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December 18, 2017 File No. 115157

Triton Engineering Services Limited
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Fergus, ON N1M 1S6

Attn: **Christine Furlong, P.Eng.**
Project Manager

Ref: **Town of Erin, Urban Centre Wastewater Servicing Class EA**
Effluent Outfall Site Selection, Technical Memorandum

Dear Ms. Furlong:

We are pleased to present our Technical Memorandum for the "Effluent Outfall Site Selection" for the Urban Centre Wastewater Servicing Schedule 'C' Municipal Class Environmental Assessment (EA).

This Technical Memorandum provides a review of the effluent outfall site alternatives for discharge of treated wastewater to the West Credit River and is based on the preferred general alternative solution identified in the Servicing and Settlement Master Plan (SSMP). The Technical Memorandum establishes and evaluates alternative sites for the effluent outfall as a component of Phase 3 and of the Municipal Class EA process. The recommended preferred effluent outfall site presented in this Technical Memorandum will remain in draft until completion of the public review process.

Yours truly,

AINLEY & ASSOCIATES LIMITED

DRAFT

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Joe Mullan, P.Eng.
Project Manager

Town of Erin

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum Treated Effluent Outfall Site Selection

Draft

December 2017

CONSULTING
ENGINEERS
PLANNERS

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum
Treated Effluent Outfall Site Selection

Project No. 115157

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The Town of Erin

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Glossary of Terms

ACS	Assimilative Capacity Study: see assimilative capacity.
Ainley	Primary engineering consultant for the Class EA process.
Alternative Solution	A possible approach to fulfilling the goal and objective of the study or a component of the study.
Assimilative Capacity	The ability of receiving water (lake or river) to receive a treated effluent discharge without adverse effects on surface water quality, eco-system and aquatic life.
Benthic	Of, relating to, or occurring at the bottom of a body of water.
Build-out	Refers to a future date where all vacant and underdeveloped lots have been fully developed in accordance with the Town's Official Plan.
Class EA	Municipal Class Environmental Assessment, a planning process approved under the EA Act in Ontario for a class or group of municipal undertakings. The process must meet the requirements outlined in the "Municipal Class Environmental Assessment" document (Municipal Engineers Association, October 2000, as amended). The Class EA process involves evaluating the environmental effects of alternative solutions and design concepts to achieve a project objective and goal and includes mandatory requirements for public consultation.
CVC	Credit Valley Conservation Authority
Design Concept	A method of implementing an alternative solution(s).
Environmental Compliance Approval (ECA)	This approval covers emissions and discharges related to air, noise, waste or sewage.
Effluent	Liquid after treatment. Effluent refers to the liquid discharged from the WWTP to the receiving water.
ESR	Environmental Study Report, a report prepared at the culmination of Phase 4 of the Class EA process under a Schedule C planning process.
Evaluation Criteria	Criteria applied to assist in identifying the preferred solution(s).
Forcemain	A pressurized pipe used to convey pumped wastewater from a sewage pumping station.
Geotechnical Investigation	Study of the engineering behavior of earth materials such as soil properties, rock characteristics, natural slopes, earthworks and foundations, etc.
Gravity sewer	A pipe that relies on gravity to convey sewage.
HSEL	Hardy Stevenson and Associates Limited is the firm conducting the public consultation process for this Class EA.
Hydrogeological	Study of the distribution and movement of groundwater in soil or bedrock.
Master Plan	A comprehensive plan to guide long-term development in a particular area that is broad in scope. It focuses on the analysis of a system for the purpose of outlining a framework for use in future individual projects.
MOECC	Ministry of the Environment and Climate Change, the provincial agency responsible for water, wastewater and waste regulation and approvals, and environmental assessments in Ontario.
NPV	Net Present Value is the value in the present of a sum of money, in

	contrast to some future value it will have when it has been invested at compound interest.
O&M	Operation and maintenance
Open-cut Construction	Method of constructing a pipeline by open excavation of a trench, laying the pipe, and backfilling the excavation.
Peak Flow	An estimation of the maximum volume of wastewater generated over a single day. The peak day flow is calculated by multiplying the ADF by the Harmon Peaking Factor.
Preferred Alternative	The alternative solution which is the recommended course of action to meet the objective statement based on its performance under the selection criteria.
Sewage Pumping Station (SPS)	A facility containing pumps to convey sewage through a forcemain to a higher elevation.
PWQO	Provincial Water Quality Objectives (PWQO) are numerical criteria which serve as chemical and physical indicators representing a satisfactory level for surface waters (i.e. lakes and rivers). The PWQO are set at a level of water quality which is protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to the water.
ROW	Right-of-way applies to lands which have an access right for highways, roads, railways or utilities, such as wastewater conveyance pipes.
Screening Criteria	Criteria applied to identify the short-list of alternative solutions from the long-list of alternative solutions.
Service Life	The length of time that an infrastructure component is anticipated to remain in use assuming proper preventative maintenance.
Sewage	The liquid waste products of domestic, industrial, agricultural and manufacturing activities directed to the wastewater collection system.
Sewage Treatment Plant (STP)	A plant that treats urban wastewater to remove solids, contaminants and other undesirable materials before discharging the treated effluent back to the environment. Referred to in this Class EA as a Wastewater Treatment Plant.
SSMP	Servicing and Settlement Master Plan – the master plan for Erin which was conducted by B.M. Ross in 2014 and establishes the general preferred alternative solution for wastewater.
Terms of Reference (ToR)	The Terms of Reference define the purpose and structures of a project, committee, meeting, negotiation, or any similar collection of people who have agreed to work together to accomplish a shared goal.
Trenchless technology	Methods of installing a utility, such as a sewer, without excavating a trench, including directional drilling, microtunneling etc.
Triton	Town of Erin engineering consultant.
UCWS Class EA	Urban Centre Wastewater Servicing Class Environmental Assessment.
Wastewater	See Sewage.
Wastewater Treatment Plant (WWTP)	See Sewage Treatment Plant.

1.0 Purpose and Study Background

In 2014 the Town of Erin completed a Servicing and Settlement Master Plan (SSMP) to address servicing, planning and environmental issues within the urban areas of Erin Village and Hillsburgh. The aforementioned SSMP examined issues related to wastewater servicing and concluded that the preferred solution for both urban areas was a municipal wastewater collection system conveying wastewater to a single wastewater treatment plant located south east of Erin Village with treated effluent being discharged to the West Credit River.

In August of 2013, B. M. Ross concluded an Assimilative Capacity Study (ACS) establishing that a surface water discharge of treated effluent to the West Credit River was a viable alternative and suggested that the most suitable location for a WWTP outfall to the West Credit River would be situated between 10th Line and Winston Churchill Boulevard. It should be noted that the discharge from a WWTP was recommended to be located below Erin Village because of the greater assimilative capacity in this part of the river. The water quality records within this span of the river indicate lower contaminant concentrations than in other locations upstream. MOECC and CVC agreed with this approach. An update to the ACS during this Urban Centre Wastewater Servicing (UCWS) Class EA study has confirmed the viability of this location and has established effluent criteria that will permit both communities to be built out to full build out of the present OP. Whereas the SSMP recommended preferred alternative was a single treatment plant with a capacity of 2,610 m^3/d, servicing a population of 6,000 persons, this UCWS Class EA study has identified a recommended preferred alternative treatment plant with a capacity of 7,172 m^3/d servicing a population of 14,459 persons and the updated ACS confirmed this discharge capacity potential.

The Terms of Reference for this UCWS Class EA study require that alternative sites for the effluent discharge location be identified and evaluated and a recommended preferred site selected. The purpose of this memorandum is to identify alternative potential locations for the discharge of treated wastewater effluent to the West Credit River and to conduct a detailed evaluation to select the recommended preferred discharge site.

1.1. Related Documents and Projects

Several related studies were completed prior to the commencement of the UCWS Class EA study. During Phase 1 of the UCWS Class EA, each of these studies was reviewed for pertinent information related to this project. They are described in brief in the following subsections.

1.2. Zoning Bylaw

The Town of Erin's Zoning Bylaw (No. 07-67) provides detailed information to control the development of properties within the Town. The bylaw regulates many aspects of development, including the permitted uses of property, the location, size, and height of buildings, as well as parking and open space requirements.

1.3. Servicing and Settlement Master Plan (SSMP)

The SSMP was developed by B.M. Ross and Associates Limited (2014) with the goal to develop appropriate strategies for community planning and municipal servicing, consistent with current provincial, county and municipal planning policies. The SSMP process followed the Master Plan approach, specifically Approach 1, as defined in the Municipal Class Environmental Assessment (Class EA) document, dated October 2000 (as amended in 2007 and 2011).

2.0 General Review of Potential Outfall Locations

The potential location for an effluent outfall site to the West Credit River was reviewed during the 2014 SSMP and a rationale was established for the location between 10th Line and Winston Churchill Boulevard where the assimilative capacity of the West Credit River is maximised. The updated Assimilative Capacity Study (ACS) completed for this UCWS Class EA has confirmed the validity of this stretch of the river as being suitable for the discharge from a water quality point of view.

The Collection System Alternatives Technical Memorandum completed as part of this UCWS Class EA study identifies a preferred collection system that conveys all wastewater to a Sewage Pumping Station at the South end of Erin Village and a forcemain from that Sewage Pumping Station that pumps all wastewater along Wellington Road 52 towards 10th Line. Wastewater treatment and disposal is therefore recommended to be located in the area of 10th line and Winston Churchill Boulevard (WCB). Based on this, Figure 1 shows the area for the potential locations of the outfall.

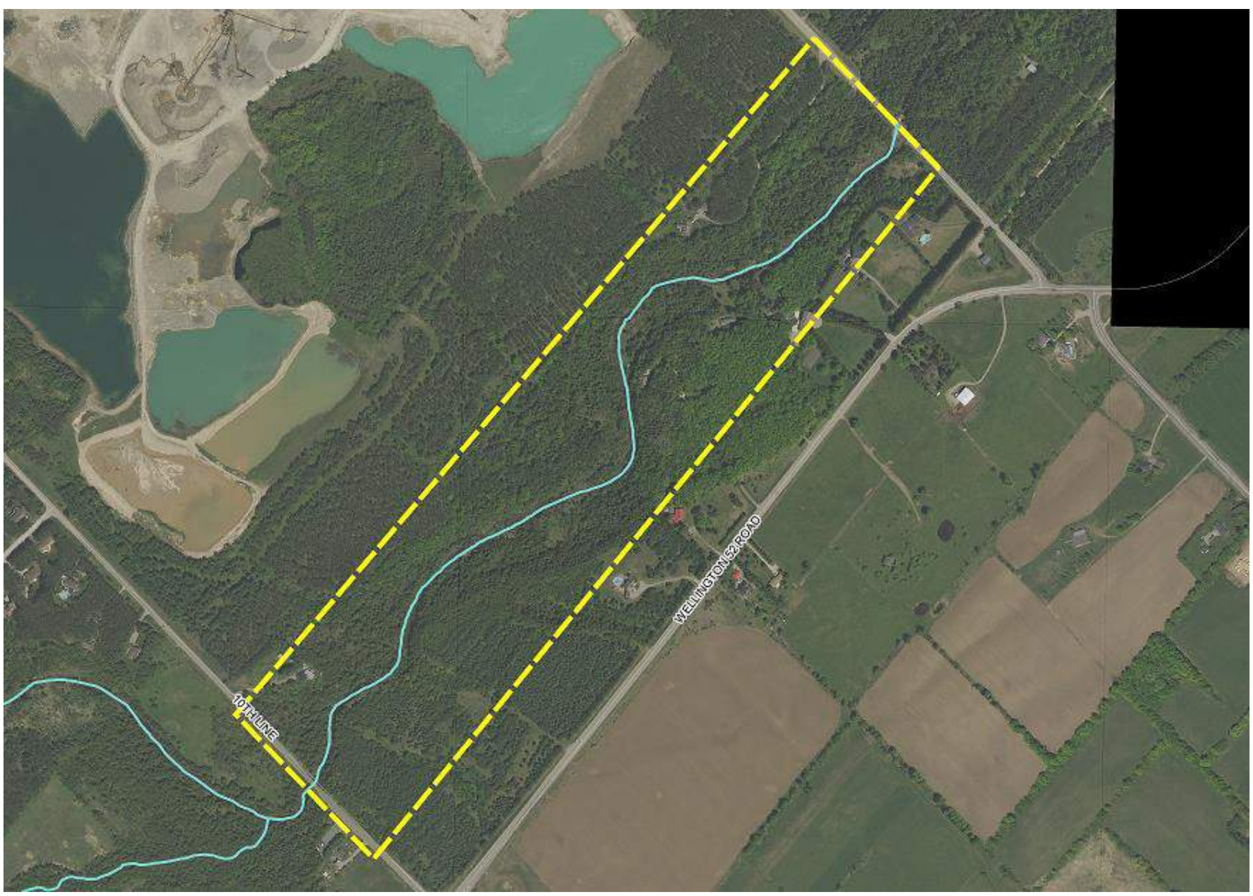

Figure 1 - Study Area for Potential Outfall Locations

As a first step in identification of alternative discharge locations, the following key aspects were considered:

- The need for permanent access to the discharge point to support collection of samples and maintain the discharge pipe and diffusers
- Minimising impacts to the natural environment during construction and operation
- Minimising impacts on the riverbed and banks
- Minimising the impacts on private property

The entire stretch of the river between 10th Line and Winston Churchill Boulevard is heavily wooded and privately owned. Locating an outfall anywhere along this stretch would require purchase of an easement from 10th Line to the potential discharge point from land owners (possibly several owners) and the removal of trees sufficient to create a permanent access road for construction of the pipeline and ongoing operation and maintenance activities. This would have a significant impact on the natural environment. In addition, the nature of the river along this stretch is such that there is no particular location that would present a natural outfall location.

3.0 Potential WWTP Discharge Outfall Sites

Based on the above, two locations were examined as potential discharge points.

- Where 10th Line crosses the West Credit River
- Where Winston Churchill Boulevard crosses the West Credit River

Both of these locations are fully accessible from public road allowances leading from the area of the proposed WWTP. A field review established that an outfall could be constructed within the public right of way on either side of the bridge on 10th Line and on the west side of Winston Churchill Boulevard. It is noted that the east side of Winston Churchill Boulevard is in Peel Region.

Three (3) alternative sites for the treated effluent outfall have been identified as follows:

- Alternative 1A 10th Line West Side
- Alternative 1B 10th Line East Side
- Alternative 2 Winston Churchill Boulevard West Side

In all three alternatives, the treated effluent will be discharged though the effluent pump station at the recommended WWTP site and conveyed through forcemains and gravity sewers to the discharge locations which are depicted in Figures 2 and 3.

A natural environment assessment was carried out along this stretch of the river including the above alternative sites, during June 2017 by Hutchinson Environmental Sciences Ltd (HESL). The HESL report forms part of the project documentation.

A Fluvial Geomorphological Assessment along this stretch of the river was carried out by Palmer Environmental Consulting Group Inc. This report is attached as an appendix to this Technical Memorandum.

A geotechnical field investigation along the routes of the proposed sewers/forcemains from the WWTP to the outfall alternative sites was carried out by GeoPro Limited, during October 2017 and this report also forms part of the project documentation.

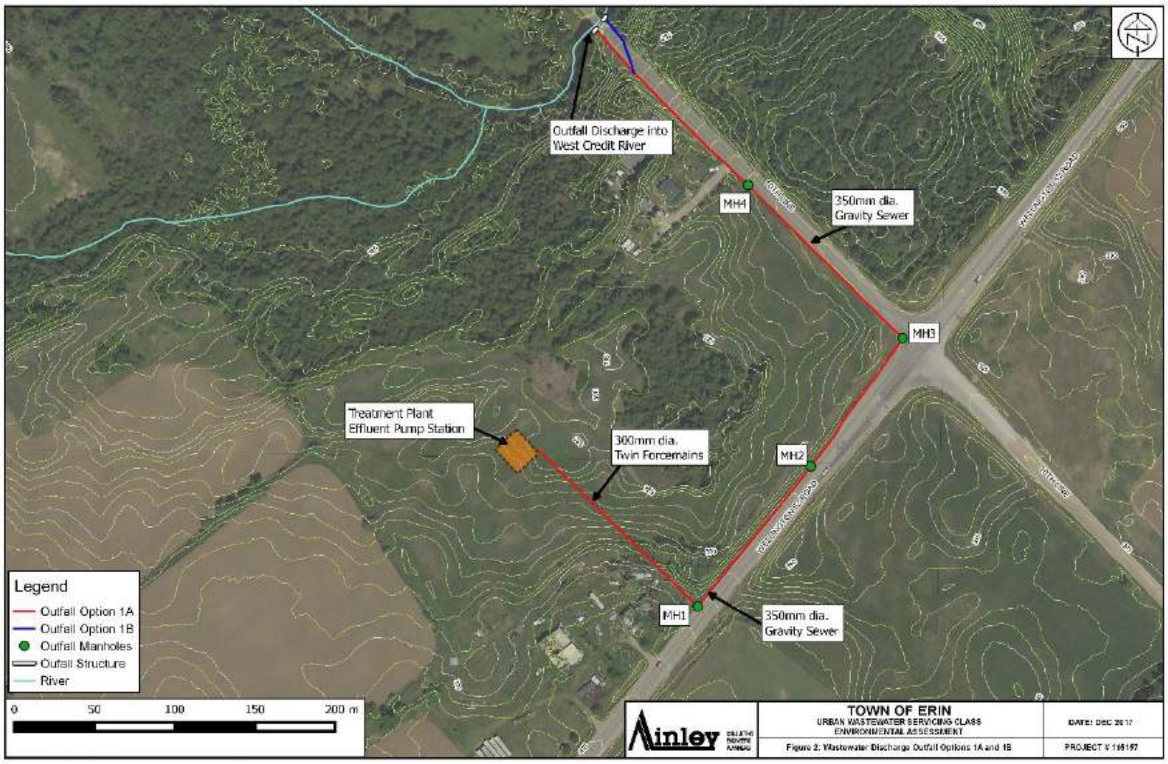

Figure 2 – Wastewater Effluent Discharge Outfall Alternatives 1A and 1B

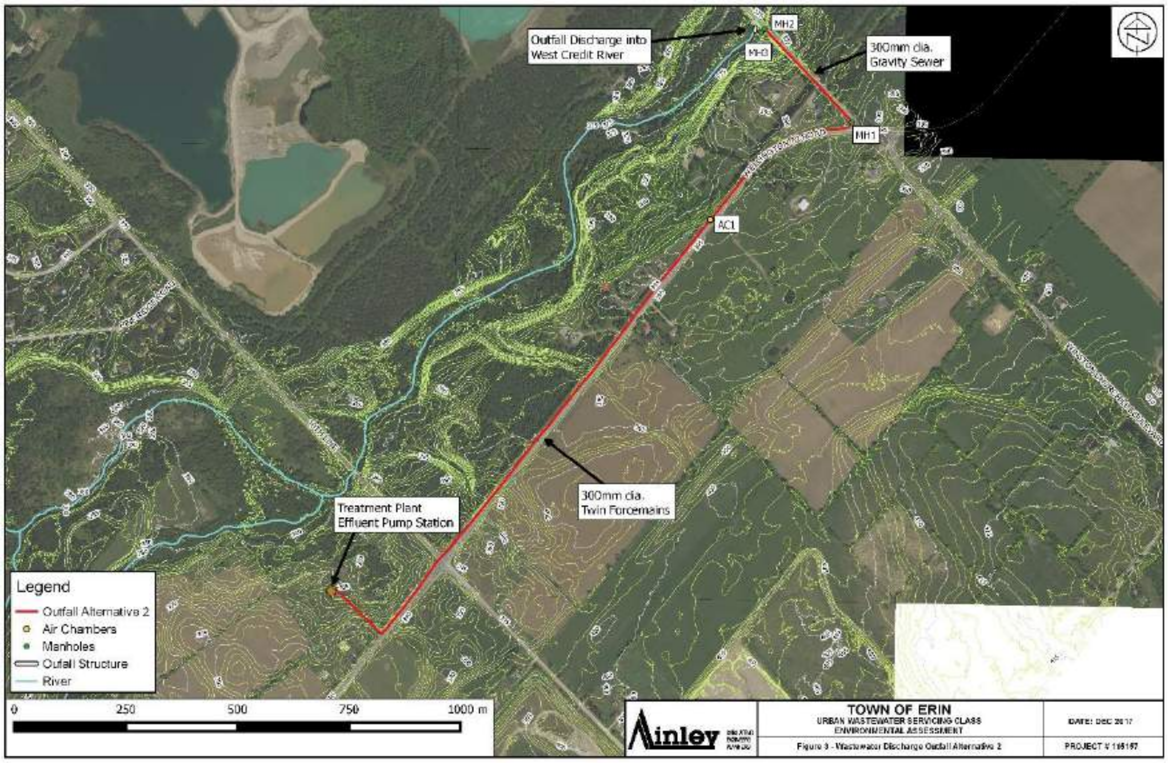

Figure 3 – Wastewater Effluent Discharge Outfall Alternative 2

3.1. Description of Alternatives

3.1.1. Alternative 1A/1B –10th Line

Alternatives 1A and 1B will consist of gravity sewers that run East on Wellington Rd 52 from the proposed WWTP Site and then North on 10th Line before discharging into the West Credit River. There is significant downwards slope on Wellington Rd 52 heading towards 10th Line and from the intersection of 10th Line North to the West Credit River bridge. As can be seen in Figure 4, there is enough room on the north shoulder of Wellington Rd 52 to place the discharge sewer within the shoulder and not in the road.

Figure 4 – Wellington Rd 52 facing West from 10th Line Intersection

The gravity discharge sewer will continue East on Wellington Rd 52 towards the intersection of Wellington Rd 52 and 10th Line. At the manhole within that intersection, the sewer will turn North on 10th Line. Figure 5 shows the view North down 10th Line from the Wellington Rd 52 / 10th Line intersection.

Figure 5 – 10th Line Facing North Towards West Credit River

There appears to be sufficient clearance from power lines to permit construction while retaining two-way traffic on 10th Line. As the sewer approaches the bridge over the West Credit River, there are two options for discharge: the West side of the bridge or the East side of the bridge. For Alternative 1A, the discharge is on the West side of the bridge.

It can be seen in Figure 6 that the road reduces to one lane over the bridge, however the sewer can still be constructed on the west side of the road allowance without affecting the bridge. The roadside barrier will need to be temporarily removed to allow construction of the sewer to the river. The CVC monitoring station will need to be protected during construction.

Figure 6 – 10th Line West Credit River Bridge (CVC monitoring station also pictured)

Figure 7 - Outfall Alternative 1A Discharge Location (Facing South)

In accordance with the recommendations in the Assimilative Capacity Study, the outfall will need to extend either along the bank for 5 metres with 15 equally spaced diffuser ports to disperse the effluent. Details of the diffuser will be developed during detailed design.

3.1.2. Alternative 1B –10th Line (East Side of bridge)

Alternative 1B is the same as Alternative 1A until the sewer nears the West Credit River bridge. At this point the discharge sewer will need to cross 10th Line and discharge into the river on the east side of the bridge. Figure 8 depicts the bridge area and the difference between Alternative 1A and 1B in more detail.

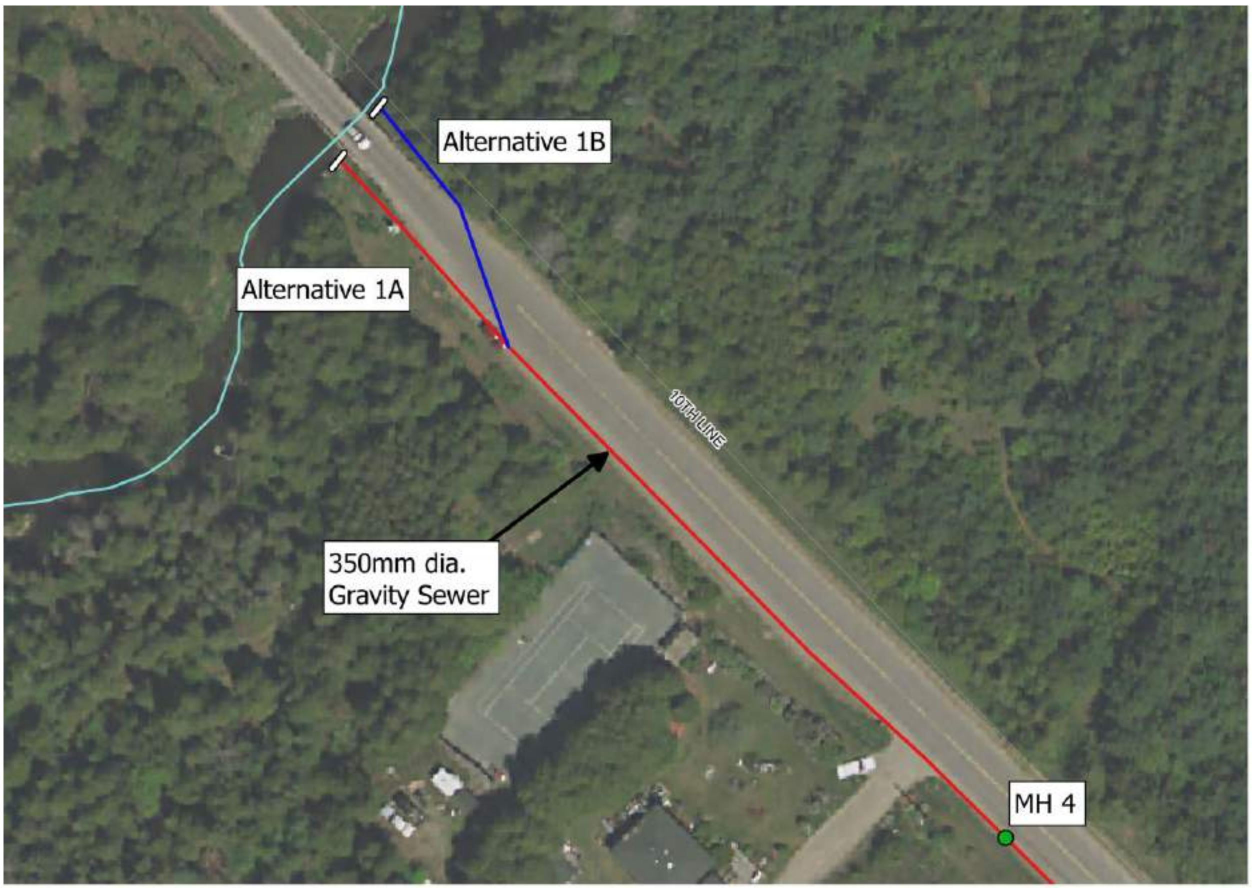

Figure 8 – 10th Line West Credit River Bridge for Alternatives 1A and 1B

The East side of 10th Line has a steep bank immediately off the shoulder making it difficult to construct the sewer. For this reason, Alternative 1B will need to cross the road at the point shown in Figure 8. Figure 9 shows the approximate outfall location for Alternative 1B.

Figure 9 - Alternative 1B Discharge Sewer Outfall Location (Facing South)

3.1.3. Alternative 2 –Winston Churchill (West Side of Bridge)

Alternative 2 will require a forcemain all the way from the WWTP site along Wellington Rd 52 to Winston Churchill Boulevard. This 1.6 km stretch of road slopes back towards 10th Line requiring the effluent to be pumped.

Figure 10 - Wellington Rd 52, From 10th Line Intersection Facing East

Figure 10 illustrates ample width of the shoulder available to place the forcemains with minimal impact on the existing road. The forcemains will follow the North shoulder of Wellington Rd 52 to a proposed manhole at the intersection with Winston Churchill Boulevard. From the intersection, a gravity sewer will convey effluent north, downhill along the west side of Winston Churchill Boulevard to the river. The sewer will require to be constructed down the west side of the road to remain in Wellington County. The road centreline represents the boundary between Wellington County and Peel Region.

Figure 11 - Winston Churchill Blvd Facing North from Wellington Rd 52 Intersection

Figure 11 also illustrates the narrowness of the shoulder and proximity to overhead power lines on the west side of the road. This will necessitate a lane closure of the road during construction. Due to the steepness of the road and height above the river, an energy dissipation manhole will be required to ensure an even velocity for dispersion into the river. The discharge will be as shown in Figure 12.

Figure 12 - Winston Churchill Blvd River Crossing and Alternative 2 Discharge

The same Alternative 1A/1B outfall structure will be used for the Alternative 2 discharge (Appendix A). Figures 13 and 14 show how the future sewer approaches the West Credit River.

Figure 13 - Facing North on Winston Churchill Blvd towards West Credit River

Figure 14 - West Side of Winston Churchill Blvd River Crossing

It can be seen in Figure 15 that the outfall will discharge directly before the opening of the culvert crossing.

Figure 15 - Alternative 2 Outfall Discharge Location

3.2. Impact Analysis of Alternatives

Cost Impacts

In order to compare the capital costs of the three (3) outfall sites, the following was considered:

- Costs of forcemain/sewer to convey treated effluent to each outfall site
- Costs for manholes/chambers for each outfall site
- Costs associated with any unique development features for each outfall site
- Costs for the actual outfall diffuser pipe.

Since all outfall scenarios require an effluent pumping station, this was not considered in the cost impact analysis. For the comparative analysis of the alternatives, costs were taken from the 10th Line/Wellington road intersection.

The peak flows for both Phases 1 and 2 of the WWTP were generated within our technical memorandum titled "Wastewater Treatment Technology Evaluation" and established as 11,779 m^3 /day (136.2 L/s) and 19,148 m^3 /day (221.6 L/s), respectively. These flows were used to size all discharge outfall alternatives. Unit costs were taken from the cost tables established in the "Collection System Alternatives Review". Once the forcemains reach the road, Alternatives 1A/B and Alternative 2 were sized and costed differently as shown in the following sections. The costs were generated from Tables 1, 2 and 3 which provide prices for installation of sewer pipe, forcemain and manholes.

- All costs are presented in 2016 Canadian dollars.
- Net present value costs are based on 80 years of operation, maintenance, and component replacement. Capital costs are excluded.
- Inflation and escalation to account for actual expected prices at the time of tendering cannot be accounted for at this time.
- Life cycle costs have been estimated based on an inflation rate of 4%.

For alternatives 1A and 1B, the gravity sewer size was determined to be a 350 mm diameter sewer based on a full build out peak flow of 19,148 m^3 /day (221.6 L/s) for both alternatives 1A and 1B. Based on that pipe size, the number of manholes shown in Figure 2, and an approximate outfall structure cost of $30,000, the cost breakdown of these alternatives can be seen in Tables 1 and 2 below.

Table 1 – Alternative 1A Capital Cost

Alternative 1A (350mm Gravity Sewer)			
	Units	**Unit Cost**	**Cost**
350mm PVC Pipe	588 m	$ 560	$ 329,280
Manholes	4	$ 10,000	$ 40,000
Outfall Structure	1	$ 30,000	$ 30,000
		Total	**$ 399,280**

Table 2 – Alternative 1B Capital Cost

Alternative 1B (350mm Gravity Sewer)			
	Units	**Unit Cost**	**Cost**
350mm PVC Pipe	590 m	$ 560	$ 330,400
Manholes	4	$ 10,000	$ 40,000
Outfall Structure	1	$ 30,000	$ 30,000
Total			**$ 400,400**

For Alternative 2, twin 300 mm diameter forcemains are proposed for the full build out flows. One air/vacuum relief valve chamber will also be required along Wellington 52 at the high point. From the intersection of Winston Churchill Boulevard and Wellington Rd 52 a 300 mm gravity sewer is required down to the river. Using these pipe sizes, the one proposed air chamber, and four proposed manholes, the cost breakdown of this alternative is shown in Table 3:

Table 3 – Alternative 2 Capital Cost

Alternative 2 (Twin 300mm Forcemains + 300mm Gravity Sewer)			
	Units	**Unit Cost**	**Cost**
Twin 300mm PVC Pipe	1696 m	$ 800	$ 1,356,800
300mm Gravity Sewer	323 m	$ 520	$ 167,960
Manholes	4	$ 10,000	$ 40,000
Air Chambers	1	$ 12,000	$ 12,000
Outfall Structure	1	$ 40,000	$ 30,000
		Total	**$ 1,606,760**

The operation and maintenance costs for Alternative 1A/1B will involve routine maintenance of the short sewer section and energy costs for pumping from the WWTP to Wellington Road 52. Alternative 2 will involve a slightly higher cost for operation and maintenance of the forcemains, and a similar cost for the sewer section. Alternative 2 will also involve increased energy costs to pump the effluent to Winston Churchill Boulevard. This would involve double the energy used compared to Alternatives 1A/1B.

Environmental Impacts

The Assimilative Capacity Study (ACS) completed by HESL in 2017 outlines and delineates effluent limits and objectives sufficient to ensure that effluent is not directly toxic to the aquatic environment, and determines the characteristics of the mixing zone and water quality at the point of complete mixing downstream of the effluent outfall site. Water quality modelling results are compared to Provincial Water Quality Objectives (PWQO) or Canadian Water Quality Guidelines to determine the potential for any impacts to aquatic biota. Water quality objectives and guidelines are protective of all forms of aquatic life and all aspects of the aquatic life cycles during indefinite exposure to water (MOE 1994).

There is an additional requirement that the effluent stream, at the point of discharge, not be acutely lethal to aquatic life.

The size and shape of the effluent plume and water quality in the mixing zone was modelled using the CORMIX water quality model (as required by MOECC) and oxygen and temperature modelling of the discharge was modelled using the Qualk2K model (HESL 2017). The 10th Line was used as the modelled effluent outfall location, but the results can be conservatively applied at Winston Churchill Boulevard since there is approximately 15% more dilution potential at Winston Churchill Boulevard due to inputs of groundwater between the two locations.

The HESL (2017) ACS concluded the following with respect to parameters most relevant to aquatic life, including fisheries and sensitive Brook Trout habitat in the study area:

- For the Full Build Out summer low flow scenario, dissolved oxygen concentrations were predicted to decrease by 1.33 mg/L to a minimum concentration of 6.39 mg/L at a distance approximately 700 m downstream of the WWTP discharge location and then begin recovering. As such, dissolved oxygen concentrations were predicted to remain well above the PWQO of 5 mg/L for cold water biota at river temperatures of 20°C and 25°C.
- Given that the maximum summer water temperature for the WWTP effluent of 19°C proposed by BM Ross (2014) is below the 75th percentile West Credit River water temperature of 21.18°C, the input from the WWTP effluent will slightly cool the river temperatures downstream of the outfall.
- A total ammonia effluent limit of 2.1 mg/L or less would meet the requirement for non-lethality during the summer discharge period. The distance to meet the PWQO for un-ionized ammonia of 0.02 mg/L is 153 m from the outfall at full build out and through implementation of a multiport diffuser. The mixing zone does not occupy the complete width of the river and meets all MOECC requirements for mixing zones.

From an Environmental perspective, the potential effluent outfall locations at 10th Line and Winston Churchill Boulevard were evaluated through the following criteria characterizing aquatic ecology conditions: water temperature, dissolved oxygen, Brook Trout redds and benthic invertebrate biological metric results.

Water temperature and dissolved oxygen data were gathered from HESL (2017) and compared at each site. Water temperatures were cooler in the summer at Winston Churchill Boulevard, as measured as maximum water temperature and 75th percentiles, because groundwater upwellings are abundant in the study reach upstream of Winston Churchill Boulevard. Dissolved oxygen concentrations were slightly higher as well at Winston Churchill Boulevard because of upstream groundwater inputs (HESL 2017). These provide more resilience and potential for assimilation of effluent and any associated changes in temperature and oxygen demand.

Only three Brook Trout redds were observed in the potential mixing zone within 153 m of the 10th Line. Dissolved oxygen was modelled to decline slightly downstream of the outfall. More Brook Trout redds (39) were observed within the oxygen sag zone downstream of the 10th Line than downstream of Winston Churchill Blvd (15). The benthic invertebrate assemblage at the 10th Line contained a greater proportion and a more diverse assemblage of sensitive invertebrates.

Based on Environmental considerations, the preferred effluent outfall location to the West Credit River is Winston Churchill Boulevard because of the presence of more sensitive aquatic features and functions at the 10th Line and the density of Brook Trout redds downstream. Treated effluent discharged at the 10th Line would flow downstream through the sensitive study area to Winston Churchill Blvd. and beyond but an outfall location at Winston Churchill Blvd. would avoid the most sensitive area altogether, initial mixing would occur within the culvert where habitat has already been impacted and there is ~ 15% more assimilation flow (HESL 2017).

Fluvial Geomorphological Impacts

Based on the results of the fluvial geomorphological assessment, all alternative sites would provide suitable effluent discharge locations. The study indicates that the discharge would not impact the stream bed or banks to any meaningful extent.

Archaeological Impacts

Construction of all the treated effluent outfall alternatives will be completed in public rights of way (road allowances) including the actual outfall locations at the West Credit River. As such, all of the disturbed lands are previously disturbed for construction of the road or bridge works. It is not anticipated that archaeological impacts will be significant for any of the alternatives.

Geotechnical Impacts

All of the construction of the treated effluent outfall alternatives will be completed in public rights of way (road allowances) including the actual outfall locations at the West Credit River. As such, all of the disturbed lands are previously disturbed for construction of the road or bridge works. It is not anticipated that archaeological impacts will be significant for any of the alternatives.

4.0 Evaluation Methodology

The evaluation methodology used to select the preferred treated effluent outfall site was established in a manner consistent with the principles of environmental assessment planning and decision-making as outlined in Municipal Class Environmental Assessment.

A decision model consistent with the principles of environmental assessment planning and decision making as outlined in Municipal Class Environmental Assessment manual was developed to select the preferred outfall site.

In developing the decision model, relevant and specific evaluation criteria were identified and compared distinguishing features between the sites. Whereas other components of the UCWS Class EA place a higher emphasis on Technical Criteria, for the outfall site selection evaluation, Environmental and Economic Criteria play a more important role.

Based on the above, the three (3) Alternative Sites (Site 1A, 1B, and 2) will be evaluated against the specific evaluation criteria described in the Table 4 below:

Table 4 – Outfall Alternatives Evaluation Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social/Culture	10%	Impacts During Construction	30%
		Aesthetics (Appearance of discharge)	40%
		Effect on Residential Properties	10%
		Effect on Businesses/ Commercial Properties	10%
		Effect on Industrial Properties	10%
Technical	10%	Functionality and Performance	30%
		Suitability for Phasing	10%
		Constructability	30%

Primary Criteria	Weight	Secondary Criteria	Weight
		Operation and Maintenance Impacts	30%
Environmental	60%	Effect on Surface Water/ Fisheries	50%
		Effect on Vegetation/ Wetlands	20%
		Effect on Groundwater	20%
		Effect on Habitat/ Wildlife	10%
Economic	20%	Capital Cost	100%

4.1. Screening Criteria Definitions

4.1.1. Social/Culture, Impacts During Construction

This criterion captures the level of disturbance to the community the proposed solution will have during the construction period. These effects include noise levels, vibration, odours, dust production, as well as the amount of time for which these disturbances will persist.

4.1.2. Social/Culture, Aesthetics (appearance of Discharge)

This criterion captures the level of impact from the visual appearance of the outfall and discharge to the river.

4.1.3. Social/Culture, Effect on Residential Properties

This criterion captures the level of impact that the outfall has on individual residential properties. Impacts considered include operation and maintenance activities.

4.1.4. Social/Culture, Effect on Commercial Properties

This criterion captures the level of impact that the outfall has on individual commercial properties. Impacts considered include operation and maintenance activities.

4.1.5. Social/Culture, Effect on Industrial Properties

This criterion captures the level of impact that the outfall has on individual industrial properties. Impacts considered include operation and maintenance activities.

4.1.6. Technical, Functionality and Performance

This criteria compares the methods of conveying the effluent to the outfall location (pumping or gravity) and the technical suitability of the sites to accept and mix the effluent into the river.

4.1.7. Technical, Suitability for Phasing

This criterion captures the ability to be expanded under a phased development plan. Outfall locations that allow flexibility in development to promote ease of expansion would have a higher score.

4.1.8. Constructability

This criterion captures the constructability of each alternative. This would include geotechnical aspects and hydrogeological aspects affecting structural design of the outfall.

4.1.9. Technical, Operational and Maintenance Impacts

This criterion captures the impacts of each site on the operability of the overall system. This would take into consideration, access to the outfall sites and level of effort required by operations staff to operate and maintain the outfall.

4.1.10. Environmental, Effect on Surface Water/ Fisheries

The criterion captures the impact that the establishment and operation of the outfall alternative has on the local surface waters both during construction and over the long term and in terms of impacts to water quality and fisheries. Minimizing contamination of the local surface water is rated favourably.

4.1.11. Environmental, Effect on Vegetation/ Wetlands

The criterion captures the impact that the establishment and operation of the system alternative has on the local vegetation and wetlands both during construction and over the long term. Minimizing negative impacts on the local vegetation and wetlands is rated favourably.

4.1.12. Environmental, Effect on Groundwater

The criterion captures the level of groundwater contamination associated with the establishment and operation. Minimizing contamination of the local groundwater is rated favourably.

4.1.13. Environmental, Effect on Habitat/ Wildlife

The criterion captures the impact that the establishment and operation of the system alternative has on the local habitat and wildlife both during construction and over the long term. Minimizing contamination of the local habitat and wildlife is rated favourably.

4.1.14. Economic

The criterion captures the estimated cost to construct the alternative and to operate and maintain the system on an annual basis.

4.2. Evaluation of Alternatives

4.2.1. Overview

As discussed in Section 3.0 above, the following three (3) alternatives for outfall were developed:

- Alternative 1A – 10th Line (West Side of Bridge)
- Alternative 1B – 10th Line (East Side of Bridge)
- Alternative 2 – Winston Churchill Blvd (West Side of Crossing)

A description and layout of these options can be found in Section 3.0.

4.2.2. Detailed Evaluation of Outfall Alternatives

The evaluation of each of the outfall alternatives, using the criteria and weightings listed in Table 4 is provided in Table 5.

Using the weighted percentages assigned to each category and criteria, each criteria is then scored from 1 to 5 with one having the most negative effect and 5 the least negative impact. The highest score therefore represents the preferred alternative.

Table 5 – Weighted Scoring of WWTP Outfall Site Alternatives

Primary Criteria		Secondary Criteria		Absolute Weight (WT)	Site 1A (10th Line West)		Site 1B (10th Line East)		Site 2 (Winston Churchill Blvd West)		Comments
Criteria	Weight	Criteria	Weight		Score	WT Score	Score	WT Score	Score	WT Score	
Social/Culture	10%	Impacts During Construction	50%	5	4	4	4	4	1	1	Site 2 has significant traffic impact on Wellington Road 52 and WCB
		Aesthetics (Appearance of discharge)	20%	2	3	1.2	3	1.2	4	1.6	All sites used by public but WCB discharge can be better hidden
		Effect on Residential Properties	10%	1	4	0.8	4	0.8	4	0.8	Little effect anticipated
		Effect on Businesses/ Commercial Properties	10%	1	5	1	5	1	5	1	Little effect anticipated
		Effect on Industrial Properties	10%	1	5	1	5	1	5	1	Little effect anticipated
Technical	10%	Functionality and Performance	50%	5	3	3	3	3	2	2	WCB better mixing and outfall location but higher energy use
		Suitability for Phasing	10%	1	2	0.4	2	0.4	2	0.4	Typically outfalls are sized for ultimate
		Constructability	30%	3	4	2.4	4	2.4	2	1.2	All relatively straight forward but WCB considerably longer and must be pumped
		Operation and Maintenance Impacts	10%	1	5	1	5	1	2	0.4	WCB more remote from plant and not so easy access for sampling
Environmental	60%	Effect on Surface Water/ Fisheries	70%	42	1	8.4	1	8.4	4	33.6	Discharge at 10th line has potential for substantially higher impact on fish
		Effect on Vegetation/ Wetlands	10%	6	4	4.8	4	4.8	4	4.8	Little effect anticipated
		Effect on Groundwater	10%	6	4	4.8	4	4.8	4	4.8	Small additional effect on local well at 10th Line
		Effect on Habitat/ Wildlife	10%	6	3	3.6	3	3.6	4	4.8	Slightly higher impact upstream of WCB
Economic	20%	Capital Cost	100%	20	5	20	5	20	1	4	Site 2 has considerably higher capital cost
			TOTAL SCORE	100		56.4		56.4		61.4	

Based on the detailed evaluation of the alternatives, Alternative 2 returns the highest score and therefore offers the most benefit. The details of the scoring rationale are provided in Table 6.

Table 6 – Criteria Rating Rationale

Criteria	Site 1A (10th Line West)	Site 1B (10th Line East)	Site 2 (Winston Churchill Boulevard)
Social/ Culture - Impacts During Construction	▪ Open cut construction of sewer on Wellington 52 and 10th Line. Potential impact to one residence and small traffic impact	▪ As Site 1A	▪ Forcemain open cut construction along Wellington 52 shoulder and sewer down Winston Churchill Boulevard southbound lane. Potential impact on over 10 homes. ▪ Potential substantial traffic impact on Winston Churchill Boulevard and small impact on Wellington Road 52.
Social/ Culture - Aesthetics	▪ Outfall can be relatively well hidden beside bridge	▪ Outfall can be made slightly less visible than for Site 1A.	▪ Outfall can be well hidden from the road
Social/ Culture - Effect on Residential Properties	▪ Minimal long term impact on local properties	▪ Minimal long term impact on local properties	▪ Minimal long term impact on local properties
Social/ Culture - Effect on Businesses/ Commercial Properties	▪ Minimal long term impact on local businesses.	▪ Minimal long term impact on local businesses	▪ Minimal long term impact on local businesses
Social/ Culture - Effect on Industrial Properties	▪ Minimal long term impact on local businesses.	▪ Minimal long term impact on local businesses.	▪ Minimal long term impact on local businesses.
Technical – Functionality and Performance	▪ Requires pumping up to Wellington Road 52 then gravity to outfall. ▪ Reasonable access to outfall point for operation and maintenance. ▪ Enough space available within road property for outfall. ▪ Good location from geomorphological aspect ▪ Potential future bridge replacement/widening could affect outfall	▪ Requires pumping up to Wellington Road 52 then gravity to outfall. ▪ Reasonable access to outfall point for operation and maintenance. ▪ Enough space available within road property for outfall. ▪ Good location from geomorphological aspect ▪ Potential future bridge replacement/widening could affect outfall	▪ Requires pumping all the way to Winston Churchill Boulevard then gravity to outfall. ▪ Steep access to outfall point from river would require safe access construction. ▪ Good location for outfall for mixing. ▪ Good location from geomorphological aspect
Technical - Suitability for Phasing	▪ Typically outfalls are sized and constructed for full build out flows with port left closed off until needed. Likely full sized sewer would be build day one.	▪ Typically outfalls are sized and constructed for full build out flows with port left closed off until needed. Likely full sized sewer would be build day one.	▪ Typically outfalls are sized and constructed for full build out flows with port left closed off until needed. ▪ This alternative offers possibility to construct one forcemain at Phase 1 and add a second at Phase 2, however this does not provide redundancy during Phase 1 and overall results in higher capital cost.
Technical - Constructability	▪ Fairly easy to construct with few impacts.	▪ Fairly easy to construct with few impacts.	▪ Construction down Winston Churchill will have traffic and utility impacts. ▪ Steep bank between road and river will require energy dissipation before outfall.
Technical - Operation and Maintenance Impacts	▪ Easy access for maintenance	▪ Easy access for maintenance	▪ More remote access for maintenance and more difficult to get to river bank.
Environmental - Effect on Surface Water/ Fisheries	▪ Water temperature higher and oxygen levels lower than at Winston Churchill Boulevard ▪ Higher impact on Brook Trout and benthic invertebrates downstream of 10th Line than downstream of Winston Churchill Boulevard	▪ As Alternative 1A	▪ Water temperature lower and oxygen levels higher than at 10th Line ▪ Lower impact on Brook Trout and benthic invertebrates downstream of Winston Churchill Boulevard
Environmental - Effect on Vegetation/ Wetlands	▪ Little impact anticipated	▪ Little impact anticipated	▪ Little impact anticipated
Environmental - Effect on Groundwater	▪ Little impact anticipated	▪ Little impact anticipated	▪ Little impact anticipated
Environmental - Effect on Habitat/ Wildlife	▪ Little impact anticipated	▪ Little impact anticipated	▪ Little impact anticipated
Economic - Capital Cost	▪ Least cost alternative at $400,000	▪ Similar cost to 1A	▪ Capital Cost $1,600,000. ▪ Considerably more expensive alternative

5.0 Conclusions and Recommendations

- The 2014 Servicing and Settlement Master Plan (SSMP) identified a general area for a discharge of treated effluent to the West Credit River south east of Erin Village.
- The UCWS EA is a continuation of the Class EA process and aims to establish the preferred design alternative for the wastewater system servicing Erin Village and Hillsburgh.
- The updated Assimilative Capacity study completed for the UCWS Class EA study confirmed the suitability of the general effluent discharge area identified in the SSMP.
- The proposed treated water effluent Limits and Objectives for the discharge as outlined in the ACS confirm that all alternative outfall locations provide acceptable locations from a water quality perspective.
- Based on the above and a more detailed examination of the area, this UCWS Class EA study has refined the general area for the potential treated effluent outfall and selected three (3) sites within this area for more detailed evaluation.
- The three (3) alternatives effluent outfall sites are defined as follows:
    - Site 1A 10th Line West Side
    - Site 1B 10th Line East Side
    - Site 2 Winston Churchill Boulevard West Side
- The Outfall Alternatives were sized, conceptually designed and costed.
- In addition to the Assimilative Capacity Study, a Natural Environment Study, a Fluvial Geomorphological Study and Geotechnical study were undertaken for the river between 10th Line and downstream of Winston Churchill Boulevard and the outfall pipe routes from a potential WWTP site to assist with defining potential impacts.
- The team has compiled sufficient information on the environmental, geotechnical, archaeological and costing aspects of the sites to support an evaluation process aimed at selecting the preferred site.
- The evaluation criteria were established with the following weighting for the primary criteria:
    - Social/ Cultural Impacts – 10%
    - Technical Impacts – 10%
    - Environmental Impacts - 60%
    - Economic Impacts– 20%
- The evaluation criteria reflect the relative importance of the criteria on water quality and the potential impact on fisheries as well as cost
- The relative capital costs for each site are summarized as follows:

Alternative	Estimated Capital Cost
Site 1A (10th Line West)	$ 399,300
Site 1B (10th Line East	$ 400,400
Site 2 (WCB West)	$ 1,606,800

- In addition, Alternative 2 will require additional pumping costs to pump the effluent to Winston Churchill Boulevard.
- Environmental impacts for Alternative 2 are summarized as follows:
  - Water temperature is lower and oxygen levels higher at Winston Churchill Boulevard
  - Lower impact on Brook Trout and benthic invertebrates
- Geotechnical impacts are summarized as follows:
  - Prevalent sand and gravel deposits in the area will not present major construction issues for outfall pipelines until close to the river where groundwater will affect construction. It is anticipated that dewatering will be required for the 100 m closest to the river. This applies to all alternatives.
- Archaeological impacts are not expected to be significant for any of the alternatives.
  - Since all of the works will take place in established road allowances, it is not anticipated that archaeological resources will be encountered.
- A Fluvial Geomorphological assessment confirmed that all potential outfall locations are suitable and will not cause erosion or affect the existing channel
- The results of the evaluation process indicate that, Alternative 2 (Winston Churchill Boulevard) has the highest score and is preferred over sites 1A and 1B.
- The primary reasons for this are:
  - The potential impact on Brook Trout and fisheries in the river reach downstream of 10th Line
  - Lower water temperature and higher oxygen levels at the Winston Churchill Boulevard location
  - Opportunity for improved mixing at Winston Churchill Boulevard location
- In examining the sensitivity of the scoring to changes in the criteria weightings, it should be noted that a 4% decrease in the Environmental weighting and corresponding 4% increase in the Economic weighting would result in Alternative 1A or 1B being the preferred Alternative. In this case the Environmental criteria has been rated highly because of the potential impact on brook trout which represents a valuable resource for the West Credit River. While the high quality effluent will protect river water quality and all of the fish species, there remains a risk to this sensitive and significant resource which cannot be mitigated.
- The recommended effluent limits are protective of all fish at all critical life stages and so meet the requirements for protection of aquatic habitat. Mitigation to be considered during design to achieve an even higher level of protection, in consideration of the resident population of Brook Trout are outlined below:
  - Any in-stream work should adhere to Fisheries and Oceans Canada's in-stream construction timing windows for spring (March 15 to July 15) and fall spawners (October 1 to May 31) to protect the sensitive life stages of spawning and rearing for resident species such as Rainbow and Brook Trout.
  - An Erosion and Sediment Control Plan should be developed to prevent runoff and solids from entering the river. A construction mitigation plan should be developed (CISEC Canada 2012)
- A monitoring plan should be developed in combination with the regulatory WWTP effluent monitoring to assess the response of the river to the effluent discharge. The monitoring plan will ultimately be

reviewed by CVC and regulated through the ECA and should include an assessment of fisheries, benthic invertebrates and aquatic habitat with sufficient effort to allow for natural variability to be controlled and allow for a sensitive determination of any impact.

Appendix A
Fluvial Geomorphological Assessment

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Fluvial Geomorphological Assessment of West Credit River to Support Siting of a Proposed WWTP Discharge Location

Prepared for

Hutchinson Environmental Sciences Ltd.

December 13, 2017

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

374 Wellington Street West, Suite 3, Toronto, ON M5V 1E3 ***t*** *647-795-8153*

December 13, 2017

Deborah Sinclair
Hutchinson Environmental Sciences Ltd.
1-5 Chancery Lane
Bracebridge, ON
P1L 2E3

Dear Ms. Sinclair,

Re: Fluvial Geomorphological Assessment of West Credit River to Support Siting of a Proposed WWTP Discharge Location

Palmer Environmental Consulting Group Inc. is pleased to provide the results of our fluvial geomorphological assessment of West Credit River between 10th Line and Winston Churchill Boulevard, in the Town of Erin, in support of the overall Class Environmental Assessment for urban centre wastewater servicing.

The subject reach of West Credit River is an irregular-meandering, partly confined channel that has adopted a stable cross-sectional form and pool-riffle bed morphology. The proposed effluent discharge (0.083 m^3/s) will have negligible impact on erosion processes along West Credit River, and the two proposed discharge locations (10th Line and Winston Churchill Boulevard) are both morphologically stable.

Should you have any questions, please do not hesitate to contact Robin McKillop at 647-795-8153 (ext. 106) or robin@pecg.ca.

Yours truly,
Palmer Environmental Consulting Group Inc.

Robin McKillop, M.Sc., P.Geo., CISEC
Principal, Senior Fluvial Geomorphologist

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1 Introduction

Palmer Environmental Consulting Group Inc. (PECG) is pleased to provide Hutchinson Environmental Sciences Ltd. (HESL) with the results of our fluvial geomorphological assessment of West Credit River, between 10th Line and Winston Churchill Boulevard, in the Town of Erin (**Figure 1**). The fluvial geomorphological assessment will support the overall Class Environmental Assessment for urban centre wastewater servicing in the Town of Erin, which includes a proposed wastewater treatment plant (WWTP) along County Road 52. Effluent from the WWTP will discharge into West Credit River. A fluvial geomorphological assessment is required as a basis for evaluating the morphological implications of increased flow in West Credit River. As well, the assessment encompassed candidate discharge locations, with an emphasis on documenting and analyzing conditions in the areas most sensitive to increases in flow.

2 Methods

The fluvial geomorphology of West Credit River was assessed through a combination of desktop and field investigations. We reviewed a number of important background information sources for the study area, including Credit Valley Conservation's (CVC) 2005 and 2013 Watershed Report Cards, Management Plan Credit River Fisheries (2002), and Rising to the Challenge: A Handbook for Understanding and Protecting the Credit River Watershed (2009); 50 cm topographic contour data provided by HESL; and Ontario Geological Survey bedrock and surficial geology mapping (Ontario Geological Survey, 2014a,b). Ortho-photography (2010) of the study area and Google Earth (2004, 2006, 2012, 2013, 2014, 2015, 2016) provided a basis for characterizing channel conditions in West Credit River.

Field reconnaissance and detailed data collection were completed on June 28, 2016 by PECG's Fluvial Geomorphologist during baseflow conditions without any significant antecedent precipitation. West Credit River was walked from ~400 m upstream of 10th Line to ~350 m downstream of Winston Churchill Boulevard to observe channel conditions, examine patterns and processes of local erosion, determine channel reach breaks, and ground truth aerial photograph-based interpretations. Furthermore, a Rapid Geomorphic Assessment (RGA; Ontario Ministry of the Environment, 2003) was completed along the study reach to document evidence of channel aggradation, degradation, widening and planimetric form adjustment. The RGA tool provides a useful checklist of evidence to consider, but its results are dependent on the presence or absence of a set number of specific features within a reach and thus must be interpreted carefully to ensure accuracy (McKillop, 2016).

Detailed data were collected at three sites in order to establish erosion thresholds: ~100 m downstream of 10th Line, ~100 m upstream of Winston Churchill Boulevard, and ~100 m downstream of Winston Churchill Boulevard (**Figure 1**). The three sites were deemed likely WWTP discharge locations through consultation with HESL (the proposed WWTP discharge locations were not determined at the time of the field work). Four to five cross-sections and a longitudinal profile were surveyed at each site according to CVC Fluvial

Geomorphic Guidelines (2015). The surveyed cross-sections were strategically positioned in representative morphological units (e.g. pools, riffles). Bankfull dimensions were based on field indicators defining the principal limit of scour, including abrupt changes in bank vegetation, material and steepness (Harrelson et al., 1994), which is assumed to represent the 'channel-forming discharge'. The grain size distribution of the alluvial material within each site was determined through modified Wolman (1954) pebbles counts.

All bed erosion threshold and critical discharge analyses were completed based on a Shields (1936) approach as outlined by Church (2006), as it is a semi-empirical approach (as opposed to completely empirical) and is well-suited for gravel bed rivers. A bed erosion threshold is the hydraulic condition at which the channel bed is in a state of incipient motion, and the critical discharge is the flow that produces that threshold condition at a particular location along the channel. Iterative hydraulic simulations were completed to determine the flow at which the erosion threshold is exceeded (i.e. critical discharge).

3 Physical Setting and Historical Changes

The Credit River watershed is within the Regional Municipality of Peel, Regional Municipality of Halton, Wellington County, and Dufferin County. Major urban centers within the watershed include Caledon, Brampton and Mississauga. The entire watershed encompasses 871 km^2 and the main branch of Credit River is ~90 km long and contains over 1,500 km of tributaries (Credit Valley Conservation, 2002). The Niagara Escarpment, a major topographic feature, runs diagonally across the watershed. The headwaters of Credit River, including West Credit River, are located above the Niagara Escarpment. Streams above the Niagara Escarpment have remained in a relativity natural condition (Credit Valley Conservation, 2009).

The West Credit River subwatershed comprises hummocky moraines and drumlins (Guelph Drumlin Field) as well as glacial spillways, yielding undulating topography (Credit Valley Conservation, 2009). Within the study area, the West Credit River flows within a valley dominated by glaciofluvial deposits and the channel is underlain by modern alluvial deposits. Prominent fluvial terraces are present along the edges of the valleys (Ontario Geological Survey, 2014b). The coarse sands and gravels of the surficial material are highly permeable and support high infiltration rates. As such, baseflow in West Credit River is maintained from groundwater discharge. Maximum stream flow typically occurs in late winter or early spring as a result of snowmelt or rainfall on frozen ground, or a combination of both. High intensity summer storms also lead to high flow events. Stream monitoring conducted by CVC in 2003 suggests that watercourses within the West Credit River subwatershed are stable channels that are "In Regime" (Credit Valley Conservation, 2009).

Traditionally, agricultural (primarily beef cattle farming) has been a dominant land use in the upper Credit River watershed; however, there has been a significant decrease in the amount of land cultivated in recent decades. Deciduous forests and white cedar swamps are common atop the Niagara Escarpment and it is estimated that 60% of the upper watershed is forested (Credit Valley Conservation, 2009). Upstream of the study reach, land use is mostly natural areas and agricultural. Furthermore, the West Credit River catchment has many wetland complexes that moderate flood flows (Credit Valley Conservation, 2002).

Client: Hutchinson Environmental Services Limited
Project: Erin Waster Water Treatment Plant

PREPARED BY:
PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DRAWN: B. Elder
DESIGNED: D. McParland
CHECKED: R. McKillop
PROJECT: 13183
DATE Jul 26, 2017

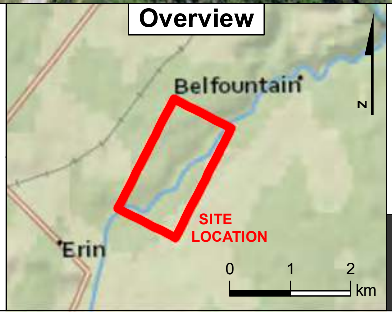
LEGEND

- Detailed Data Collection Site
- Anthropogenic Rock Weir
- Candidate Discharge Location
- Reach Break
- Flow Direction
- Contour (5 m Interval)
- Contour (1 m Interval)

DATA SOURCES: SWOOP Aerial imagery (2010) and topographic data provided by Hutchinson Environmental Services Limited. Roads, Additional basemap imagery ©ESRI, DigitalGlobe 2010. Inset backgorund - National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN (Content may not reflect National Geographic's current map policy).

COORDINATE SYSTEM:
NAD 1983 UTM ZONE 17N
SCALE: 1:5000

0 50 100 150 200 250
METRES



Study Area and Detailed Data Collection Sites

FIGURE 1

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4 Description of Channel Morphology

A description of channel morphology at the reach scale is provided in Section 4.1. Results of the site-scale detailed data collection, including the erosion threshold analyses, is documented in Section 4.2.

4.1 Reach Scale

A partly confined reach extending from ~50 m upstream of 10th Line to ~350 m downstream of Winston Churchill Boulevard was identified (**Figure 1**). Upstream of the reach, West Credit River is unconfined and low gradient and contains many large woody debris (LWD) jams. Downstream of the reach, the channel is significantly backwatered upstream of an anthropogenic rock weir. The identified reach exhibits a low-sinuosity, irregular meander pattern and is partly confined by prominent fluvial terraces and valley walls. The channel has a moderate gradient and, generally, has a defined pool-riffle bed morphology with pools located near the apices of meanders. The pool cross-sections tended to be asymmetric with larger depths along the outer bank, whereas riffles are typically symmetrical.

Bed material in the riffles is mostly coarse gravel and cobble derived from erosion of the underlying glaciofluvial materials. The coarser cobble particles are commonly covered in aquatic lichens and mosses, indicating they are rarely entrained (**Photo 1**). The bed material in the pools is dominated by gravel covered with a thin veneer of silts and sands. Bank materials are dominated by alluvial sands and silts. The channel banks are well-vegetated and have gentle slopes. Minimal bank and bed erosion was observed within the reach. The riparian vegetation, which is a mixture of herbaceous and mature forest, has locally been cleared near residential properties. Throughout the reach, fallen/leaning trees line the channel banks and many LWD jams are present (**Photo 2**). The jams locally perturb the energy gradient, cause local channel braiding/cutoffs, and store significant volumes of gravel (**Photo 3**). Furthermore, five anthropogenic rock weirs were observed adjacent to the residential properties (**Photo 4**). The rock weirs cause local channel impoundment but have minimal impact on channel morphology at the reach scale.

Overall, the study reach of West Credit River exhibits only minor departures from a state of dynamic equilibrium with an RGA Stability Index of 0.29 (**Table 1**). According to the RGA, aggradation and widening were the dominant modes of adjustment based on the following observations: embedded coarse material in riffles, siltation in pools, deposition in overbank zone, fallen/leaning trees, occurrence of large organic debris, exposed tree roots. Based on professional interpretation of reach-scale geomorphological form and processes, the channel lacked strong evidence of a dominant mode of channel adjustment and was in a state of dynamic equilibrium. Localized channel instabilities were, for the most part, caused by LWD jams.

Photo 1. Algae covered cobble

Photo 2. Fallen trees within the bankfull channel

Photo 3. Local channel splitting due to downstream LWD jam

Photo 4. Looking upstream at an anthropogenic rock weir

Table 1. Summary Results of Rapid Geomorphic Assessment (RGA) along West Credit River

Form/Process	Index
Evidence of Aggradation	0.43
Evidence of Degradation	0.00
Evidence of Widening	0.43
Evidence of Planimetric Form Adjustment	0.29
Stability Index	**0.29**
Classification	**Transitional or Stressed**

4.2 Site Scale

All three detailed data collection sites had similar bankfull channel dimensions (**Table 2**) and bankfull channel hydraulics (**Table 3**). The width to depth ratios are greater than 20 at all three sites, indicating the channel has good access to its floodplain (i.e. is not entrenched). Due to increases in cross-sectional area, the bankfull discharge increased in the downstream direction. All three sites have sub-critical flows conditions (Froude Number < 1) at bankfull conditions.

Table 2. Averaged bankfull channel dimensions

Measure	Site 1	Site 2	Site 3
Width (m)	11.62	13.25	13.25
Average Depth (m)	0.52	0.52	0.66
Maximum Depth (m)	0.71	0.65	0.88
Width:Average Depth	22.56	26.43	20.06
Cross-sectional Area (m^2)	6.02	6.80	8.83

Table 3. Averaged bankfull channel hydraulics

Measure	Site 1	Site 2	Site 3
Energy Gradient (m/m)	0.0028	0.0036	0.0025
Discharge (m^3/s)	6.23	9.51	10.49
Average Velocity (m/s)	1.03	1.38	1.18
Froude Number	0.46	0.62	0.46
Average Shear Stress (N/m^2)	13.82	24.84	15.85

Notes: Manning’s ‘n’ assumed to be 0.035 for all-cross-sections for the full range of flows because the beds are level with water levels much deeper than the grains are in diameter and the channel had moderate sinuosity (Hicks and Mason, 1998)

All three sites had similar grain size distributions dominated by gravels (**Table 4**). The critical discharge was lowest at Site 2, likely because it had the steepest energy gradient that induces entrainment of the gravel bed material more readily than the other two sites (**Table 5**). The critical discharges ranged from 52 to 84% of bankfull discharge, indicating there are few sediment transport inducing events in a given year. The stable pool-riffle morphology and moss-covered cobble corroborate these critical values.

Table 4. Grain size distribution summary statistics

Measure	Site 1	Site 2	Site 3
D_{16}	5	9	5
D_{35}	13	18	16
D_{50}	22	26	24
D_{65}	35	34	35
D_{84}	58	70	90

Notes: D_x is the grain size than which X% of the substrate is finer

Table 5. Critical hydraulic conditions

Measure	Site 1	Site 2	Site 3
Critical Shear Stress (N/m^2)	16.02	18.81	17.16
Critical Discharge (m^3/s)	5.21	4.91	7.84
% of Bankfull Flow	84	52	75

Notes: Critical Shields parameter used to calculate erosion thresholds was 0.045 because the channel had stable gravel-cobble bedforms (Church, 2006)

5 Effluent Discharge Rate and Location

The following information regarding the effluent discharge rates and location was provided to PECG by HESL in February 2017:

- The proposed effluent discharge will be a constant 0.083 m^3/s
- The 7Q20 flow for the subject reach of West Credit River is 0.225 m^3/s
- The two candidate discharge locations are the 10^{th} Line road crossing and the Winston Churchill Boulevard road crossing

The proposed effluent discharge of 0.083 m^3/s is 0.8% to 1.3% of the bankfull discharge and 1.1% to 1.7% of the critical discharge, based on channel measurements and erosion threshold analyses at three sites (see **Section 4.2**). Given that sediment transport occurs almost exclusively during moderate to high flow events, once a local erosion threshold has been exceeded, it follows that channel morphology (and the aquatic habitat it supports) is largely determined by moderate to high flows (Knighton, 1998). A relatively small increase in discharge at critical and bankfull conditions will have an unmeasurable and negligible impact on natural erosional processes along West Credit River. Furthermore, due to minimal anthropogenic disturbance and upstream urbanization, West Credit River has adopted a stable geomorphological form. Thus, there is little concern the effluent discharge will disrupt the existing dynamic equilibrium of West Credit River or exacerbate existing instabilities.

Detailed morphological data were collected immediately downstream of both candidate effluent discharge locations. Both locations are morphologically stable with no specific erosion concerns. Discharging the effluent at either location is appropriate from a fluvial geomorphological perspective. The outlet should be oriented in the downstream direction require energy dissipation measures regardless of the flow conditions in the channel. The flow dissipation can be as simple as a rip-rap splash pad, baffle features, and/or a drop-structure. Discharging the effluent downstream of the road crossing is ideal from a fluvial geomorphology perspective because crossing inlets can be zones of complex hydraulics that lead to bank and bed scour. Additional flow from the proposed outlet could exacerbate the tractive forces and turbulent flow at the inlet. However, discharging the effluent upstream of the crossing is appropriate from a geomorphology perspective provided appropriate energy dissipation measures are installed and the hydraulic modelling confirms that the discharge will not exacerbate tractive forces or turbulent flow at the inlet and through the road crossing.

6 Summary and Conclusions

PECG completed a fluvial geomorphological assessment of West Credit River between 10th Line and Winston Churchill Boulevard, in the Town of Erin, as a basis for evaluating the morphological implications of increased flow in West Credit River from a proposed WWTP. The assessment included establishing erosion thresholds and documenting existing channel processes and areas of instability. The subject reach of West Credit River is an irregular-meandering, partly confined channel that has adopted a stable cross-sectional form and pool-riffle bed morphology. The proposed effluent discharge (0.083 m^3/s) will have negligible impact on erosion processes along West Credit River. The two proposed discharge locations (10th Line and Winston Churchill Boulevard) are morphologically stable with no existing erosion concerns. The outlet should be constructed in such a manner that flow is not directed towards the bed and/or bank, and some form of energy dissipation is utilized.

7 Certification

This report was prepared and reviewed by the undersigned:

Prepared by:

Dan McParland, M.Sc., P.Geo.
Fluvial Geomorphologist

Reviewed by:

Robin McKillop, M.Sc., P.Geo., CISEC
Principal, Senior Fluvial Geomorphologist

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