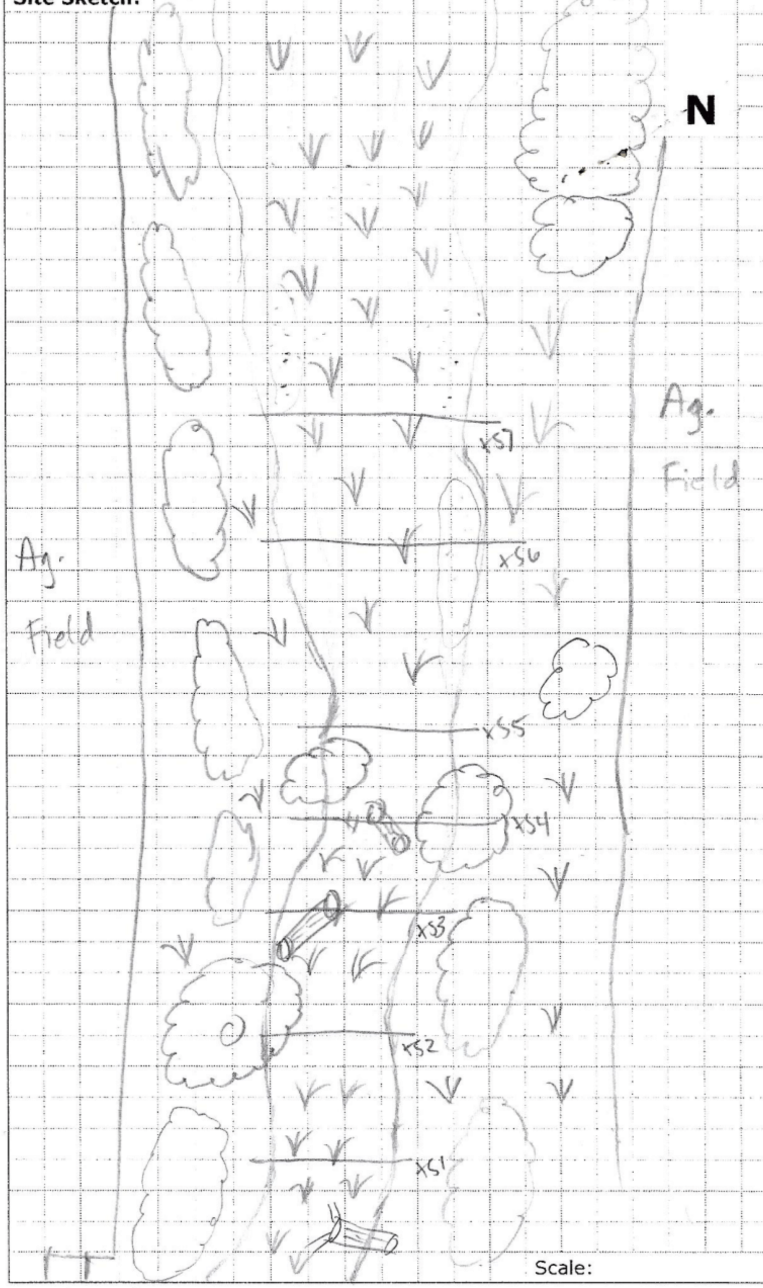
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

~40 cm of sediment/organics build up before bed

Completed by: BM2 Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 22/17	**Stream/Reach:**	FCD2
Weather:	Sunny 25°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Process	No.	Description	Yes	No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			N/A
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration		X	0/3
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	3	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	X		2/7
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots		X	
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.		X	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	2	5	0.28
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/5
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form		N/A	
	7	Bar forms poorly formed / reworked / removed		X	
		Sum of indices =	0	5	0

- riffle pool absent
- point bars absent

- infrastructure absent
- bar forms absent

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =			0.07
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique

Project Code: 17071

Date:	June 21 / 17	**Stream/Reach:**	FCD2
Weather:	sunny 25°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability - no roots seen	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☒ 9 ☐ 10 ☐ 11
Channel Scouring/ Sediment Deposition N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:		Reach:		Project Code:	

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
N/A	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6 7	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0-42) = 31	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD3
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Rain 18C	Watershed:	Jock River

Location

lat=45.25976031175945, long=-75.75790180828797, alt=1.5463331083301004, accuracy=12.0

General Characteristics

Land Use:	Agricultural,Residential
Valley Type:	Unconfined
Channel Type:	11 - Straight suspended load
Flow Type:	Perennial
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Trees,Grasses
Dominant Species:	Grass
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Heavy
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Emergent
Coverage of Reach (%):	100
Presence of Woody Debris:	Present in Channel
Density of Woody Debris:	Low
Number of WDJs per 50 m:	0
Notes:	

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Low (>2.2)
Bank Failures (Brierley and Fryirs, 2005):	None
Downs Model of Channel Evolution (1995):	S – stable
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt, Organics
Bank Material:	Clay, Silt, Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	< 5%

Notes:

Channel Measurements

Cross Section #1:

Bankfull Width (m):	11.5	**Wetted Width (m):**	4
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	0.12
Velocity (m/s):	0.02	**Measurement Type:**	Wiffle ball

Cross Section #2: Run

Bankfull Width (m):	12	**Wetted Width (m):**	3.5
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	0.11
Velocity (m/s):	N/A	**Measurement Type:**	N/A

Cross Section #3:

Bankfull Width (m):	13.5	**Wetted Width (m):**	4
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	0.15
Velocity (m/s):	N/A	**Measurement Type:**	N/A

Additional Measurements

Is riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes: Height of left bank: 0.60. No notable velocity at cross section 1.

Water Quality

Odour:	None
Turbidity:	Slightly Turbid
Notes:	

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Geomorphology Earth Science Observations

General Site Characteristics

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	FCD3
Weather:	rainy, 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

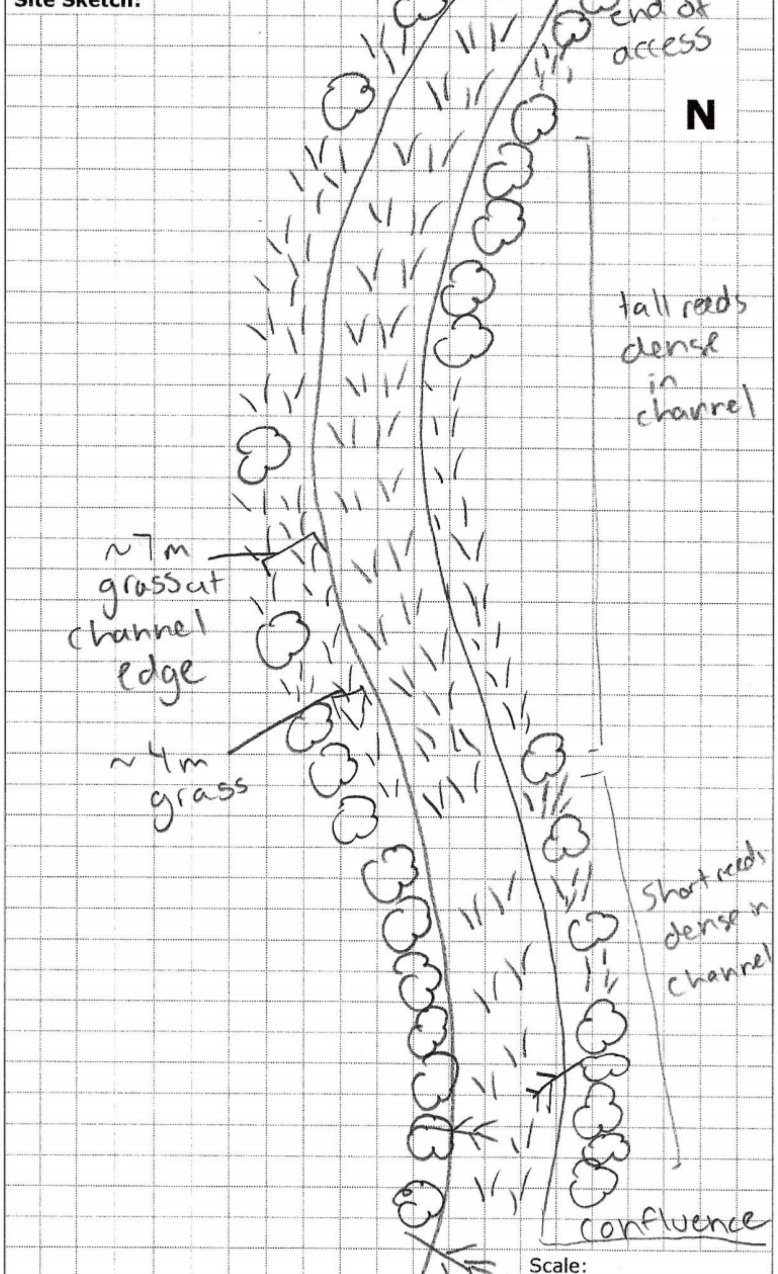
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	FC03
Weather:	rainy 20°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM²	**Watershed/Subwatershed:**	

Process	No.	Geomorphic Indicator Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			0/3
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s) N/A			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	3	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		X	1/7
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots		X	
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.		N/A	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		X	
		Sum of indices =	1	6	0.14
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/5 -ask
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form			
	7	Bar forms poorly formed / reworked / removed		X	
		Sum of indices =	0	5	0

- no bars
- riffle pool absent

- infrastructure absent

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.035

Condition	In Regime	In Transition/Stress	In Adjustment
SI score =	☒ 0.00 - 0.20	☐ 0.21 - 0.40	☐ 0.41

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	FCD3
Weather:	rainy 20°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM²	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability no roots exposed	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots ~~scarce~~ • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11
Channel Scouring/ Sediment Deposition N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☑ 8

Date:		Reach:		Project Code:	

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
N/A	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☒ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • ~~TDS: 50-100 mg/L~~	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☒ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 29.5	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD3-1
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Rain 18C	Watershed:	Jock River

Location

lat=45.25719582508419, long=-75.76280598993611, alt=49.93364386812506, accuracy=12.0

General Characteristics

Land Use:	Agricultural,Residential
Valley Type:	Unconfined
Channel Type:	12 - Sinuous suspended load
Flow Type:	Intermittent
Groundwater:	No
Notes:	No flow . Channel fully encroached by reeds and grasses. Only small puddles of water found .

Riparian Vegetation

Dominant Vegetation Type:	Trees,Grasses
Dominant Species:	Reeds and grasses
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Heavy
Notes:	Grasses and reeds fully encroach channel . Scattered trees present , trees denser at the upstream confluence with FCD3-1 AND FCD4-1

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Emergent
Coverage of Reach (%):	100
Presence of Woody Debris:	Not Present
Density of Woody Debris:	None
Number of WDJs per 50 m:	0
Notes:	There may have been debris present , grasses to thick to see anything on the ground

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Low (>2.2)
Bank Failures (Brierley and Fryirs, 2005):	None
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	Clay, silt
Bank Material:	Clay,Silt,Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	< 5%

Notes:

Channel Measurements

Cross Section #1:

Bankfull Width (m):	12	**Wetted Width (m):**	N/A
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	N/A
Velocity (m/s):	N/A	**Measurement Type:**	N/A

Cross Section #2:

Bankfull Width (m):	8	**Wetted Width (m):**	N/A
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	N/A
Velocity (m/s):	N/A	**Measurement Type:**	N/A

Additional Measurements

Is riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes:

Water Quality

Odour:	N/A
Turbidity:	N/A
Notes:	No flow

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Geomorphology Earth Science Observations

General Site Characteristics **Project Code:** 17071

Date:	June 23/17	**Stream/Reach:**	FCD3-1
Weather:	rainy 70°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:

Scale:

Additional Notes:

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 23 / 17	**Stream/Reach:**	FCD3-1
Weather:	Cloudy 20°	**Location:**	Ottawa- Barrhaven
Field Staff:	LG, BM²	**Watershed/Subwatershed:**	

Process	No.	Geomorphic Indicator Description	Present? Yes	No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			0/3
	2	Exposed sanitary / storm sewer / pipeline / etc. N/A			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	3	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		X	0/7
	2	Occurrence of large organic debris		X	
	3	Exposed tree roots		X	
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.		X	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	0	7	0
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/4
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form		N/A	
	7	Bar forms poorly formed / reworked / removed		N/A	
		Sum of indices =	0	4	0

-no flow
-reed / grass encroached
-no bars present
-riffle pool absent
-no infrastructure present

Additional notes:
- no flow
- heavy reed / grass encroachment

Stability Index (SI) = (AI+DI+WI+PI)/4 =	0		
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

GEO | MORPHIX

Rapid Stream Assessment Technique

Project Code: 17071

Date:	June 23 /17	**Stream/Reach:**	FCD3-1
Weather:	cloudy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BMZ	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
-no roots seen	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☒ 10 ☐ 11

N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:	June 23/17	Reach:	FCD3-1	Project Code:	17071

Evaluation Category	Poor	Fair	Good	Excellent
-water in small pockets -no flow	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
Physical Instream Habitat	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
N/A	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☒ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
N/A Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☒ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 30	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD3-2
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Rain 18C	Watershed:	Jock River

Location

lat=45.25550095657881, long=-75.76600135181351, alt=66.9408353150523, accuracy=24.0

General Characteristics

Land Use:	Agricultural, Residential
Valley Type:	Unconfined
Channel Type:	12 – Meandering suspended load
Flow Type:	Intermittent
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Grass, Trees
Dominant Species:	Grass
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Heavy
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Reeds
Coverage of Reach (%):	90%
Presence of Woody Debris:	None
Density of Woody Debris:	N/A
Number of WDJs per 50 m:	N/A
Notes:	

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Low sinuosity
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Slightly
Bank Failures (Brierley and Fryirs, 2005):	N/A
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	Silt, organics
Bank Material:	Clay, Silt,
Bank Angle:	0 - 30
Extent of Bank Erosion:	<5%

Notes:

Channel Measurements

Cross Section #1:

Bankfull Width (m):	5.3	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A

Cross Section #2:

Bankfull Width (m):	4	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A

Cross Section #3:

Bankfull Width (m):	2.9	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A

Additional Measurements

Is riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes:

Water Quality

Odour: N/A

Turbidity:	N/A
Notes:	

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Geomorphology Earth Science Observations

General Site Characteristics

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	FC302
Weather:	rainy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG, BM²	**Watershed/Subwatershed:**	

Features
- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

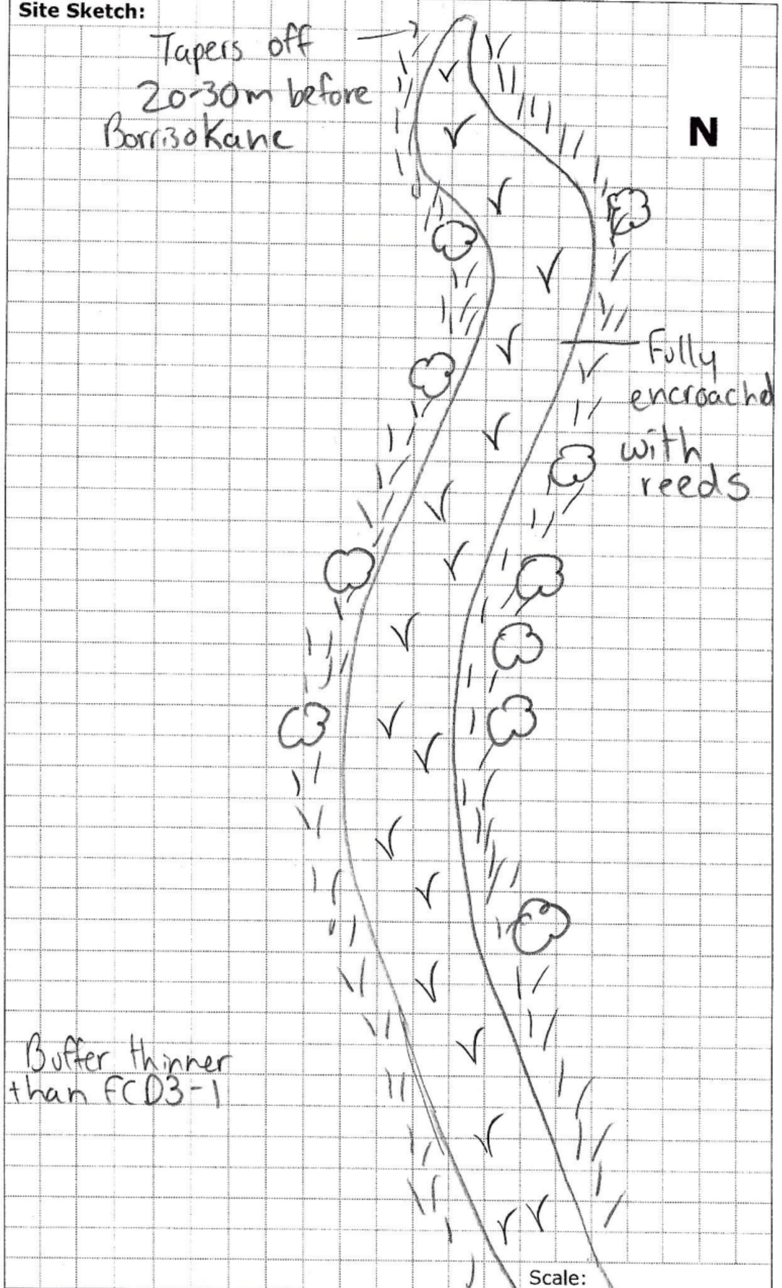
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 23/17	**Stream/Reach:**	FCD3-2
Weather:	rainy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BMZ	**Watershed/Subwatershed:**	

Process	No.	Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	-no point bars
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		N/A	0/4
	2	Exposed sanitary / storm sewer / pipeline / etc.		N/A	
	3	Elevated storm sewer outfall(s)		N/A	
	4	Undermined gabion baskets / concrete aprons / etc.		N/A	
	5	Scour pools downstream of culverts / storm sewer outlets		X	
	6	Cut face on bar forms		N/A	no bars
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	no bars
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	4	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		X	0/7
	2	Occurrence of large organic debris		X	
	3	Exposed tree roots		X	
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	no riff not present
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.		X	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	0	7	0
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/6
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		X	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form		X	
	7	Bar forms poorly formed / reworked / removed		N/A	
		Sum of indices =	0	6	0

-no flow
-reed encroached
-riffle pool absent
-no infrastructure present
-no bars

Additional notes:
- no flow
- reed / grass encroached

Stability Index (SI) = (AI+DI+WI+PI)/4 =			0
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	FCD3-2
Weather:	rainy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BMZ	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
- no roots seen in banks b/c high veg	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
reeds	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11

N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:		Reach:		Project Code:
Evaluation Category	**Poor**	**Fair**	**Good**	**Excellent**
Physical Instream Habitat N/A	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☒ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Water Quality N/A	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☒ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 27	**Poor (<13)**	**Fair (13-24)**	**Good (25-34)**	**Excellent (>35)**

Completed by: LG Checked by: ________

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD5
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Cloudy 20 degrees	Watershed:	Jock River

Location

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	11 – Straight suspended load
Flow Type:	Intermittent
Groundwater:	No
Notes:	No water present.

Riparian Vegetation

Dominant Vegetation Type:	Grasses, Trees
Dominant Species:	Grass
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 – 4Widths
Riparian Age Class:	Established
Extent of Encroachment into channel:	Heavy
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Reeds
Coverage of Reach (%):	100%
Presence of Woody Debris:	Not present
Density of Woody Debris:	None
Number of WDJs per 50 m:	0
Notes:	

Channel Characteristics

Type of Sinuosity:	N/A
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Slightly Entrenched
Bank Failures (Brierley and Fryirs, 2005):	N/A
Downs Model of Channel Evolution (1995):	S – stable
Riffle Substrate:	N/A
Pool Substrate:	N/A
Bank Material:	Clay, Silt, Sand
Bank Angle:	0 – 30
Extent of Bank Erosion:	<5%

Notes:

Channel Measurements

Additional Measurements

Is riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes:

Water Quality

Odour:	N/A
Turbidity:	N/A
Notes:	

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Geomorphology Earth Science Observations

General Site Characteristics

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	FCD5
Weather:	Cloudy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

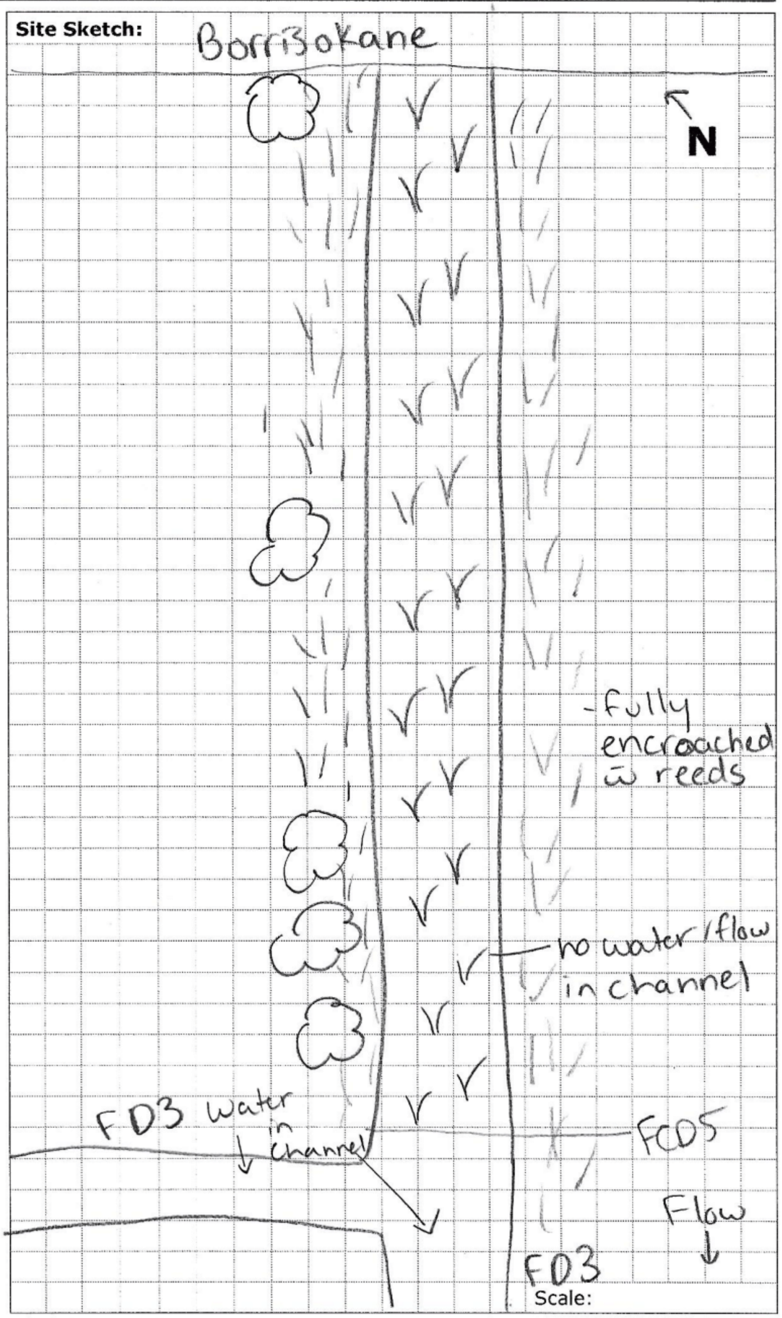
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 23 / 17	**Stream/Reach:**	FCD5
Weather:	Cloudy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Process	No.	Description	Yes	No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		N/A	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		x	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			0/3
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s) N/A			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		X	
	9	Suspended armour layer visible in bank		N/A	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	3	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		X	0/4
	2	Occurrence of large organic debris		X	
	3	Exposed tree roots		X	
	4	Basal scour on inside meander bends			
	5	Basal scour on both sides of channel through riffle N/A			
	6	Outflanked gabion baskets / concrete walls / etc.			
	7	Length of basal scour >50% through subject reach			
	8	Exposed length of previously buried pipe / cable / etc.			
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	0	4	0
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/4
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form		N/A	
	7	Bar forms poorly formed / reworked / removed		N/A	
		Sum of indices =	0	4	0

- no water
- riffle/pool absent
- no infrastructure
- no bars

Additional notes:
- no water
- reeds fully encroached

Stability Index (SI) = (AI+DI+WI+PI)/4 =	0		
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique **Project Code:** 17071

Date:	June 23/17	**Stream/Reach:**	FCD5
Weather:	cloudy 20°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
Channel Stability	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☒ 9 ☐ 10 ☐ 11

N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
N/A	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:	June 23/17	Reach:	FCD5	Project Code:	17071

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☒ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Water Quality (N/A)	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7
Total overall score (0–42) = 28.5	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

Project Number: PN17071

Reach Characteristics

Date:	2017-06-22	Reach:	FD1
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Sunny 25 degrees	Watershed:	Jock River

Location

lat=45.25182925690391, long=-75.768392678713, alt=61.008241515689946, accuracy=12.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	12 - Sinuous suspended load
Flow Type:	Perennial
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Trees,Grasses
Dominant Species:	Grasses
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Minimal
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Submergent
Coverage of Reach (%):	80
Presence of Woody Debris:	Present in Channel
Density of Woody Debris:	Low
Number of WDJs per 50 m:	0
Notes:	Rooted emergent and submergent veg.

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Undercutting (Hydraulic Action)
Downs Model of Channel Evolution (1995):	S – Stable – no observable morphological change
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt
Bank Material:	Clay, Silt
Bank Angle:	60 - 90
Extent of Bank Erosion:	30 - 60%

Notes:	Riffle pool sequence absent .

Channel Measurements

Additional Measurements	
Is riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.20,
Notes:	50-75% erosion extent along reach .

Water Quality

Odour:	None
Turbidity:	Clear
Notes:	Slightly turbid to opaque, appears clear because of bed sediment being close to surface

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General Site Characteristics

Project Code: 17071

Date:	June 22/17	**Stream/Reach:**	FD1
Weather:	Cloudy 20°	**Location:**	
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

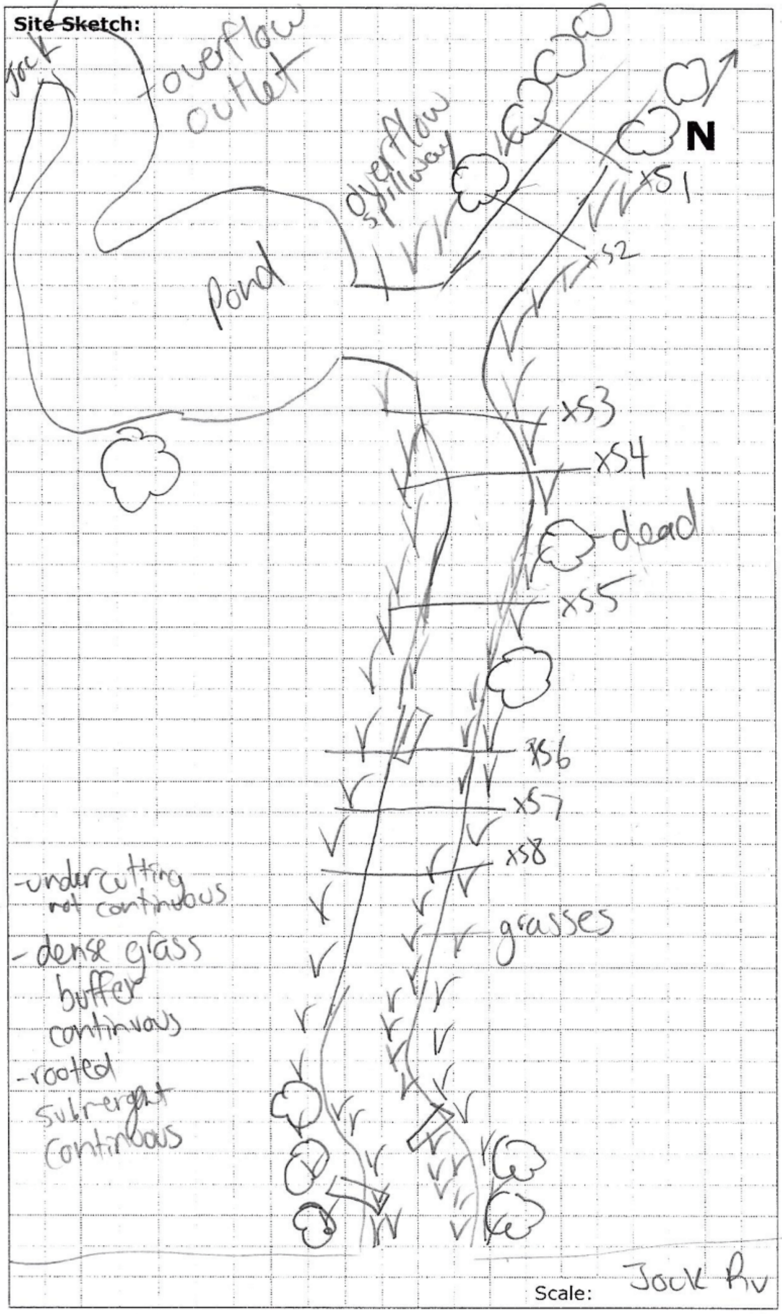
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 22/17	**Stream/Reach:**	FD1
Weather:	cloudy 20°	**Location:**	Nepean/Ottawa
Field Staff:	BM2 LG	**Watershed/Subwatershed:**	

Process	Geomorphic Indicator		Present?		Factor Value
	No.	Description	Yes	No	
Evidence of Aggradation (AI)	1	Lobate bar		X	
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools	X		
	4	Medial bars		X	
	5	Accretion on point bars		X	
	6	Poor longitudinal sorting of bed materials	X		b/c of rip rap
	7	Deposition in the overbank zone		X	
		Sum of indices =			
Evidence of Degradation (DI)	1	Exposed bridge footing(s) N/A	—	—	
	2	Exposed sanitary / storm sewer / pipeline / etc.	—	—	
	3	Elevated storm sewer outfall(s)	—	—	
	4	Undermined gabion baskets / concrete aprons / etc.	—		
	5	Scour pools downstream of culverts / storm sewer outlets	—		
	6	Cut face on bar forms		X	
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		X	
	9	Suspended armour layer visible in bank N/A			
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =			
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		X	
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots N/A	—		no trees
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle	—		N/A
	6	Outflanked gabion baskets / concrete walls / etc.	—	—	N/A
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.	—	X	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		—	N/A
		Sum of indices =			
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		X	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form			check
	7	Bar forms poorly formed / reworked / removed		X	
		Sum of indices =			

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =			
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☐ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique

Project Code: 1707|

Date:	June 22/17	**Stream/Reach:**	FD1
Weather:	Cloudy 20°	**Location:**	Nepean/Ottawa
Field Staff:	BMZ LG	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure 10
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m 8
N/A No trees	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material 10 clay in DS
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped 8	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☑ 9 ☐ 10 ☐ 11
N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
N/A	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:		Reach:		Project Code:

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas) 8
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low) 0	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
N/A	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
N/A	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
N/A	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement 8
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C 8
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☒ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 30.5	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

Project Number: PN17071

Reach Characteristics

Date:	2017-06-22	Reach:	FD2
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Cloudy 20 degrees	Watershed:	Jock River

Location

lat=45.25212204614041, long=-75.7685473728085, alt=69.52584001778119, accuracy=16.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	12 – Sinuous, suspended load
Flow Type:	Perennial
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Trees, Shrubs, Grasses
Dominant Species:	Grass
Riparian Coverage:	Continuous
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Minimal
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Emergent
Coverage of Reach (%):	55
Presence of Woody Debris:	Present in Cutbank, Present in Channel
Density of Woody Debris:	Moderate
Number of WDJs per 50 m:	2
Notes:	Extensive reed encroachment in channel, rooted submergent plants, algae

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Low sinuosity (1.06-1.30)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Slightly
Bank Failures (Brierley and Fryirs, 2005):	Undercutting (hydraulic action)
Downs Model of Channel Evolution (1995):	S - Stable – no observable morphological change
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt
Bank Material:	Clay, Silt
Bank Angle:	60 - 90
Extent of Bank Erosion:	0 – 30%

Notes:

Channel Measurements

Cross Section #1: Run

Bankfull Width (m):	7.7	**Wetted Width (m):**	5.7
Bankfull Depth (m):	1.15	**Wetted Depth (m):**	0.14
Velocity (m/s):	0.2	**Measurement Type:**	Wiffle Ball

Cross Section #2: Run

Bankfull Width (m):	7.5	**Wetted Width (m):**	5
Bankfull Depth (m):	1.2	**Wetted Depth (m):**	0.11
Velocity (m/s):	0.14	**Measurement Type:**	Wiffle Ball

Additional Measurements

Is riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.10
Notes:	Cross Section 1 near culvert at upstream break. Cross Section 2 downstream at bend near woody debris.

Water Quality

Odour:	None
Turbidity:	Clear
Notes:	Slightly organic smell

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General Site Characteristics

Project Code: 17071

Date:	June 22 /17	**Stream/Reach:**	FD2
Weather:	cloudy 70°	**Location:**	Nepean, Ottawa
Field Staff:	BMZ LCg	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

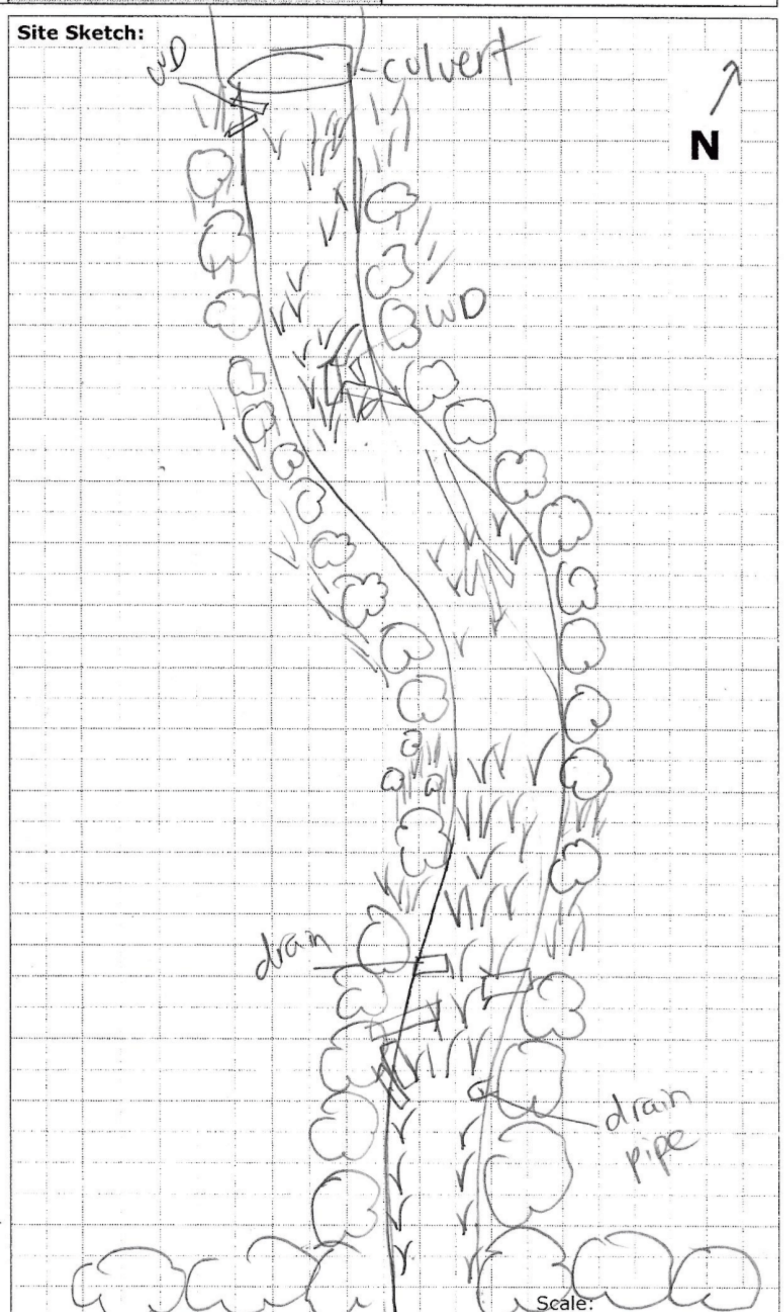
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Additional Notes:

pic 379 start
last pic 403

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 23 /17	**Stream/Reach:**	FD2
Weather:	cloudy 20	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Process	No.	Geomorphic Indicator Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		N/A	0/4
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets		X	
	6	Cut face on bar forms		N/A	
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	4	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	X		4/7
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots	X		
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.	x		
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	4	3	0.57
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/4 -ask
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form			
	7	Bar forms poorly formed / reworked / removed		N/A	
		Sum of indices =	0	4	0

- riffle pool absent - bars absent

drain pipe but we think it was placed like that

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =	0.14		
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique **Project Code:** 17071

Date:	June 23/17	**Stream/Reach:**	FD2
Weather:	Cloudy 20°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG, BM2	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☒ 8	☐ 9 ☐ 10 ☐ 11

Evaluation Category	Poor	Fair	Good	Excellent
N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
N/A	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

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Date: June 23/17		Reach: FD2	Project Code: 17071	
Evaluation Category	**Poor**	**Fair**	**Good**	**Excellent**
Physical Instream Habitat N/A N/A	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☒ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 31	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

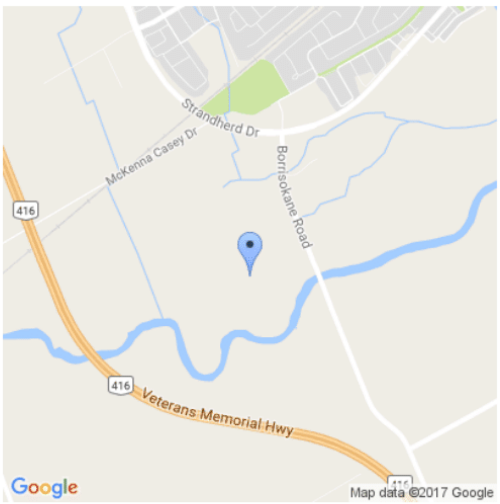
Completed by: LG Checked by: ________

Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FD3
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Cloudy 20 degrees	Watershed:	Jock River

Location



lat=45.25255737724697, long=-75.76969411847692, alt=60.14974220112034, accuracy=6.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	11 - Straight suspended load
Flow Type:	Perennial
Groundwater:	no
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Trees,Grasses
Dominant Species:	Grass
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Minimal
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Submergent
Coverage of Reach (%):	75
Presence of Woody Debris:	Present in Channel
Density of Woody Debris:	Low
Number of WDJs per 50 m:	0.25
Notes:	1 large WDJ causing extensive back watering Rooted submergent dominant, emergent also moderately present

Channel Characteristics

Type of Sinuosity:	N/A
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Undercutting (Hydraulic Action)
Downs Model of Channel Evolution (1995):	S – Stable – no observable morphological change
Riffle Substrate:	N/A
Pool Substrate:	N/A
Bank Material:	Clay, Silt, Sand
Bank Angle:	60 - 90, Undercut
Extent of Bank Erosion:	30 - 60%

Notes:

Channel Measurements

Cross Section #1: Run

Bankfull Width (m):	8.2	**Wetted Width (m):**	5.4
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	0.31
Velocity (m/s):	0.22	**Measurement Type:**	Wiffle Ball

Cross Section #2:

Bankfull Width (m):	5.5	**Wetted Width (m):**	4.3
Bankfull Depth (m):	N/A	**Wetted Depth (m):**	0.48
Velocity (m/s):	0.15	**Measurement Type:**	Wiffle Ball

Additional Measurements

Is riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.08 , most likely higher in some areas

Notes: Upstream of culvert bank height ~1.4

Water Quality

Odour:	None
Turbidity:	Opaque
Notes:	Turbid/ opaque

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Geomorphology
Earth Science
Observations

General Site Characteristics

Project Code: 17071

Date:	June 23/17	**Stream/Reach:**	F03
Weather:	cloudy 20°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG BM²	**Watershed/Subwatershed:**	

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

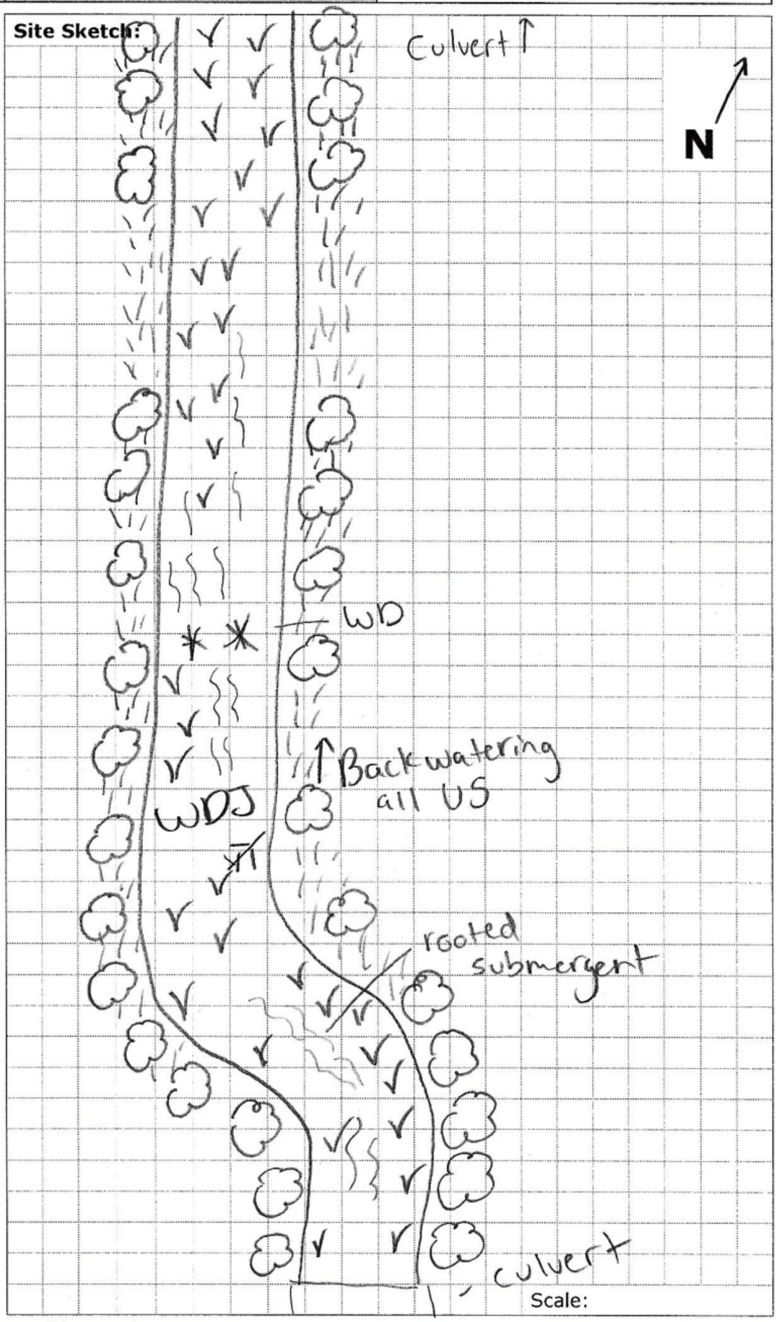
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

Completed by: LG Checked by:

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 23 /17	**Stream/Reach:**	FD3
Weather:	cloudy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM²	**Watershed/Subwatershed:**	

Process	No.	Description	Present? Yes	No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			N/A
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets		X	
	6	Cut face on bar forms		N/A	0/4
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	4	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	X		3/7
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots	X		
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.		X	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	3	4	0.42
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/5
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form		N/A	
	7	Bar forms poorly formed / reworked / removed		X	
		Sum of indices =	0	5	0

- riffle pool absent
- bars absent

causing backwater ↑ large WD

at lower end before backwater

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =	0.11		
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique **Project Code:** 17071

Date:	June 23/17	**Stream/Reach:**	FD3
Weather:	Cloudy 20°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM²	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability exposed @ beginning	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • ~~Outer bank height 0.6-0.9 m above stream bank~~ (1.2-1.5 m above stream bank ~~for large mainstem areas~~) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11

Evaluation Category	Poor	Fair	Good	Excellent
Channel Scouring/ Sediment Deposition N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:	June 23/17	Reach:	FD3	Project Code:	17071

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
N/A	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	1 • Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☒ 1	① ☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 30	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

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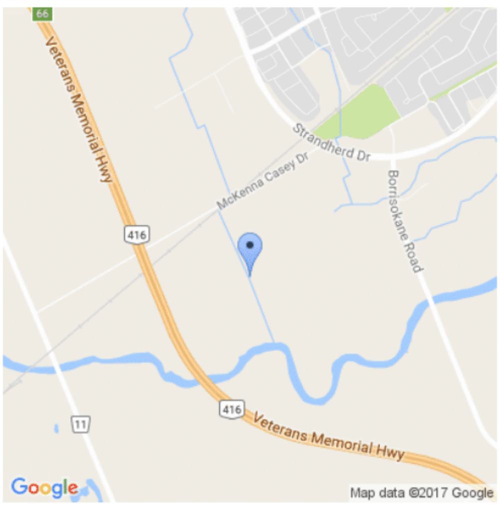
Project Number: PN17071

Reach Characteristics

Date:	2017-06-20	Reach:	OK D1
Field Staff:	BM2, LG	Watercourse:	O'Keefe Drain
Weather:	Sunny and cloudy 25 degrees	Watershed:	Jock River

Location



lat=45.25370261269744, long=-75.777420503692, alt=59.06083766710607, accuracy=4.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	11 - Straight suspended load
Flow Type:	Perennial
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Trees,Shrubs,Grasses
Dominant Species:	Trees, shrubs, some grasses
Riparian Coverage:	Continuous
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Minimal
Notes:	

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Emergent
Coverage of Reach (%):	5
Presence of Woody Debris:	Present in Channel
Density of Woody Debris:	High
Number of WDJs per 50 m:	2
Notes:	

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Fluvial Entrainment (Hydraulic Action), Undercutting
Downs Model of Channel Evolution (1995):	e - intiation of continuous erosion
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt, Sand, Organics
Bank Material:	Clay, Silt
Bank Angle:	60 - 90, Undercut
Extent of Bank Erosion:	60 - 100%

Notes: Extensive undercutting and exposed roots.

Channel Measurements

Cross Section #1: Run

Bankfull Width (m):	N/A	**Wetted Width (m):**	2.5
Bankfull Depth (m):	1.4	**Wetted Depth (m):**	0.14
Velocity (m/s):	0.2	**Measurement Type:**	Wiffle ball

Cross Section #2: Run

Bankfull Width (m):	N/A	**Wetted Width (m):**	2.4
Bankfull Depth (m):	1.6	**Wetted Depth (m):**	0.19
Velocity (m/s):	0.14	**Measurement Type:**	Wiffle ball

Cross Section #3: Run

Bankfull Width (m):	N/A	**Wetted Width (m):**	1.5
Bankfull Depth (m):	2	**Wetted Depth (m):**	0.12
Velocity (m/s):	0.2	**Measurement Type:**	Wiffle ball

Additional Measurements

Is riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.30, 0.80, 0.40,

Notes:

Water Quality

Odour:	None
Turbidity:	Turbid
Notes:	

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Geomorphology Earth Science Observations

General Site Characteristics

Project Code: 17071

Date:	June 20/17	**Stream/Reach:**	OKD1
Weather:	Sunny 25°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BMZ	**Watershed/Subwatershed:**	

Features
- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

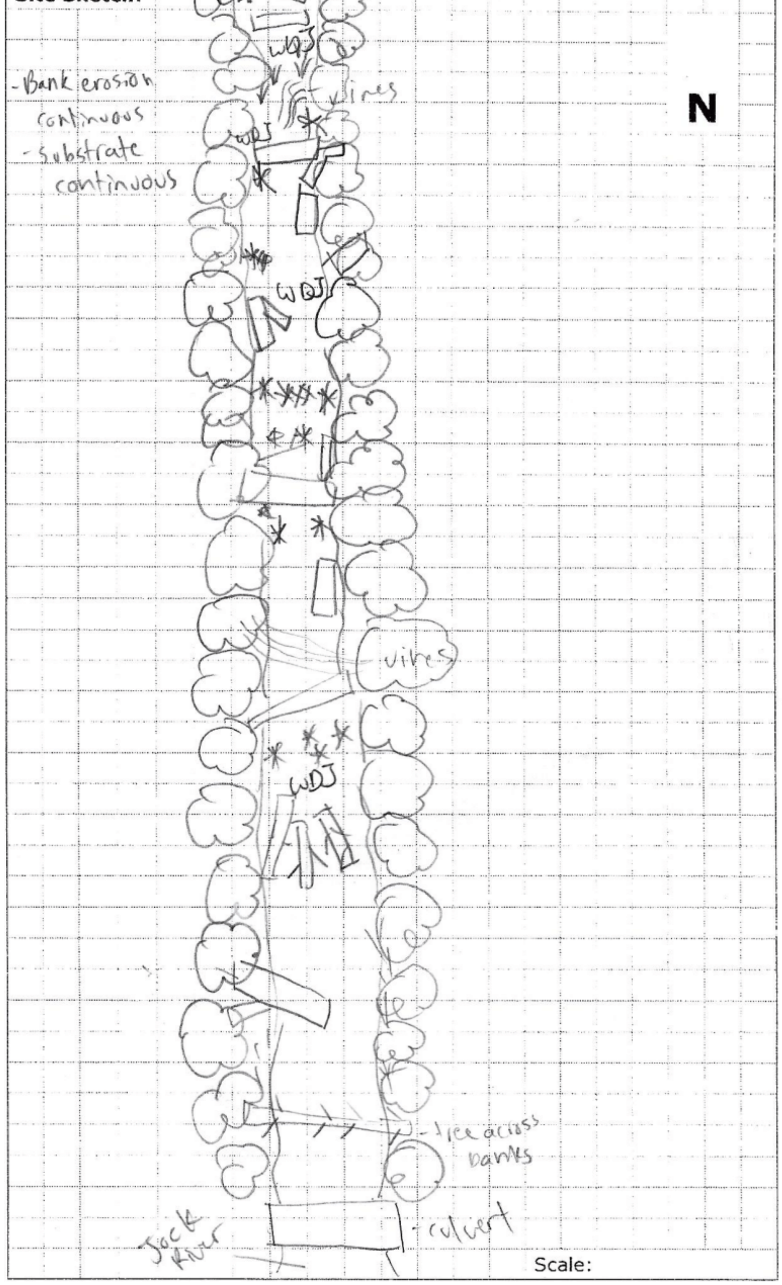
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Scale:

Additional Notes:

pictures 12 - 100 reach

Completed by: LG Checked by: ________

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Rapid Stream Assessment Technique **Project Code:** 17071

Date:	Jun 20/17	**Stream/Reach:**	OKD1
Weather:	Sunny 25°C	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

some erosion/ fluvial entr. scars

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11

Channel Scouring/ Sediment Deposition N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
N/A	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

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Date:	June 20/17	Reach:	OK 01	Project Code:	17071

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
N/A	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☒ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☒ 5	☐ 6 ☐ 7

Total overall score (0–42) = 30	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

GEO | MORPHIX

Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 20/17	**Stream/Reach:**	OK01
Weather:	Sunny 25°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BMZ	**Watershed/Subwatershed:**	

Process	No.	Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	0/4
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =	0	4	0
Evidence of Degradation (DI)	1	Exposed bridge footing(s)			N/A 0/3
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	6	Cut face on bar forms			
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =	0	3	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	X		3/6
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots	X		
	4	Basal scour on inside meander bends		N/A straight channel	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.		X	
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =	3	3	0.5
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	0/4
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form		N/A	
	7	Bar forms poorly formed / reworked / removed		N/A	
		Sum of indices =	0	4	0

-riffle pool absent
-infrastructure absent
-bars absent

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 =			0.125
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**
SI score =	☒ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**

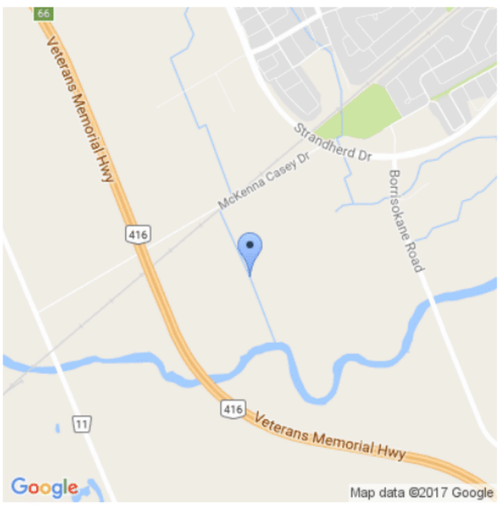
Completed by: LG Checked by: ________

Project Number: PN17071

Reach Characteristics

Date:	2017-06-21	Reach:	OKD2
Field Staff:	LG BM2	Watercourse:	O'Keefe Drain
Weather:	Sun and cloud 18C	Watershed:	Jock River

Location



lat=45.253683882781495, long=-75.77752606140785, alt=57.03539215789929, accuracy=6.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	11 - Straight suspended load
Flow Type:	Perennial
Groundwater:	No
Notes:	

Riparian Vegetation

Dominant Vegetation Type:	Grasses, trees
Dominant Species:	Grass
Riparian Coverage:	Fragmented
Width of Riparian Zone:	1 - 4 Channel Widths
Riparian Age Class:	Established (5-30 years)
Extent of Encroachment into channel:	Moderate
Notes:	A few trees scattered along banks.

Aquatic/Instream Vegetation

Type of Instream Vegetation:	Rooted Emergent
Coverage of Reach (%):	100
Presence of Woody Debris:	Not Present
Density of Woody Debris:	None
Number of WDJs per 50 m:	0
Notes:	Top half of reach heavily encroached with reeds.

Channel Characteristics

Type of Sinuosity:	N/A
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Fall/Sloughing (Mass Failure)
Downs Model of Channel Evolution (1995):	C – Compound – aggradation of channel bed with erosion of channel banks
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt
Bank Material:	Clay, Silt
Bank Angle:	60 - 90,Undercut
Extent of Bank Erosion:	30 - 60%

Notes:	Two erosion scars, potentially from sloughing brought on by undercutting photos 191-192 Significant erosion on the sides of the upstream culvert photos 183-185

Channel Measurements

Additional Measurements

Is riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A
Notes:	

Water Quality

Odour:	None
Turbidity:	Opaque
Notes:	

GEO | MORPHIX
Geomorphology
Earth Science
Observations

General Site Characteristics

Project Code: 17071

Date:	June 21	**Stream/Reach:**	OK-D2
Weather:	cloudy 20°	**Location:**	Ottawa-Barrhaven
Field Staff:	LG, BMZ	**Watershed/Subwatershed:**	

Features
- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

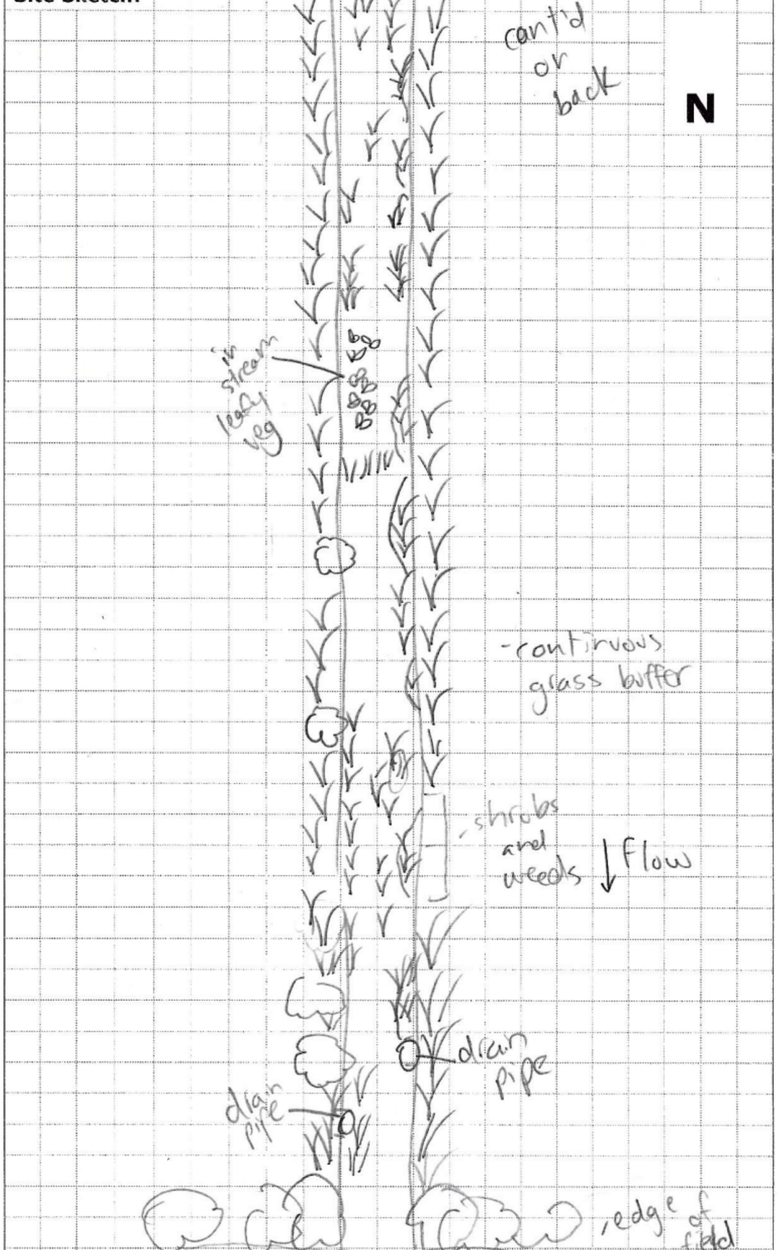
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:

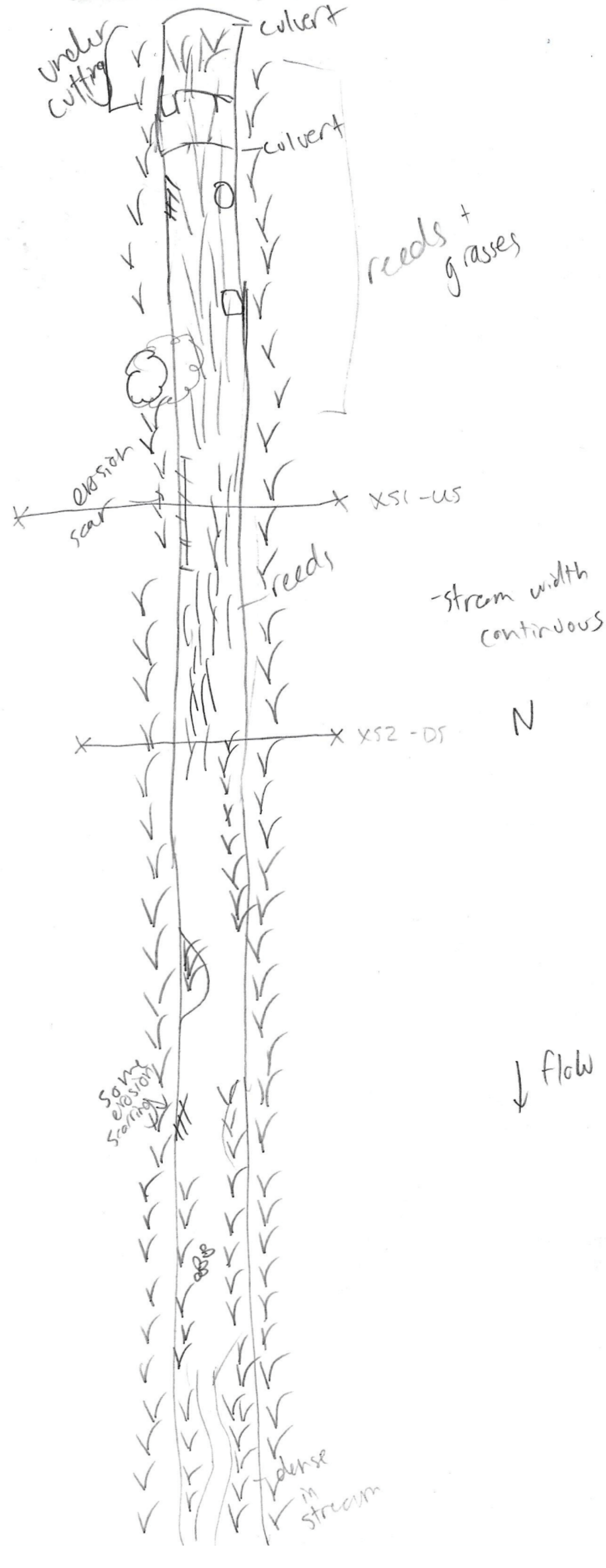


Scale:

Additional Notes:

Photos #142 - 187

Completed by: LG Checked by: ________



culvert
under cutting
culvert
reeds + grasses
erosion scar
XS1 -US
reeds
-stream width continuous
XS2 -DS
N
flow
some erosion scarring
dense in stream

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Rapid Stream Assessment Technique **Project Code:** 17071

Date:	June 21/17	**Stream/Reach:**	OKD2
Weather:	Sunny 25°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM²	**Watershed/Subwatershed:**	

Evaluation Category	Poor	Fair	Good	Excellent → erosion scars
	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure 7	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
N/A straight	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
Channel Stability no roots seen	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile 11
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material 8	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped 8	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☒ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11

Evaluation Category	Poor	Fair	Good	Excellent
N/A	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
Channel Scouring/ Sediment Deposition	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent 8
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank 8
N/A	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☒ 8

Date:		Reach:		Project Code:	

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas) 8
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low) 1	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
N/A	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement 8
N/A	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C 8
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☑ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 29.5	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: LG Checked by: ________

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Rapid Geomorphic Assessment **Project Code:** 17071

Date:	June 21 /17	**Stream/Reach:**	OK D2
Weather:	sunny 25°	**Location:**	Ottawa - Barrhaven
Field Staff:	LG BM2	**Watershed/Subwatershed:**	

Process	No.	Description	Yes	No	Factor Value
		Geomorphic Indicator	Present?		
Evidence of Aggradation (AI)	1	Lobate bar		X	
	2	Coarse materials in riffles embedded		N/A	
	3	Siltation in pools		N/A	
	4	Medial bars		X	
	5	Accretion on point bars		N/A	
	6	Poor longitudinal sorting of bed materials		X	
	7	Deposition in the overbank zone		X	
		Sum of indices =			
Evidence of Degradation (DI)	1	Exposed bridge footing(s)	N/A		
	2	Exposed sanitary / storm sewer / pipeline / etc.			
	3	Elevated storm sewer outfall(s)			
	4	Undermined gabion baskets / concrete aprons / etc.			
	5	Scour pools downstream of culverts / storm sewer outlets			
	6	Cut face on bar forms	N/A		
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		N/A	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock		X	
		Sum of indices =			
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.		X	
	2	Occurrence of large organic debris		X	
	3	Exposed tree roots		X	
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		N/A	
	6	Outflanked gabion baskets / concrete walls / etc.		N/A	
	7	Length of basal scour >50% through subject reach		X	
	8	Exposed length of previously buried pipe / cable / etc.	X		
	9	Fracture lines along top of bank		X	
	10	Exposed building foundation		N/A	
		Sum of indices =			
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		N/A	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form			-ask
	7	Bar forms poorly formed / reworked / removed		N/A	
		Sum of indices =			

- riffle pool absent
- bars absent
- infrastruc absent

erosion around culvert - its exposed now @ US break

Additional notes:

	Stability Index (SI) = (AI+DI+WI+PI)/4 =			
Condition	**In Regime**	**In Transition/Stress**	**In Adjustment**	
SI score =	☐ **0.00 - 0.20**	☐ **0.21 - 0.40**	☐ **0.41**	

Completed by: ________ Checked by: ________

Appendix E RGA and RSAT Results


GEO MORPHIX
RGA Results
O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain
Barrhaven, Ottawa
Jock River
JR-2
JR-3
JR-4
Legend
1:12,000
N
Reach break
Drainage Feature
O'Keefe Drain (OKD)
Foster Drain (FD)
Fraser-Clarke Drain (FCD)
Not present at time of assessment
RGA Condition
In Regime


GEO MORPHIX
RSAT Results
O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain
Barrhaven, Ottawa
Jock River
JR-2
JR-3
JR-4
Legend
1:12,000
N
Reach break
Drainage Feature
O'Keefe Drain (OKD)
Foster Drain (FD)
Fraser-Clarke Drain (FCD)
Not present at time of assessment
RSAT Condition
Good
N/A

Appendix F Detailed Assessments Locations

GEO MORPHIX
Detailed Assessments
O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain
Barrhaven, Ottawa
Legend
1:12,000
N
Reach break
Drainage Feature
O'Keefe Drain (OKD)
Foster Drain (FD)
Fraser-Clarke Drain (FCD)
Not present at time of assessment
Detailed Assessment
GEO Morphix Ltd. (2017)
Reach break: Stantec, 2007, PARISH Geomorphic Ltd., 2013, and GEO Morphix Ltd., 2017.
Drainage Feature: MNRF, 2010, City of Ottawa, 2016, and GEO Morphix Ltd., 2017.
Detailed Assessment: GEO Morphix Ltd., 2017. Imagery: Google Earth Pro, 2016.
Jock River
JR-2
JR-3
JR-4
OKD1
OKD2
OKD3
OKD5
OKD6
OKD7
FD1
FD1-1
FD2
FD3
FD7
FCD2
FCD4

Appendix G Detailed Assessment Summaries

Detailed Geomorphological Assessment Summary

Reach FCD2

Project Number:	PN17071	**Date:**	June 20/ 2017
Client:	David Schaeffer Engineering Ltd.	**Length Surveyed (m):**	99.4
Location:	Barrhaven, Ottawa	**# of Cross-Sections:**	7

Reach Characteristics

Drainage Area:	Not measured	**Dominant Riparian Vegetation Type:**	Shrubs and grasses
Geology/Soils:	Clay Plains	**Extent of Riparian Cover:**	Fragmented
Surrounding Land Use:	Agricultural, Residential	**Width of Riparian Cover:**	1 - 4 Channel widths
Valley Type:	Unconfined	**Age Class of Riparian Vegetation:**	Established (5-30 years)
Dominant Instream Vegetation Type:	Rooted emergent	**Extent of Encroachment into Channel:**	Moderate
Portion of Reach with Vegetation:	70%	**Density of Woody Debris:**	Low

Hydrology

Measured Discharge (m^3/s):	0.04	**Calculated Bankfull Discharge (m^3/s):**	0.42
Modelled 2-year Discharge (m^3/s):	Not modelled	**Calculated Bankfull Velocity (m/s):**	0.19
Modelled 2-year Velocity (m/s):	Not modelled		

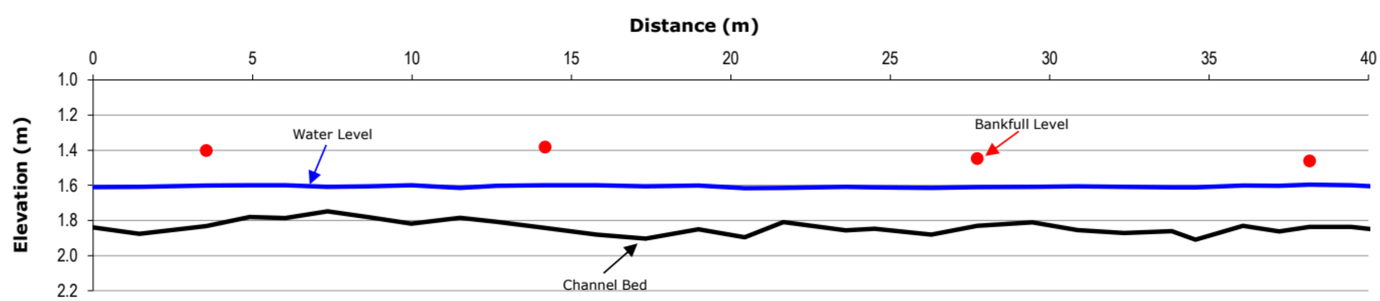
Profile Characteristics

Bankfull Gradient (%):	0.17
Channel Bed Gradient (%):	0.12
Riffle Gradient (%):	N/A: no riffles
Riffle Length (m):	N/A: no riffles
Riffle-Pool Spacing (m):	N/A: no riffle-pool spacing

Planform Characteristics

Sinuosity:	1.79
Meander Belt Width (m):	Not measured
Radius of Curvature (m):	Not measured
Meander Amplitude (m):	Not measured
Meander wavelength (m):	Not measured

Longitudinal Profile



Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	0.3	0.60	0.46
Bank Angle (deg):	15	25	19
Root Depth (m):	0.10	0.10	0.10
Root Density (%):	50	100	90
Bank Undercut (m):		N/A: no undercuts	

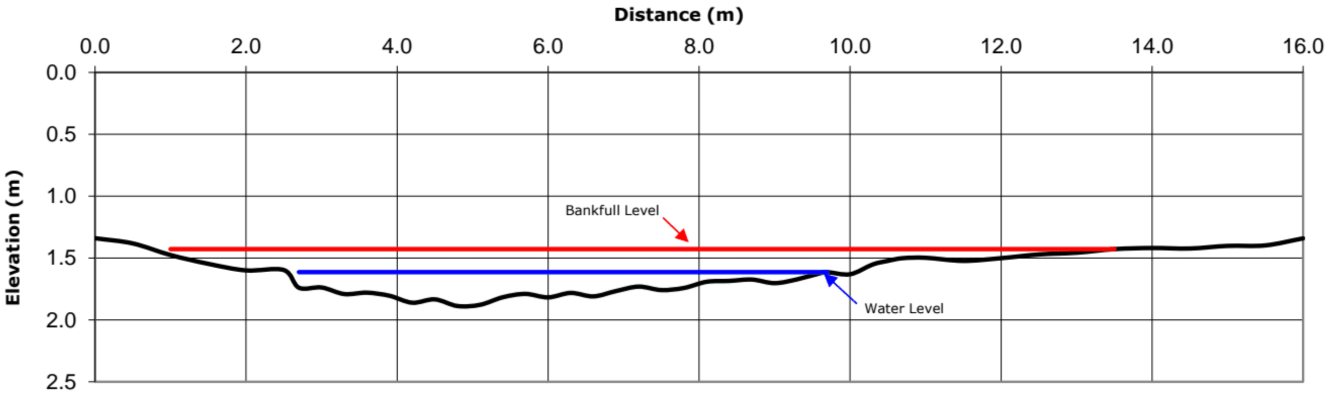
	Minimum	Maximum	Average
Torvane Value (kg/cm^2):		Not measured	
Penetrometer Value (kg/cm^3):		Not measured	
Bank Material (range):		Sandy Loam	

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	5.10	12.50	9.33
Average Bankfull Depth (m):	0.19	0.26	0.23
Bankfull Width/Depth (m/m):	21	50	40
Wetted Width (m):	1.80	10.40	5.54
Average Water Depth (m):	0.02	0.22	0.13
Wetted Width/Depth (m/m):	19	86	54
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.01	0.28	0.22
Manning's *n* :		0.080	

Photograph at cross section 2 (facing upstream)

Representative Cross-Section 2



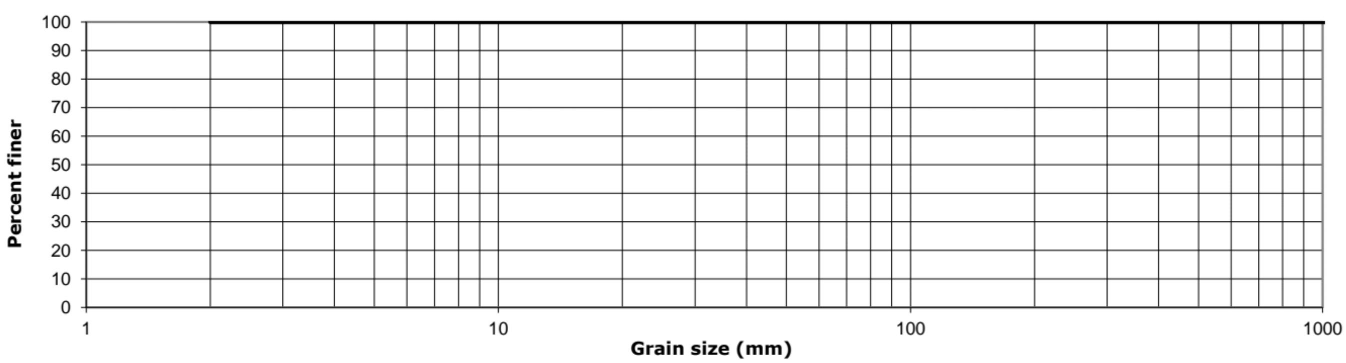
Substrate Characteristics

Particle Size (mm)

D_{10} :	<	2.0
D_{50} :	<	2.0
D_{84} :	<	2.0

Subpavement:	Clay
Particle shape:	N/A: fine sediment
Embeddedness (%):	N/A: fine sediment
Particle range (riffle):	N/A: riffle-pool sequence absent
Particle Range (pool):	N/A: riffle-pool sequence absent

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		**Tractive Force at Bankfull (N/m^2):**	3.76
for D_{50}:	0.27	**Tractive Force at 2-year flow (N/m^2):**	Not modelled
for D_{84}:	0.27	**Critical Shear Stress (D_{50}) (N/m^2):**	1.46
Unit Stream Power at Bankfull (W/m^2):	0.72		

General Field Observations

Channel Description

This channel runs between agricultural fields before flowing into Jock River. The channel is straight, slightly entrenched, and has a low gradient. Riffle-pool sequences are absent within this reach, only run features are present. Bank erosion was not present. Woody debris is present in the channel at a low density. Average bankfull width and depth are 9.23 m and 0.23 m, respectively. Bank material consists of sandy loam, bed material consists of fine sediment and organics. Depth of fine sediment on the bed at the time of assessment was approximately 0.30 - 0.40 m.

Cross Section 4 - Facing Downstream

Detailed Geomorphological Assessment Summary

Reach FD1

Project Number:	PN 17071	**Date:**	June 22/ 2017
Client:	David Schaeffer Engineering Ltd.	**Length Surveyed (m):**	110.0
Location:	Barrhaven, Ottawa	**# of Cross-Sections:**	8

Reach Characteristics

Drainage Area:	Not measured	**Dominant Riparian Vegetation Type:**	Grasses
Geology/Soils:	Clay Plains	**Extent of Riparian Cover:**	Fragmented
Surrounding Land Use:	Agricultural	**Width of Riparian Cover:**	1 - 4 Channel widths
Valley Type:	Unconfined	**Age Class of Riparian Vegetation:**	Established (5-30 years)
Dominant Instream Vegetation Type:	Rooted submergent	**Extent of Encroachment into Channel:**	Minimal
Portion of Reach with Vegetation:	80%	**Density of Woody Debris:**	Low

Hydrology

Measured Discharge (m^3/s):	0.13	**Calculated Bankfull Discharge (m^3/s):**	0.77
Modelled 2-year Discharge (m^3/s):	Not modelled	**Calculated Bankfull Velocity (m/s):**	0.45
Modelled 2-year Velocity (m/s):	Not modelled		

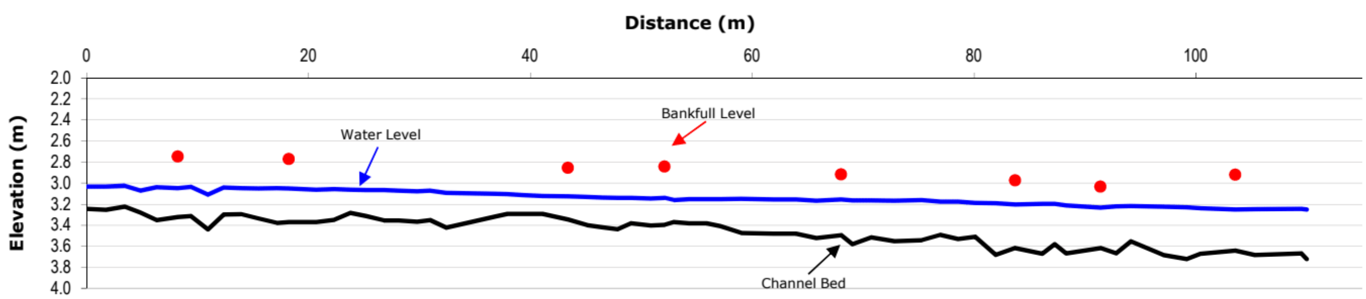
Profile Characteristics

Bankfull Gradient (%):	0.17
Channel Bed Gradient (%):	0.40
Riffle Gradient (%):	N/A: no riffles
Riffle Length (m):	N/A: no riffles
Riffle-Pool Spacing (m):	N/A: no riffle-pool spacing

Planform Characteristics

Sinuosity:	1.22
Meander Belt Width (m):	Not measured
Radius of Curvature (m):	Not measured
Meander Amplitude (m):	Not measured
Meander wavelength (m):	Not measured

Longitudinal Profile



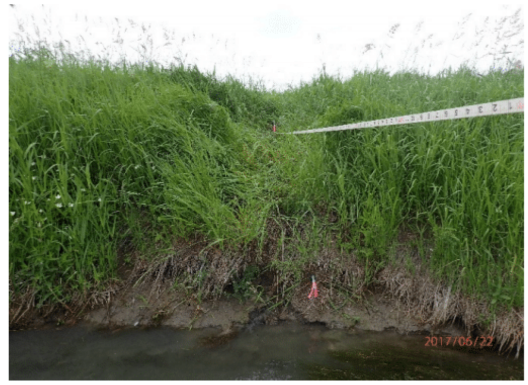
Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	1.3	1.75	1.48
Bank Angle (deg):	45	70	53
Root Depth (m):	0.10	0.10	0.10
Root Density (%):	40	90	84
Bank Undercut (m):	0.05	0.30	0.13

	Minimum	Maximum	Average
Torvane Value (kg/cm^2):		Not measured	
Penetrometer Value (kg/cm^3):		Not measured	
Bank Material (range):		Clay, Silt, Sand, some Rip-Rap present	

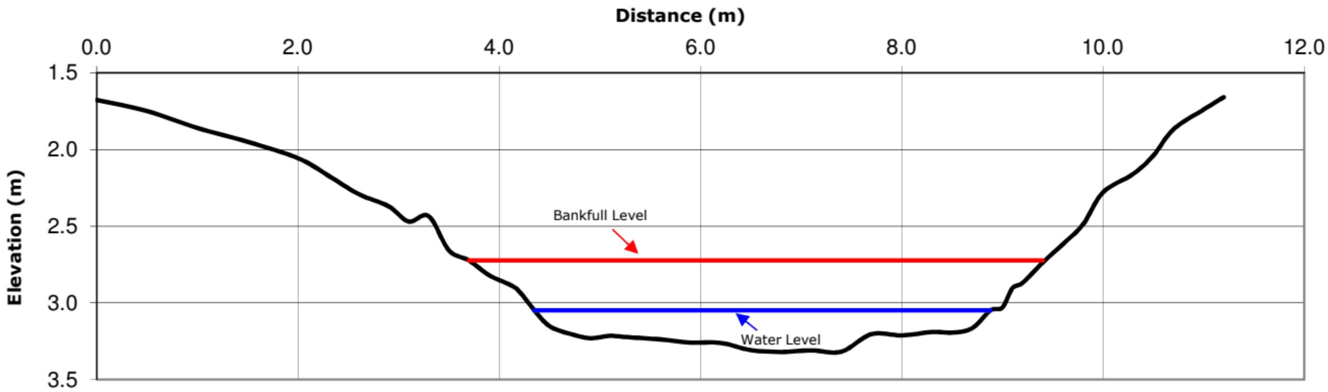
Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	3.30	5.70	4.29
Average Bankfull Depth (m):	0.34	0.48	0.40
Bankfull Width/Depth (m/m):	9	14	11
Wetted Width (m):	2.17	4.95	3.34
Average Water Depth (m):	0.15	0.27	0.21
Wetted Width/Depth (m/m):	11	24	16
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.22	0.41	0.31
Manning's *n* :		0.050	



Photograph at cross section 6 (looking at the right bank)

Representative Cross-Section 2



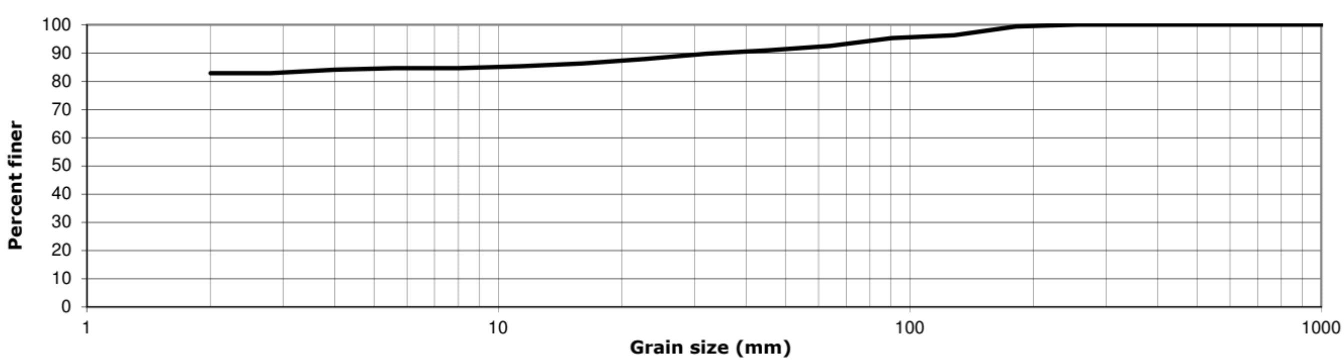
Substrate Characteristics

Particle Size (mm)

D_{10} :	<	2.0
D_{50} :	<	2.0
D_{84} :		4.0

Subpavement:	Clay
Particle shape:	Rip-rap: Subangular
Embeddedness (%):	Rip-rap: 0-50%
Particle range (riffle):	N/A: riffle-pool sequence absent
Particle Range (pool):	N/A: riffle-pool sequence absent

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		**Tractive Force at Bankfull (N/m^2):**	6.70
for D_{50}:	0.27	**Tractive Force at 2-year flow (N/m^2):**	Not modelled
for D_{84}:	0.37	**Critical Shear Stress (D_{50}) (N/m^2):**	1.46
Unit Stream Power at Bankfull (W/m^2):	3.01		

General Field Observations

Channel Description

This channel runs between agricultural fields before flowing into Jock River. The channel is sinuous with a low gradient, and highly entrenched. Riffle-pool sequences are absent within this reach, only run features are present. Undercutting is present in the downstream portion of the reach. A low density of woody debris is present in the channel. Average bankfull width and depth are 4.69 m and 0.50 m, respectively. Bank material consists of clay, silt and sand, with rip-rap between cross sections 2 and 5. Bed material consists of clay, and sporatic rip-rap. Depth of fine sediment on the bed at time of assessment was approximately 0.05 - 0.20 m.

Cross Section 4 - Facing Downstream

Detailed Geomorphological Assessment Summary

Reach OKD1

Project Number:	PN 17071	**Date:**	June 20, 2017
Client:	David Schaeffer Engineering Ltd.	**Length Surveyed (m):**	82.0
Location:	Barrhaven, Ottawa	**# of Cross-Sections:**	8

Reach Characteristics

Drainage Area:	Not measured	**Dominant Riparian Vegetation Type:**	Trees and Grasses
Geology/Soils:	Clay Plains	**Extent of Riparian Cover:**	Continuous
Surrounding Land Use:	Agricultural	**Width of Riparian Cover:**	1 - 4 Channel widths
Valley Type:	Unconfined	**Age Class of Riparian Vegetation:**	Established (5-30 Years)
Dominant Instream Vegetation Type:	Rooted emergent	**Extent of Encroachment into Channel:**	Minimal
Portion of Reach with Vegetation:	5%	**Density of Woody Debris:**	High

Hydrology

Measured Discharge (m^3/s):	0.08	**Calculated Bankfull Discharge (m^3/s):**	1.69
Modelled 2-year Discharge (m^3/s):	Not modelled	**Calculated Bankfull Velocity (m/s):**	0.51
Modelled 2-year Velocity (m/s):	Not modelled		

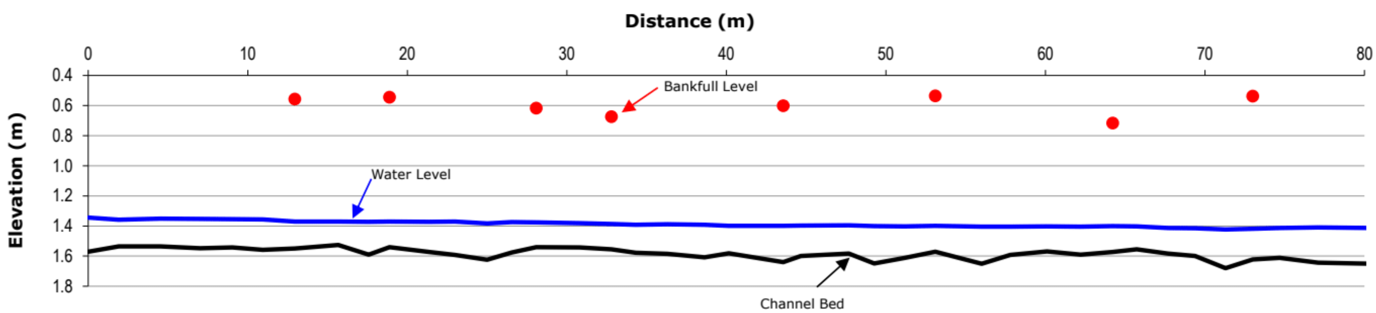
Profile Characteristics

Bankfull Gradient (%):	0.05
Channel Bed Gradient (%):	0.10
Riffle Gradient (%):	N/A: no riffles
Riffle Length (m):	N/A: no riffles
Riffle-Pool Spacing (m):	N/A: no riffle-pool spacing

Planform Characteristics

Sinuosity:	1.00
Meander Belt Width (m):	Not measured
Radius of Curvature (m):	Not measured
Meander Amplitude (m):	Not measured
Meander wavelength (m):	Not measured

Longitudinal Profile



Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	1.4	1.70	1.59
Bank Angle (deg):	50	80	67
Root Depth (m):	0.20	1.00	0.53
Root Density (%):	5	25	13
Bank Undercut (m):	N/A: no undercuts		

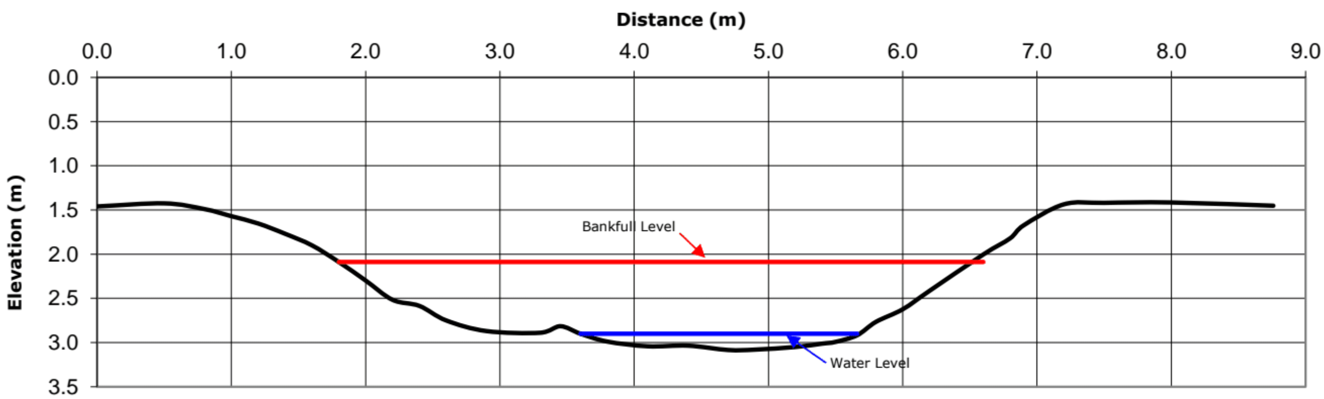
	Minimum	Maximum	Average
Torvane Value (kg/cm^2):		Not measured	
Penetrometer Value (kg/cm^3):		Not measured	
Bank Material (range):		Clay, Silt	

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	4.30	4.83	4.59
Average Bankfull Depth (m):	0.62	0.81	0.72
Bankfull Width/Depth (m/m):	5	8	6
Wetted Width (m):	1.95	2.61	2.29
Average Water Depth (m):	0.13	0.16	0.14
Wetted Width/Depth (m/m):	14	20	16
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.17	0.24	0.19
Manning's *n*:		0.035	

Photograph at cross section 6 (looking at the right bank)

Representative Cross-Section 2



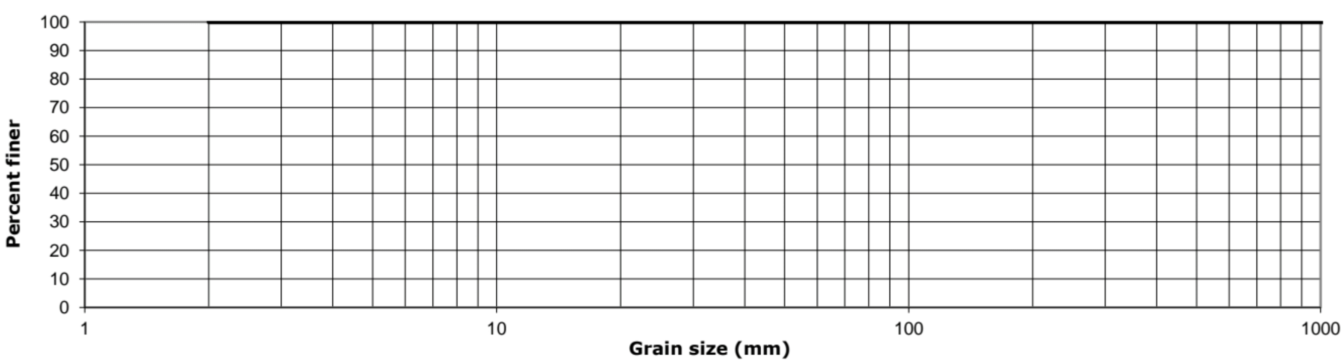
Substrate Characteristics

Particle Size (mm)

D_{10} :	0.002
D_{50} :	0.002
D_{84} :	0.002

Subpavement:	Clay
Particle shape:	N/A : Fine Sediment
Embeddedness (%):	N/A : Fine Sediment
Particle range (riffle):	N/A : Riffle pool sequence absent
Particle Range (pool):	N/A : Riffle pool sequence absent

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		**Tractive Force at Bankfull (N/m^2):**	3.53
for D_{50}:	0.01	**Tractive Force at 2-year flow (N/m^2):**	Not modelled
for D_{84}:	0.01	**Critical Shear Stress (D_{50}) (N/m^2):**	0.00
Unit Stream Power at Bankfull (W/m^2):	1.81		

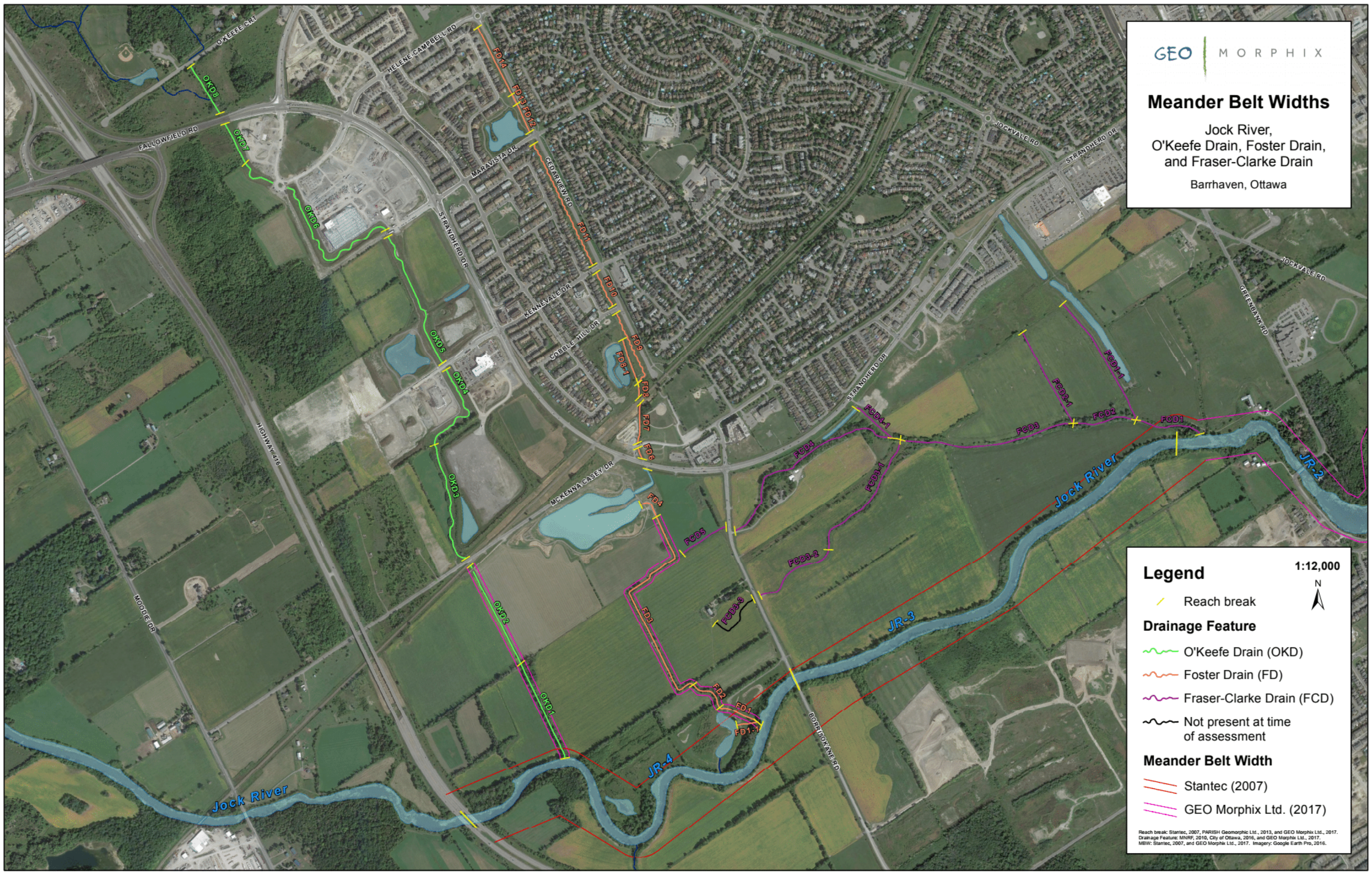
General Field Observations

Channel Description

This channel runs between agricultural fields before flowing into Jock River. The channel is straight and highly entrenched, with a low gradient. This reach did not contain riffle-pool sequences, only run features were present. Average bankfull width and depth are 4.6 m and 0.7 m, respectively. Bank erosion was evident. Woody debris was commonly observed in the channel. Both bed and bank material consisted of a sandy loam. Depth of fines on the bed were approximately 0.2 - 0.3 m at time of assessment.

Cross Section 5 - Facing Upstream

Appendix H Meander Belt Widths


GEO MORPHIX
Meander Belt Widths
Jock River,
O'Keefe Drain, Foster Drain,
and Fraser-Clarke Drain
Barrhaven, Ottawa
Legend
1:12,000
N
Reach break
Drainage Feature
O'Keefe Drain (OKD)
Foster Drain (FD)
Fraser-Clarke Drain (FCD)
Not present at time of assessment
Meander Belt Width
Stantec (2007)
GEO Morphix Ltd. (2017)
Reach break: Stantec, 2007, PARISH Geomorphic Ltd., 2013, and GEO Morphix Ltd., 2017.
Drainage Feature: MNRF, 2010, City of Ottawa, 2016, and GEO Morphix Ltd., 2017.
MBW: Stantec, 2007, and GEO Morphix Ltd., 2017. Imagery: Google Earth Pro, 2016.
Jock River
Jock River
JR-2
JR-3
JR-4
OKD1
OKD2
OKD3
OKD4
OKD5
OKD6
OKD7
OKD8
FCD1
FCD2
FCD5
FD3
FD2

APPENDIX H

STORM SERVICING

DSEL
david schaeffer engineering ltd

120 Iber Road, Unit 103
Stittsville, ON K2S 1E9
Tel. (613) 836-0856
Fax. (613) 836-7183
www.DSEL.ca

BARRHAVEN CONSERVANCY
STORM TRIBUTARY AREA
CITY OF OTTAWA

PROJECT No. :	16-891
SCALE:	1:4000
DATE:	JUNE 2020
DRAWING No.	3

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning

LOCATION			AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min)	Q/Q full
TRUNK 11																																	
			1.29	0.65	2.33	2.33			0.00	0.00			0.00	0.00			0.00	0.00	11.02														
	4103	4104			0.00	2.33			0.00	0.00			0.00	0.00			0.00	0.00	11.02	73.10	99.10	116.14	169.74	170	600	600	CONC	0.15	94.5	237.8056	0.8411	1.8726	0.717
	4104	4106	1.14	0.65	2.06	4.39			0.00	0.00			0.00	0.00			0.00	0.00	12.89	67.23	91.05	106.66	155.83	295	675	675	CONC	0.20	112.5	375.9224	1.0505	1.7848	0.785
	4106	4107	0.48	0.65	0.87	5.26	0.25	0.65	0.45	0.45			0.00	0.00			0.00	0.00	14.68	62.54	84.61	99.09	144.72	367	750	750	CONC	0.15	49.0	431.1703	0.9760	0.8368	0.851
	4107	OGS 11	0.13	0.65	0.23	5.49			0.00	0.45			0.00	0.00			0.00	0.00	14.68	62.54	84.61	99.09	144.72	382	825	825	CONC	0.15	26.0	555.9418	1.0400	0.4167	0.687
TRUNK 12																																	
			2.09	0.65	3.78	3.78			0.00	0.00			0.00	0.00			0.00	0.00	13.10														
	4206	4207			0.00	3.78			0.00	0.00			0.00	0.00			0.00	0.00	13.10	66.65	90.24	105.72	154.44	252	825	825	CONC	0.10	56.5	453.9246	0.8492	1.1089	0.555
	4207	4216	1.34	0.65	2.42	6.20			0.00	0.00			0.00	0.00			0.00	0.00	14.21	63.70	86.20	100.96	147.46	395	900	900	CONC	0.10	59.5	572.4707	0.8999	1.1020	0.690
	4216	4220	1.43	0.65	2.58	8.78			0.00	0.00			0.00	0.00			0.00	0.00	15.31	61.04	82.57	96.69	141.18	536	900	900	CONC	0.15	64.5	701.1305	1.1021	0.9754	0.765
	4220	4224	1.10	0.65	1.99	10.77			0.00	0.00			0.00	0.00			0.00	0.00	15.31	61.04	82.57	96.69	141.18	657	975	975	CONC	0.15	51.0	867.9562	1.1625	0.7312	0.757
	4224	4226	0.88	0.65	1.59	12.36			0.00	0.00			0.00	0.00			0.00	0.00	15.31	61.04	82.57	96.69	141.18	754	975	975	CONC	0.15	58.0	867.9562	1.1625	0.8315	0.869
	4226	4228	1.35	0.65	2.44	14.80			0.00	0.00			0.00	0.00			0.00	0.00	16.14	59.20	80.04	93.71	136.82	876	975	975	CONC	0.20	59.0	1002.2295	1.3424	0.7325	0.874
	4228	4230	1.34	0.65	2.42	17.22			0.00	0.00			0.00	0.00			0.00	0.00	16.88	57.67	77.95	91.26	133.22	993	975	975	CONC	0.25	58.5	1120.5266	1.5008	0.6497	0.886
	4230	4237			0.00	17.22			0.00	0.00			0.00	0.00			0.00	0.00	16.88	57.67	77.95	91.26	133.22	993	975	975	CONC	0.25	29.5	1120.5266	1.5008	0.3276	0.886
	4237	OGS 12	0.70	0.65	1.26	18.49			0.00	0.00			0.00	0.00			0.00	0.00	16.88	57.67	77.95	91.26	133.22	1066	1050	1050	CONC	0.20	26.5	1221.2174	1.4103	0.3132	0.873
TRUNK 13																																	
			2.65	0.65	4.79	4.79			0.00	0.00			0.00	0.00			0.00	0.00	13.05														
	4304	4305			0.00	4.79			0.00	0.00			0.00	0.00			0.00	0.00	13.05	66.79	90.44	105.95	154.77	320	825	825	CONC	0.15	90.5	555.9418	1.0400	1.4503	0.575
	4305	4312	1.53	0.65	2.76	7.55			0.00	0.00			0.00	0.00			0.00	0.00	14.50	62.97	85.21	99.79	145.74	476	825	825	CONC	0.15	115.5	555.9418	1.0400	1.8510	0.856
	4312	4314	0.68	0.65	1.23	8.78			0.00	0.00			0.00	0.00			0.00	0.00	16.35	58.75	79.43	93.00	135.78	516	825	825	CONC	0.20	58.5	641.9463	1.2009	0.8119	0.804
	4314	4316	0.85	0.65	1.54	10.32			0.00	0.00			0.00	0.00			0.00	0.00	16.35	58.75	79.43	93.00	135.78	606	975	975	CONC	0.10	58.5	708.6833	0.9492	1.0272	0.855
	4316	4318	0.78	0.65	1.41	11.73			0.00	0.00			0.00	0.00			0.00	0.00	17.38	56.67	76.59	89.65	130.87	665	1050	1050	CONC	0.10	72.5	863.5311	0.9973	1.2117	0.770
	4318	OGS 13	0.52	0.65	0.94	12.67			0.00	0.00			0.00	0.00			0.00	0.00	18.59	54.42	73.51	86.03	125.56	689	1050	1050	CONC	0.20	27.0	1221.2174	1.4103	0.3191	0.564
TRUNK 14																																	
			1.38	0.65	2.49	2.49			0.00	0.00			0.00	0.00			0.00	0.00	11.66														
	5205	5206	0.98	0.65	1.77	4.26			0.00	0.00			0.00	0.00			0.00	0.00	11.66	70.97	96.17	112.70	164.69	303	825	825	CONC	0.15	88.5	555.9418	1.0400	1.4183	0.544
	5206	5214	0.50	0.65	0.90	5.17			0.00	0.00			0.00	0.00			0.00	0.00	13.08	66.71	90.33	105.82	154.59	345	825	825	CONC	0.15	87.0	555.9418	1.0400	1.3942	0.620
	5214	5215	0.56	0.65	1.01	6.18			0.00	0.00			0.00	0.00			0.00	0.00	14.47	63.04	85.30	99.90	145.90	390	900	900	CONC	0.15	85.0	701.1305	1.1021	1.2854	0.556
	5215	5216	0.24	0.65	0.43	6.61			0.00	0.00			0.00	0.00			0.00	0.00	15.76	60.03	81.19	95.06	138.80	397	975	975	CONC	0.15	58.5	867.9562	1.1625	0.8387	0.457
	5216	OGS 14	0.23	0.65	0.42	7.03			0.00	0.00			0.00	0.00			0.00	0.00	16.60	58.24	78.73	92.18	134.57	409	975	975	CONC	0.15	26.5	867.9562	1.1625	0.3799	0.472
TRUNK 15																																	
			2.88	0.65	5.20	5.20			0.00	0.00			0.00	0.00			0.00	0.00	12.85														
	5106	5109			0.00	5.20			0.00	0.00			0.00	0.00			0.00	0.00	12.85	67.36	91.21	106.86	156.12	351	750	750	CONC	0.15	58.5	431.1703	0.9760	0.9990	0.813
	5109	5112	1.05	0.65	1.90	7.10			0.00	0.00			0.00	0.00			0.00	0.00	13.85	64.62	87.47	102.45	149.65	459	825	825	CONC	0.15	58.5	555.9418	1.0400	0.9375	0.826
	5112	5115	1.01	0.65	1.83	8.93			0.00	0.00			0.00	0.00			0.00	0.00	14.79	62.28	84.25	98.67	144.10	556	825	825	CONC	0.20	58.5	641.9463	1.2009	0.8119	0.866
	5115	5118	1.06	0.65	1.92	10.84			0.00	0.00			0.00	0.00			0.00	0.00	15.60	60.39	81.67	95.64	139.64	655	900	900	CONC	0.20	58.5	809.5958	1.2726	0.7661	0.809
	5118	5121	1.04	0.65	1.88	12.72			0.00	0.00			0.00	0.00			0.00	0.00	16.36	58.72	79.39	92.96	135.71	747	975	975	CONC	0.15	58.5	867.9562	1.1625	0.8387	0.861
	5121	5125			0.00	12.72			0.00	0.00			0.00	0.00			0.00	0.00	17.20	57.01	77.05	90.21	131.68	725	975	975	CONC	0.20	36.5	1002.2295	1.3424	0.4532	0.724
	5125	OGS 15	0.48	0.65	0.87	13.59			0.00	0.00			0.00	0.00			0.00	0.00	17.66	56.13	75.85	88.79	129.61	763	1050	1050	CONC	0.20	26.5	1221.2174	1.4103	0.3132	0.625
TRUNK 16																																	
			0.71	0.65	1.28	1.28			0.00	0.00			0.00	0.00			0.00	0.00	10.98														
	5004	5006			0.00	1.28			0.00	0.00			0.00	0.00			0.00	0.00	10.98	73.24	99.29	116.36	170.07	94	450	450	CONC	0.20	58.5	127.5033	0.8017	1.2162	0.737
	5006	5008			0.00	1.28			0.00	0.00			0.00	0.00			0.00	0.00	12.20	69.29	93.87	109.98	160.70	89	600	600	CONC	0.15	58.5	237.8056	0.8411	1.1592	0.374
	5008	5010	0.43	0.65	0.78	2.06			0.00	0.00			0.00	0.00			0.00	0.00	13.36	65.94	89.28	104.58	152.77	136	600	600	CONC	0.15	58.5	237.8056	0.8411	1.1592	0.571
			0.14	0.65	0.25	2.31			0.00	0.00			0.00	0.00			0.00	0.00															
	5010	5012	0.19	0.65	0.34	2.66			0.00	0.00			0.00	0.00			0.00	0.00	14.51	62.94	85.16	99.74	145.66	167	600	600	CONC	0.15	33.5	237.8056	0.8411	0.6638	0.703
	5012	5013	0.55	0.65	0.99	3.65			0.00	0.00			0.00	0.00			0.00	0.00	15.18	61.35	82.98	97.18	141.91	224	675	675	CONC	0.15	21.5	325.5584	0.9098	0.3939	0.688
	5013	OGS 16	0.34	0.65	0.61	4.26			0.00	0.00			0.00	0.00			0.00	0.00	15.57	60.45	81.75	95.73	139.78	258	975	975	CONC	0.15	26.5	867.9562	1.1625	0.3799	0.297

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: R.B.	PROJECT: BARRHAVEN COSERVANCY WEST		
Checked: D.A.	LOCATION: City of Ottawa		
Dwg. Reference: 3	File Ref: 16-891	Date: July 2020	Sheet No. SHEET 1 OF 1

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

Ottawa

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
TRUNK 10																																	
			0.79	0.65	1.43	1.43			0.00	0.00			0.00	0.00			0.00	0.00	11.81														
	3304	3305			0.00	1.43			0.00	0.00			0.00	0.00			0.00	0.00	11.81	70.49	95.51	111.92	163.55	101	450	450	CONC	0.20	71.0	127.5033	0.8017	1.4760	0.789
	3305	3310	0.38	0.65	0.69	2.11			0.00	0.00			0.00	0.00			0.00	0.00	13.29	66.13	89.54	104.89	153.22	140	600	600	CONC	0.15	71.0	237.8056	0.8411	1.4069	0.588
			1.37	0.65	2.48	4.59			0.00	0.00			0.00	0.00			0.00	0.00	13.25														
	3310	3311			0.00	4.59			0.00	0.00			0.00	0.00			0.00	0.00	14.69	62.50	84.56	99.03	144.63	287	675	675	CONC	0.20	68.5	375.9224	1.0505	1.0868	0.763
	3311	3313			0.00	4.59	0.07	0.65	0.13	0.13			0.00	0.00			0.00	0.00	15.78	59.99	81.12	94.99	138.69	286	750	750	CONC	0.15	11.0	431.1703	0.9760	0.1878	0.662
			0.49	0.65	0.89	5.48			0.00	0.13			0.00	0.00			0.00	0.00	11.00														
			0.17	0.65	0.31	5.78			0.00	0.13			0.00	0.00			0.00	0.00															
	3313	3314			0.00	5.78	0.24	0.65	0.43	0.56			0.00	0.00			0.00	0.00	15.97	59.57	80.56	94.32	137.72	390	825	825	CONC	0.15	94.5	555.9418	1.0400	1.5144	0.701
	3314	3318	0.05	0.65	0.09	5.87			0.00	0.56			0.00	0.00			0.00	0.00	17.48	56.47	76.31	89.33	130.39	374	825	825	CONC	0.10	13.0	453.9246	0.8492	0.2552	0.825
			0.36	0.65	0.65	6.52			0.00	0.56			0.00	0.00			0.00	0.00	12.53														
	3318	OGS 10			0.00	6.52			0.00	0.56			0.00	0.00			0.00	0.00	17.74	55.98	75.64	88.55	129.24	408	825	825	CONC	0.15	5.0	555.9418	1.0400	0.0801	0.733
TRUNK 9																																	
			0.81	0.65	1.46	1.46			0.00	0.00			0.00	0.00			0.00	0.00	12.00														
	3205	3207			0.00	1.46			0.00	0.00			0.00	0.00			0.00	0.00	12.00	69.89	94.70	110.96	162.13	102	450	450	CONC	0.20	58.5	127.5033	0.8017	1.2162	0.802
			0.39	0.65	0.70	2.17			0.00	0.00			0.00	0.00			0.00	0.00	10.72														
	3207	3209			0.00	2.17			0.00	0.00			0.00	0.00			0.00	0.00	13.22	66.33	89.80	105.20	153.68	144	525	525	CONC	0.20	64.5	192.3297	0.8885	1.2100	0.748
			0.23	0.65	0.42	2.58			0.00	0.00			0.00	0.00			0.00	0.00	10.68														
	3209	3213			0.00	2.58			0.00	0.00			0.00	0.00			0.00	0.00	14.43	63.16	85.46	100.09	146.18	163	525	525	CONC	0.20	16.0	192.3297	0.8885	0.3001	0.849
			0.95	0.65	1.72	4.30			0.00	0.00			0.00	0.00			0.00	0.00	13.51														
	3213	3215			0.00	4.30			0.00	0.00			0.00	0.00			0.00	0.00	14.73	62.42	84.45	98.90	144.44	268	675	675	CONC	0.15	62.5	325.5584	0.9098	1.1450	0.825
			0.45	0.65	0.81	5.11			0.00	0.00			0.00	0.00			0.00	0.00	10.58														
			0.07	0.65	0.13	5.24			0.00	0.00			0.00	0.00			0.00	0.00															
	3215	3216			0.00	5.24	0.07	0.65	0.13	0.13			0.00	0.00			0.00	0.00	15.87	59.78	80.84	94.66	138.21	324	750	750	CONC	0.15	87.5	431.1703	0.9760	1.4942	0.750
	3216	3217	0.11	0.65	0.20	5.44			0.00	0.13			0.00	0.00			0.00	0.00	17.37	56.70	76.62	89.69	130.93	318	750	750	CONC	0.15	11.5	431.1703	0.9760	0.1964	0.738
	3217	3222	0.16	0.65	0.29	5.73			0.00	0.13			0.00	0.00			0.00	0.00	17.56	56.32	76.10	89.08	130.03	332	750	750	CONC	0.15	50.0	431.1703	0.9760	0.8539	0.770
			0.51	0.65	0.92	6.65			0.00	0.13			0.00	0.00			0.00	0.00	13.07														
			0.20	0.65	0.36	7.01			0.00	0.13			0.00	0.00			0.00	0.00															
	3222	OGS 9			0.00	7.01	0.21	0.65	0.38	0.51			0.00	0.00			0.00	0.00	18.42	54.73	73.93	86.54	126.29	421	825	825	CONC	0.15	5.5	555.9418	1.0400	0.0881	0.757
TRUNK 8																																	
			1.03	0.80	2.29	2.29			0.00	0.00			0.00	0.00			0.00	0.00	13.09														
	3105	3106	0.06	0.80	0.13	2.42			0.00	0.00			0.00	0.00			0.00	0.00	13.09	66.68	90.28	105.76	154.51	162	600	600	CONC	0.15	41.0	237.8056	0.8411	0.8125	0.680
	3106	3107	0.27	0.80	0.60	3.02			0.00	0.00			0.00	0.00			0.00	0.00	13.90	64.49	87.28	102.23	149.32	195	600	600	CONC	0.15	71.0	237.8056	0.8411	1.4069	0.820
	3107	3109	0.33	0.80	0.73	3.76			0.00	0.00			0.00	0.00			0.00	0.00	15.31	61.05	82.57	96.69	141.19	229	600	600	CONC	0.20	71.0	274.5943	0.9712	1.2185	0.836
			0.05	0.80	0.11	3.87			0.00	0.00			0.00	0.00			0.00	0.00	10.41														
	3109	3117			0.00	3.87			0.00	0.00			0.00	0.00			0.00	0.00	16.53	58.38	78.93	92.41	134.90	226	675	675	CONC	0.15	33.5	325.5584	0.9098	0.6137	0.694
			0.36	0.80	0.80	4.67			0.00	0.00			0.00	0.00			0.00	0.00	13.79														
			0.04	0.65	0.07	4.74			0.00	0.00			0.00	0.00			0.00	0.00															
	3117	3119	1.07	0.65	1.93	6.68			0.00	0.00			0.00	0.00			0.00	0.00	17.14	57.14	77.22	90.40	131.96	381	750	750	CONC	0.20	43.5	497.8726	1.1270	0.6433	0.766
					0.00	6.68	0.15	0.65	0.27	0.27			0.00	0.00			0.00	0.00	11.06														
			0.05	0.80	0.11	6.79			0.00	0.27			0.00	0.00			0.00	0.00															
			0.10	0.65	0.18	6.97			0.00	0.27			0.00	0.00			0.00	0.00															
	3119	3121	0.05	0.80	0.11	7.08			0.00	0.27			0.00	0.00			0.00	0.00	17.78	55.89	75.52	88.40	129.03	416	750	750	CONC	0.20	37.5	497.8726	1.1270	0.5546	0.836
			0.11	0.80	0.24	7.32			0.00	0.27			0.00	0.00			0.00	0.00	11.09														
			0.27	0.65	0.49	7.81			0.00	0.27			0.00	0.00			0.00	0.00															
	3121	3125	0.30	0.80	0.67	8.48			0.00	0.27			0.00	0.00			0.00	0.00	18.34	54.87	74.12	86.76	126.62	485	750	750	CONC	0.20	62.5	497.8726	1.1270	0.9243	0.975
			0.24	0.65	0.43	8.91			0.00	0.27			0.00	0.00			0.00	0.00	11.74														
	3125	3129	0.30	0.80	0.67	9.58			0.00	0.27			0.00	0.00			0.00	0.00	19.26	53.25	71.91	84.16	122.81	530	825	825	CONC	0.20	52.5	641.9463	1.2009	0.7286	0.825
			0.59	0.65	1.07	10.65			0.00	0.27			0.00	0.00			0.00	0.00	12.57														
			0.16	0.65	0.29	10.94			0.00	0.27			0.00	0.00			0.00	0.00															
	3129	3131			0.00	10.94	0.19	0.65	0.34	0.61			0.00	0.00			0.00	0.00	19.99	52.04	70.27	82.23	119.98	612	900	900	CONC	0.15	22.5	701.1305	1.1021	0.3403	0.873
	3131	OGS 8	0.93	0.40	1.03	11.97			0.00	0.61			0.00	0.00			0.00	0.00	20.33	51.50	69.53	81.36	118.71	659	900	900	CONC	0.20	42.5	809.5958	1.2726	0.5566	0.814

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed:	PROJECT:		
R.B	BARRHAVEN COSERVANCY EAST		
Checked:	LOCATION:		
D.A.	City of Ottawa		
Dwg. Reference:	File Ref:	Date:	Sheet No.
3	16-891	Ju\lye 2020	SHEET 1 OF 4

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Manning 0.013

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Ottawa

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
TRUNK 7A																																	
			1.19	0.65	2.15	2.15			0.00	0.00			0.00	0.00			0.00	0.00	16.89														
					0.00	2.15	0.06	0.65	0.11	0.11			0.00	0.00			0.00	0.00															
			0.05	0.65	0.09	2.24			0.00	0.11			0.00	0.00			0.00	0.00															
	6205	6224	0.81	0.65	1.46	3.70			0.00	0.11			0.00	0.00			0.00	0.00	16.89	57.64	77.91	91.21	133.15	222	675	675	CONC	0.15	60.5	325.5584	0.9098	1.1083	0.682
To TRUNK 7, Pipe 6224 - OGS 7						3.70				0.11				0.00				0.00	18.00														
					0.00	0.00			0.00	0.00	3.98	0.80	8.85	8.85			0.00	0.00	17.54														
	6150	6151			0.00	0.00			0.00	0.00			0.00	8.85			0.00	0.00	17.54	56.36	76.16	89.15	130.13	789	1050	1050	CONC	0.15	26.5	1057.6053	1.2214	0.3616	0.746
	6151	6224			0.00	0.00			0.00	0.00			0.00	8.85			0.00	0.00	17.90	55.67	75.22	88.05	128.51	779	1050	1050	CONC	0.15	64.0	1057.6053	1.2214	0.8733	0.737
To TRUNK 7, Pipe 6224 - OGS 7						0.00				0.00				8.85				0.00	18.77														
TRUNK 7																																	
			0.39	0.65	0.70	0.70			0.00	0.00			0.00	0.00			0.00	0.00	12.58														
	6210	6213	0.70	0.80	1.56	2.26			0.00	0.00			0.00	0.00			0.00	0.00	12.58	68.14	92.29	108.13	157.97	154	525	525	CONC	0.20	43.5	192.3297	0.8885	0.8160	0.801
			0.05	0.80	0.11	2.37			0.00	0.00			0.00	0.00			0.00	0.00															
					0.00	2.37	0.41	0.65	0.74	0.74			0.00	0.00			0.00	0.00	11.13														
			0.04	0.80	0.09	2.46			0.00	0.74			0.00	0.00			0.00	0.00															
			0.03	0.80	0.07	2.53			0.00	0.74			0.00	0.00			0.00	0.00															
	6213	6216	0.05	0.80	0.11	2.64			0.00	0.74			0.00	0.00			0.00	0.00	13.40	65.83	89.12	104.40	152.51	240	600	600	CONC	0.30	31.5	336.3080	1.1894	0.4414	0.713
			0.13	0.80	0.29	2.93			0.00	0.74			0.00	0.00			0.00	0.00	11.15														
			0.10	0.80	0.22	3.15			0.00	0.74			0.00	0.00			0.00	0.00															
			0.09	0.80	0.20	3.35			0.00	0.74			0.00	0.00			0.00	0.00															
	6216	6217	0.29	0.65	0.52	3.88			0.00	0.74			0.00	0.00			0.00	0.00	13.84	64.65	87.51	102.50	149.72	315	750	750	CONC	0.15	76.0	431.1703	0.9760	1.2979	0.731
			0.13	0.80	0.29	4.16			0.00	0.74			0.00	0.00			0.00	0.00															
	6217	6222	0.23	0.65	0.42	4.58			0.00	0.74			0.00	0.00			0.00	0.00	15.14	61.45	83.12	97.34	142.14	343	750	750	CONC	0.15	76.0	431.1703	0.9760	1.2979	0.796
			0.18	0.65	0.33	4.91			0.00	0.74			0.00	0.00			0.00	0.00	13.44														
			0.55	0.80	1.22	6.13			0.00	0.74			0.00	0.00			0.00	0.00															
	6222	6223	0.10	0.65	0.18	6.31			0.00	0.74			0.00	0.00			0.00	0.00	16.43	58.58	79.20	92.72	135.37	428	750	750	CONC	0.30	27.0	609.7669	1.3802	0.3260	0.702
	6223	6224	0.02	0.65	0.04	6.35			0.00	0.74			0.00	0.00			0.00	0.00	16.76	57.91	78.27	91.64	133.78	425	750	750	CONC	0.30	10.5	609.7669	1.3802	0.1268	0.698
Contribution From TRUNK 7A, Pipe 6151 - 6224						0.00				0.00				8.85				0.00	18.77														
Contribution From TRUNK 7A, Pipe 6205 - 6224						3.70				0.11				0.00				0.00	18.00														
	6224	OGS 7			0.00	10.05			0.00	0.85			0.00	8.85			0.00	0.00	18.77	54.09	73.06	85.51	124.79	1363	1200	1200	CONC	0.20	3.5	1743.5652	1.5417	0.0378	0.781
TRUNK 6																																	
			0.92	0.65	1.66	1.66			0.00	0.00			0.00	0.00			0.00	0.00	12.35														
	6303	6305			0.00	1.66			0.00	0.00			0.00	0.00			0.00	0.00	12.35	68.82	93.23	109.23	159.59	114	450	450	CONC	0.25	47.0	142.5531	0.8963	0.8739	0.803
			0.85	0.65	1.54	3.20			0.00	0.00			0.00	0.00			0.00	0.00	12.35														
	6305	6307			0.00	3.20			0.00	0.00			0.00	0.00			0.00	0.00	13.22	66.30	89.77	105.16	153.62	212	675	675	CONC	0.15	69.0	325.5584	0.9098	1.2641	0.651
			0.55	0.65	0.99	4.19			0.00	0.00			0.00	0.00			0.00	0.00	12.20														
	6307	6309			0.00	4.19	0.39	0.65	0.70	0.70			0.00	0.00			0.00	0.00	14.49	63.00	85.25	99.84	145.81	324	675	675	CONC	0.25	31.5	420.2941	1.1745	0.4470	0.771
			0.19	0.65	0.34	4.54			0.00	0.70			0.00	0.00			0.00	0.00	10.86														
	6309	6312			0.00	4.54			0.00	0.70			0.00	0.00			0.00	0.00	14.93	61.92	83.77	98.10	143.26	340	675	675	CONC	0.25	25.5	420.2941	1.1745	0.3619	0.809
			0.87	0.65	1.57	6.11			0.00	0.70			0.00	0.00			0.00	0.00	12.42														
	6312	6316			0.00	6.11			0.00	0.70			0.00	0.00			0.00	0.00	15.30	61.08	82.61	96.74	141.26	431	750	750	CONC	0.25	59.0	556.6385	1.2600	0.7804	0.775
			0.99	0.65	1.79	7.90			0.00	0.70			0.00	0.00			0.00	0.00	12.55														
	6316	6317			0.00	7.90			0.00	0.70			0.00	0.00			0.00	0.00	16.08	59.34	80.23	93.94	137.15	525	825	825	CONC	0.20	66.5	641.9463	1.2009	0.9229	0.818
			0.22	0.65	0.40	8.29			0.00	0.70			0.00	0.00			0.00	0.00															
	6317	6318	0.85	0.40	0.95	9.24			0.00	0.70			0.00	0.00			0.00	0.00	17.00	57.42	77.61	90.85	132.63	585	900	900	CONC	0.15	67.0	701.1305	1.1021	1.0132	0.835
	6318	OGS 6	0.06	0.65	0.11	9.35			0.00	0.70			0.00	0.00			0.00	0.00	18.01	55.46	74.94	87.72	128.02	571	900	900	CONC	0.15	12.0	701.1305	1.1021	0.1815	0.815
TRUNK 5A																																	
			1.40	0.65	2.53	2.53			0.00	0.00			0.00	0.00			0.00	0.00	13.39														
	2331	2332			0.00	2.53			0.00	0.00			0.00	0.00			0.00	0.00	13.39	65.85	89.15	104.43	152.55	167	600	600	CONC	0.15	73.5	237.8056	0.8411	1.4565	0.701
To TRUNK 5, Pipe 2332 - 2334						2.53				0.00				0.00				0.00	14.85														
TRUNK 5																																	
			0.71	0.65	1.28	1.28			0.00	0.00			0.00	0.00			0.00	0.00	11.72														
	2303	2305			0.00	1.28			0.00	0.00			0.00	0.00			0.00	0.00	11.72	70.78	95.91	112.39	164.23	91	450	450	CONC	0.20	52.5	127.5033	0.8017	1.0914	0.712

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: R.B	PROJECT: BARRHAVEN COSERVANCY EAST		
Checked: D.A.	LOCATION: City of Ottawa		
Dwg. Reference: 3	File Ref: 16-891	Date: June 2020	Sheet No. SHEET 2 OF 4

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

LOCATION			AREA (Ha) 2 YEAR				5 YEAR				10 YEAR				100 YEAR				FLOW						SEWER DATA								
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min)	RATIO Q/Q full
			0.57	0.65	1.03	2.31			0.00	0.00			0.00	0.00			0.00	0.00	11.79														
	2305	2308			0.00	2.31			0.00	0.00			0.00	0.00			0.00	0.00	12.81	67.47	91.37	107.04	156.38	156	525	525	CONC	0.20	68.0	192.3297	0.8885	1.2756	0.811
			0.18	0.65	0.33	2.64			0.00	0.00			0.00	0.00			0.00	0.00															
			0.27	0.65	0.49	3.13			0.00	0.00			0.00	0.00			0.00	0.00	11.74														
					0.00	3.13	0.43	0.65	0.78	0.78			0.00	0.00			0.00	0.00															
	2308	2309	0.50	0.40	0.56	3.68			0.00	0.78			0.00	0.00			0.00	0.00	14.09	64.01	86.63	101.46	148.19	303	675	675	CONC	0.20	54.5	375.9224	1.0505	0.8647	0.806
	2309	2311	0.33	0.65	0.60	4.28			0.00	0.78			0.00	0.00			0.00	0.00	14.95	61.88	83.71	98.04	143.16	330	750	750	CONC	0.15	60.5	431.1703	0.9760	1.0332	0.765
			0.45	0.65	0.81	5.09			0.00	0.78			0.00	0.00			0.00	0.00	10.92														
	2311	2312			0.00	5.09			0.00	0.78			0.00	0.00			0.00	0.00	15.98	59.54	80.50	94.26	137.63	366	825	825	CONC	0.10	72.5	453.9246	0.8492	1.4230	0.806
	2312	2326	0.28	0.65	0.51	5.60			0.00	0.78			0.00	0.00			0.00	0.00	17.41	56.61	76.51	89.56	130.73	376	825	825	CONC	0.10	72.5	453.9246	0.8492	1.4230	0.829
			3.25	0.65	5.87	11.47			0.00	0.78			0.00	0.00			0.00	0.00	15.74														
	2326	2332			0.00	11.47			0.00	0.78			0.00	0.00			0.00	0.00	18.83	53.99	72.93	85.35	124.56	676	975	975	CONC	0.15	58.5	867.9562	1.1625	0.8387	0.779
Contribution From TRUNK 5A, Pipe 2331 - 2332						2.53				0.00				0.00				0.00	14.85														
	2332	OGS 5	0.30	0.65	0.54	14.54			0.00	0.78			0.00	0.00			0.00	0.00	19.67	52.57	70.98	83.07	121.21	820	1050	1050	CONC	0.15	25.0	1057.6053	1.2214	0.3411	0.775
TRUNK 4A																																	
			1.97	0.65	3.56	3.56			0.00	0.00			0.00	0.00			0.00	0.00	14.68														
			0.27	0.65	0.49	4.05			0.00	0.00			0.00	0.00			0.00	0.00															
	2224	2225			0.00	4.05	0.33	0.65	0.60	0.60			0.00	0.00			0.00	0.00	14.68	62.53	84.61	99.08	144.70	304	675	675	CONC	0.20	78.0	375.9224	1.0505	1.2375	0.808
	2225	2226	0.02	0.65	0.04	4.08			0.00	0.60			0.00	0.00			0.00	0.00	15.92	59.68	80.71	94.50	137.97	292	675	675	CONC	0.20	8.0	375.9224	1.0505	0.1269	0.776
To TRUNK 4, Pipe 2226 - OGS 4						4.08				0.60				0.00				0.00	16.04														
TRUNK 4																																	
			1.18	0.65	2.13	2.13			0.00	0.00			0.00	0.00			0.00	0.00	12.58														
	2204	2206			0.00	2.13			0.00	0.00			0.00	0.00			0.00	0.00	12.58	68.14	92.29	108.13	157.97	145	525	525	CONC	0.20	27.5	192.3297	0.8885	0.5159	0.755
			0.44	0.65	0.80	2.93			0.00	0.00			0.00	0.00			0.00	0.00	11.75														
	2206	2209			0.00	2.93			0.00	0.00			0.00	0.00			0.00	0.00	13.10	66.66	90.26	105.74	154.47	195	525	525	CONC	0.30	25.0	235.5548	1.0881	0.3829	0.828
			0.83	0.65	1.50	4.43			0.00	0.00			0.00	0.00			0.00	0.00	12.56														
	2209	2210			0.00	4.43			0.00	0.00			0.00	0.00			0.00	0.00	13.48	65.61	88.82	104.04	151.98	290	675	675	CONC	0.20	68.0	375.9224	1.0505	1.0788	0.773
					0.00	4.43	0.09	0.65	0.16	0.16			0.00	0.00			0.00	0.00															
	2210	2211	0.27	0.65	0.49	4.92			0.00	0.16			0.00	0.00			0.00	0.00	14.56	62.83	85.01	99.57	145.41	323	675	675	CONC	0.25	54.5	420.2941	1.1745	0.7734	0.768
	2211	2213	0.33	0.65	0.60	5.51			0.00	0.16			0.00	0.00			0.00	0.00	15.33	61.00	82.50	96.61	141.07	350	750	750	CONC	0.15	60.5	431.1703	0.9760	1.0332	0.811
			0.40	0.65	0.72	6.23			0.00	0.16			0.00	0.00			0.00	0.00	10.60														
	2213	2214			0.00	6.23			0.00	0.16			0.00	0.00			0.00	0.00	16.36	58.72	79.39	92.96	135.71	379	825	825	CONC	0.10	75.0	453.9246	0.8492	1.4721	0.835
	2214	2215	0.34	0.65	0.61	6.85			0.00	0.16			0.00	0.00			0.00	0.00	17.84	55.79	75.39	88.25	128.80	394	825	825	CONC	0.15	75.0	555.9418	1.0400	1.2019	0.709
	2215	2226	0.23	0.65	0.42	7.26			0.00	0.16			0.00	0.00			0.00	0.00	19.04	53.63	72.44	84.78	123.71	401	900	900	CONC	0.10	63.5	572.4707	0.8999	1.1761	0.701
Contribution From TRUNK 4A, Pipe 2225 - 2226						4.08				0.60				0.00				0.00	16.04														
	2226	OGS 4	0.02	0.65	0.04	11.38			0.00	0.76			0.00	0.00			0.00	0.00	20.21	51.69	69.78	81.66	119.15	641	975	975	CONC	0.15	23.5	867.9562	1.1625	0.3369	0.739
TRUNK 3																																	
			0.95	0.65	1.72	1.72			0.00	0.00			0.00	0.00			0.00	0.00	11.41														
	2103	2105			0.00	1.72			0.00	0.00			0.00	0.00			0.00	0.00	11.41	71.78	97.29	114.01	166.62	123	525	525	CONC	0.20	111.0	192.3297	0.8885	2.0823	0.641
			0.45	0.65	0.81	2.53			0.00	0.00			0.00	0.00			0.00	0.00	10.64														
	2105	2110			0.00	2.53			0.00	0.00			0.00	0.00			0.00	0.00	13.49	65.57	88.77	103.98	151.89	166	600	600	CONC	0.15	67.0	237.8056	0.8411	1.3277	0.698
			0.54	0.65	0.98	3.51			0.00	0.00			0.00	0.00			0.00	0.00	12.13														
	2110	OGS 3	0.67	0.40	0.75	4.25			0.00	0.00			0.00	0.00			0.00	0.00	14.82	62.20	84.14	98.54	143.91	264	675	675	CONC	0.15	25.0	325.5584	0.9098	0.4580	0.812
TRUNK 2																																	
			1.05	0.65	1.90	1.90			0.00	0.00			0.00	0.00			0.00	0.00	13.03														
	1204	1207			0.00	1.90			0.00	0.00			0.00	0.00			0.00	0.00	13.03	66.85	90.51	106.04	154.91	127	525	525	CONC	0.20	45.0	192.3297	0.8885	0.8442	0.659
			1.00	0.65	1.81	3.70			0.00	0.00			0.00	0.00			0.00	0.00	12.68														
	1207	1209			0.00	3.70			0.00	0.00			0.00	0.00			0.00	0.00	13.87	64.56	87.38	102.35	149.49	239	600	600	CONC	0.25	68.5	307.0058	1.0858	1.0514	0.779
					0.00	3.70	0.12	0.65	0.22	0.22			0.00	0.00			0.00	0.00	10.60														
			0.03	0.65	0.05	3.76			0.00	0.22			0.00	0.00			0.00	0.00															
	1209	1211	0.09	0.65	0.16	3.92			0.00	0.22			0.00	0.00			0.00	0.00	14.93	61.94	83.80	98.14	143.31	261	675	675	CONC	0.15	19.5	325.5584	0.9098	0.3572	0.802
			0.29	0.65	0.52	4.45			0.00	0.22			0.00	0.00			0.00	0.00	12.13														
			0.26	0.65	0.47	4.92			0.00	0.22			0.00	0.00			0.00	0.00															
	1211	1215			0.00	4.92	0.28	0.65	0.51	0.72			0.00	0.00			0.00	0.00	15.28	61.11	82.65	96.79	141.34	360	750	750	CONC	0.15	56.5	431.1703	0.9760	0.9649	0.835

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: R.B
Checked: D.A.
Dwg. Reference: 3

PROJECT: BARRHAVEN COSERVANCY EAST
LOCATION: City of Ottawa
File Ref: 16-891
Date: June 2020
Sheet No. SHEET 3 OF 4

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STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

Ottawa

LOCATION			AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
			1.20	0.65	2.17	7.08			0.00	0.72			0.00	0.00			0.00	0.00	12.38														
	1215	1217			0.00	7.08			0.00	0.72			0.00	0.00			0.00	0.00	16.25	58.97	79.73	93.35	136.29	475	750	750	CONC	0.30	58.5	609.7669	1.3802	0.7064	0.780
			0.57	0.65	1.03	8.11			0.00	0.72			0.00	0.00			0.00	0.00	10.78														
	1217	1218			0.00	8.11			0.00	0.72			0.00	0.00			0.00	0.00	16.95	57.51	77.73	91.00	132.85	523	825	825	CONC	0.20	90.0	641.9463	1.2009	1.2491	0.814
			0.94	0.65	1.70	9.81			0.00	0.72			0.00	0.00			0.00	0.00	13.42														
	1218	1260			0.00	9.81			0.00	0.72			0.00	0.00			0.00	0.00	18.20	55.11	74.46	87.15	127.20	595	900	900	CONC	0.15	3.5	701.1305	1.1021	0.0529	0.848
	1260	OGS 2			0.00	9.81			0.00	0.72			0.00	0.00			0.00	0.00	18.20	55.11	74.46	87.15	127.20	595	900	900	CONC	0.15	22.5	701.1305	1.1021	0.3403	0.848
TRUNK 1																																	
			0.89	0.65	1.61	1.61			0.00	0.00			0.00	0.00			0.00	0.00	10.75														
	1103	1104			0.00	1.61			0.00	0.00			0.00	0.00			0.00	0.00	10.75	74.04	100.39	117.66	171.98	119	450	450	CONC	0.25	109.0	142.5531	0.8963	2.0268	0.835
			0.60	0.65	1.08	2.69			0.00	0.00			0.00	0.00			0.00	0.00															
	1104	1106	0.76	0.40	0.85	3.54			0.00	0.00			0.00	0.00			0.00	0.00	12.78	67.57	91.50	107.20	156.62	239	675	675	CONC	0.15	108.5	325.5584	0.9098	1.9877	0.734
			0.56	0.65	1.01	4.55			0.00	0.00			0.00	0.00			0.00	0.00	11.63														
	1106	1108			0.00	4.55			0.00	0.00			0.00	0.00			0.00	0.00	14.76	62.33	84.33	98.76	144.22	284	675	675	CONC	0.20	64.5	375.9224	1.0505	1.0233	0.754
			0.82	0.65	1.48	6.03			0.00	0.00			0.00	0.00			0.00	0.00	12.30														
	1108	1117			0.00	6.03			0.00	0.00			0.00	0.00			0.00	0.00	15.79	59.97	81.10	94.96	138.65	362	750	750	CONC	0.15	58.5	431.1703	0.9760	0.9990	0.839
					0.00	6.03	0.29	0.65	0.52	0.52			0.00	0.00			0.00	0.00															
			0.52	0.65	0.94	6.97			0.00	0.52			0.00	0.00			0.00	0.00															
	1117	1122	1.04	0.65	1.88	8.85			0.00	0.52			0.00	0.00			0.00	0.00	16.79	57.85	78.20	91.55	133.64	553	825	825	CONC	0.25	17.0	717.7178	1.3426	0.2110	0.770
			0.08	0.65	0.14	8.99			0.00	0.52			0.00	0.00			0.00	0.00	15.57														
	1122	1121			0.00	8.99			0.00	0.52			0.00	0.00			0.00	0.00	17.00	57.42	77.61	90.86	132.64	557	825	825	CONC	0.25	9.0	717.7178	1.3426	0.1117	0.776
	1121	1120	0.06	0.65	0.11	9.10			0.00	0.52			0.00	0.00			0.00	0.00	17.11	57.20	77.31	90.50	132.11	561	900	900	CONC	0.15	48.5	701.1305	1.1021	0.7334	0.800
			0.64	0.65	1.16	10.26			0.00	0.52			0.00	0.00			0.00	0.00	12.10														
	1120	OGS 1			0.00	10.26			0.00	0.52			0.00	0.00			0.00	0.00	17.84	55.78	75.37	88.23	128.77	612	900	900	CONC	0.20	3.5	809.5958	1.2726	0.0458	0.756

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: R.B	PROJECT: BARRHAVEN COSERVANCY EAST	
Checked: D.A.	LOCATION: City of Ottawa	
Dwg. Reference: 3	File Ref: 16-891	Date: June 2020	Sheet No. SHEET 4 OF 4

891_STM_Trunk.xlsx

CONTECH ENGINEERED SOLUTIONS

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD BASED ON A FINE PARTICLE SIZE DISTRIBUTION

CDS TECHNOLOGIES

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	1	**Report Date:**	22-May-20

Area	6.24	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4040		**CDS Treatment Capacity**	170	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	5.6	5.6	3.3	97.9	9.0
1.0	10.6%	19.8%	11.3	11.3	6.6	97.0	10.3
1.5	9.9%	29.7%	16.9	16.9	10.0	96.0	9.5
2.0	8.4%	38.1%	22.6	22.6	13.3	95.1	8.0
2.5	7.7%	45.8%	28.2	28.2	16.6	94.1	7.2
3.0	5.9%	51.7%	33.8	33.8	19.9	93.2	5.5
3.5	4.4%	56.1%	39.5	39.5	23.2	92.2	4.0
4.0	4.7%	60.7%	45.1	45.1	26.5	91.2	4.3
4.5	3.3%	64.0%	50.7	50.7	29.9	90.3	3.0
5.0	3.0%	67.1%	56.4	56.4	33.2	89.3	2.7
6.0	5.4%	72.4%	67.7	67.7	39.8	87.4	4.7
7.0	4.4%	76.8%	78.9	78.9	46.5	85.5	3.7
8.0	3.5%	80.3%	90.2	90.2	53.1	83.6	3.0
9.0	2.8%	83.2%	101.5	101.5	59.7	81.7	2.3
10.0	2.2%	85.3%	112.8	112.8	66.4	79.8	1.7
15.0	7.0%	92.3%	169.1	169.1	99.5	70.3	4.9
20.0	4.5%	96.9%	225.5	169.9	100.0	52.9	2.4
25.0	1.4%	98.3%	281.9	169.9	100.0	42.3	0.6
30.0	0.7%	99.0%	338.3	169.9	100.0	35.3	0.2
35.0	0.5%	99.5%	394.6	169.9	100.0	30.2	0.1
40.0	0.5%	100.0%	451.0	169.9	100.0	26.4	0.1
45.0	0.0%	100.0%	507.4	169.9	100.0	23.5	0.0
50.0	0.0%	100.0%	563.8	169.9	100.0	21.2	0.0
							87.4

Removal Efficiency Adjustment[2] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**80.9%**
Predicted % Annual Rainfall Treated =	**97.4%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name: 891 Caivan — **Engineer:** DSEL
Location: Ottawa, ON — **Contact:** A. Fobert, P.Eng.
OGS #: 2 — **Report Date:** 22-May-20

Area	5.82	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4040		**CDS Treatment Capacity**	170	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	5.3	5.3	3.1	98.0	9.0
1.0	10.6%	19.8%	10.5	10.5	6.2	97.1	10.3
1.5	9.9%	29.7%	15.8	15.8	9.3	96.2	9.5
2.0	8.4%	38.1%	21.0	21.0	12.4	95.3	8.0
2.5	7.7%	45.8%	26.3	26.3	15.5	94.4	7.3
3.0	5.9%	51.7%	31.6	31.6	18.6	93.5	5.6
3.5	4.4%	56.1%	36.8	36.8	21.7	92.6	4.0
4.0	4.7%	60.7%	42.1	42.1	24.8	91.8	4.3
4.5	3.3%	64.0%	47.3	47.3	27.9	90.9	3.0
5.0	3.0%	67.1%	52.6	52.6	30.9	90.0	2.7
6.0	5.4%	72.4%	63.1	63.1	37.1	88.2	4.8
7.0	4.4%	76.8%	73.6	73.6	43.3	86.4	3.8
8.0	3.5%	80.3%	84.1	84.1	49.5	84.7	3.0
9.0	2.8%	83.2%	94.7	94.7	55.7	82.9	2.3
10.0	2.2%	85.3%	105.2	105.2	61.9	81.1	1.8
15.0	7.0%	92.3%	157.8	157.8	92.8	72.2	5.0
20.0	4.5%	96.9%	210.3	169.9	100.0	56.7	2.6
25.0	1.4%	98.3%	262.9	169.9	100.0	45.4	0.7
30.0	0.7%	99.0%	315.5	169.9	100.0	37.8	0.3
35.0	0.5%	99.5%	368.1	169.9	100.0	32.4	0.2
40.0	0.5%	100.0%	420.7	169.9	100.0	28.4	0.2
45.0	0.0%	100.0%	473.3	169.9	100.0	25.2	0.0
50.0	0.0%	100.0%	525.8	169.9	100.0	22.7	0.0
							88.1

Removal Efficiency Adjustment[2] = 6.5%

Predicted Net Annual Load Removal Efficiency = 81.6%

Predicted % Annual Rainfall Treated = 97.7%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	DSEL
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	3	**Report Date:**	22-May-20

Area	2.63	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	3025		**CDS Treatment Capacity**	68	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	2.4	2.4	3.5	97.9	9.0
1.0	10.6%	19.8%	4.8	4.8	7.0	96.9	10.3
1.5	9.9%	29.7%	7.1	7.1	10.5	95.9	9.5
2.0	8.4%	38.1%	9.5	9.5	14.0	94.8	7.9
2.5	7.7%	45.8%	11.9	11.9	17.5	93.8	7.2
3.0	5.9%	51.7%	14.3	14.3	21.0	92.8	5.5
3.5	4.4%	56.1%	16.6	16.6	24.5	91.8	4.0
4.0	4.7%	60.7%	19.0	19.0	28.0	90.8	4.2
4.5	3.3%	64.0%	21.4	21.4	31.5	89.8	3.0
5.0	3.0%	67.1%	23.8	23.8	35.0	88.8	2.7
6.0	5.4%	72.4%	28.5	28.5	42.0	86.8	4.7
7.0	4.4%	76.8%	33.3	33.3	48.9	84.8	3.7
8.0	3.5%	80.3%	38.0	38.0	55.9	82.8	2.9
9.0	2.8%	83.2%	42.8	42.8	62.9	80.8	2.3
10.0	2.2%	85.3%	47.5	47.5	69.9	78.8	1.7
15.0	7.0%	92.3%	71.3	68.0	100.0	66.9	4.7
20.0	4.5%	96.9%	95.0	68.0	100.0	50.2	2.3
25.0	1.4%	98.3%	118.8	68.0	100.0	40.2	0.6
30.0	0.7%	99.0%	142.6	68.0	100.0	33.5	0.2
35.0	0.5%	99.5%	166.3	68.0	100.0	28.7	0.1
40.0	0.5%	100.0%	190.1	68.0	100.0	25.1	0.1
45.0	0.0%	100.0%	213.9	68.0	100.0	22.3	0.0
50.0	0.0%	100.0%	237.6	68.0	100.0	20.1	0.0
							86.7

Removal Efficiency Adjustment[2] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**80.2%**
Predicted % Annual Rainfall Treated =	**96.8%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	4	**Report Date:**	22-May-20

Area	6.66	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4040		**CDS Treatment Capacity**	170	l/s

Rainfall Intensity[1] (mm/hr)	**Percent Rainfall Volume[1]**	**Cumulative Rainfall Volume**	**Total Flowrate (l/s)**	**Treated Flowrate (l/s)**	**Operating Rate (%)**	**Removal Efficiency (%)**	**Incremental Removal (%)**
0.5	9.2%	9.2%	6.0	6.0	3.5	97.8	9.0
1.0	10.6%	19.8%	12.0	12.0	7.1	96.8	10.3
1.5	9.9%	29.7%	18.1	18.1	10.6	95.8	9.5
2.0	8.4%	38.1%	24.1	24.1	14.2	94.8	7.9
2.5	7.7%	45.8%	30.1	30.1	17.7	93.8	7.2
3.0	5.9%	51.7%	36.1	36.1	21.2	92.8	5.5
3.5	4.4%	56.1%	42.1	42.1	24.8	91.8	4.0
4.0	4.7%	60.7%	48.1	48.1	28.3	90.7	4.2
4.5	3.3%	64.0%	54.2	54.2	31.9	89.7	3.0
5.0	3.0%	67.1%	60.2	60.2	35.4	88.7	2.7
6.0	5.4%	72.4%	72.2	72.2	42.5	86.7	4.7
7.0	4.4%	76.8%	84.2	84.2	49.6	84.6	3.7
8.0	3.5%	80.3%	96.3	96.3	56.7	82.6	2.9
9.0	2.8%	83.2%	108.3	108.3	63.7	80.6	2.3
10.0	2.2%	85.3%	120.3	120.3	70.8	78.6	1.7
15.0	7.0%	92.3%	180.5	169.9	100.0	66.1	4.6
20.0	4.5%	96.9%	240.7	169.9	100.0	49.6	2.3
25.0	1.4%	98.3%	300.9	169.9	100.0	39.6	0.6
30.0	0.7%	99.0%	361.0	169.9	100.0	33.0	0.2
35.0	0.5%	99.5%	421.2	169.9	100.0	28.3	0.1
40.0	0.5%	100.0%	481.4	169.9	100.0	24.8	0.1
45.0	0.0%	100.0%	541.6	169.9	100.0	22.0	0.0
50.0	0.0%	100.0%	601.7	169.9	100.0	19.8	0.0
							86.5
						Removal Efficiency Adjustment[2] =	6.5%
						Predicted Net Annual Load Removal Efficiency =	**80.0%**
						Predicted % Annual Rainfall Treated =	**96.6%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	5	**Report Date:**	22-May-20

Area	8.66	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	5640		**CDS Treatment Capacity**	255	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	7.8	7.8	3.1	98.0	9.0
1.0	10.6%	19.8%	15.6	15.6	6.1	97.1	10.3
1.5	9.9%	29.7%	23.5	23.5	9.2	96.2	9.5
2.0	8.4%	38.1%	31.3	31.3	12.3	95.3	8.0
2.5	7.7%	45.8%	39.1	39.1	15.3	94.5	7.3
3.0	5.9%	51.7%	46.9	46.9	18.4	93.6	5.6
3.5	4.4%	56.1%	54.8	54.8	21.5	92.7	4.0
4.0	4.7%	60.7%	62.6	62.6	24.6	91.8	4.3
4.5	3.3%	64.0%	70.4	70.4	27.6	90.9	3.0
5.0	3.0%	67.1%	78.2	78.2	30.7	90.1	2.7
6.0	5.4%	72.4%	93.9	93.9	36.8	88.3	4.8
7.0	4.4%	76.8%	109.5	109.5	43.0	86.5	3.8
8.0	3.5%	80.3%	125.2	125.2	49.1	84.8	3.0
9.0	2.8%	83.2%	140.8	140.8	55.3	83.0	2.3
10.0	2.2%	85.3%	156.5	156.5	61.4	81.3	1.8
15.0	7.0%	92.3%	234.7	234.7	92.1	72.5	5.1
20.0	4.5%	96.9%	313.0	254.9	100.0	57.2	2.6
25.0	1.4%	98.3%	391.2	254.9	100.0	45.7	0.7
30.0	0.7%	99.0%	469.5	254.9	100.0	38.1	0.3
35.0	0.5%	99.5%	547.7	254.9	100.0	32.7	0.2
40.0	0.5%	100.0%	625.9	254.9	100.0	28.6	0.2
45.0	0.0%	100.0%	704.2	254.9	100.0	25.4	0.0
50.0	0.0%	100.0%	782.4	254.9	100.0	22.9	0.0
							88.2
						Removal Efficiency Adjustment[2] =	6.5%
						Predicted Net Annual Load Removal Efficiency =	**81.7%**
						Predicted % Annual Rainfall Treated =	**97.8%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

CONTECH ENGINEERED SOLUTIONS — CDS TECHNOLOGIES

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	6	**Report Date:**	22-May-20

Area	5.92	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4040		**CDS Treatment Capacity**	170	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	5.3	5.3	3.1	98.0	9.0
1.0	10.6%	19.8%	10.7	10.7	6.3	97.1	10.3
1.5	9.9%	29.7%	16.0	16.0	9.4	96.2	9.5
2.0	8.4%	38.1%	21.4	21.4	12.6	95.2	8.0
2.5	7.7%	45.8%	26.7	26.7	15.7	94.3	7.3
3.0	5.9%	51.7%	32.1	32.1	18.9	93.4	5.6
3.5	4.4%	56.1%	37.4	37.4	22.0	92.5	4.0
4.0	4.7%	60.7%	42.8	42.8	25.2	91.6	4.3
4.5	3.3%	64.0%	48.1	48.1	28.3	90.7	3.0
5.0	3.0%	67.1%	53.5	53.5	31.5	89.8	2.7
6.0	5.4%	72.4%	64.2	64.2	37.8	88.0	4.7
7.0	4.4%	76.8%	74.9	74.9	44.1	86.2	3.8
8.0	3.5%	80.3%	85.6	85.6	50.4	84.4	3.0
9.0	2.8%	83.2%	96.3	96.3	56.7	82.6	2.3
10.0	2.2%	85.3%	107.0	107.0	63.0	80.8	1.8
15.0	7.0%	92.3%	160.5	160.5	94.4	71.8	5.0
20.0	4.5%	96.9%	213.9	169.9	100.0	55.7	2.5
25.0	1.4%	98.3%	267.4	169.9	100.0	44.6	0.6
30.0	0.7%	99.0%	320.9	169.9	100.0	37.2	0.2
35.0	0.5%	99.5%	374.4	169.9	100.0	31.9	0.2
40.0	0.5%	100.0%	427.9	169.9	100.0	27.9	0.2
45.0	0.0%	100.0%	481.4	169.9	100.0	24.8	0.0
50.0	0.0%	100.0%	534.9	169.9	100.0	22.3	0.0
							87.9

Removal Efficiency Adjustment[2] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**81.4%**
Predicted % Annual Rainfall Treated =	**97.6%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name: 891 Caivan　　**Engineer:** DSEL
Location: Ottawa, ON　　**Contact:** A. Fobert, P.Eng.
OGS #: 7　　**Report Date:** 22-May-20

Area 9.30 ha　　**Rainfall Station #** 215
Weighted C 0.73　　**Particle Size Distribution** FINE
CDS Model 5653　　**CDS Treatment Capacity** 396 l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	9.4	9.4	2.4	98.2	9.0
1.0	10.6%	19.8%	18.9	18.9	4.8	97.5	10.4
1.5	9.9%	29.7%	28.3	28.3	7.1	96.8	9.6
2.0	8.4%	38.1%	37.7	37.7	9.5	96.1	8.1
2.5	7.7%	45.8%	47.2	47.2	11.9	95.4	7.3
3.0	5.9%	51.7%	56.6	56.6	14.3	94.8	5.6
3.5	4.4%	56.1%	66.1	66.1	16.7	94.1	4.1
4.0	4.7%	60.7%	75.5	75.5	19.0	93.4	4.4
4.5	3.3%	64.0%	84.9	84.9	21.4	92.7	3.1
5.0	3.0%	67.1%	94.4	94.4	23.8	92.0	2.8
6.0	5.4%	72.4%	113.2	113.2	28.6	90.7	4.9
7.0	4.4%	76.8%	132.1	132.1	33.3	89.3	3.9
8.0	3.5%	80.3%	151.0	151.0	38.1	87.9	3.1
9.0	2.8%	83.2%	169.9	169.9	42.8	86.6	2.4
10.0	2.2%	85.3%	188.7	188.7	47.6	85.2	1.9
15.0	7.0%	92.3%	283.1	283.1	71.4	78.4	5.5
20.0	4.5%	96.9%	377.5	377.5	95.2	71.6	3.3
25.0	1.4%	98.3%	471.8	396.5	100.0	59.0	0.9
30.0	0.7%	99.0%	566.2	396.5	100.0	49.2	0.3
35.0	0.5%	99.5%	660.6	396.5	100.0	42.1	0.2
40.0	0.5%	100.0%	754.9	396.5	100.0	36.9	0.2
45.0	0.0%	100.0%	849.3	396.5	100.0	32.8	0.0
50.0	0.0%	100.0%	943.7	396.5	100.0	29.5	0.0
							90.8

Removal Efficiency Adjustment[2] = 6.5%
Predicted Net Annual Load Removal Efficiency = 84.3%
Predicted % Annual Rainfall Treated = 99.1%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CONTECH ENGINEERED SOLUTIONS

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

CDS TECHNOLOGIES

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	8	**Report Date:**	22-May-20

Area	5.42	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4040		**CDS Treatment Capacity**	170	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	4.9	4.9	2.9	98.0	9.0
1.0	10.6%	19.8%	9.8	9.8	5.8	97.2	10.3
1.5	9.9%	29.7%	14.7	14.7	8.6	96.4	9.5
2.0	8.4%	38.1%	19.6	19.6	11.5	95.6	8.0
2.5	7.7%	45.8%	24.5	24.5	14.4	94.7	7.3
3.0	5.9%	51.7%	29.4	29.4	17.3	93.9	5.6
3.5	4.4%	56.1%	34.3	34.3	20.2	93.1	4.1
4.0	4.7%	60.7%	39.2	39.2	23.1	92.2	4.3
4.5	3.3%	64.0%	44.1	44.1	25.9	91.4	3.0
5.0	3.0%	67.1%	49.0	49.0	28.8	90.6	2.7
6.0	5.4%	72.4%	58.8	58.8	34.6	88.9	4.8
7.0	4.4%	76.8%	68.6	68.6	40.3	87.3	3.8
8.0	3.5%	80.3%	78.4	78.4	46.1	85.6	3.0
9.0	2.8%	83.2%	88.1	88.1	51.9	84.0	2.4
10.0	2.2%	85.3%	97.9	97.9	57.6	82.3	1.8
15.0	7.0%	92.3%	146.9	146.9	86.5	74.1	5.2
20.0	4.5%	96.9%	195.9	169.9	100.0	60.9	2.8
25.0	1.4%	98.3%	244.8	169.9	100.0	48.7	0.7
30.0	0.7%	99.0%	293.8	169.9	100.0	40.6	0.3
35.0	0.5%	99.5%	342.8	169.9	100.0	34.8	0.2
40.0	0.5%	100.0%	391.8	169.9	100.0	30.4	0.2
45.0	0.0%	100.0%	440.7	169.9	100.0	27.1	0.0
50.0	0.0%	100.0%	489.7	169.9	100.0	24.4	0.0
							88.9

Removal Efficiency Adjustment[2] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**82.4%**
Predicted % Annual Rainfall Treated =	**98.1%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	9	**Report Date:**	22-May-20

Area	4.18	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	3035		**CDS Treatment Capacity**	108	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	3.8	3.8	3.5	97.9	9.0
1.0	10.6%	19.8%	7.6	7.6	7.0	96.8	10.3
1.5	9.9%	29.7%	11.3	11.3	10.5	95.8	9.5
2.0	8.4%	38.1%	15.1	15.1	14.0	94.8	7.9
2.5	7.7%	45.8%	18.9	18.9	17.5	93.8	7.2
3.0	5.9%	51.7%	22.7	22.7	21.1	92.8	5.5
3.5	4.4%	56.1%	26.4	26.4	24.6	91.8	4.0
4.0	4.7%	60.7%	30.2	30.2	28.1	90.8	4.2
4.5	3.3%	64.0%	34.0	34.0	31.6	89.8	3.0
5.0	3.0%	67.1%	37.8	37.8	35.1	88.8	2.7
6.0	5.4%	72.4%	45.3	45.3	42.1	86.8	4.7
7.0	4.4%	76.8%	52.9	52.9	49.1	84.8	3.7
8.0	3.5%	80.3%	60.4	60.4	56.1	82.8	2.9
9.0	2.8%	83.2%	68.0	68.0	63.2	80.8	2.3
10.0	2.2%	85.3%	75.5	75.5	70.2	78.7	1.7
15.0	7.0%	92.3%	113.3	107.6	100.0	66.7	4.7
20.0	4.5%	96.9%	151.1	107.6	100.0	50.0	2.3
25.0	1.4%	98.3%	188.8	107.6	100.0	40.0	0.6
30.0	0.7%	99.0%	226.6	107.6	100.0	33.3	0.2
35.0	0.5%	99.5%	264.4	107.6	100.0	28.6	0.1
40.0	0.5%	100.0%	302.1	107.6	100.0	25.0	0.1
45.0	0.0%	100.0%	339.9	107.6	100.0	22.2	0.0
50.0	0.0%	100.0%	377.7	107.6	100.0	20.0	0.0
							86.6

Removal Efficiency Adjustment[2] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**80.1%**
Predicted % Annual Rainfall Treated =	**96.7%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name: 891 Caivan   **Engineer:** DSEL
Location: Ottawa, ON   **Contact:** A. Fobert, P.Eng.
OGS #: 10   **Report Date:** 22-May-20

Area 3.91 ha   **Rainfall Station #** 215
Weighted C 0.65   **Particle Size Distribution** FINE
CDS Model 3035   **CDS Treatment Capacity** 108 l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	3.5	3.5	3.3	97.9	9.0
1.0	10.6%	19.8%	7.1	7.1	6.6	97.0	10.3
1.5	9.9%	29.7%	10.6	10.6	9.8	96.0	9.5
2.0	8.4%	38.1%	14.1	14.1	13.1	95.1	8.0
2.5	7.7%	45.8%	17.7	17.7	16.4	94.2	7.2
3.0	5.9%	51.7%	21.2	21.2	19.7	93.2	5.5
3.5	4.4%	56.1%	24.7	24.7	23.0	92.3	4.0
4.0	4.7%	60.7%	28.3	28.3	26.3	91.3	4.3
4.5	3.3%	64.0%	31.8	31.8	29.5	90.4	3.0
5.0	3.0%	67.1%	35.3	35.3	32.8	89.4	2.7
6.0	5.4%	72.4%	42.4	42.4	39.4	87.6	4.7
7.0	4.4%	76.8%	49.5	49.5	46.0	85.7	3.7
8.0	3.5%	80.3%	56.5	56.5	52.5	83.8	3.0
9.0	2.8%	83.2%	63.6	63.6	59.1	81.9	2.3
10.0	2.2%	85.3%	70.7	70.7	65.7	80.0	1.7
15.0	7.0%	92.3%	106.0	106.0	98.5	70.6	4.9
20.0	4.5%	96.9%	141.3	107.6	100.0	53.5	2.4
25.0	1.4%	98.3%	176.6	107.6	100.0	42.8	0.6
30.0	0.7%	99.0%	212.0	107.6	100.0	35.6	0.2
35.0	0.5%	99.5%	247.3	107.6	100.0	30.5	0.1
40.0	0.5%	100.0%	282.6	107.6	100.0	26.7	0.1
45.0	0.0%	100.0%	317.9	107.6	100.0	23.8	0.0
50.0	0.0%	100.0%	353.3	107.6	100.0	21.4	0.0
							87.5

Removal Efficiency Adjustment[2] = 6.5%
Predicted Net Annual Load Removal Efficiency = 81.0%
Predicted % Annual Rainfall Treated = 97.4%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	11	**Report Date:**	22-May-20

Area	4.50	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4030		**CDS Treatment Capacity**	127	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	4.1	4.1	3.2	97.9	9.0
1.0	10.6%	19.8%	8.1	8.1	6.4	97.0	10.3
1.5	9.9%	29.7%	12.2	12.2	9.6	96.1	9.5
2.0	8.4%	38.1%	16.3	16.3	12.8	95.2	8.0
2.5	7.7%	45.8%	20.3	20.3	16.0	94.3	7.2
3.0	5.9%	51.7%	24.4	24.4	19.1	93.4	5.5
3.5	4.4%	56.1%	28.5	28.5	22.3	92.5	4.0
4.0	4.7%	60.7%	32.5	32.5	25.5	91.5	4.3
4.5	3.3%	64.0%	36.6	36.6	28.7	90.6	3.0
5.0	3.0%	67.1%	40.7	40.7	31.9	89.7	2.7
6.0	5.4%	72.4%	48.8	48.8	38.3	87.9	4.7
7.0	4.4%	76.8%	56.9	56.9	44.7	86.1	3.7
8.0	3.5%	80.3%	65.1	65.1	51.0	84.2	3.0
9.0	2.8%	83.2%	73.2	73.2	57.4	82.4	2.3
10.0	2.2%	85.3%	81.3	81.3	63.8	80.6	1.8
15.0	7.0%	92.3%	122.0	122.0	95.7	71.4	5.0
20.0	4.5%	96.9%	162.6	127.4	100.0	55.0	2.5
25.0	1.4%	98.3%	203.3	127.4	100.0	44.0	0.6
30.0	0.7%	99.0%	243.9	127.4	100.0	36.7	0.2
35.0	0.5%	99.5%	284.6	127.4	100.0	31.4	0.1
40.0	0.5%	100.0%	325.3	127.4	100.0	27.5	0.2
45.0	0.0%	100.0%	365.9	127.4	100.0	24.4	0.0
50.0	0.0%	100.0%	406.6	127.4	100.0	22.0	0.0
							87.8

Removal Efficiency Adjustment[2] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**81.3%**
Predicted % Annual Rainfall Treated =	**97.6%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	12	**Report Date:**	25-May-20

Area	11.11	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	5653		**CDS Treatment Capacity**	396	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	10.0	10.0	2.5	98.1	9.0
1.0	10.6%	19.8%	20.1	20.1	5.1	97.4	10.3
1.5	9.9%	29.7%	30.1	30.1	7.6	96.7	9.6
2.0	8.4%	38.1%	40.2	40.2	10.1	96.0	8.0
2.5	7.7%	45.8%	50.2	50.2	12.7	95.2	7.3
3.0	5.9%	51.7%	60.2	60.2	15.2	94.5	5.6
3.5	4.4%	56.1%	70.3	70.3	17.7	93.8	4.1
4.0	4.7%	60.7%	80.3	80.3	20.3	93.1	4.3
4.5	3.3%	64.0%	90.3	90.3	22.8	92.3	3.1
5.0	3.0%	67.1%	100.4	100.4	25.3	91.6	2.8
6.0	5.4%	72.4%	120.5	120.5	30.4	90.1	4.9
7.0	4.4%	76.8%	140.5	140.5	35.4	88.7	3.9
8.0	3.5%	80.3%	160.6	160.6	40.5	87.2	3.1
9.0	2.8%	83.2%	180.7	180.7	45.6	85.8	2.4
10.0	2.2%	85.3%	200.8	200.8	50.6	84.3	1.8
15.0	7.0%	92.3%	301.1	301.1	76.0	77.1	5.4
20.0	4.5%	96.9%	401.5	396.5	100.0	69.3	3.2
25.0	1.4%	98.3%	501.9	396.5	100.0	55.5	0.8
30.0	0.7%	99.0%	602.3	396.5	100.0	46.2	0.3
35.0	0.5%	99.5%	702.7	396.5	100.0	39.6	0.2
40.0	0.5%	100.0%	803.0	396.5	100.0	34.7	0.2
45.0	0.0%	100.0%	903.4	396.5	100.0	30.8	0.0
50.0	0.0%	100.0%	1003.8	396.5	100.0	27.7	0.0
							90.2

Removal Efficiency Adjustment[2] = 6.5%

Predicted Net Annual Load Removal Efficiency = 83.7%

Predicted % Annual Rainfall Treated = 98.9%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

3 - CDS Efficiency based on testing conducted at the University of Central Florida

4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	13	**Report Date:**	22-May-20

Area	8.22	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4045		**CDS Treatment Capacity**	212	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	7.4	7.4	3.5	97.9	9.0
1.0	10.6%	19.8%	14.9	14.9	7.0	96.9	10.3
1.5	9.9%	29.7%	22.3	22.3	10.5	95.9	9.5
2.0	8.4%	38.1%	29.7	29.7	14.0	94.8	7.9
2.5	7.7%	45.8%	37.1	37.1	17.5	93.8	7.2
3.0	5.9%	51.7%	44.6	44.6	21.0	92.8	5.5
3.5	4.4%	56.1%	52.0	52.0	24.5	91.8	4.0
4.0	4.7%	60.7%	59.4	59.4	28.0	90.8	4.2
4.5	3.3%	64.0%	66.8	66.8	31.5	89.8	3.0
5.0	3.0%	67.1%	74.3	74.3	35.0	88.8	2.7
6.0	5.4%	72.4%	89.1	89.1	42.0	86.8	4.7
7.0	4.4%	76.8%	104.0	104.0	49.0	84.8	3.7
8.0	3.5%	80.3%	118.8	118.8	55.9	82.8	2.9
9.0	2.8%	83.2%	133.7	133.7	62.9	80.8	2.3
10.0	2.2%	85.3%	148.5	148.5	69.9	78.8	1.7
15.0	7.0%	92.3%	222.8	212.4	100.0	66.9	4.7
20.0	4.5%	96.9%	297.1	212.4	100.0	50.2	2.3
25.0	1.4%	98.3%	371.3	212.4	100.0	40.1	0.6
30.0	0.7%	99.0%	445.6	212.4	100.0	33.5	0.2
35.0	0.5%	99.5%	519.9	212.4	100.0	28.7	0.1
40.0	0.5%	100.0%	594.1	212.4	100.0	25.1	0.1
45.0	0.0%	100.0%	668.4	212.4	100.0	22.3	0.0
50.0	0.0%	100.0%	742.7	212.4	100.0	20.1	0.0
							86.7

Removal Efficiency Adjustment[2] = 6.5%

Predicted Net Annual Load Removal Efficiency = 80.2%

Predicted % Annual Rainfall Treated = 96.8%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
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CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name: 891 Caivan | **Engineer:** DSEL
Location: Ottawa, ON | **Contact:** A. Fobert, P.Eng.
OGS #: 14 | **Report Date:** 22-May-20

Area	6.91	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4045		**CDS Treatment Capacity**	212	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	6.2	6.2	2.9	98.0	9.0
1.0	10.6%	19.8%	12.5	12.5	5.9	97.2	10.3
1.5	9.9%	29.7%	18.7	18.7	8.8	96.3	9.5
2.0	8.4%	38.1%	25.0	25.0	11.8	95.5	8.0
2.5	7.7%	45.8%	31.2	31.2	14.7	94.6	7.3
3.0	5.9%	51.7%	37.5	37.5	17.6	93.8	5.6
3.5	4.4%	56.1%	43.7	43.7	20.6	93.0	4.0
4.0	4.7%	60.7%	49.9	49.9	23.5	92.1	4.3
4.5	3.3%	64.0%	56.2	56.2	26.5	91.3	3.0
5.0	3.0%	67.1%	62.4	62.4	29.4	90.4	2.7
6.0	5.4%	72.4%	74.9	74.9	35.3	88.7	4.8
7.0	4.4%	76.8%	87.4	87.4	41.2	87.1	3.8
8.0	3.5%	80.3%	99.9	99.9	47.0	85.4	3.0
9.0	2.8%	83.2%	112.4	112.4	52.9	83.7	2.4
10.0	2.2%	85.3%	124.9	124.9	58.8	82.0	1.8
15.0	7.0%	92.3%	187.3	187.3	88.2	73.6	5.1
20.0	4.5%	96.9%	249.7	212.4	100.0	59.7	2.7
25.0	1.4%	98.3%	312.2	212.4	100.0	47.8	0.7
30.0	0.7%	99.0%	374.6	212.4	100.0	39.8	0.3
35.0	0.5%	99.5%	437.0	212.4	100.0	34.1	0.2
40.0	0.5%	100.0%	499.5	212.4	100.0	29.9	0.2
45.0	0.0%	100.0%	561.9	212.4	100.0	26.5	0.0
50.0	0.0%	100.0%	624.3	212.4	100.0	23.9	0.0
							88.7

Removal Efficiency Adjustment[2] = 6.5%
Predicted Net Annual Load Removal Efficiency = 82.2%
Predicted % Annual Rainfall Treated = 98.0%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	15	**Report Date:**	22-May-20

Area	6.39	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4040		**CDS Treatment Capacity**	170	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	5.8	5.8	3.4	97.9	9.0
1.0	10.6%	19.8%	11.5	11.5	6.8	96.9	10.3
1.5	9.9%	29.7%	17.3	17.3	10.2	95.9	9.5
2.0	8.4%	38.1%	23.1	23.1	13.6	95.0	8.0
2.5	7.7%	45.8%	28.9	28.9	17.0	94.0	7.2
3.0	5.9%	51.7%	34.6	34.6	20.4	93.0	5.5
3.5	4.4%	56.1%	40.4	40.4	23.8	92.0	4.0
4.0	4.7%	60.7%	46.2	46.2	27.2	91.1	4.2
4.5	3.3%	64.0%	52.0	52.0	30.6	90.1	3.0
5.0	3.0%	67.1%	57.7	57.7	34.0	89.1	2.7
6.0	5.4%	72.4%	69.3	69.3	40.8	87.2	4.7
7.0	4.4%	76.8%	80.8	80.8	47.6	85.2	3.7
8.0	3.5%	80.3%	92.4	92.4	54.4	83.3	2.9
9.0	2.8%	83.2%	103.9	103.9	61.2	81.3	2.3
10.0	2.2%	85.3%	115.5	115.5	68.0	79.4	1.7
15.0	7.0%	92.3%	173.2	169.9	100.0	68.9	4.8
20.0	4.5%	96.9%	230.9	169.9	100.0	51.6	2.3
25.0	1.4%	98.3%	288.7	169.9	100.0	41.3	0.6
30.0	0.7%	99.0%	346.4	169.9	100.0	34.4	0.2
35.0	0.5%	99.5%	404.1	169.9	100.0	29.5	0.1
40.0	0.5%	100.0%	461.9	169.9	100.0	25.8	0.1
45.0	0.0%	100.0%	519.6	169.9	100.0	23.0	0.0
50.0	0.0%	100.0%	577.3	169.9	100.0	20.7	0.0
							87.1

Removal Efficiency Adjustment[2] = 6.5%

Predicted Net Annual Load Removal Efficiency = 80.6%

Predicted % Annual Rainfall Treated = 97.1%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

3 - CDS Efficiency based on testing conducted at the University of Central Florida

4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

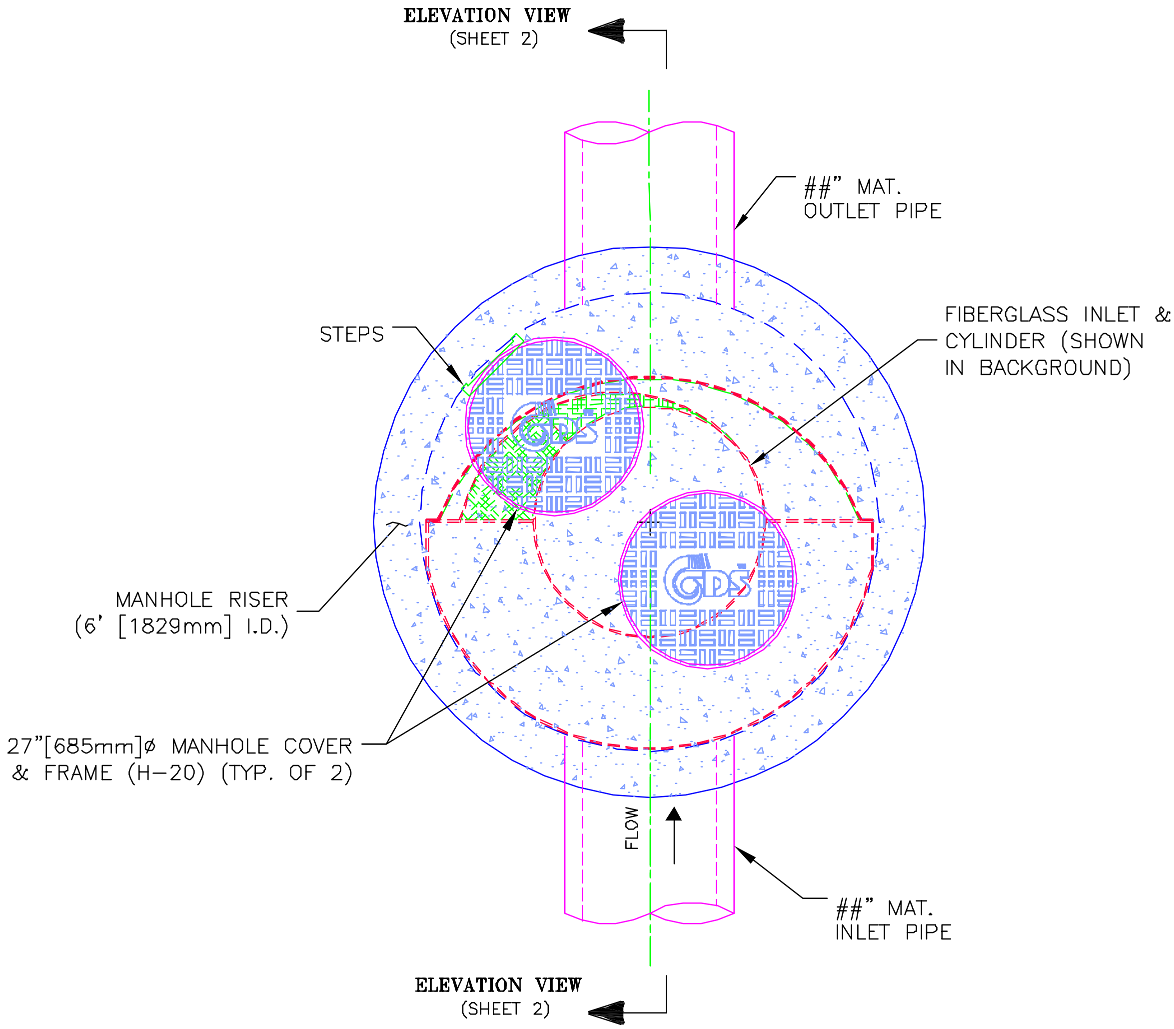
Project Name:	891 Caivan	**Engineer:**	**DSEL**
Location:	Ottawa, ON	**Contact:**	A. Fobert, P.Eng.
OGS #:	16	**Report Date:**	22-May-20

Area	4.72	ha	**Rainfall Station #**	215	
Weighted C	0.65		**Particle Size Distribution**	FINE	
CDS Model	4030		**CDS Treatment Capacity**	127	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	4.3	4.3	3.3	97.9	9.0
1.0	10.6%	19.8%	8.5	8.5	6.7	96.9	10.3
1.5	9.9%	29.7%	12.8	12.8	10.0	96.0	9.5
2.0	8.4%	38.1%	17.1	17.1	13.4	95.0	8.0
2.5	7.7%	45.8%	21.3	21.3	16.7	94.1	7.2
3.0	5.9%	51.7%	25.6	25.6	20.1	93.1	5.5
3.5	4.4%	56.1%	29.9	29.9	23.4	92.1	4.0
4.0	4.7%	60.7%	34.1	34.1	26.8	91.2	4.3
4.5	3.3%	64.0%	38.4	38.4	30.1	90.2	3.0
5.0	3.0%	67.1%	42.6	42.6	33.5	89.3	2.7
6.0	5.4%	72.4%	51.2	51.2	40.2	87.3	4.7
7.0	4.4%	76.8%	59.7	59.7	46.8	85.4	3.7
8.0	3.5%	80.3%	68.2	68.2	53.5	83.5	3.0
9.0	2.8%	83.2%	76.8	76.8	60.2	81.6	2.3
10.0	2.2%	85.3%	85.3	85.3	66.9	79.7	1.7
15.0	7.0%	92.3%	127.9	127.4	100.0	69.9	4.9
20.0	4.5%	96.9%	170.6	127.4	100.0	52.4	2.4
25.0	1.4%	98.3%	213.2	127.4	100.0	42.0	0.6
30.0	0.7%	99.0%	255.9	127.4	100.0	35.0	0.2
35.0	0.5%	99.5%	298.5	127.4	100.0	30.0	0.1
40.0	0.5%	100.0%	341.2	127.4	100.0	26.2	0.1
45.0	0.0%	100.0%	383.8	127.4	100.0	23.3	0.0
50.0	0.0%	100.0%	426.5	127.4	100.0	21.0	0.0
							87.3
						Removal Efficiency Adjustment[2] =	6.5%
						Predicted Net Annual Load Removal Efficiency =	**80.8%**
						Predicted % Annual Rainfall Treated =	**97.3%**

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

PLAN VIEW

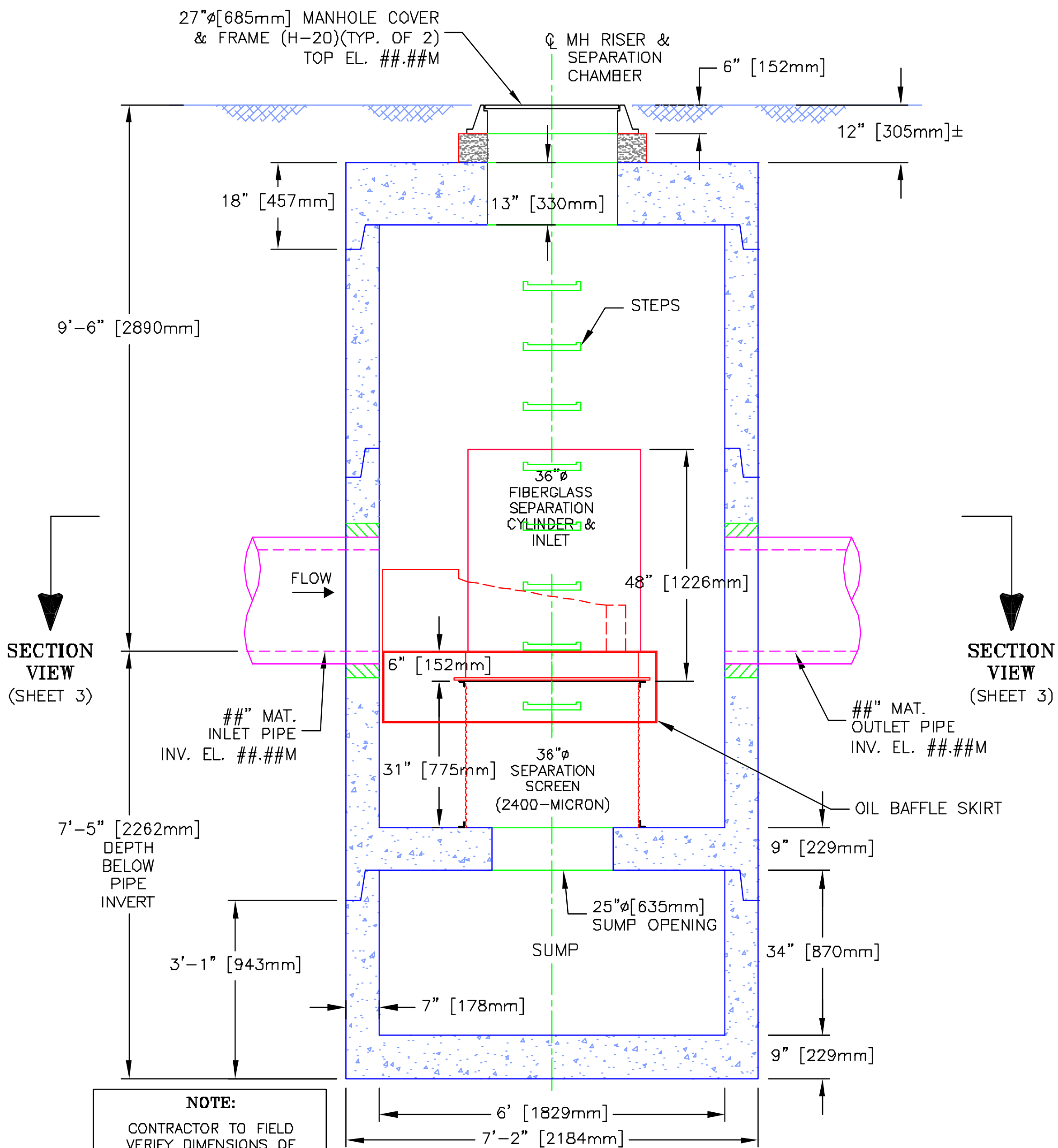


MODEL CDS30_25m, 68 L/S TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB#	CAN-##-###	SCALE 1" = 2.5'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	1
		APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577

ELEVATION VIEW



NOTE:

CONTRACTOR TO FIELD VERIFY DIMENSIONS OF OR CONCRETE SECTIONS

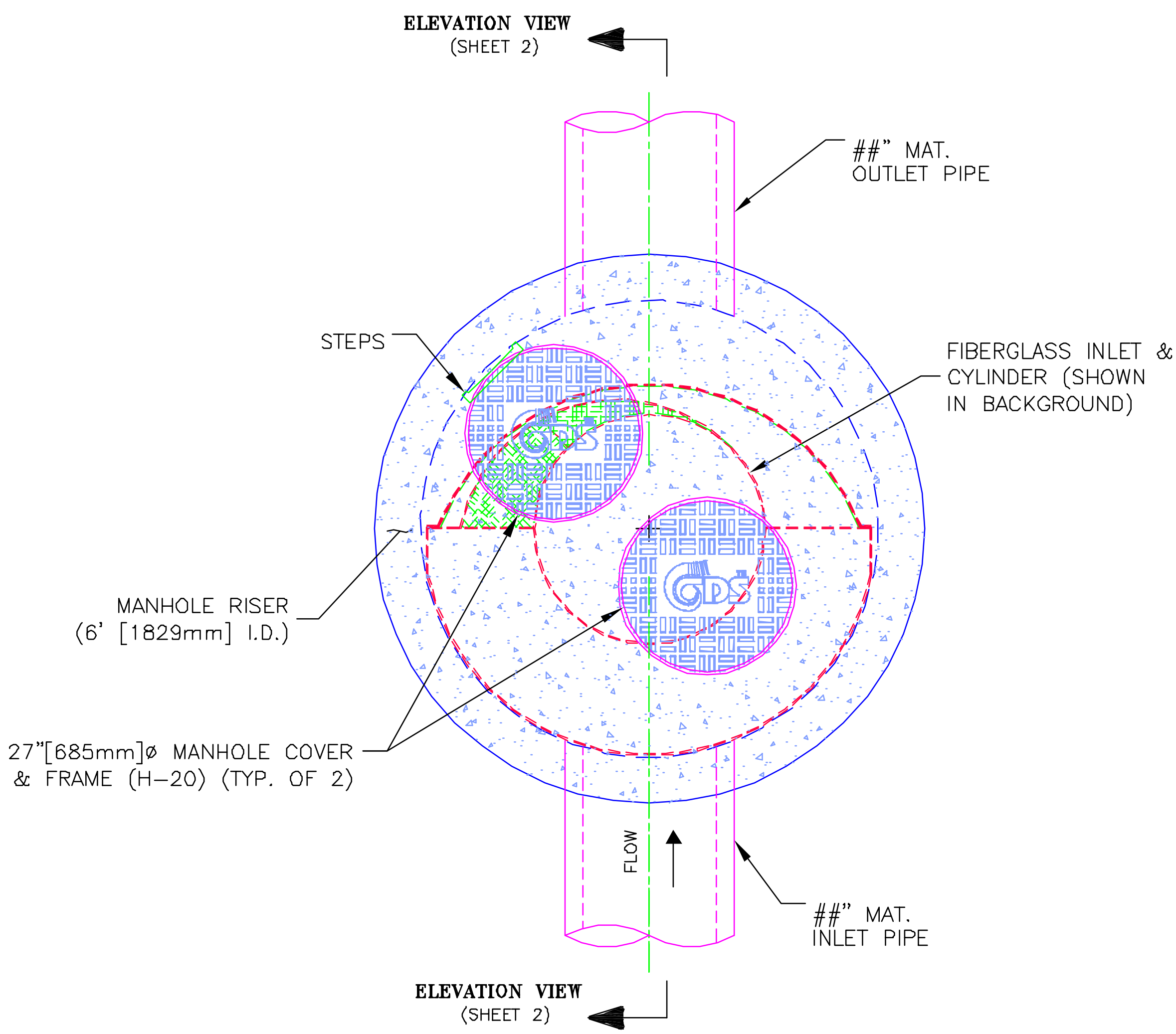
MODEL CDS30_25m, 68 L/S TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS

PROJECT NAME CITY, STATE			
JOB#	CAN-##-###	SCALE 1" = 3'	
DATE	##/##/##	SHEET	
DRAWN	INITIALS	2	
APPROV.			

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577

PLAN VIEW

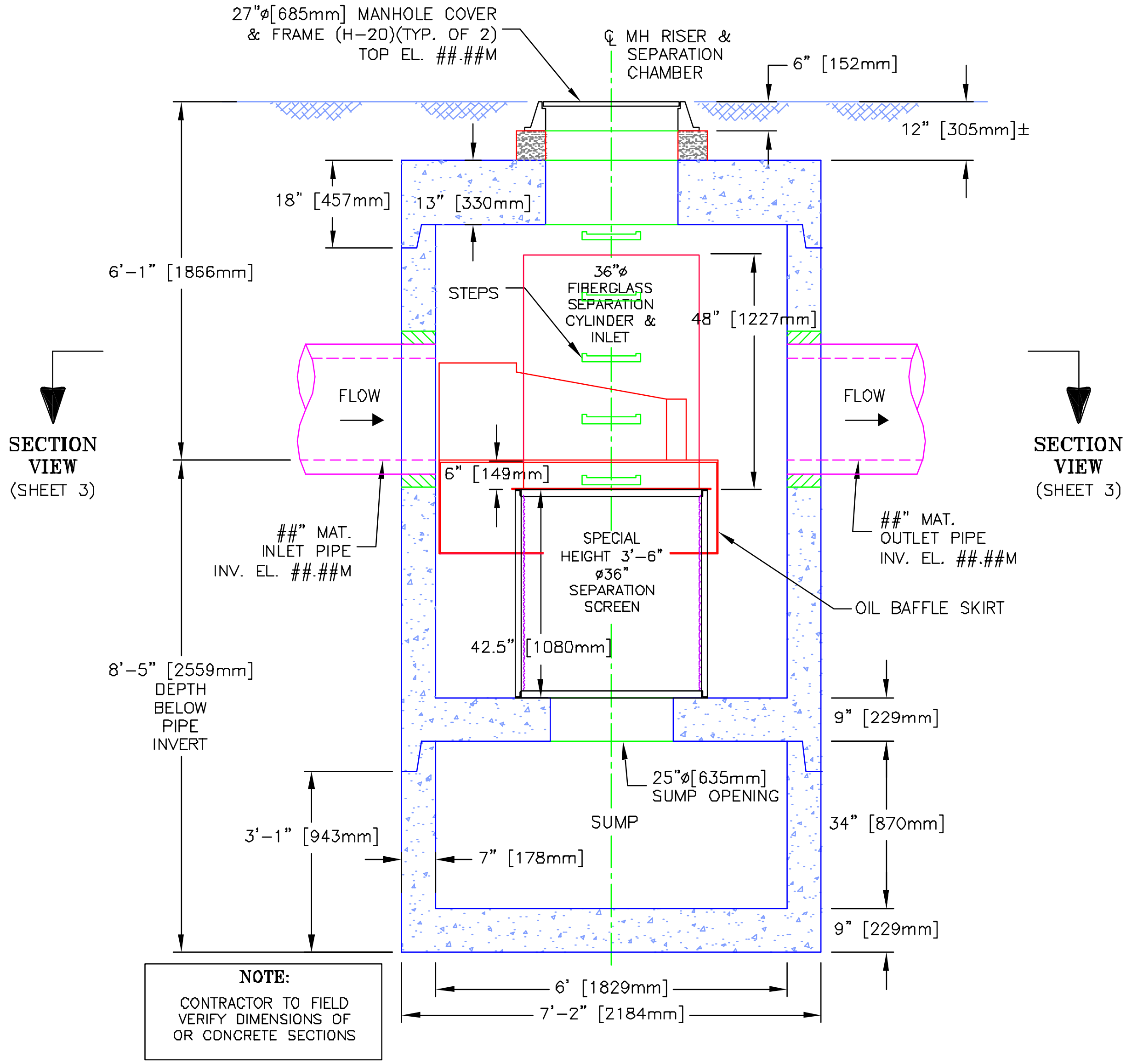


CDS MODEL PMSU30_35m
STORM WATER TREATMENT UNIT
FLOW RATE 106 L/S

CONTECH STORMWATER SOLUTIONS INC.	PROJECT NAME CITY, STATE	JOB#	CAN-##-###	SCALE 1" = 2.5'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	1
		APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577

ELEVATION VIEW

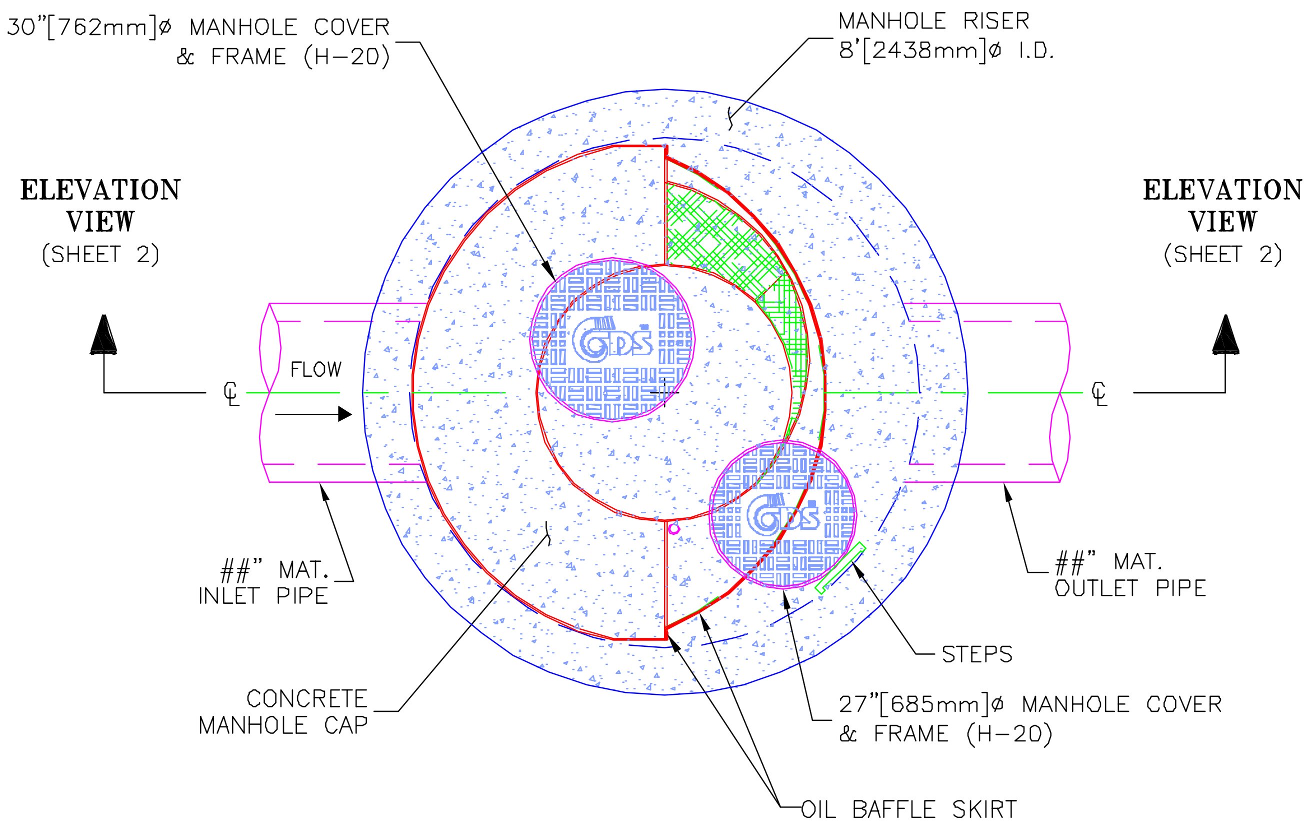


CDS MODEL PMSU30_35m
STORM WATER TREATMENT UNIT
FLOW RATE 106 L/S

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# CAN-##-###	SCALE 1" = 3'
		DATE ##/##/##	SHEET
		DRAWN INITIALS	2
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577

PLAN VIEW

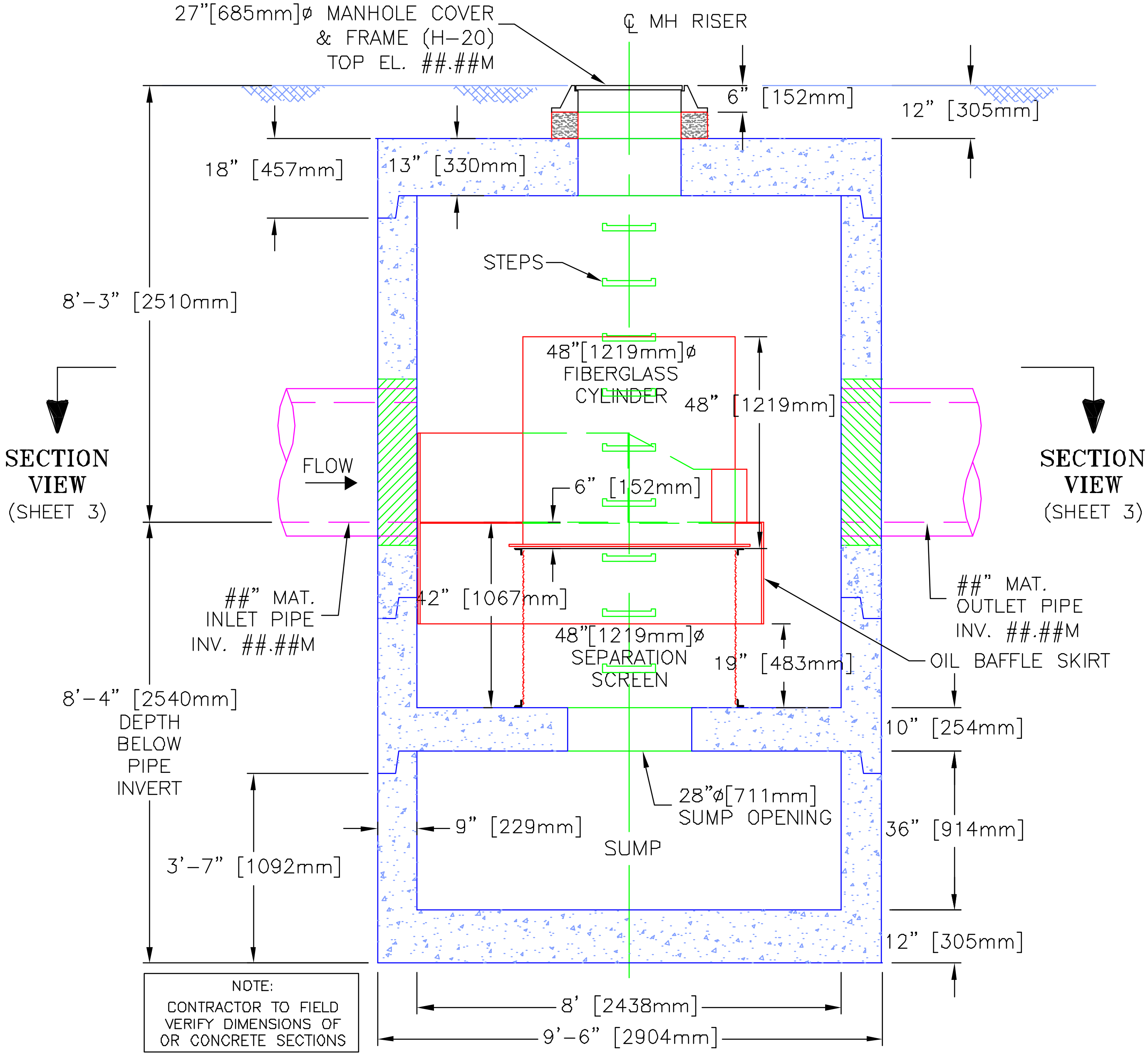


CDS MODEL PMSU40_30m, 4.5 CFS TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB#	XX-##-###	SCALE 1" = 3'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	1
		APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW

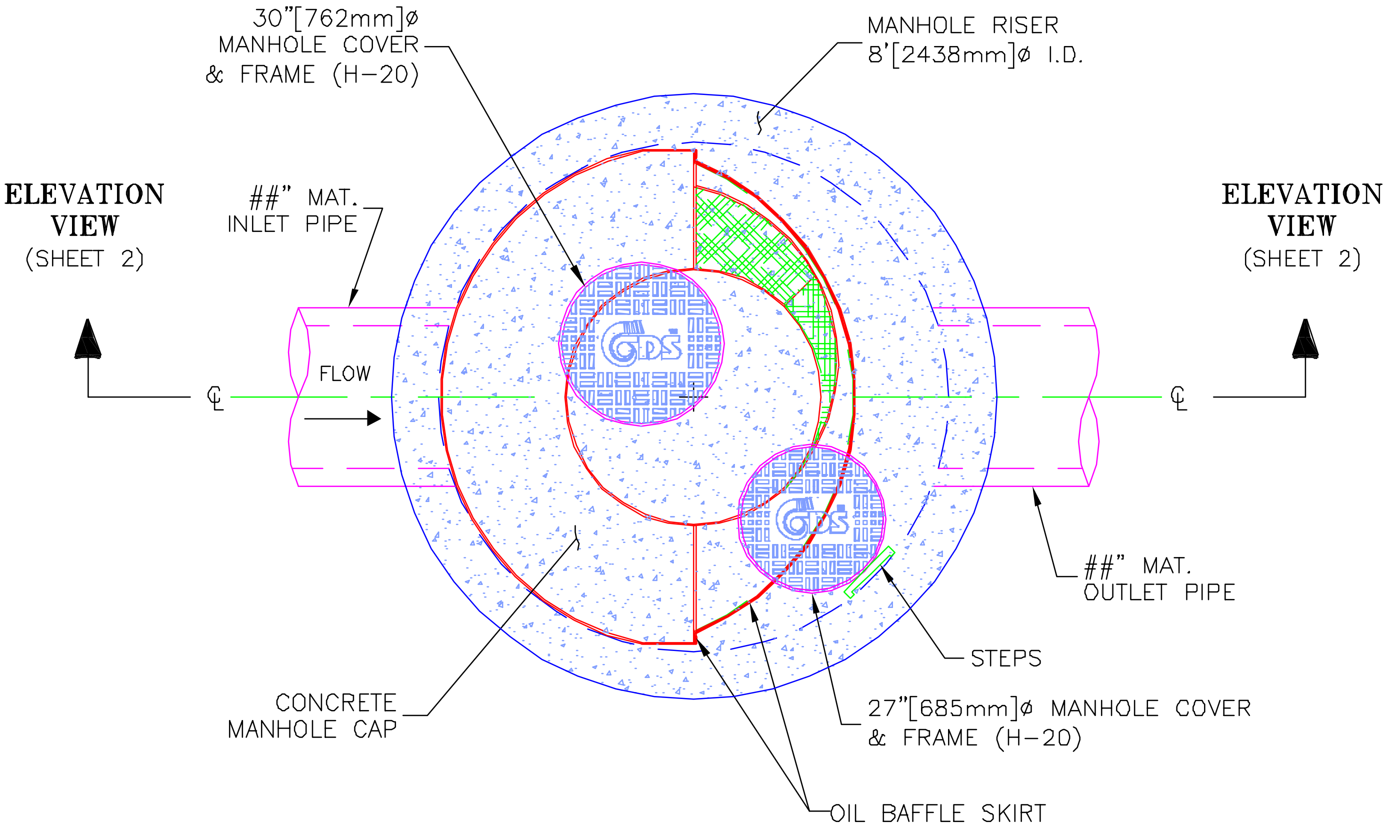


CDS MODEL PMSU40_30m, 4.5 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

PROJECT NAME CITY, STATE	JOB#	XX-##-###	SCALE 1" = 3'
	DATE	##/##/##	SHEET
	DRAWN	INITIALS	2
	APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

PLAN VIEW

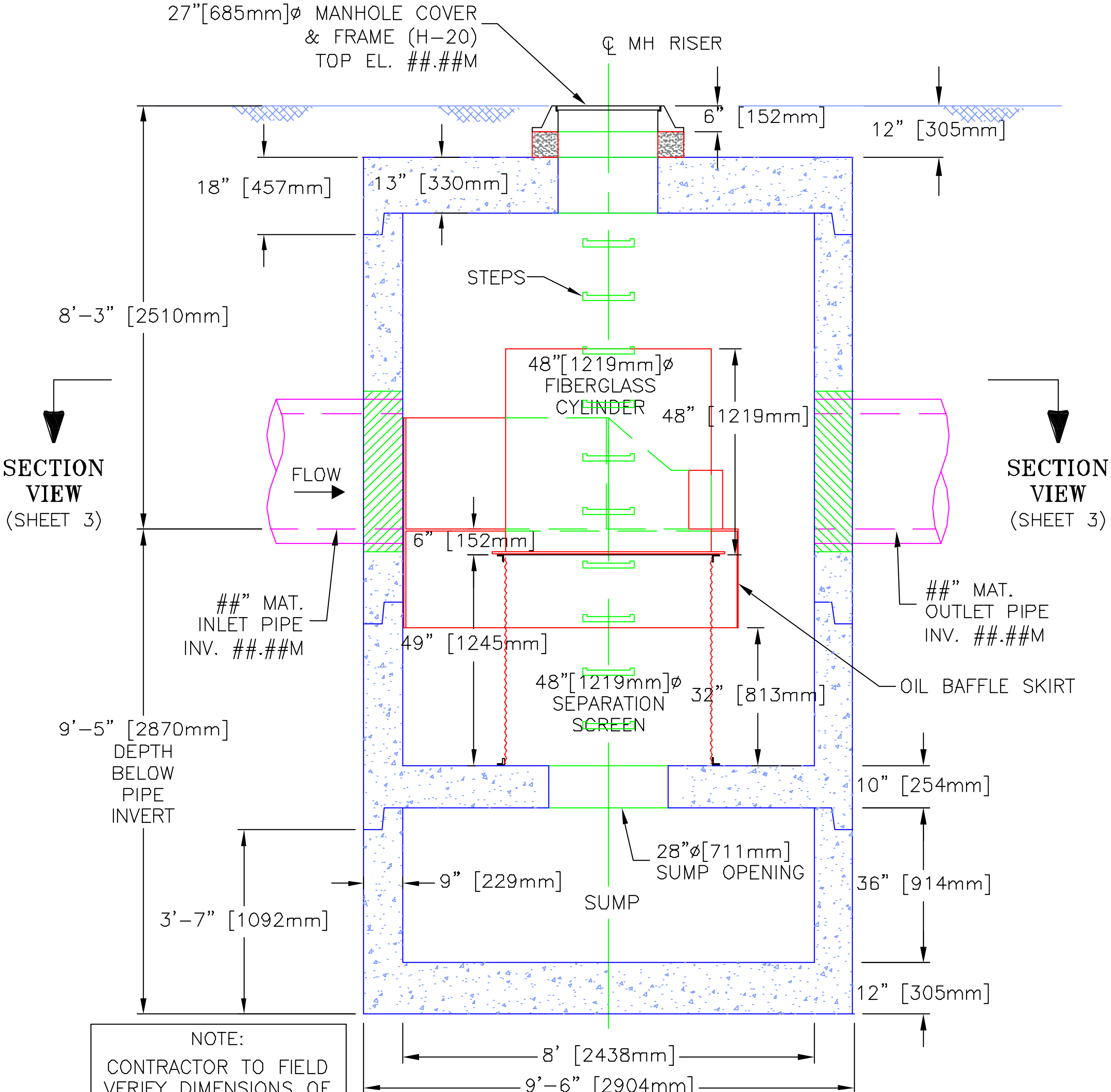


CDS MODEL PMSU40_40m, 6.0 CFS TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB#	XX-##-###	SCALE 1" = 3'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	1
		APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW



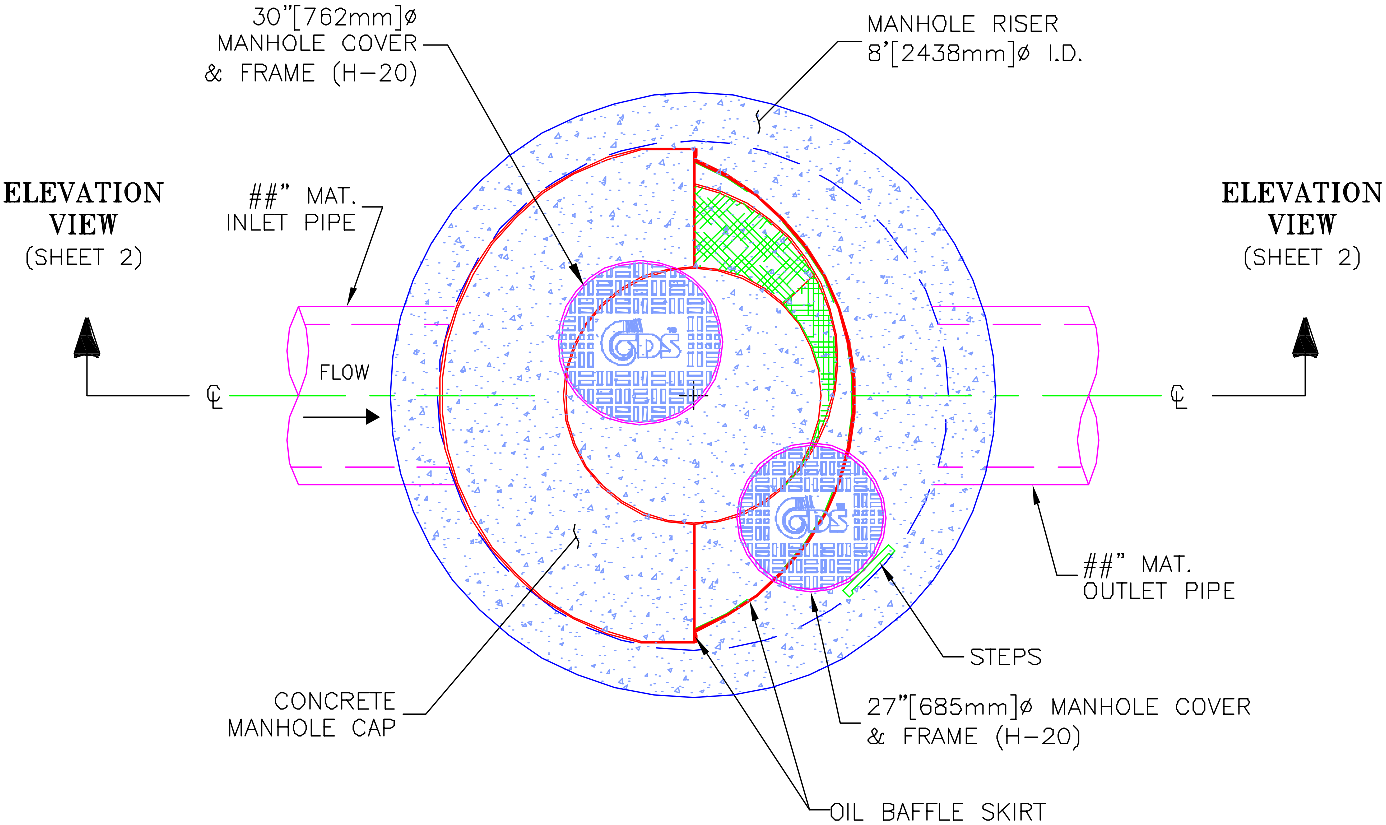
NOTE:
CONTRACTOR TO FIELD
VERIFY DIMENSIONS OF
OR CONCRETE SECTIONS

CDS MODEL PMSU40_40m, 6.0 CFS TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# XX–##–### DATE ##/##/## DRAWN INITIALS APPROV.	SCALE 1" = 3' SHEET 2

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948–0000 Fax: (905) 948–0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848–9955

PLAN VIEW

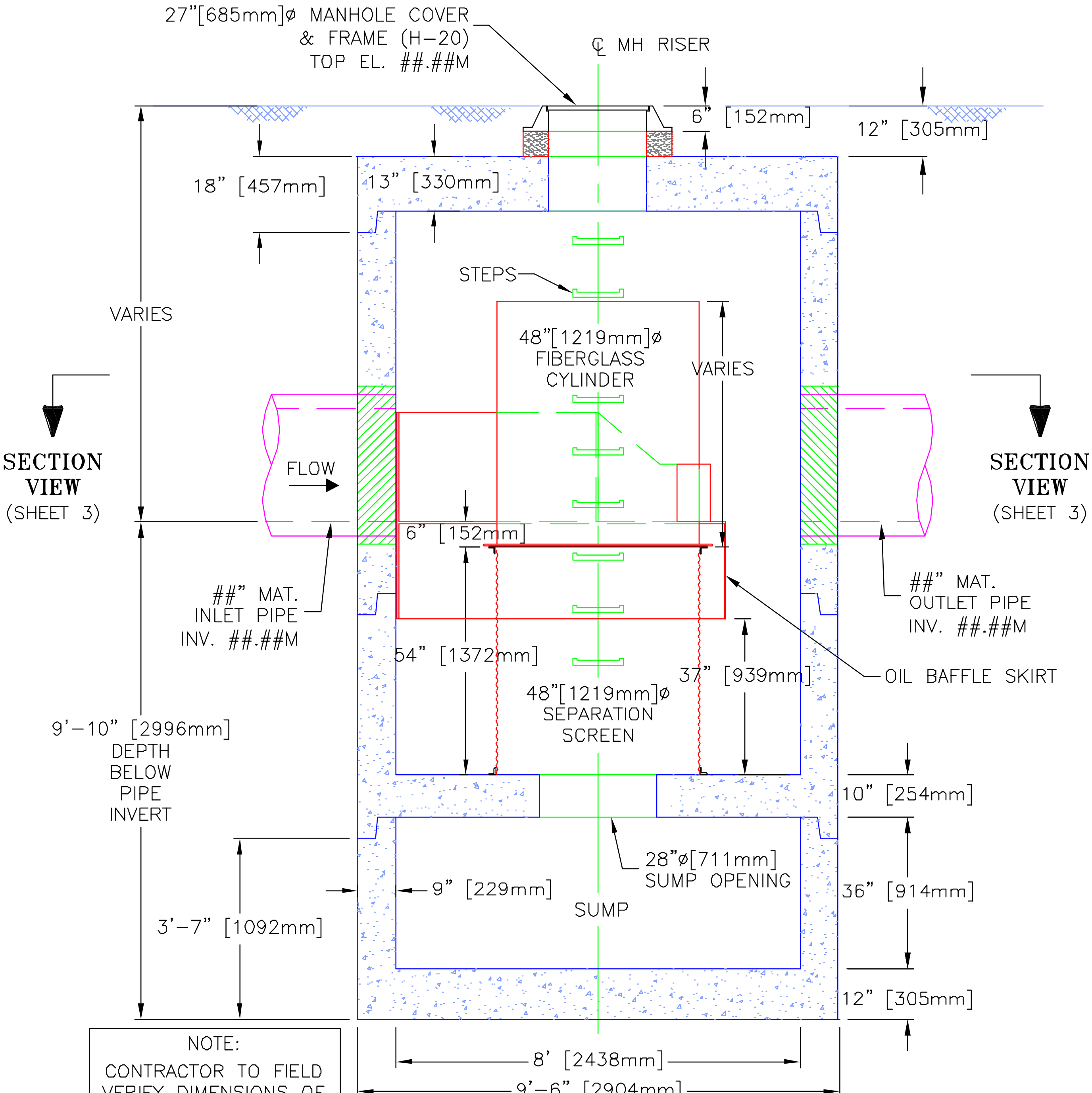


CDS MODEL PMSU40_45m, 7.5 CFS TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# XX-##-###	SCALE 1" = 3'
		DATE ##/##/##	SHEET
		DRAWN INITIALS	1
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577

ELEVATION VIEW



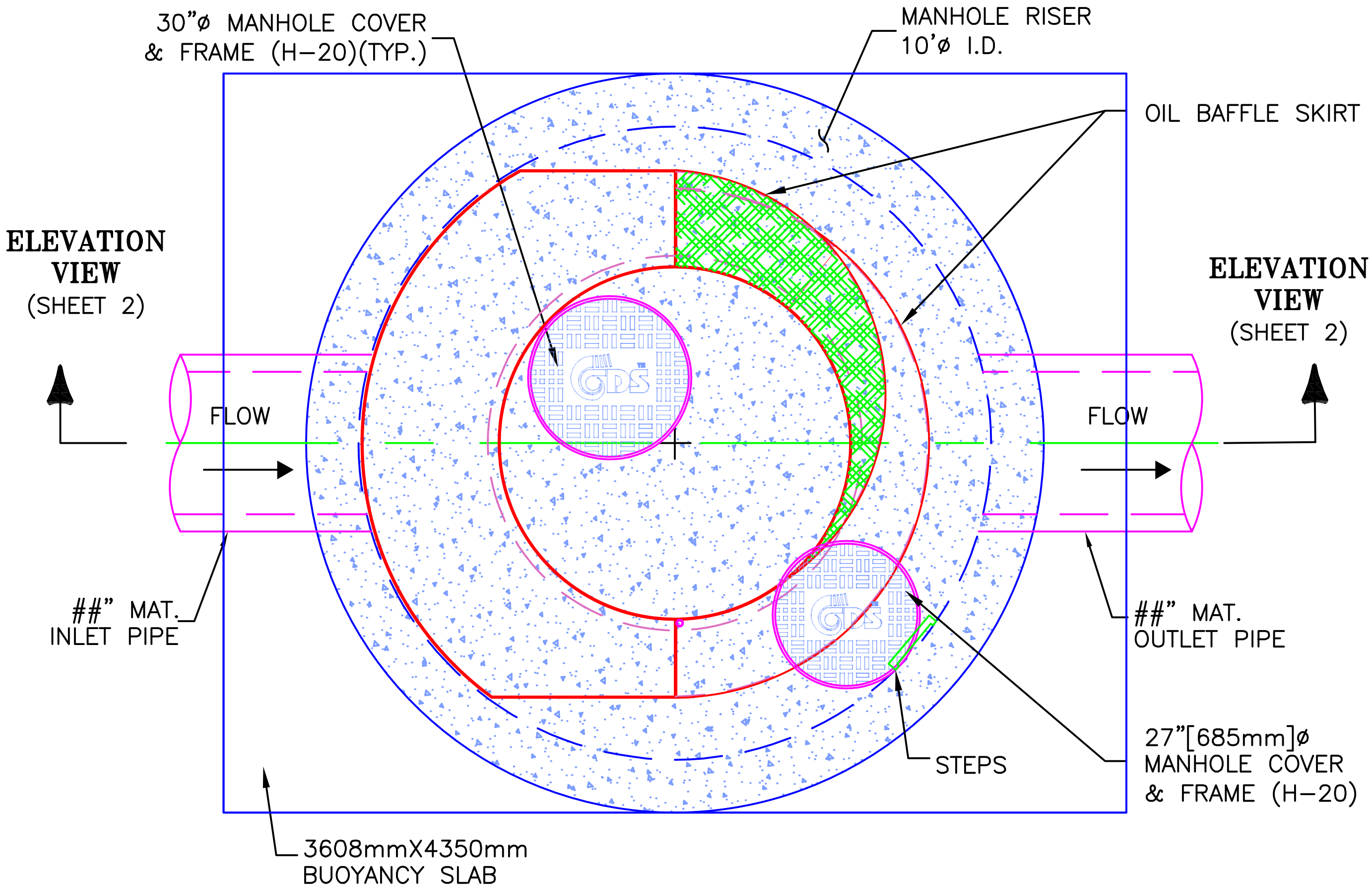
NOTE:
CONTRACTOR TO FIELD
VERIFY DIMENSIONS OF
OR CONCRETE SECTIONS

CDS MODEL PMSU40_45m, 7.5 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB# XX-##-###	SCALE 1" = 3'
		DATE ##/##/##	SHEET
		DRAWN INITIALS	2
		APPROV.	

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577

PLAN VIEW

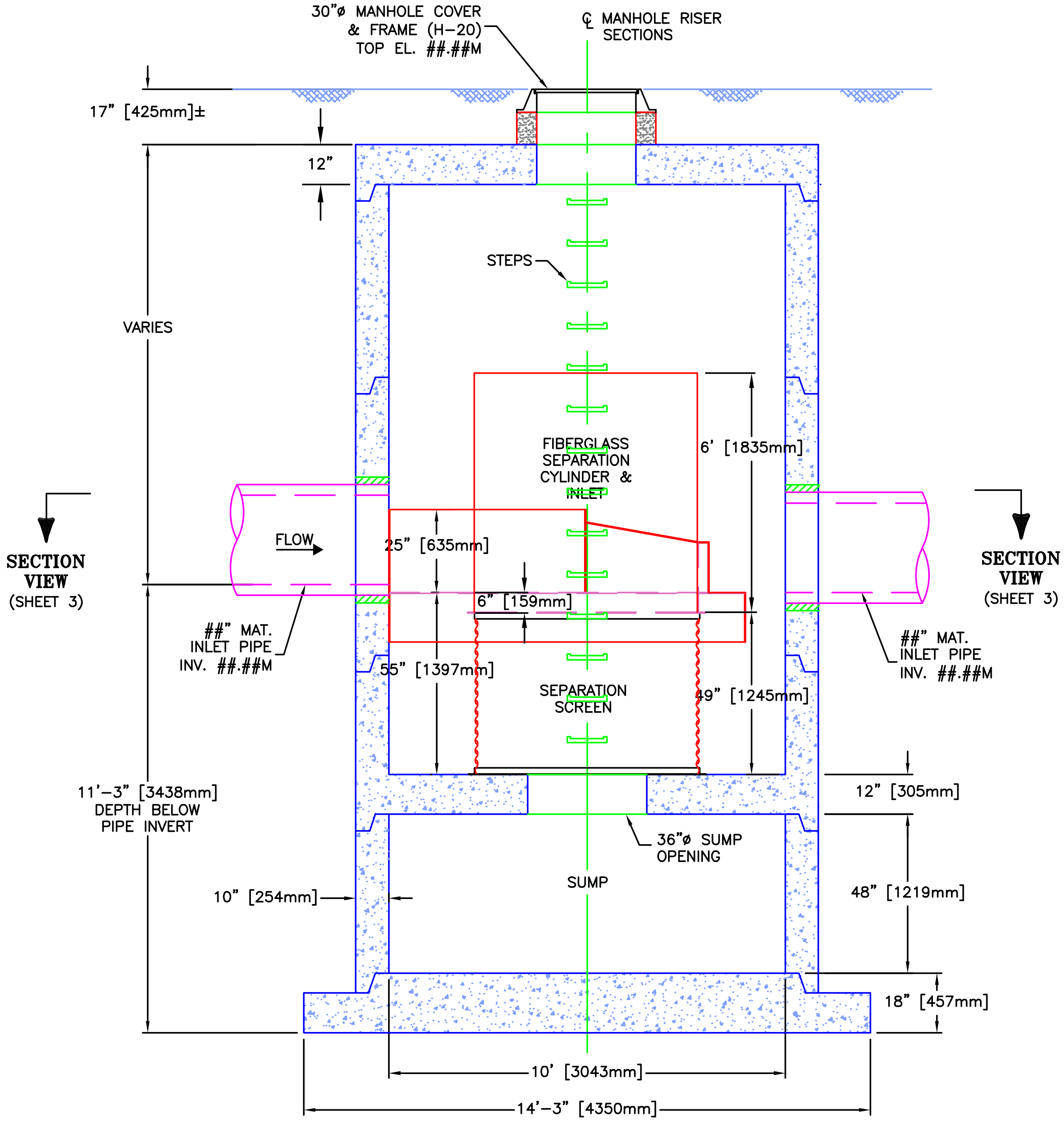


CDS MODEL PMSU56_40m, 9 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB#	XX-##-###	SCALE 1" = 3'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	1
		APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW



CDS MODEL PMSU56_40m, 9 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

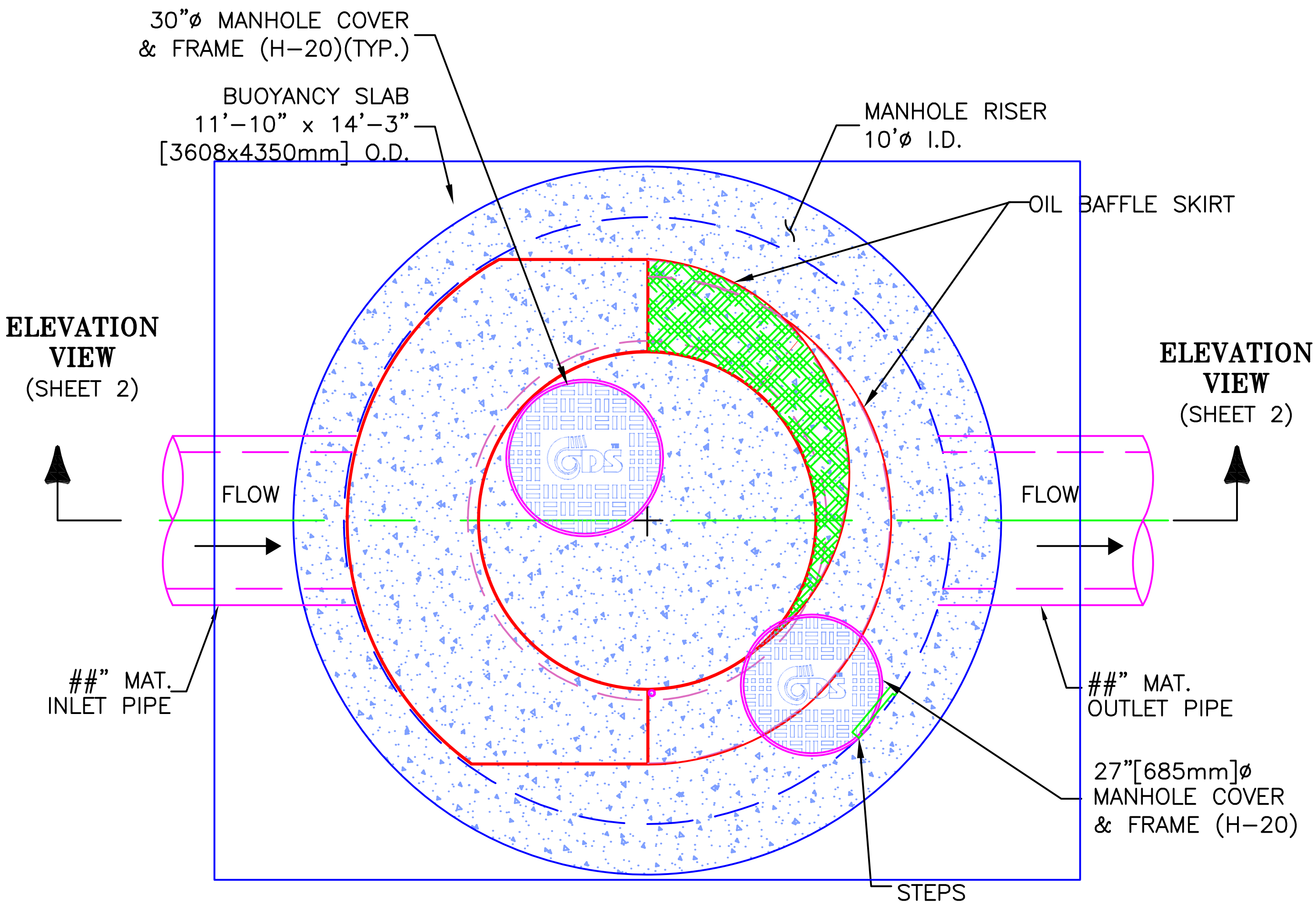
CONTECH® STORMWATER SOLUTIONS

PROJECT NAME
CITY, STATE

JOB#	XX-##-###	SCALE 1" = 4'
DATE	##/##/##	SHEET
DRAWN	INITIALS	2
APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

PLAN VIEW



CDS MODEL PMSU56_53m, 396 L/s TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

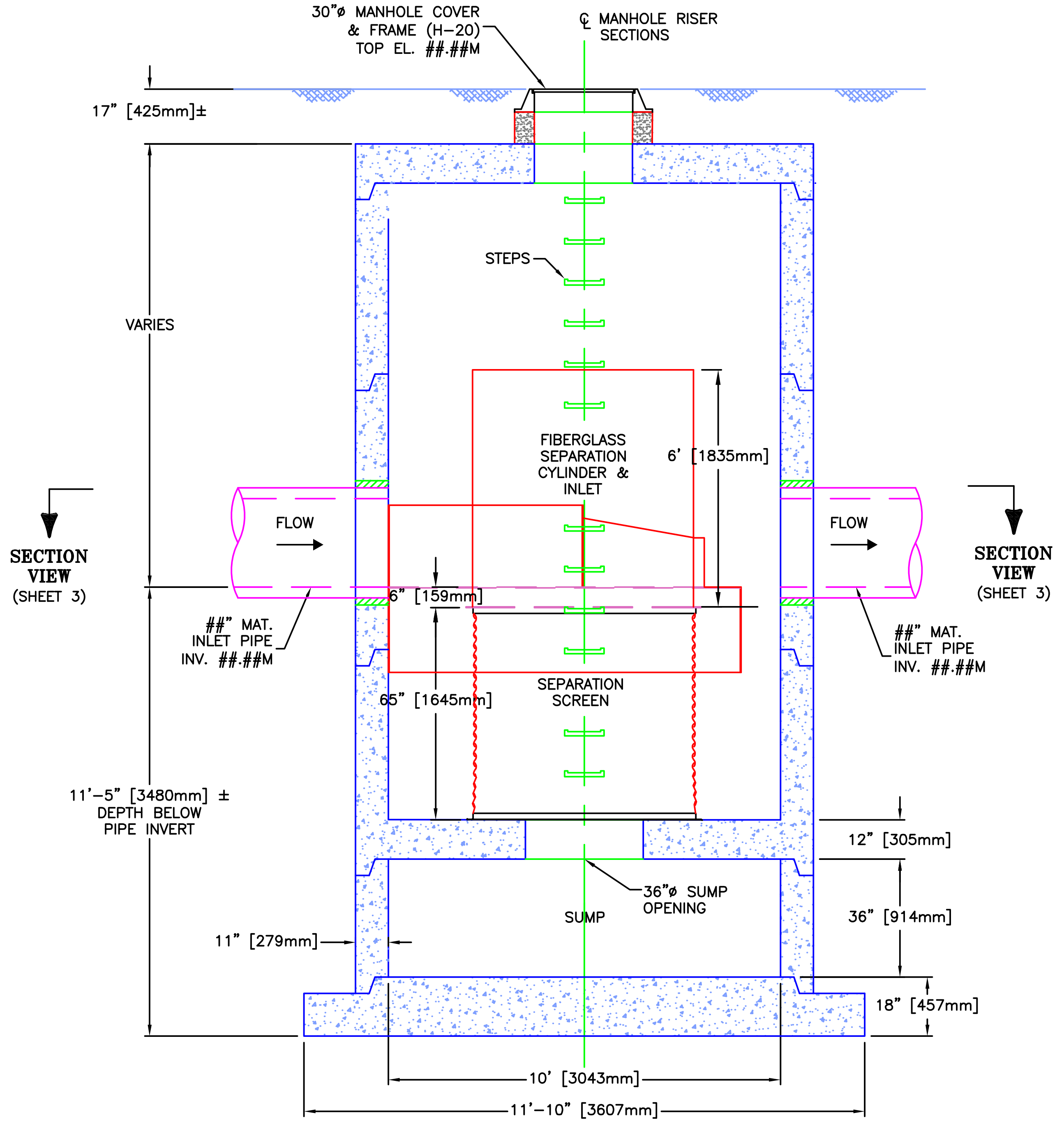
CONTECH STORMWATER SOLUTIONS

PROJECT NAME
CITY, STATE

JOB#	XX-##-###	SCALE 1" = 3'
DATE	##/##/##	SHEET
DRAWN	INITIALS	1
APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955

ELEVATION VIEW



CDS MODEL PMSU56_53m, 396 L/s TREATMENT CAPACITY
STORM WATER TREATMENT UNIT

CONTECH STORMWATER SOLUTIONS	PROJECT NAME CITY, STATE	JOB#	XX-##-###	SCALE 1" = 4'
		DATE	##/##/##	SHEET
		DRAWN	INITIALS	2
		APPROV.		

Echelon Environmental 505 Hood Road, Unit 26, Markham, Ontario L3R 5V6 Tel: (905) 948-0000 Fax: (905) 948-0577
CONTECH Stormwater Solutions Inc. 930 Woodcock Road, Suite 101, Orlando, Florida 32803 Tel: (800) 848-9955