Urban Centre Wastewater Servicing
Class Environmental Assessment
Volume 3

Appendix K – V

Appendix - K

Wastewater Collection Alternatives

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File No. 115157

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

Ref: **Town of Erin, Urban Centre Wastewater Class EA**
Wastewater Collection Alternatives, Technical Memorandum

Dear Ms. Furlong:

We are pleased to present the Project File Report for the "Wastewater Collection System" for the Urban Centre Wastewater Servicing Schedule 'C' Municipal Class Environmental Assessment (EA).

This Technical Memorandum provides a review of the Wastewater Collection System Alternatives and includes those alternatives identified in the Servicing and Settlement Master Plan (SSMP). The Technical Memorandum establishes and evaluates alternative for the collection system as a component of Phase 3 of the Municipal Class EA process. The recommended preferred Alternative is presented in the Technical Memorandum which will remain in draft until completion of the public review process.

Yours truly,

AINLEY & ASSOCIATES LIMITED

Joe Mullan, P.Eng.
Project Manager

Town of Erin
Urban Centre Wastewater Servicing
Class Environmental Assessment

Technical Memorandum
Wastewater Collection System Alternatives

Final

April 2018

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Wastewater Collection System Alternatives

Project No. 115157

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Glossary of Terms

ACS	Assimilative Capacity Study: see assimilative capacity.
Assimilative Capacity	Assimilative capacity refers to the ability of a body of water to cleanse itself; its capacity to receive waste waters or toxic substances without deleterious effects and without damage to aquatic life or humans who consume the water.
ADF	Average Daily Flow, typically presented through the report in units of cubic metres per day (m3/d).
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.
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.
Catchment	The collection of water over a drainage area due to the ground's natural topography. In sewer works, a catchment is the area over which wastewater is collected to a single point.
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.
Cover	The depth of a buried pipeline measured from the ground surface to the obvert of the pipe.
Design Concept	A method of implementing an alternative solution(s).
Drain, Waste and Vent (DWV)	A piping system that removes sewage and greywater from a building and regulates air pressure in the waste-system pipes in order to aid free flow. Negative pressure is relieved and odours are expelled through the utilization of an air vent.
Dynamic Head-Loss	Additional pumping pressure required to overcome an increase in friction loss within a pipeline.
EA Act	*Environmental Assessment Act*, R.S.O. 1990, c.E.18 (Ontario)
Easement	An easement is a nonpossessory right to use and/or enter onto the real property of another without possessing it.
Effluent	Liquid after treatment. Effluent refers to the liquid discharged from the WWTP to the receiving water.
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.
Gravity Sewer	A pipe that relies on gravity to convey sewage.
Gravity Line	The energy grade line of water without external pressure applied to it, which is a dependent on its elevation.
Horizontal Directional Drilling (HDD)	A trenchless technology method of pipeline construction that could be used for the construction of sewage forcemains or for small diameter sewer construction under watercourse crossings.
Infill	A process of development within urban areas that are already largely developed. Refers specifically to the development of vacant or underdeveloped lots.

Infiltration/Inflow (I&I)	Rainwater and groundwater that enters a sanitary sewer during wet weather events or due to leakages, etc.
Intensification	A process of development within existing urban areas that are already largely developed. Refers specifically to the redevelopment of lots to increase occupancy.
Interceptor tanks	A tank intercepting effluent from the house to the main, such as a septic tank.
kWh	Kilowatt Hour, a composite unit of energy equivalent.
Lifecycle Cost	The total cost of facility ownership. It takes into account all costs of acquiring, owning, operating, and disposing of an asset.
Lift Station	See Sewage Pumping Station.
LPS System	Low-Pressure Sewer System refers to a network of grinder pump units installed at each property pumping into a common forcemain.
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.
MEA	The Ontario Municipal Engineers Association (MEA) is an association of public sector Professional Engineers in the full time employment of municipalities performing the various functions that comprise the field of municipal engineering.
Minimum Scouring Velocity	The minimum velocity in a gravity sewer that allows self cleansing of the pipe.
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.
Negative Line Pressure	The negative pressure required for fluids to be sucked to a vacuum station.
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.
Peaking Factor	The Harmon Peaking Factor is applied to the average daily flow in order to account for the possibility of uncertainty or underestimation. This factor reduces as contributing population increases and vise versa.
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.
Private Treatment System	Lot-level or communal sewage treatment methods, such as septic systems or aerobic treatment systems, which remain in private ownership.
Sewage Pumping Station (SPS)	A facility containing pumps to convey sewage through a forcemain to a higher elevation.
ROW	Right-of-way applies to lands which have an access right for highways, roads, railways or utilities, such as wastewater conveyance pipes.
Sanitary Sewer	Sewer pipe that conveys sewage to a sewage pumping station or sewage treatment plant. Part of the sewage collection system.
Screening Criteria	Criteria applied to identify the short-list of alternative solutions from the long-list of alternative solutions.
Septic Waste	Wastewater characterised by the absence of dissolved oxygen and high concentration of sulphides and odours.

Service Area	The area that will receive sewage servicing as a result of this study.
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.
Small Bore Sewer	A sewer system that collects all household wastewater (blackwater and greywater) from septic tanks into small-diameter pipes laid at fairly flat gradients.
Slurry	A semiliquid mixture of fine particles of manure suspended in water.
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.
STEP/STEG	Septic Tank Effluent Pumping/ Septic Tank Effluent Gravity, refers to a method of wastewater collection which collects the liquid portion of waste from the septic tanks while the solids remain for removal and treatment by a separate method.
Study Area	The area under investigation in which construction may take place in order to provide servicing to the Service Area.
Trenchless technology	Methods of installing a utility, such as a sewer, without excavating a trench, including directional drilling, microtunneling etc.
Trunk Sewer	A sewer that collects sewage from a number of tributary sewers.
UCWS Class EA	Urban Centre Wastewater Servicing Class Environmental Assessment
Vacuum Sewer System	A vacuum sewer system is a method of transporting sewage from its source to a sewage treatment plant. It uses the difference between atmospheric pressure and a partial vacuum maintained in the piping network and vacuum station collection vessel
Wastewater	See Sewage
Wastewater Treatment Plant (WWTP)	See Sewage Treatment Plant.

1.0 Introduction

In 2014, the Town of Erin completed a Servicing and Settlement Master Plan (SSMP) to address servicing, planning and environmental issues within the Town. The study area for the SSMP included Erin Village and Hillsburgh as well as a portion of the surrounding rural lands. The SSMP considered servicing and planning alternatives for wastewater and identified a preferred wastewater servicing strategy for existing and future development in the study area. The SSMP was conducted in accordance with the requirements of the Municipal Class Environmental Assessment (Class EA), which is an approved process under Ontario's Environmental Assessment Act (EA Act*) and addressed Phase 1 & components of Phase 2 of the Class EA planning process.

Through the Urban Centres Wastewater Servicing Class EA (UCWS Class EA) the Town is now continuing with a review of Phase 2 and completing Phases 3 & 4 of the Class EA Planning Process to determine the preferred design alternative for wastewater collection for the existing urban areas of Erin Village and Hillsburgh, and to accommodate future growth. The aforementioned SSMP concluded that the preferred solution for both communities is a municipal wastewater collection system conveying sewage to a single wastewater treatment plant located south east of the Erin Village with treated effluent being discharged to the West Credit River servicing a population of 6,000. In completing Phase 2 activities within the UCWS Class EA, the preferred solution, remains as established under the SSMP, however, the service population potential has increased to 14,559 persons based on the Assimilative Capacity Study (ACS) review completed under this Class EA.

The UCWS Class EA will outline a wastewater servicing plan for a population of 14,559, sufficient to service both existing communities and full build-out growth. However, at present there are no approved developments for designated growth areas and no basis to determine local collection systems for these development areas. As such, this "Collection System Alternatives" technical memorandum compares the collection system technologies on the basis of servicing the existing communities including infill and intensification and potential growth within the urban boundaries. This technical memorandum shows the cost to service existing developed areas and convey the wastewater to the treatment plant. In addition, this technical memorandum identifies the "oversizing" required to the trunk network to service growth to full build-out.

During Phase 3 of the UCWS Class EA, the SSMP's preferred alternative solution is refined and a preferred design concept for wastewater* collection is identified. This Class EA process follows the planning and design process for Schedule 'C' projects as described in the Municipal Class Environmental Assessment Document (October 2000 as amended in 2007, 2011 & 2015), published by the Municipal Engineer's Association (MEA).

1.1 Objectives

The objective of this technical memorandum is as follows:

- Identify the range of collection system alternatives
- Present the advantages and disadvantages of each system as it applies to the Town of Erin
- Screen out alternatives that do not meet the requirements of the community
- Establish evaluation criteria
- Evaluate system capital costs, maintenance costs, and lifecycle costs
- Compare the "short list" of collection alternatives under the evaluation/Screening criteria

- Select a recommended system alternative

2.0 Defining Collection Areas

In order to develop the layout of a proposed wastewater* collection system, it is essential to review the topography of the Town. No matter which alternative system is used, there are geographical features which will necessitate the use of pumping facilities in order to transmit all of the wastewater to the treatment plant location. In examining the planned service areas, the natural topographical restraints dictate how the wastewater will generally be conveyed to the Wastewater Treatment Plant (WWTP) from each area of the two communities. Wastewater collection systems are generally composed of two main elements:

- A "Trunk System" that conveys wastewater through all of the individual areas, all the way to a WWTP. It generally consists of main sewers, pumping* stations and forcemains that form the back bone of the system
- "Collection Areas" servicing properties in a specific area and connecting to the Trunk System by gravity or by pumping depending on the topography in the areas and the system adopted.

The Trunk System would consist of main trunk lines, pumping stations and forcemains that intercept individual Collection Areas and convey wastewater through the entire system from Hillsburgh to the WWTP south of Erin Village. The most efficient Trunk System typically passes through or close to all of the individual "Collection Areas" making best use of gravity. It should also pass as close as possible to planned future development areas.

Collection Areas are developed by examining the pattern of development as well as topography and the natural drainage patterns throughout the service area. Since both Erin Village and Hillsburgh may be characterised as undulating, this presents challenges for the development of a wastewater collection system and results in multiple Collection Areas to service the existing communities. An example of the challenges presented by the natural topography would be the river valley between the Erin Heights subdivision and Main Street through Erin Village necessitating a pumping station to convey wastewater from the Erin Heights Collection Area to the Trunk System through the village.

During Phase 2 of the UCWS Class EA, in reviewing the condition of existing septic systems, "Decision Areas" were developed essentially representing "Collection Areas" in order to assist in determining the extent of the potential service area. This section of the Technical Memorandum discusses in detail the potential challenges for the establishment of a collection system within each "Decision Area" as defined by the Septic System Overview Memorandum. The challenges are discussed in general as they apply to all potential collection system alternatives. The impacts specific to each collection system technology will be discussed through Section 3.0.

2.1 Erin Village – Industrial Area

The industrial area in Erin is located at the north end of Erin Village primarily located along Thompson Crescent, Erinville Drive, Erin Park Drive, and Pioneer Drive.

There are two locations within this area which present challenges for the establishment of a wastewater collection network, shown in Figure 1:

- The intersection of Sideroad 17 and Shamrock Road is at a significantly higher elevation compared to the intersection of Pioneer Drive and Sideroad 17.

- The turning circle at the south end of Erin Park Drive is 4.25 m below the intersection of Erin Park Drive and Erinville Drive.

Figure 1 – Industrial Area Design Challenges

2.2 Erin Village – Town Core 1

The area designated as Erin Town Core 1 comprises the majority of Erin Village and is primarily residential development. The area is bounded at the north end by Elora Cataract Trail and on the south end by the West Credit River.

There are five locations within this area which present challenges for the establishment of a wastewater collection system, shown in Figure 2:

- The intersection of Boland Drive and Dundas Street East is at an elevation 2 m below the surrounding area. In order to achieve adequate fall from Erinlea Crescent to Daniel Street along Dundas Street East, the sewer cover quickly reaches 9 m depth.
- The intersection of May Street and Pine Street is approximately 3 m below the surrounding area. In order to achieve adequate fall from the north end of May St. to Daniel St., the sewer along Daniel St. would need to be placed at a minimum depth of 5.3 m.
- Carberry Street and Dundas Street West both drop off rapidly in elevation when approaching the West Credit River. The intersection of Carberry Street and Dundas Street West is 3 m below the intersection of Dundas Street West and Main Street.
- There is a low lying area at the intersection of the south end of Erinlea Crescent and Scotch Street. The low lying area at this intersection is 2 m below the surrounding area.

- The fifth and final challenge is Wheelock St. connected to East Church St. The east end of Wheelock St. is 6 m below the intersection of East Church St. and Daniel Street.

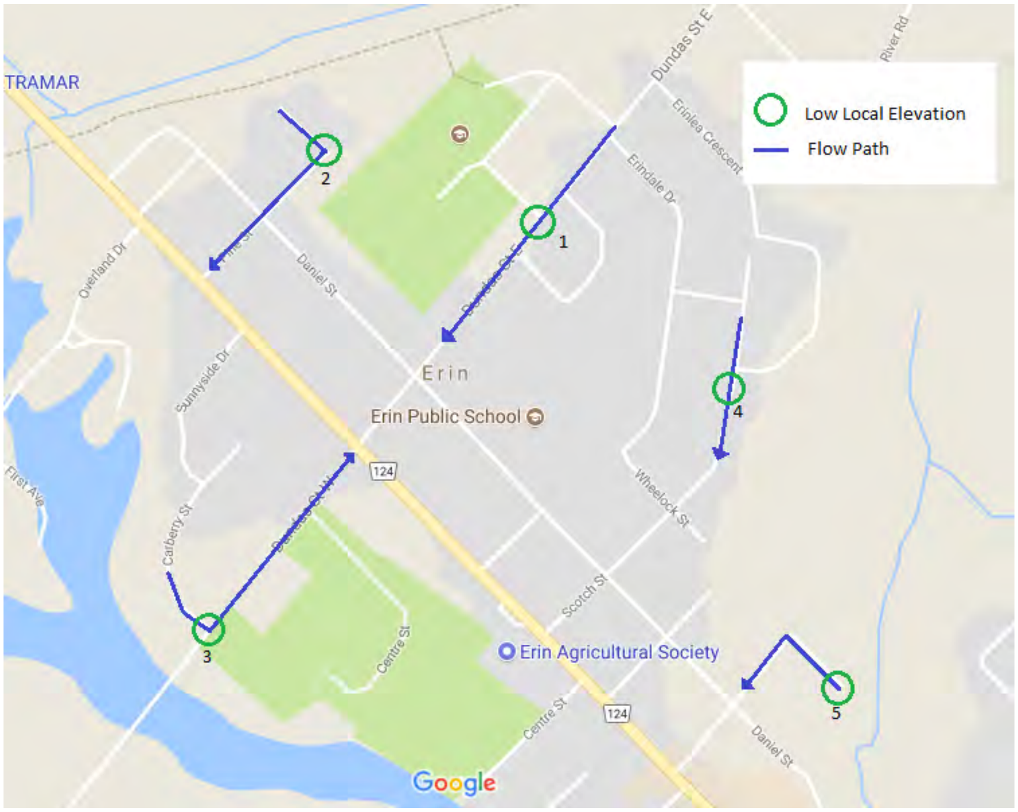


Figure 2 – Erin Town Core 1 Design Challenges

2.3 Erin Village - Town Core 2

The area designated as Erin Town Core 2 is at the south end of the Erin Village and primarily consists of residential development. The area is bounded at the north end the West Credit River and on the south end by Wellington 124 Rd.

There are two locations within this area which present challenges for the establishment of a sewer network, shown in Figure 3:

- The north end of Waterford Drive which is at an elevation 6 m below Main Street.
- There is a creek crossing south east of the intersection of Main Street and Wellington 124.
- There is a river crossing near the intersection of Water St. and Main St.

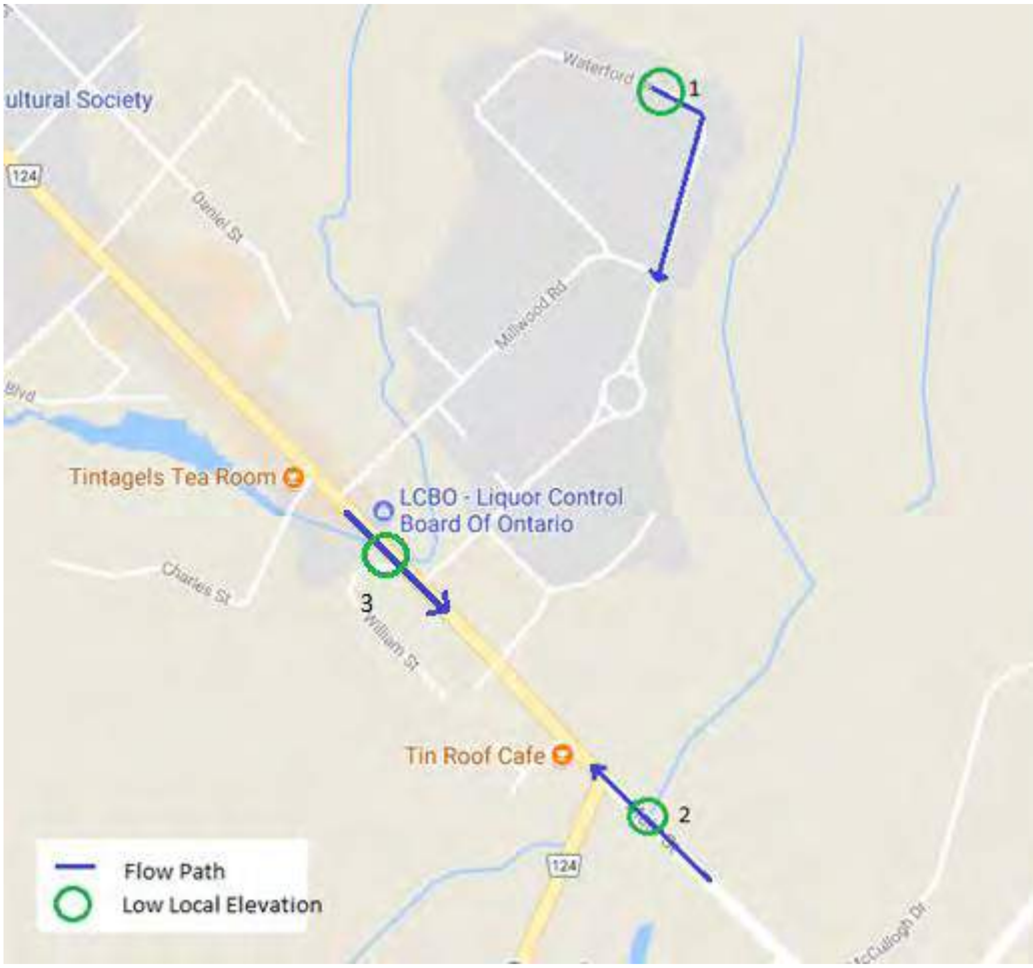


Figure 3 – Erin Town Core 2 Design Challenges

2.4 Erin Village – South East Erin

The area designated as South East Erin is primarily a residential area with limited commercial properties and covers the properties in Erin along 9^{th} Line south of Wellington Rd 124. There are no significant drainage challenges for this area. The area naturally slopes down to the intersection of Main St. and Wellington Road 124.

2.5 Erin Village – Erin Heights

The Erin Heights area is a residential subdivision which is separated from the downtown by the West Credit River valley.

The elevations within this area are highly variable with the lowest point located at approximately 145m of Erin Heights Dr. north of Dundas Street West with an elevation 10-30 m lower than the surrounding area. The steep topography forms a natural drainage to the low lying area however there is no natural outlet to Main Street. Drainage from this subdivision to a trunk sewer in the core of Erin is not feasible by any means other than pumping.

2.6 Hillsburgh - Town Core 1 and 2

The areas designated as Hillsburgh Town Core 1 and 2 comprise the majority of the community and are primarily residential development, along with the majority of commercial properties in Hillsburgh. In total, these areas are bounded at the north by Howe St., Trafalgar Road on the west and to the south by Douglas Cres.

There is one challenge to servicing this area, shown in Figure 4:

- A stream runs parallel to Mill St. and separates the Town Core 1 and Town Core 2 areas. It is suggested that a single crossing of the stream be established along Covert Lane. A pump station will be required for this collection area regardless of system type.

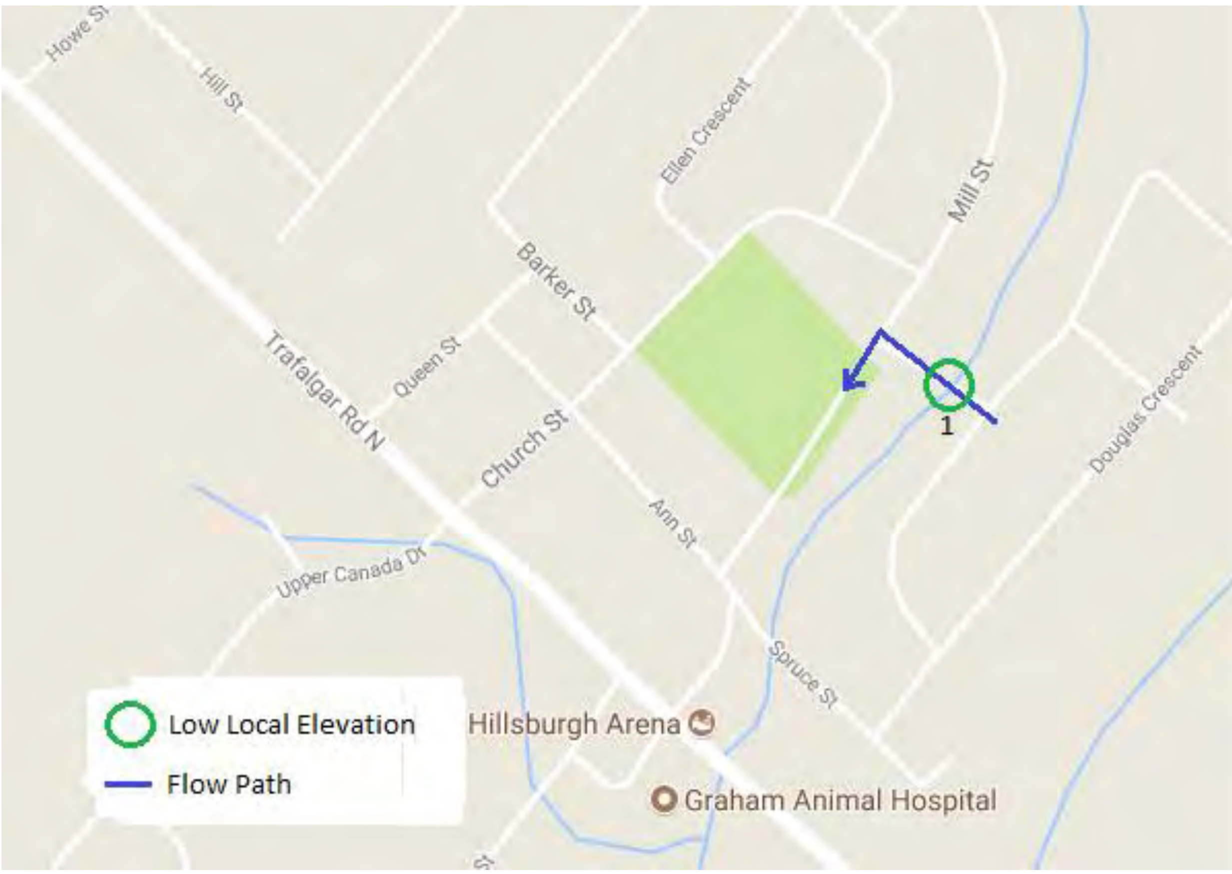


Figure 4 – Hillsburgh Town Core 1 and 2 Design Challenges

2.7 Hillsburgh - George Street

George Street is a short residential street on the west side of Trafalgar Road.

There are no design challenges for this area; George Street can be connected to the Hillsburgh Town Core Area 1 and 2 collection area.

2.8 Hillsburgh - South Trafalgar Road

South Trafalgar Road includes all the properties along Trafalgar Road south of Mill Street. A sewage pumping station will be required at the south end of Trafalgar Rd. to accept waste from this area and transmit it to Erin Village.

There is one challenge to servicing this area, shown in Figure 5:

- A stream crosses Trafalgar Road directly south of the Hillsburgh Arena.

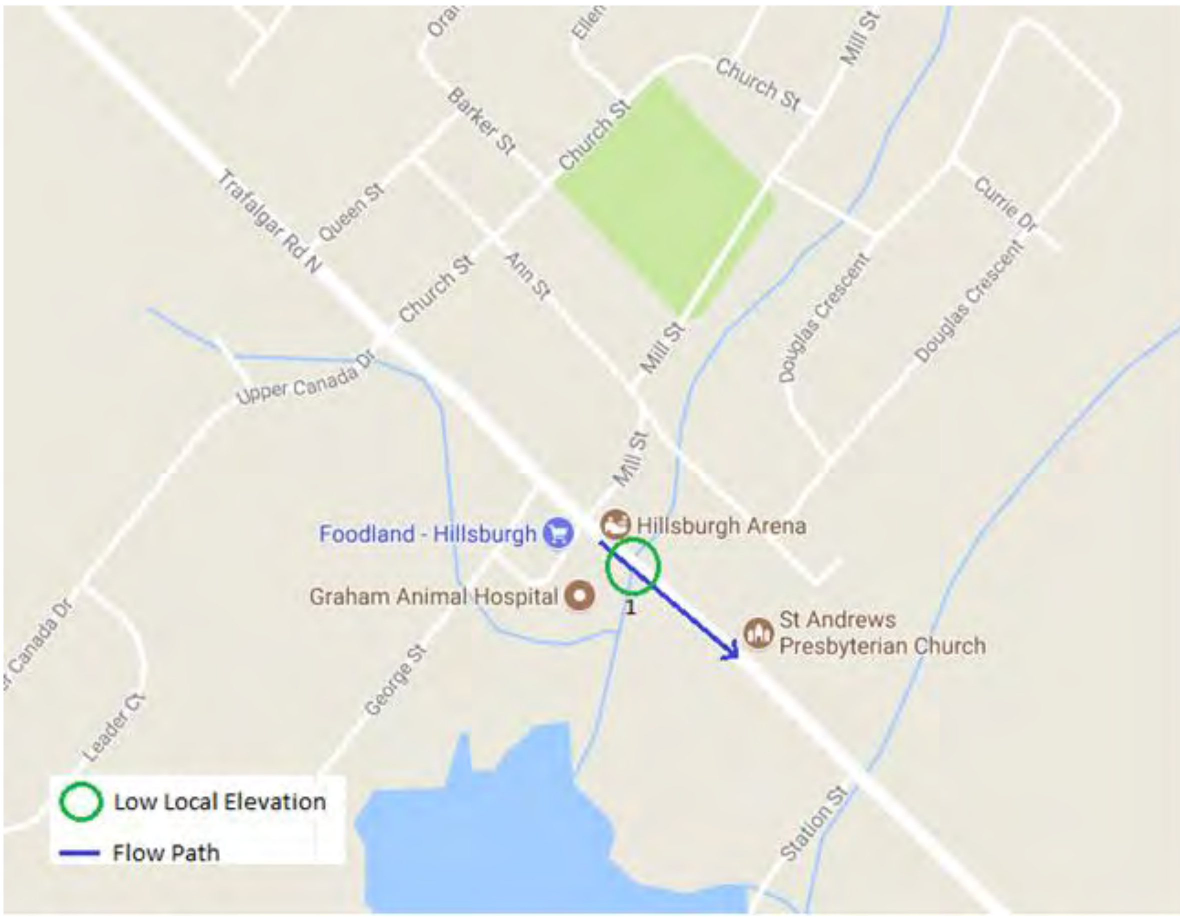


Figure 5 – South Trafalgar Road Design Challenges

3.0 Phase 3A: Identify Alternative Design Challenges for the Wastewater Collection System

Phase 3 of the Class EA process can generally be separated into two parts: the identification of alternative design concepts and the evaluation of alternative designs. A primary objective of Phase 3A is the identification of feasible alternative design concepts for a preferred solution. For Phase 3A, the six (6) alternatives design concepts considered for sanitary drainage include:

- Gravity Sewers
- Modified Gravity Sewers
- Gravity/Low Pressure Sewer Blended Sewer System

- STEG/STEP Sewer System
- Low Pressure Sewer System (LPS System)
- Vacuum Sewer System

3.1 Gravity Sewers

3.1.1 Description

Gravity sewer systems are a proven, reliable technology, requiring minimal maintenance. They typically have a long service life with low operating costs. Wastewater from each source is conveyed through a building sewer to a collection line. If gravity flow is not possible throughout the system, lift stations (pumps) are used. Lift stations are installed at the lowest elevations of the network in order to pump the sewage to another gravity line, to convey wastewater over hills, and/or up to a trunk system that conveys the wastewater to the WWTP.

3.1.2 Conceptual Planning

In order to properly consider the economic and technical impacts of a gravity system for the service areas, a conceptual system layout was developed.

A potential gravity system design alternative was developed using the SewerGEMS sanitary modeling platform. Building upon the issues identified in Section 2, the collection system has been separated into four primary catchments / collection service areas. The catchment areas are shown graphically in ***Appendix A*** and the catchments identified are discussed herein. Additionally, 4 sub-catchments have been identified all discharging to Catchment 4.

A trunk system was developed to convey wastewater from all of the existing catchments through to the WWTP. The trunk network is shown graphically in ***Appendix B***. This trunk system consists of the following elements:

- a sewer on Trafalgar Road in Hillsburgh ,
- a pumping station at the junction of the Elora Cataract Trail and Trafalgar Road in Hillsburgh,
- forcemains from the Hillsburgh pumping station to a pumping station on Main Street in North Erin Village,
- a pumping station on Main Street in North Erin Village,
- a forcemain from the North Erin Village pumping station along Main Street to the intersection of Main Street and Dundas Street,
- a trunk sewer down Main Street and Daniel Street to a pumping station in South Erin Village,
- a pumping station in South Erin Village,
- forcemains from the South Erin Village pumping station to the WWTP site.

Hillsburgh Town Core (Catchment 1)

The Hillsburgh Town Core catchment collects all wastewater from the main residential area of Hillsburgh including the properties along George Street. It is recommended that this catchment should terminate at a location on Mill St south of Covert Lane. One stream crossing will be required for this catchment to transmit flow from the Douglas Crescent Area to the proposed pumping station location. The pumping station at this location will pump to the north end of Catchment 2.

Trafalgar Road North (Catchment 2)

The Trafalgar Road North catchment collects all wastewater along Trafalgar Road South of the main residential area. A potential pumping station location has been identified at the intersection of Trafalgar Road North and the Elora Cataract Trail. The trunk sewer for this catchment would transmit flow from Catchment 1 and Catchment 2. The pumping station at this location will pump wastewater from Hillsburgh to Erin Village.

North Erin Village (Catchment 3)

The North Erin Village catchment collects all wastewater from the industrial area and a portion of the wastewater from the core residential area. A potential pumping station location for this catchment has been identified near the intersection of the Elora Cataract Trail and Main Street in Erin Village. The pumping station at this location will pump wastewater to the trunk sewer that's starts at the intersection of Main St. and Dundas St. in Erin Village.

South Erin Village (Catchment 4)

The South Erin Village catchment collects waste from locations within Erin Village, south of Scotch St. In addition, this catchment also includes the Erin Heights Dr. subdivision. It is recommended that this catchment should terminate around the intersection of Main St. and Wellington Road 124 or alternatively in Lion's Park. All waste from Hillsburgh and Erin Village will ultimately pass through this station and be transmitted to the preferred treatment plant location.

Erin Heights, Sub-Catchment 1

The Erin Heights subdivision is separated from the downtown of Erin Village by a significant river valley intersecting Dundas St. W. west of Carberry St. In addition, the Erin Heights subdivision is situated on a significant slope with an elevation difference of over 30 m between the highest location at the west side of the subdivision and the lowest location at the northern most extent of Erin Heights Drive. Based on the local topography, a pumping station will be required at the north end of the sub-catchment.

Dundas St. E., Sub-Catchment 2

The intersection of Dundas St. East and Tomwell Crescent is a local low point which lies at an elevation of 5 m below the surrounding area. Connecting this low lying area to a gravity main along Daniel St. or Main St. would require an excessively deep excavation, in excess of 9 m at some points, in order to convey wastewater to the primary pump stations for either North Erin Village or South Erin Village. A local pumping station is one option to eliminate the requirement for such a deep trunk sewer excavation.

Scotch St., Sub-Catchment 3

A section of Scotch St., north of the intersection with Wheelock St. lies at an elevation 4 m below the surrounding area. Connecting this low lying area to a gravity main along Daniel St. would require a section of the Daniel St. sewer to be constructed at a depth of up to 10 m. A local pumping station eliminates the requirement for an excessively deep trunk sewer along Daniel St. This pumping station would lift wastewater to a sewer on Main St. or Daniel St. which would eventually reach the primary pumping station for the south end of Erin Village.

Wheelock St., Sub-Catchment 4

The east end of Wheelock St. lies at an elevation of 6 m below the intersection of East Church St. and Daniel St. Due to this drop in elevation in this area, connecting the few homes on this street to a gravity sewer on Daniel St. would require the trunk sewer to be constructed at a depth in excess of 10 m. A local pumping station eliminates the requirement for an excessively deep trunk sewer along Daniel St. This pumping station would lift wastewater to a sewer on Daniel St. which would eventually reach the primary pumping station for the south end of Erin Village.

3.1.3 Gravity Conceptual Plan (Downtown Servicing)

After the baseline gravity collection system layout was completed, a more focused assessment of servicing the downtown core area of Erin was conducted. There are a series of commercial buildings along Main St. between East Church St. and Millwood Rd. which would be difficult to connect to a sewer main along Main St. Instead, it is proposed that the main trunk be situated on Daniel St and continue along the driveway which extends from the end of Daniel St. to Millwood Rd; this sewer would service the commercial buildings on the east side of Main St. In addition, a gravity main would be required along the path extending from Church Blvd. to Charles St. behind the buildings on the west side of Main St. for servicing. The proposed gravity sewer alignment is provided graphically in ***Appendix C***.

3.1.4 Analysis of Gravity Sewer Alternatives

Alternative 1A – Traditional Gravity Sewer System

The traditional gravity sewer system consisting of the Catchment area servicing and the trunk system is described in Section 3.1. This approach will require owners to remove their septic tank and connect to the new system at the street line. Advantages and disadvantages of traditional gravity sewers are listed in Table 1.

Table 1 – Advantages and Disadvantages for Traditional Gravity Sewer System

Advantages	Disadvantages
▪ Widely used throughout Ontario and the developed world ▪ Secure operation not dependent on power supply ▪ Not a proprietary technology ▪ Suitable for areas with natural slope/terrain ▪ Proven technology with good track record ▪ Familiarity with the operation and maintenance ▪ System primarily constructed in the road allowances ▪ There are no mechanical components on private properties for gravity connections and little routine maintenance is associated with connections and main sewers ▪ Operational costs for the gravity sewer systems mainly associated with lift stations. ▪ Lift Station operation is made secure through the use of a stand by power unit and can be fully automated. ▪ New developments where all utilities are being placed in new streets, typically have a reduced	▪ Deeper excavations may require some excavations in Bedrock to achieve gravity flow ▪ Potential for inflow and infiltration due to leaky pipes/manholes in the future ▪ Due to topography within study area, multiple lift stations are required ▪ Property will be required to facilitate the installation of the lift stations and sewer easements through Main Street ▪ Homeowner connection costs can be high where lots slope below road. ▪ MOECC design guidelines require a minimum 200mm diameter for gravity sewers. ▪ Septic tanks and tile beds to be decommissioned by the property owner.

Advantages	Disadvantages
cost for gravity sewers. ▪ No municipally owned sewer components to operate and maintain on private property ▪ Both liquid and solid components of sewage. removed from the property at the same time.	

Alternative 1B – Modified Gravity System

A modified gravity sewer system is similar in principle to a traditional gravity sewer system, however, whereas the traditional gravity system services properties down to basement level, the Modified gravity system is installed at a shallower depth of cover and does not provide full basement servicing in all or portions of the service area. Because of the decreased depth, the initial capital costs of the collection system are typically less than the costs associated with a traditional gravity sewer installation.

Advantages and disadvantages of modified gravity sewers are listed in the Table 2.

Table 2 - Advantages and Disadvantages for Modified Gravity Sewer System

Advantages	Disadvantages
▪ Sewer Pipe installed at minimal excavation depth ▪ Initial Capital cost is less compared to traditional gravity sewers ▪ Other advantages same as traditional gravity system	▪ Leaves some plumbing fixtures in basements to be pumped to the sewer at the Owners expense ▪ Results in different service levels for different community members ▪ Other disadvantages same as traditional gravity system

Alternative 1C – Blended Gravity/LPS System

The blended gravity/low-pressure sewer system is by-in-large a traditional gravity system however, where isolated low-lying areas exist, grinder pump units are utilised instead of creating a local drainage area with a small centralised pumping station. Due to the relatively high capital cost of establishing, operating and maintaining small centralised pumping stations, this alternative takes advantage of the pre-packaged design of the grinder pump units available on the market to service small isolated areas.

Advantages and disadvantages of the blended gravity/LPS sewers are listed in the Table 3.

Table 3 - Advantages and Disadvantages for Blended Gravity/LPS Sewer System

Advantages	Disadvantages
▪ Suitable for areas with natural slope/terrain ▪ Familiarity with the operation and maintenance ▪ System primarily constructed in the road allowances ▪ Operational costs for the gravity sewer systems mainly associated with lift stations. ▪ Lift Station operation can be automated. ▪ Avoids construction of multiple small lift stations. ▪ Simple connection solution for difficult connections.	▪ Deeper excavations may require some excavations in bedrock to achieve gravity flow ▪ Potential for I/I due to leaky pipes/manholes in future ▪ Property will be required to facilitate the installation of the centralized lift stations ▪ Capital costs higher than other alternatives ▪ Homeowner connection costs can be high where lots slope below road ▪ Creates a two-tier collection system with different requirements for different home owners. ▪ Disadvantages of grinder pump operation applies to a small portion of the overall user base. (See Section 3.3)

3.2 STEP/STEG System

3.2.1 Description

Septic tank effluent gravity (STEG) tanks trap and retain solids at the point of discharge and transfer, by gravity flow, relatively clear effluent to the next treatment stage. Septic tank effluent pump (STEP) tanks are similar, but instead pump the effluent because the treatment unit may be at a different elevation where gravity is not feasible.

STEG and STEP sewers use septic tanks on individual properties to provide liquid/solid separation before the liquid is conveyed through the collection system. The raw sewage from the building flows into a watertight underground septic tank, where the primary treatment of liquid/solid separation occurs. Typically these systems involve replacement of existing septic tanks with custom design tanks. Following the primary treatment, the effluent is conveyed by gravity (STEG) or by pump (STEP) into a 100 mm or 200 mm diameter gravity effluent sewer. Through the primary clarification process, the solids in each individual septic tank are stored to later be pumped out and disposed of at a wastewater treatment plant. The individual tanks are owned by the municipality, but are located on private property. To access the septic tanks for maintenance, legal agreements for permission to enter are required.

A typical STEP/STEG system is built on three main components: interceptor tanks, small bore sewers, and optimized wastewater treatment works. Lot-level interceptor tanks provide at-source separation of sewage solids, while a network of small bore sewers conveys the liquid effluent to the treatment facility. The single chamber tanks are equipped with a proprietary hydraulic mixer present immediately upon sewage entering the tank. There is also a flow attenuator which uses gravity to convey the effluent out of the tank and into the sanitary lateral. This attenuation, coupled with the inner tank surface area provides peak flow buffering so that the maximum design peaking factor is 2 regardless of system size. In some cases, depending on the individual property limitations, a pump may have to be employed to move the effluent out of the tank and into the sanitary lateral.

The small bore sewer pipes are not constrained by the minimum scouring velocity in conventional sewers because sewage solids are removed at the source, significantly reducing the potential for sewer blockages. The systems are assembled from high-density polyethylene (HDPE) pipe and fittings that are thermally fused to create a flexible and watertight collection network. Seamless joints between pipe sections and fittings ensure that there is no infiltration and no leakage of sewage to the environment. This reduces the amount of extraneous flow reaching the sewage treatment stage. Both STEP and STEG can be combined within a given collection system.

3.2.2 Conceptual Planning for STEP/STEG

A potential STEP/STEG system design alternative was provided to Ainley by a STEP/STEG system supplier and was subsequently modified by the Ainley team based on our review of the Town's topography and anticipated flows. There are four primary catchments identified for the STEP/STEG system which mirror the primary catchments for the gravity system. The catchment areas are shown graphically in ***Appendix D***. The catchments identified are described herein.

The STEP/STEG system essentially operates as a gravity sewer system with subsections of the overall system operating as a low-pressure system. Due to the topography of the community in order to establish a functional collection system a trunk system similar that required for the gravity collection system was adopted. All of the small sub-catchment zones identified for the gravity collection system will be serviced with STEP systems.

Hillsburgh Town Core (Catchment 1)

The Hillsburgh Town Core catchment collects all wastewater from the main residential area of Hillsburgh including the properties along George Street. It is recommended that this catchment should terminate at a location near Mill St south of Covert Lane. One stream crossing will be required for this catchment to transmit flow from the Douglas Crescent Area to the proposed pumping station location. The pumping station at this location will pump to the north end of Catchment 2.

Trafalgar Road North (Catchment 2)

The Trafalgar Road North catchment collects all wastewater along Trafalgar Road South of the main residential area. The trunk sewer along Trafalgar Road N will terminate at a location close to the intersection of Trafalgar Road N and Wellington Road 22. This trunk sewer will also transmit flow from Catchment 1. The pumping station at this location will pump waste from Hillsburgh to the north end of Catchment 3 in Erin Village.

North Erin Village (Catchment 3)

The North Erin Village catchment collects all wastewater from the industrial area and a portion of the wastewater from the core residential area. It is recommended that this catchment should terminate at the junction of the Elora Cataract Trail and Main Street. The pumping station at this location will pump wastewater to the trunk sewer along Main Street in Erin Village.

South Erin Village (Catchment 4)

The South Erin Village catchment collects wastewater from locations within Erin Village south of Scotch St. in addition this catchment also includes the Erin Heights Dr. subdivision. It is recommended that this catchment should terminate around the intersection of Main St. and Wellington Road 124 or alternatively in Lion's Park. All wastewater from Hillsburgh and the Erin Village will ultimately pass through this station and be transmitted to the preferred treatment plant location.

3.2.3 Analysis of STEP/STEG

Ownership of STEP/STEG Systems

Ownership considerations of the STEP/STEG system are unique since there are two connection variants depending on the location within the community. The ownership of each septic tank/ septic tank pump is a decision which must be made in establishing a STEP/STEG system, i.e. whether the Town should own and maintain all of the septic tanks/ pumps or if the tanks/pumps should be owned and maintained by each property owner. It is likely that community members who would be required to connect using the STEP system may take issue with the additional costs they would face in comparison to those with a STEG system. At a minimum, it is recommended that there should be no difference in the ownership philosophy between the STEP and STEG systems.

In order to avoid conflicts with residents, it is recommended that, should a STEP/STEG sewer system be chosen, the Town should consider opportunities to ensure level costs for system use for all residents. In essence, the Town should consider a method for residents on STEP systems to recover the cost of electricity for pumping effluent. In either a Town or private ownership model, access to each tank would need to be maintained in order to facilitate the regular tank inspection/cleanout process. In either case, home owners would be required to maintain sufficient access to their septic tanks/pumps.

Operation of STEP/STEG Collection

It is estimated that the energy use for each individual STEP pump will cost $20-40/year for each residence connected in this manner. It should be noted that there will be a small energy cost variation to each system user based on their relative distance to the relevant discharge point. This variation will not be as significant as with the low-pressure system. This energy use cost will only affect users who are required to connect using the STEP system and not those able to connect under the STEG system.

Due to the nature of the STEP/STEG collection process, each septic tank will continue to require regular cleanouts. STEP/STEG system suppliers estimate that cleanouts will be required on an 8-year cycle however the EPA Guidelines for Septage Treatment and Disposal recommend a 3-5 year cleanout cycle. The regular cleanouts are estimated to be approximately $375/ cleanout and should be covered by the system owner.

Since these tanks do not function like a regular septic tank, their operation affects the downstream sewers. If home owners fail to have the tanks pumped out in a timely manner, this could result in solids being sent to the smaller diameter sewers potentially causing blockages. For this reason, it is recommended that the Town owns and operates the entire system.

A consideration that must be made with the STEP/STEG systems is the potential for bacterial upsets to occur in the septic tank caused by misuse of the system by residents. Bacterial processes are very sensitive to system inputs and issues may occur if harmful chemicals such as bleach are released into the tank. In the event that chlorine reaches the septic tank sludge bulking may occur, if the upset is severe enough the sludge could possible enter the effluent chamber and be released to the collection system. Due to the small sewer size recommended for the STEP/STEG system, fowling from sludge entering the system may cause blockages. To avoid problems with the operation of a STEP/STEG system, an education program is recommended in order to notify the public on the proper use and maintenance of these systems.

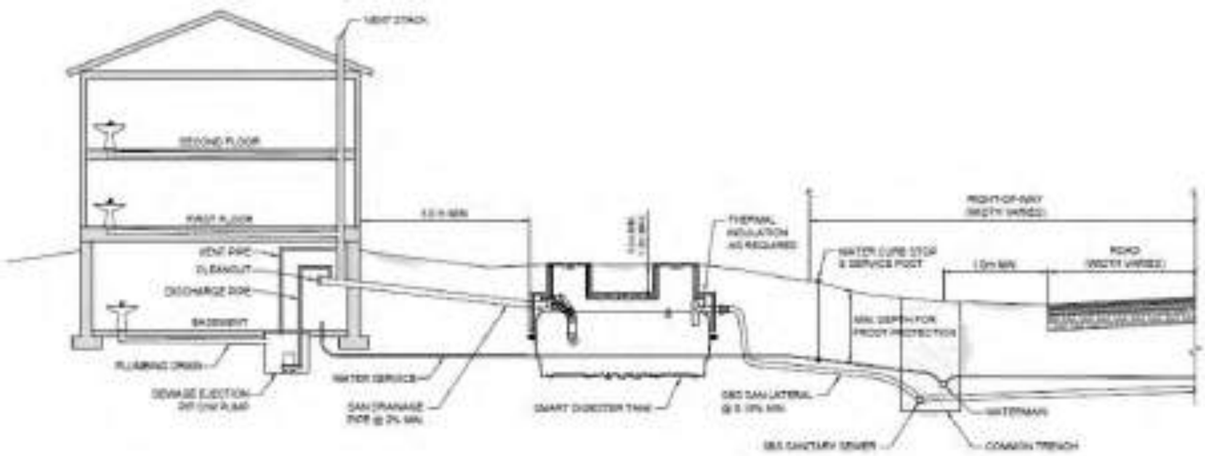


Figure 6 – Schematic of STEG/STEP System from Clearford Water System Inc.

Advantages and disadvantages of STEG and STEP are listed in Table 3.

Table 4 - Advantages and Disadvantages of STEP/STEG System

Advantages	Disadvantages
▪ Potentially less excavation required for sewer pipes ▪ Where STEP used, pipes can be installed to follow the surface topography, remaining at a relatively constant depth below the surface ▪ Minimal inflow and infiltration into the system so smaller pipes and lower flow to WWTP ▪ Solids not pumped to WWTP so smaller pipes and less capital costs for pipes ▪ Lower initial capital costs due to shallower placement and small size of pipes ▪ Low pump maintenance compared to grinder pumps (low pressure system).	▪ All private properties require an Interceptor Tank similar to a Septic Tank ▪ Small diameter pipes subject to blockage if interceptor tanks do not function properly ▪ On lot components require maintenance (Solids Removal, Pump Maintenance). ▪ If Interceptor tanks Municipally owned, legal access agreement is needed for maintenance ▪ Municipality may also be responsible for solids pump out if they own the tanks ▪ Property owners still have the restriction of having a septic tank system ▪ Power needs to be available all the time for STEP. Power failure results in properties having no wastewater outlet ▪ Property owners will be required to supply and pay for power to the onsite pump at their property. ▪ STEP/STEG is a proprietary technology which means maintenance and procurements of parts will be through the same supplier which could increase capital and maintenance costs. ▪ Existing Septic tanks will need to be

Advantages	Disadvantages
	decommissioned by the Town ▪ Tile bed decommissioned by the property owner. ▪ Not widely used in Canada and not on this scale ▪ Developers for growth areas would be required to use the same system and this may affect house prices as the system does not provide a secure sewer outlet ▪ Production of odour is common from improper house ventilation, manholes and system vents. ▪ Effluent tends to be corrosive due to the presence of hydrogen sulphide gas from septic sewage. ▪ Odour control needed at all SPS's.

3.3 Low Pressure System

3.3.1 Description

A Low Pressure System would require homes to have an outdoor "grinder pump" buried in the front yard instead of a septic tank. This would chop up the waste before pumping it into the public system

Pressurised sewers differ from conventional gravity collection systems, because they use pumps (grinder) instead of gravity to transport wastewater. The primary effluent is delivered to the collection tank (with a grinder pump) by gravity where it is ground up before being transported into the pressurised system by pumps. A typical arrangement is for each connection (or a small cluster of connections) to have a basin that receives wastewater. Within that basin is a grinder pump and when the basin fills to a set point, the pump is activated and injects the wastewater into the sewer. Throughout the collection system, there are many basins with pumps injecting wastewater into the sewer; these pumps convey the wastewater to the treatment facility. The system consists of conventional drain, waste and vent (DWV) piping within the residence connected to the grinder pump basin inlet. The grinder pump may be installed above or below grade, indoors or outdoors. The pump and basin are typically owned by the municipality and located on private property, so easements would be required for maintenance purposes.

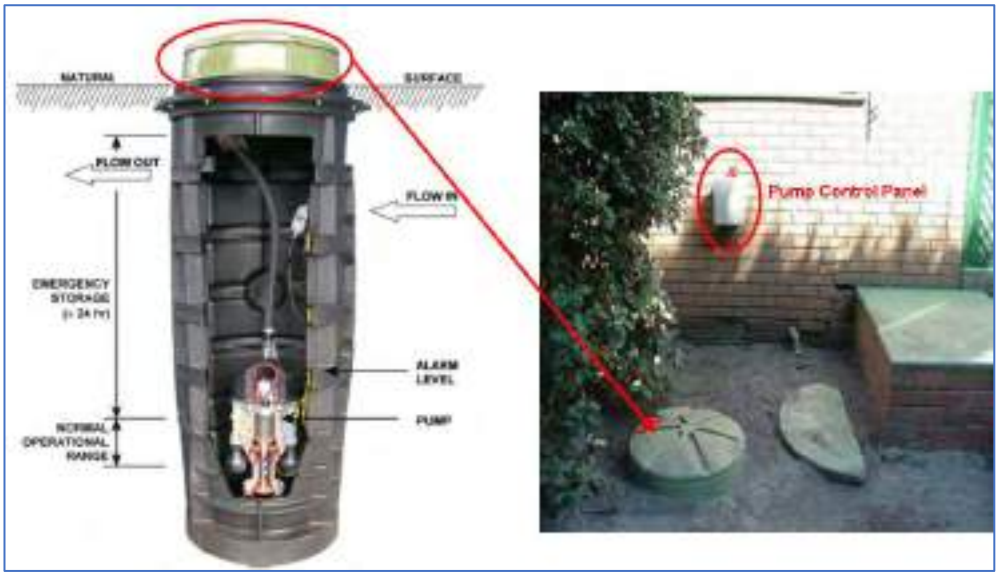


Figure 7 – Low Pressure System Grinder Chamber with an Outdoor Pump Control Panel

Depending on flow factors and the system design model used, the grinder installation may serve one or more residences, or several families in the case of apartment buildings, however the need to provide power to each pump likely would limit the system size to each individual property or condominium. Grinder pumps discharge a finely ground slurry into small–diameter pressure piping. In a completely pressurized collection system, all the piping downstream from the grinder pump (including laterals and mains) will normally be under low pressure (40-60 psig). Pipe sizes will start at 1 1/4 inches for house connections (compared to 4 or 6 inches in gravity systems) and will be proportionally smaller than the equivalent gravity pipeline throughout the system. All pipes are arranged as zone networks without loops. Depending on topography, size of the system and planned rate of buildout, appurtenances may include valve boxes, flushing arrangements, air release valves at significant high points, check valves and full-ported stops at the junction of each house connection with the low-pressure sewer main. Low pressure sewers may be combined within a given collection system. Typical details of the Low Pressure System are shown in Figure 7 and 8.

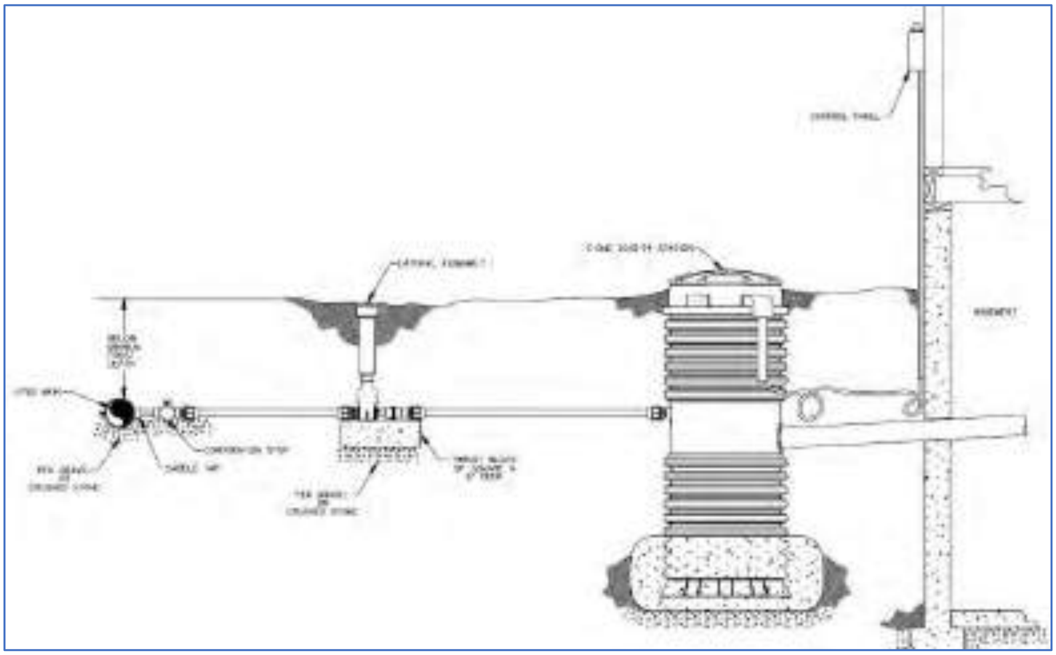


Figure 8 – Schematic of Low Pressure System from Environment One Corporation (E/One)

3.3.2 Conceptual Planning for Low Pressure Sewer System

A potential low-pressure system design alternative was provided to Ainley by a low-pressure system supplier and was subsequently modified by the Ainley team based on our review of the Town's topography and anticipated flows. There are three primary catchments identified for the pressure sewer. Pressure sewer systems are not generally designed to have multiple catchments in the same way as a gravity system; due to the geographical separation between Hillsburgh and Erin Village, multiple catchments are necessary. The catchment areas are shown graphically in ***Appendix E***. The catchments identified are outlined described herein.

Hillsburgh (Catchment 1)

The Hillsburgh catchment collects all waste from within Hillsburgh. It is recommended that this catchment should terminate at the proposed pumping station location at the junction of Trafalgar Road and the Elora Cataract Trail.

North Erin Village (Catchment 2)

The North Erin Village catchment collects all waste from the industrial area and a portion of the waste from the core residential area. The pumping station for this catchment will also receive all the waste from Hillsburgh. It is recommended that this catchment should terminate at the proposed pumping station location near the junction of Main Street and the Elora Cataract Trail. Pumping into the low pressure collection system would conflict with the operation of the grinder pump system; as such it is recommended that the forcemain from this station extend to the pumping station for South Erin Village (Catchment 3).

South Erin Village (Catchment 3)

The South Erin Village catchment collects waste from locations within Erin Village south of Scotch St. in addition this catchment also includes the Erin Heights Dr. subdivision. It is recommended that this catchment should terminate in Lion's Park. All waste from Hillsburgh and Erin Village will ultimately pass through this station and be transmitted to the treatment plant location.

3.3.3 Analysis of Low Pressure Sewer System

Ownership of Low-Pressure Pumps

The ownership of each low pressure pumping station is a decision which must be made in establishing a low pressure system, i.e. whether the Town should own and maintain all of the pumping stations or if the stations should be owned and maintained by each property owner. It should be noted that a few communities in Ontario which have opted for a low pressure sewer system have received public backlash for their decision to have the grinder pump stations privately owned. For the community of St. Davids, Niagara on the Lake, the issue of grinder pumps failing within 8 years of installation has become highly politicised with demands that the stations should be owned and maintained by the Town to ensure private residents are not responsible for covering the cost of repairs which, for some residents, have exceeded $2,000.

In order to avoid conflicts with residents it is recommended that, should a low-pressure sewer system be selected, the Town ownership model should be selected. While Town ownership of the grinder pump units resolves the issue of public complaints caused by replacement costs, it raises an issue related to access. Should the Town have ownership of the grinder pump units, access to each station would be required to ensure public works could resolve operational issues of each station. Home owners would be required to maintain access to their grinder pump station, particularly during the winter months. Home owners would still be responsible for pumping costs and would still experience loss of a wastewater outlet in the event their power is lost.

Operation of Low Pressure Pumps

Based on energy use estimations from suppliers of low-pressure sewer pumps, the yearly energy use for each individual pump will fall between 85-170 kWh/year. However, this estimation does not account for periods of pump operation where the pump is dead-heading (operating without being able to discharge). Based on the energy use estimations it is assumed that the operation of the grinder pump units will cost between $30-50/year for each resident. It should be noted that the energy cost to each system user will increase as a function of the relative distance to the discharge point.

A consideration that must be made with a low pressure system is the potential for power outages affecting the system operation. In a conventional gravity sewer system the collection and pumping of sanitary waste is centralised and generators are typically kept on site in case of a power outage. In short, there is an increased risk of system backups during power outages for individual users of the low-pressure system. The typical tank size for the grinder pump packages is 380 L which is equivalent to approximately 9 hours of use for a typical household. However it should be recognised that a power failure could occur when the tank is almost full thus preventing its use almost immediately.

Centralised Pumping Stations

While the core concept of the low-pressure system is to rely on the collective pumping capacity of the individual grinder pumps there are some feasibility issues with this as a complete solution.

Due to the distance and elevation variability between Erin and Hillsburgh a centralised pumping station is recommended. There are technical challenges related to pumping long distances, primarily, as the pumping distance increases there is a linear increase in dynamic headloss and by extension an increase in the energy required. Additionally, with long pumping distances in a pressurised forcemain there is a high probability that the sewage will become septic and highly odourous. A centralised station for pumping between the two communities will require an odour control system. A conceptual design has been developed involving establishing a central pumping station for Hillsburgh to discharge to the north end of Erin Village.

Another challenge which must be accounted for in the overall system design is control over the discharge to the treatment plant headworks. With a system of hundreds of individual pumping units automation and control of the discharge would have an incredible level of complexity and would also require significant investment in an overarching control system linked to each station. To address this complexity our solution involves establishing a pumping station in the south end of Erin Village to control discharge to the treatment plant.

Advantages and disadvantages of low pressure sewage collection systems are listed in the Table 5.

Table 5 - Advantages and Disadvantages for Low Pressure Collection Systems

Advantages	Disadvantages
▪ Less excavation required ▪ Can be installed to follow the surface topography, remaining at a relatively constant depth below the surface (below the frost line) ▪ Minimal inflow and infiltration into the system so smaller pipes and lower flow to WWTP ▪ Lower initial capital costs due to shallower placement and small size of pipes.	▪ Homes will require grinder pump unit on private property ▪ Municipally owned grinder pumps would require maintenance of over 1500 pump systems and requires access to each property ▪ If pump owned by each property owner presents ongoing operation and maintenance costs for each homeowner ▪ Each property owners will be required to supply and pay for power to the onsite pump ▪ Power failure results in properties having no wastewater outlet ▪ Odour concern due to the presence of vents on collection chambers and within downstream sewers and centralized pumping stations ▪ History of pump blockages and malfunctions cause ongoing issues for homeowners ▪ Does not provide secure alternative as the system depends on power supply at each property local control panels need to be installed inside each home/property ▪ Low pressure system is a proprietary technology which means maintenance and procurements of parts will be through same supplier which could increase capital and maintenance costs ▪ Pumps have 15 year life but operating history indicates failure occurs in less time ▪ Developers for growth areas would be required to use the same system and this may affect house prices as the system does not provide a secure sewer outlet

3.4 Vacuum Sewer System

3.4.1 Description

A vacuum sewer system is similar to a low pressure system, except that vacuum is drawn on the collection system by a central vacuum station, pulling the wastewater through the system rather than pushing it through the system with a series of pumps.

A Vacuum Sewer System Relies on a Central Vacuum Station to "Suck" Wastewater from Each Valve Pit

A traditional gravity line carries wastewater from the individual property to a valve pit. There can be multiple properties connected to a single valve pit. The wastewater collects in the valve pit until it reaches a predetermined volume, at which point the vacuum interface valve inside the valve pit opens. The valve pit has an air intake line that is open to atmosphere, so when the valve opens inside the valve pit, the negative pressure from the vacuum sewer main pulls the wastewater into the vacuum sewer main. When the sewage levels within the pit reach a predetermined minimum, the vacuum valve closes and atmospheric pressure is restored within the valve pit. After the valve closes, the sewage travels along the vacuum sewer main as far as its momentum will allow. It will sit in the vacuum main until either the same valve pit or another one connected to the vacuum sewer main has reached its maximum volume and the process gets repeated. Each time a vacuum interface valve is opened along the vacuum sewer main, it moves the wastewater closer to the vacuum station. Within each vacuum station there are vacuum pumps keeping vacuum on the system at a constant level and a collection tank. When the collection tank reaches a specific volume of sewage, it is pumped into a forcemain and carried to the treatment plant.

Like gravity sewers, vacuum sewers are installed on a slope toward the vacuum station, but with periodic lifts installed to return it to a shallower elevation, resulting in a vertical zigzag configuration. The vacuum valve pits are typically owned by the municipality and located on private property, so easements would be required for maintenance purposes. The equipment in the station includes a collection tank, a vacuum reservoir tank, vacuum pumps, sewage pumps, pump controls and an emergency generator. Vacuum stations can take advantage of available slope in the terrain, but are most economical in a flat terrain. Vacuum sewer systems may be combined with other collection system technologies. Below is a diagram of AIRVAC's vacuum sewer collection system (Figure 9).

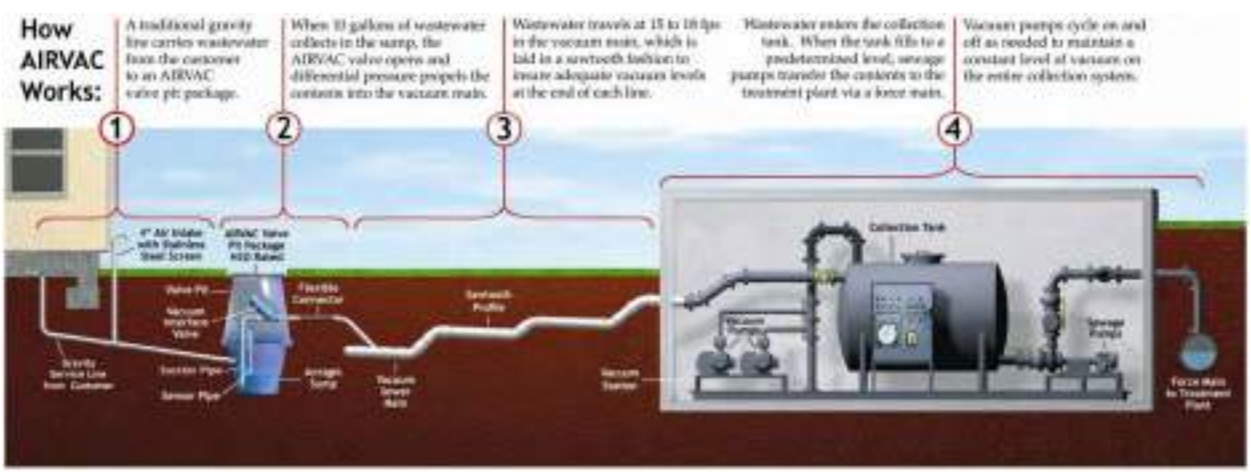


Figure 9 – Schematic of Vacuum Sewer System from AIRVAC

3.4.2 Conceptual Planning for Vacuum Sewer System

A potential vacuum system design alternative was provided to Ainley by a vacuum system supplier and was subsequently modified by the Ainley team based on our review of the Town's topography. There are three primary catchments identified for the vacuum sewer. The catchment areas are shown graphically in ***Appendix F***. The catchments identified are outlined below. Additionally, 3 sub-catchments have been identified all discharging to Catchment 3.

Hillsburgh (Catchment 1)

The Hillsburgh catchment collects all wastewater from within Hillsburgh. It is recommended that this catchment should terminate close to the junction of Trafalgar Road and the Elora Cataract Trail. Since it is not feasible to pump into a vacuum collection main, this station will discharge directly into the pumping station for Catchment 2.

North Erin Village (Catchment 2)

The North Erin catchment collects all wastewater from the industrial area and a portion of the wastewater from the core residential area. It is recommended that this catchment should terminate at the proposed pumping station location adjacent to the junction of Main Street and the Elora Cataract Trail. Since it is not feasible to pump into a vacuum collection main, this station will discharge directly into the pumping station for Catchment 3.

South Erin Village (Catchment 3)

The South Erin catchment collects wastewater from locations within Erin Village south of Scotch St. in addition this catchment also includes the Erin Heights Dr. subdivision. It is recommended that this catchment should terminate in Lion's Park. All wastewater from Hillsburgh and Erin Village will ultimately pass through this station and be transmitted to the treatment plant location.

Erin Heights, Sub-Catchment 1

The Erin Heights subdivision is separated from the downtown of Erin Village by a significant river valley intersecting Dundas St. W. west of Carberry St. In addition the Erin Heights subdivision is situated on a significant slope with an elevation difference of over 30 m between the highest location at the west end of the subdivision and the lowest location where Erin Heights Drive diverts east towards Dundas Street West Based on the local topography, a vacuum station will be required at the north end of the catchment and will likely be situated within the road allowance. Since it is not feasible to pump into a vacuum collection main, this station will discharge directly into the previously identified forcemain from the pumping station for Catchment 2. It should be noted that there is minimal space available for the construction of a vacuum station for this catchment and it would represent a significant design challenge.

Dundas St. E., Sub-Catchment 2

The intersection of Dundas St. East and Tomwell Crescent is a local low point which lies at an elevation of 5 m below the surrounding area. Connecting this low lying area to a gravity main along Daniel St. or Main St. would require deep excavation, in excess of 7m at some points in order to convey wastewater to the primary vacuum stations for either North Erin Village or South Erin Village. A local vacuum station is one option to eliminate the requirement for such a deep trunk sewer excavation. Since it is not feasible to pump into a vacuum collection main, this station will discharge directly into the previously identified forcemain from the pumping station for Catchment 2.

Scotch St., Sub-Catchment 3

There is a section of Scotch St. north of the intersection with Wheelock St. which lies at an elevation 4 m below the surrounding area. Connecting this low lying area to a gravity main along Daniel St. would require a section of the Daniel St. sewer to be constructed at a depth of up to 8 m. A local vacuum station eliminates the requirement for an excessively deep trunk sewer along Daniel St. Since it is not feasible to pump into a vacuum collection main, this station will discharge directly into the previously identified forcemain from the pumping station for Catchment 2.

3.4.3 Analysis of Vacuum Sewer System

Ownership of Vacuum Pits

The ownership of each vacuum pit is a decision which must be made in establishing a vacuum collection system, i.e. whether the Town should own and maintain all of the vacuum pits or if the pits should be owned and maintained by each property owner. In contrast to a low pressure sewer system the vacuum pits have limited mechanical components and are comparatively less likely to experience operational issues. It is possible for clogs to occur within the vacuum collection pits causing a disruption to the service. It is unlikely that all homeowners will be both willing and able to maintain their own vacuum pit. It is preferable for the Town to maintain ownership and responsibility for the vacuum system components to ensure operation.

Operation of Vacuum Collection

Unlike the operation of a low pressure system, the energy required to draw wastewater through the vacuum collection system is centralised at the vacuum collection stations. As such, the operation of the collection system during power outages can be managed through ensuring back-up power generation at each vacuum station. In this respect, the operation of a vacuum sewer system is similar to a gravity collection system, there is no variability in costs to the users of the system as all operational costs are centralised.

Unlike a conventional gravity system, it is not possible to connect a pumping station to a separate section of vacuum sewer. In short, each vacuum sewer catchment must be independent and must discharge to either the treatment site or the wetwell of a pumping station. Due to this particular property of vacuum collection systems this technology is not ideal for locations with high topographical variability. For locations with high topographic variability many small vacuum catchments are required and results in a requirement for numerous forcemains and increases the number of pumps required to generate the negative line pressure which ultimately negates the advantage of shallower pipe construction. Further, the operation of the vacuum pumps required to provide the suction and lift to the vacuum stations are expensive to operate due to the high energy demand.

For Hillsburgh and the Erin Village, a total of 7 vacuum stations would be required to service the existing community, 6 for Erin Village and 1 for Hillsburgh.

Advantages and disadvantages of vacuum sewage collection system are listed in the Table 6.

Table 6 - Advantages and Disadvantages Vacuum Sewage Collection System

Advantages	Disadvantages
▪ Less excavation required ▪ Can be installed to follow the surface topography, remaining at a relatively constant depth below the surface (below the frost line) ▪ Small pipe diameters are sufficient if vacuum	▪ Vacuum sewer systems can provide a lift of only 3 metres ▪ Homes will require a valve pit on their property ▪ Best suited for flat areas with poor soils and/or high groundwater unlike Erin and

Advantages	Disadvantages
stations properly located ▪ The risk of clogging is low because of pressure differential in pipes ▪ The vacuum station can typically cover a distance of 3 km if the terrain flat enough ▪ Minimal Inflow and Infiltration into the system so smaller pipes and lower flow to WWTP ▪ Lower initial capital costs due to shallower placement and small size of pipes	Hillsburgh. ▪ Systems typically Municipally owned requiring access to each property for maintenance. ▪ Odor concern due to the presence of vents on valve pits and at vacuum stations. ▪ Vacuum systems are proprietary which means maintenance and procurements of parts will be through same supplier which could increase capital and maintenance costs. ▪ System integrity needs to be constantly monitored. ▪ Vacuum station failure quickly affects sewage flow from each property as there is no inherent storage capacity compared to gravity sewers ▪ Vacuum pipe leaks also affect operation of system and can affect sewage servicing from many properties ▪ The system needs more specialist maintenance and operation. ▪ Limited installations in Canada.

4.0 Phase 3B: Overview of Evaluation Methodology

The evaluation methodology used to select the preferred solution for sewage collection for the UCWS Class EA 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 sewage collection system.

In general, the sewage collection system evaluation for this project follows the approach described below:

- Develop screening criteria for both the long and short list;
- Develop a long list of viable technologies;
- Screen the long list of strategies to create a short list of alternatives;
- Development of alternative design concepts for the short list of alternatives;
- Complete detailed evaluation of the short list of alternatives; and
- Identify preliminary preferred alternative solution.

The long list screening criteria identified alternatives that would meet the fundamental project requirements. The short list criteria are scored numerically in four categories: social, technical, economic and environment.

4.1 Description of the Evaluation Criteria

As indicated above, two stages of evaluation were required to enable the preferred alternative solution for wastewater collection to be identified: long list screening criteria and short list evaluation criteria

The first set of criteria was used to screen a long list of collection system options to a short list of collection system alternatives. The purpose of the preliminary screening is to identify only those collection system technologies that are considered "feasible" for this project and eliminate those technologies that do not suit the project constraints and opportunities. This step in the evaluation process ensures that only technologies that fit the project requirements are considered in the next step. Table 7 sets out the criteria used to screen the long list of wastewater collection system options.

Table 7 – Long List Screening Criteria

Criteria	Description
Track Record	Demonstrated track record of ability to collect sewage of a similar sized community and climactic conditions.
Scalability	Demonstrated reliability of full scale experience in similar size.
Staging / phasing	Ability to expand to suit housing development's growth requirements.
Operational and Maintenance (O&M)	Ability to maintain low operation and maintenance costs.
Cost	Have a capital cost commensurate with the benefits provided.

The application of the Long List Criteria to the collection system alternatives is presented in Table 8.

Table 8 – Criteria Rating Rationale

No.	Technology	Description	Screening Criteria: Track Record	Scalability	Staging / Phasing	O&M	Cost	Carry Forward	Rationale
1	Traditional Gravity Sewers	▪ Wastewater from each property is conveyed through a connecting sewer to the street/property line where it connects to a gravity sewer. ▪ Typically gravity systems consist of a combination of gravity sewers with pumping stations installed at the lowest elevations of the system, forcemains to convey the sewage to another gravity line at a higher elevation and eventually to the WWTP.	✓	✓	✓	✓	✓	Yes	▪ The technology is the simplest to operate. ▪ Widely used throughout the developed world ▪ The undulating topography in the Erin Village and Hillsburgh suits the use of a gravity system
2	Modified Gravity Sewers	▪ Modified gravity sewers are similar to traditional gravity sewer system but it is installed with a decreased depth of cover.	X	X	✓	✓	✓	No	▪ Does not provide the same level of service to all properties and leaves some property owners responsible for servicing any plumbing in their basements
3	Blended Gravity/ LPS	▪ While generally the Erin Hillsburgh area is suitable for a gravity system, there are some small catchment areas from 4 to 30 houses that would require a pumping station to convey the wastewater to the trunk system. For these smaller more confined low-lying areas grinder pump systems could be used to lift waste to higher gravity mains.	✓	✓	✓	✓	✓	Yes	▪ The technology may provide a lower cost solution for isolated areas or properties at a lower cost than using a gravity/pumping station solution
4	Septic Tank Effluent Gravity Sewer (STEG) and Septic Tank Effluent Pump Sewer (STEP)	▪ STEG and STEP sewers use customized septic tanks on the individual properties to provide liquid/solid separation before conveying just the liquid component through the collection system for treatment.	✓	✓	✓	✓	✓	Yes	▪ The technology reduces the potential for inflow and infiltration into the collection system and reduces WWTP capacity
5	Low Pressure Sewer System	▪ Pressurised sewers differ from conventional gravity collection systems, because they use pumps (grinder) instead of gravity to transport wastewater.	✓	✓	✓	✓	✓	Yes	▪ The technology has the potential to reduce construction cost of the collection system through reduction in sewer size and the lower depth of burial needed for the pipes
6	Vacuum Sewer System	▪ A vacuum sewer system is similar to a low pressure system, except that vacuum created by a central vacuum station, pulls the wastewater through the system rather than pushing it through the system with a series of pumps.	✓	✓	✓	✓	✓	Yes	▪ The technology reduces the potential for inflow and infiltration into the collection system and reduces WWTP capacity

4.2 Screening of Short List of Sewage Collection System Technologies

In order to select a preferred alternative from the short list, a secondary screening process is applied. The short list of technologies, carried forward from the long list screening, is evaluated against the specific screening criteria described in Table 9 below:

Table 9 – Sewage Collection System Short List Evaluation Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social/Culture	15%	Impacts During Construction	20%
		Traffic Disruption/ Truck Traffic	10%
		Effect on Residential Properties	30%
		Effect on Businesses/ Commercial Properties	30%
		Effect on Industrial Properties	10%
Technical	35%	Technology Robustness	30%
		Energy Requirements	20%
		Suitability for Phasing	10%
		Construction Impacts	20%
		Operation and Maintenance Impacts	10%
Economic	40%	Capital Cost	30%
		Life Cycle Net Present Value	40%
		Annual Operation and Maintenance	30%
Environmental	10%	Sustainability	15%
		Greenhouse Gas Generation	5%
		Effect on Groundwater	20%
		Effect on Surface Water/ Fisheries	20%
		Effect on Vegetation/ Wetlands	20%
		Effect on Habitat/ Wildlife	20%

4.2.1 Screening Criteria Definitions

Social/Culture, Impacts During Construction

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

Social/Culture, Traffic Disruption/Truck Traffic

This criterion captures the level of traffic disruption necessary to facilitate construction of the system. This criterion assumes that proper construction staging and traffic management plans are enacted during construction to mitigate disturbances. Also included are ongoing traffic disruptions and truck traffic required for the operation of each system.

Social/Culture, Effect on Residential Properties

This criterion captures the level of impact that establishing and maintaining a collection system alternative has on individual residential properties. Impacts considered include replumbing within the home, disturbance to landscaping, tree removals and necessary permanent fixtures on the property.

Social/Culture, Effect on Commercial Properties

This criterion captures the level of impact that establishing and maintaining a collection system alternative has on individual commercial properties. Impacts considered include loss of business, replumbing within the building, disturbance to landscaping, tree removals and necessary permanent fixtures on the property.

Social/Culture, Effect on Industrial Properties

This criterion captures the level of impact that establishing and maintaining a collection system alternative has on individual industrial properties. Impacts considered include loss of business, replumbing within the building, disturbance to landscaping, tree removals and necessary permanent fixtures on the property.

Technical, Technology Robustness

The robustness of a technology is related to the ability of the system to cope with changing system demands and adverse events. Examples would include the ability of the system to cope with unexpected high flow events or continue operation during an extended power outage.

Technical, Energy Requirements

This criterion will capture the amount of energy required to operate the system on an ongoing basis. Systems with lower energy use will be rated more favourably.

Technical, Suitability for Phasing

This criterion captures the capacity of a system to be expanded under a phased development plan. Systems which require minimal component upgrades as the system expands will be rated more favourably.

Technical, Constructability

This criterion captures the impact of the selected system design on the overall constructability of the system. Systems that can be constructed with minimal conflict with existing structures and utilities will be rated more favourably.

Technical, Operational and Maintenance Impacts

This criterion captures the level of effort required by operations staff to operate and maintain the system alternative on an annual basis. Systems which require minimal operational intervention will be rated more favorably.

Economic, Capital Cost

The criterion captures the estimated capital cost for the initial establishment of the system alternative.

Economic, Annual Operation and Maintenance

The criterion captures the estimated cost to operate and maintain the system on an annual basis. Major system component replacements and repairs are not considered as a part of this criteria.

Economic, Life Cycle Net Present Value

The criterion captures the estimated net present value of complete replacement of the proposed system and operation and maintenance of the system to the end of the first life cycle. For the purposes of analysis within this report an 80-year life cycle has been assumed.

Environmental, Sustainability

This criterion captures the level of ease or difficulty with which the system can be maintained on a long term basis. Systems that require a high level of replacement components will be ranked less favourably, particularly where system components are proprietary and may not exist on the market into the future.

Environmental, Greenhouse Gas Generation

The criterion captures the amount of greenhouse gas generation associated with the establishment and operation of the system alternative. Minimizing greenhouse gas generation is rated favourably.

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.

Environmental, Effect on Surface Water/ Fisheries

The criterion captures the impact that the establishment and operation of the system alternative has on the local surface waters. Minimizing contamination of the local surface water is rated favourably.

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. Minimizing contamination of the local vegetation and wetlands is rated favourably.

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. Minimizing contamination of the local habitat and wildlife is rated favourably.

4.3 Short Listed Treatment Technologies

4.3.1 Overview

Based on the preceding evaluation, a short list of Sewage Collection System technologies was developed. Those technologies that are considered to be feasible candidates for the collection system are listed below.

- Traditional Gravity Sewers
- Blended Gravity/LPS System
- STEP/STEG sewers
- Low Pressure sewers
- Vacuum Sewer system

4.3.2 Cost Comparison of Short Listed Technologies

The following general assumptions were made in preparation of the cost estimates:

- Estimates of probable capital costs have been developed based on prices obtained from suppliers and from data in Ainley's possession from projects of similar nature and scope. However, the cost estimates presented in this report may be significantly affected by a number of factors which cannot be readily forecast which include amongst others, volume of work in hand or in prospect for contractors or suppliers at the time of the tender calls, future labour contract settlements, inflation and market escalation. For this reason, the actual costs may be different from those presented in this report. However, for the purpose of a relative economic evaluation amongst all options under consideration, it should be highlighted that costs for all options were calculated under the same assumptions and rationale, thus, should prices change over time, the changes would apply proportionally for all options and the results of the comparative cost evaluation would remain unaltered.
- All costs are presented in 2017 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.
- All taxes have been excluded.
- Life cycle costs have been estimated based on an inflation rate of 4%.

Table 10 presents the life cycle cost estimates for the 5 short listed collection system alternatives. ***Appendix G*** includes the details of the cost estimates.

Table 10 – Cost Estimate for System Alternatives

Collection Alternative	Capital Cost	Connection Cost (Home Owner)	Total Capital Cost	System Replacement and Operation NPV	Total Cost (Capital Cost + NPV)
Gravity Sewers	$44,830,000	$10,210,000	$55,692,000	$7,772,000	$63,464,000
Blended Alternative	$42,626,000	$8,930,000	$52,206,000	$7,535,000	$59,741,000
Pressure Sewers	$55,630,000	NIL	$56,130,000	$12,944,000	$69,074,000
Vacuum Sewers	$46,822,600	NIL	$50,852,800	$9,770,000	$60,622,800
STEP/STEG Collection	$52,002,400	NIL	$52,502,400	$8,999,000	$61,501,400

4.3.3 Detailed Evaluation of Collection Options

The evaluation of the short listed sewage collection system options, using the criteria and weightings listed in Table 9 is provided in Table 13.

Table 11 – Weighted Scoring of Short Listed Sewage Collection System Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	Gravity sewer		Blended Grav/ LPS		STEG/STEP		Low Pressure		Vacuum	
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE	WT SCORE	SCORE	WT SCORE	SCORE	WT SCORE	SCORE	WT SCORE	SCORE	WT SCORE
Social/Culture	15%	Impacts During Construction	20	3	2	1.2	2.5	1.5	3	1.8	5	3	3	1.8
		Traffic Disruption/ Truck Traffic	10	1.5	2	0.6	3	0.9	4	1.2	5	1.5	4	1.2
		Effect on Residential Properties	30	4.5	4	3.6	3	2.7	2	1.8	3	2.7	3	2.7
		Effect on Businesses/ Commercial Properties	30	4.5	4	3.6	4	3.6	2	1.8	3	2.7	3	2.7
		Effect on Industrial Properties	10	1.5	4	1.2	4	1.2	2	0.6	3	0.9	3	0.9
Technical	40%	Technology Robustness	30	12	5	12	5	12	4	9.6	2	4.8	3	7.2
		Energy Requirements	20	8	4	6.4	4	6.4	5	8	5	8	2	3.2
		Suitability for Phasing	10	4	4	3.2	4	3.2	4	3.2	5	4	3	2.4
		Constructability	20	8	3	4.8	3	4.8	4	6.4	5	8	4	6.4
		Operation and Maintenance Impacts	20	8	4	6.4	5	8	4	6.4	3	4.8	3	4.8
Environmental	15%	Sustainability	15	2.25	5	2.25	5	2.25	4	1.8	4	1.8	3	1.35
		Greenhouse Gas Generation	5	0.75	3	0.45	3	0.45	4	0.6	4	0.6	2	0.3
		Effect on Groundwater	20	3	4	2.4	4	2.4	4	2.4	3	1.8	5	3
		Effect on Surface Water/ Fisheries	20	3	5	3	5	3	5	3	5	3	5	3
		Effect on Vegetation/ Wetlands	20	3	5	3	5	3	5	3	5	3	5	3
		Effect on Habitat/ Wildlife	20	3	5	3	5	3	5	3	5	3	5	3
Economic	30%	Capital Cost	30	9	3	5.4	4	7.2	4	7.2	4	7.2	5	9
		Operational Costs	40	12	5	12	5	12	4	9.6	3	7.2	2	4.8
		Net Present Value Costs	30	9	5	9	5	9	4	7.2	3	5.4	3	5.4
			TOTAL SCORE	**100**		**83.5**		**86.6**		**78.6**		**73.4**		**66.15**

Based on detailed evaluation of the alternatives, Option No 2 – Blended Gravity Sewers/ Low Pressure System returns the highest score and therefore offers the most benefit.

The details of the scoring and rationale have been provided in Table 14.

Table 12 – Criteria Rating Rationale

Criteria	Gravity Sewer	Blended Gravity / LPS	STEP / STEG	Low Pressure Sewer	Vacuum Sewer
Social/ Culture - Impacts During Construction	▪ Dust production, vibration and noise typical with open cut construction to be anticipated for sewers and SPS.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ Dust production, vibration and noise typical with open cut construction to be anticipated for sewers and SPS.	▪ Dust production, vibration and noise typical with open cut construction to be anticipated for SPS. ▪ Noise and vibration typical with directional drilling construction of sewers.	▪ Dust production, vibration and noise typical with open cut construction to be anticipated.
Social/ Culture - Traffic Disruption/ Truck Traffic	▪ The majority of sewer construction will be completed using open cut construction methods. ▪ Short to medium term traffic diversions and road closures.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ The majority of sewer construction will be completed using open cut construction methods. ▪ Short to medium term traffic diversions and road closures. ▪ Long term reliance on septage haulers	▪ Sewer construction will be completed using a mix of open cut construction methods and directional drilling. ▪ Short to medium term traffic diversions and road closures.	▪ The majority of sewer construction will be completed using open cut construction methods. ▪ Short to medium term traffic diversions and road closures.
Social/ Culture - Effect on Residential Properties	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Interior plumbing modifications potentially required.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ New septic tank will need to be installed on the property. ▪ Access to the septic tank must be maintained for regular cleanouts. ▪ Potential for septage spills from tank cleanouts. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Low pressure pump system including controls will need to be installed on the property. ▪ Access to pump will need to be maintained to facilitate maintenance. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Vacuum pit will need to be installed on the property. ▪ Access to the vacuum pit will need to be maintained for maintenance. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.
Social/ Culture - Effect on Businesses/ Commercial Properties	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Interior plumbing modifications potentially required.	▪ See Gravity Sewer • See Pressure Sewer for select areas.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ New septic tank will need to be installed on the property. ▪ Access to the septic tank must be maintained for regular cleanouts. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Low pressure pump system including controls will need to be installed on the property. ▪ Access to pump will need to be maintained to facilitate maintenance. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Vacuum pit will need to be installed on the property. ▪ Access to the vacuum pit will need to be maintained for maintenance. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.
Social/ Culture - Effect on Industrial Properties	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Interior plumbing modifications potentially required.	▪ See Gravity Sewer • See Pressure Sewer for select areas.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ New septic tank will need to be installed on the property.	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Low pressure pump system including controls will need to be	▪ Construction of sewer lateral may require tree removals. ▪ Disruption of landscaping. ▪ Vacuum pit will need to be installed on the property.

Criteria	Gravity Sewer	Blended Gravity / LPS	STEP / STEG	Low Pressure Sewer	Vacuum Sewer
			▪ Access to the septic tank must be maintained for regular cleanouts. ▪ Interior plumbing modifications potentially required. ▪ Potential for odours.	installed on the property. ▪ Access to pump will need to be maintained to facilitate maintenance. ▪ Interior plumbing modifications potentially required.	▪ Access to the vacuum pit will need to be maintained for maintenance. ▪ Interior plumbing modifications potentially required.
Technical - Technology Robustness	▪ Gravity sewers are designed to accommodate peak flow discharges and can accommodate high flow events without any adverse impacts. ▪ Loss of power has no effect on the ability of gravity sewers to transmit sewage to pumping stations. ▪ Loss of power at pumping stations is managed through the establishment of on-site power generation. ▪ Sewer line breaks may result in extraneous flows entering the collection system or exfiltration of wastewater into the groundwater	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ STEP/STEG sewers are designed to accommodate the liquid portion of sewage discharges only. ▪ Small bore sewers may be subject to fowling if septic tank upsets occur. ▪ Loss of power will result in the inability of individual pumps to operate for STEP systems. ▪ Loss of power at pumping stations is managed through the establishment of on-site power generation.	▪ Pressure sewers are designed to accommodate peak flow discharges and can accommodate high flow events without any adverse impacts. ▪ Loss of power will result in the inability of individual pumps to operate. ▪ Loss of power is managed through the storage volume of individual pump pits however power outages exceeding 24 hrs will be problematic.	▪ Vacuum sewers are designed to accommodate peak flow discharges and can accommodate high flow events without any adverse impacts. ▪ Loss of power will result in the inability of the system to transmit sewage to vacuum stations. ▪ Loss of power at vacuum stations is managed through the establishment of on-site power generation.
Technical - Energy Requirements	▪ Energy use is centralized at pumping stations.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ Energy use required for STEP systems. ▪ Energy use required at pumping stations.	▪ Energy use required for low pressure pump systems. ▪ Energy use required at pumping stations.	▪ Energy use required to operate vacuum collection ▪ Energy use required at centralised pumping stations
Technical - Sustainability for Phasing	▪ Split wetwell design can accommodate near term flows as development occurs. ▪ Pump upgrades typically required over time to accommodate greater flow rates.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ Split wetwell design can accommodate near term flows as development occurs. ▪ Pump upgrades typically required over time to accommodate greater flow rates. ▪ Low lying areas easily accommodated by relying on STEP systems.	▪ LPS systems work functionally as a "one size fits all" solution. Expansion through phasing accommodated by properly sized trunk sewers which may be difficult with uncertain growth.	▪ Vacuum stations oversized to accommodate growth. ▪ Pump upgrades typically required over time to accommodate greater flow rates.
Technical - Constructability	▪ Typical construction impacts associated with open cut sewer construction. ▪ Impacts to water crossings and environmentally sensitive areas mitigated through selective use of tunneling.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ Typical construction impacts associated with open cut sewer construction. ▪ Impacts to water crossings and environmentally sensitive areas mitigated through selective use of tunneling.	▪ Typical construction impacts associated with open cut sewer construction. ▪ Impacts to water crossings and environmentally sensitive areas mitigated through selective use of tunneling.	▪ Typical construction impacts associated with open cut sewer construction. ▪ Impacts to water crossings and environmentally sensitive areas mitigated through selective use of tunneling.

Criteria	Gravity Sewer	Blended Gravity / LPS	STEP / STEG	Low Pressure Sewer	Vacuum Sewer
Technical - Operation and Maintenance Impacts	▪ Gravity sewers are subject to fowling, reducing capacity over time. ▪ Gravity sewers are subject to infiltration increasing the hydraulic load on pumping stations and the WWTP. ▪ Major mechanical operation and maintenance requirements are centralized at pumping stations ▪ Standard mechanical components and operation that operators are familiar with. ▪ Minimizes the number of pumps required to operate the system which generally reduces operation and maintenance requirements.	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ Regular septic tank cleanouts required ▪ Septic systems are sensitive to improper use; bulking can occur and may get transmitted into the system which is designed for only water. ▪ Gravity sewers are subject to infiltration increasing the hydraulic load on pumping stations and the WWTP. ▪ Mechanical operation and maintenance requirements are dispersed throughout the community on private lots. ▪ Lies between minimum and maximum number of pumps required to operate the system. Middle range maintenance requirements. ▪ Commercial entities may introduce clogging issues.	▪ Pressure sewers minimize fowling over time and should maintain consistent capacity ▪ Centralized pumping stations still required due to the highly variant topography and the geographical separation between Erin and Hillsburgh ▪ Maximizes the number of pumps required to operate the system which generally increases operation and maintenance requirements	▪ Sawtooth vacuum sewer design may create optimal conditions for sedimentation ▪ Vacuum sewer breaks will eliminate system functionality within the catchment area. ▪ Atypical system type which operators will likely be unfamiliar with. ▪ Similar pumping arrangement to gravity sewers, however pumps cannot discharge into vacuum sewer catchments. Pumps must discharge to downstream pumping stations maximizing forcemain lengths. High potential H2S formation.
Economic - Capital Cost	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.
Economic - Life Cycle Net Present Value	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.
Economic - Annual Operation and Maintenance	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.	▪ Presented in Table 10.
Environmental - Sustainability	▪ Long lifespan anticipated for most system components ▪ No use of proprietary equipment which may be removed from the market	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ Use of proprietary equipment in selective areas for STEP ▪ Long lifespan anticipated for linear infrastructure. ▪ Anaerobic conditions from septic tanks may produce corrosive gases causing system wear	▪ Use of proprietary equipment throughout the system ▪ Short lifespan anticipated for grinder pump systems	▪ Use of proprietary equipment throughout the system ▪ Increased system complexity and potential for mechanical issues.
Environmental - Greenhouse Gas Generation	▪ GHG production associated with power consumption on the low end of alternatives. ▪ GHG production associated with construction on the high end of alternatives (deeper sewer construction, high volume of concrete used)	▪ See Gravity Sewer ▪ See Pressure Sewer for select areas.	▪ GHG production associated with power consumption in the mid-range of alternatives. ▪ GHG production associated with construction on the high end of alternatives (deeper sewer construction, high volume of concrete used) ▪ GHG production as a result of ongoing need for hauling septage	▪ GHG production associated with power consumption in the mid-range of alternatives. ▪ GHG production associated with construction in the mid-range of alternatives	▪ GHG production associated with power consumption on the high end of alternatives. ▪ GHG production associated with construction on the low end of alternatives (shallow sewer construction, less concrete used)
Environmental - Effect on	▪ Potential for moderate	▪ See Gravity Sewer	▪ Potential for moderate exfiltration of	▪ Potential for significant exfiltration of	▪ Low potential for groundwater

Criteria	Gravity Sewer	Blended Gravity / LPS	STEP / STEG	Low Pressure Sewer	Vacuum Sewer
Groundwater	exfiltration of wastewater in broken sewers. Assumes groundwater elevation is below the pipe depth. ▪ Potential for forcemain breaks and exfiltration of waste into the groundwater	▪ See Pressure Sewer for select areas.	wastewater in broken gravity sewers. Assumes groundwater elevation is below the pipe depth. ▪ Potential for significant exfiltration of wastewater from broken pressure sewers. Groundwater level independent. ▪ Potential for forcemain breaks and exfiltration of waste into the groundwater	wastewater from broken pressure sewers. Groundwater level independent. ▪ Potential for forcemain breaks and exfiltration of waste into the groundwater	contamination. ▪ Broken lines may result in significant inflow due to negative line pressure. ▪ Potential for forcemain breaks and exfiltration of waste into the groundwater
Environmental - Effect on Surface Water/ Fisheries	▪ System predominantly constructed in existing ROW, minimizing effect on water/fisheries.	▪ See Gravity Sewer	▪ System predominantly constructed in existing ROW, minimizing effect on water/fisheries.	▪ System predominantly constructed in existing ROW, minimizing effect on water/fisheries.	▪ System predominantly constructed in existing ROW, minimizing effect on water/fisheries.
Environmental - Effect on Vegetation/ Wetlands	▪ System predominantly constructed in existing ROW, minimizing effect on vegetation/wetlands.	▪ See Gravity Sewer	▪ System predominantly constructed in existing ROW, minimizing effect on vegetation/wetlands.	▪ System predominantly constructed in existing ROW, minimizing effect on vegetation/wetlands.	▪ System predominantly constructed in existing ROW, minimizing effect on vegetation/wetlands.
Environmental - Effect on Habitat/ Wildlife	▪ System predominantly constructed in existing ROW, minimizing effect on habitat/wildlife.	▪ See Gravity Sewer	▪ System predominantly constructed in existing ROW, minimizing effect on habitat/wildlife.	▪ System predominantly constructed in existing ROW, minimizing effect on habitat/wildlife.	▪ System predominantly constructed in existing ROW, minimizing effect on habitat/wildlife.

5.0 Conclusions and Recommendations

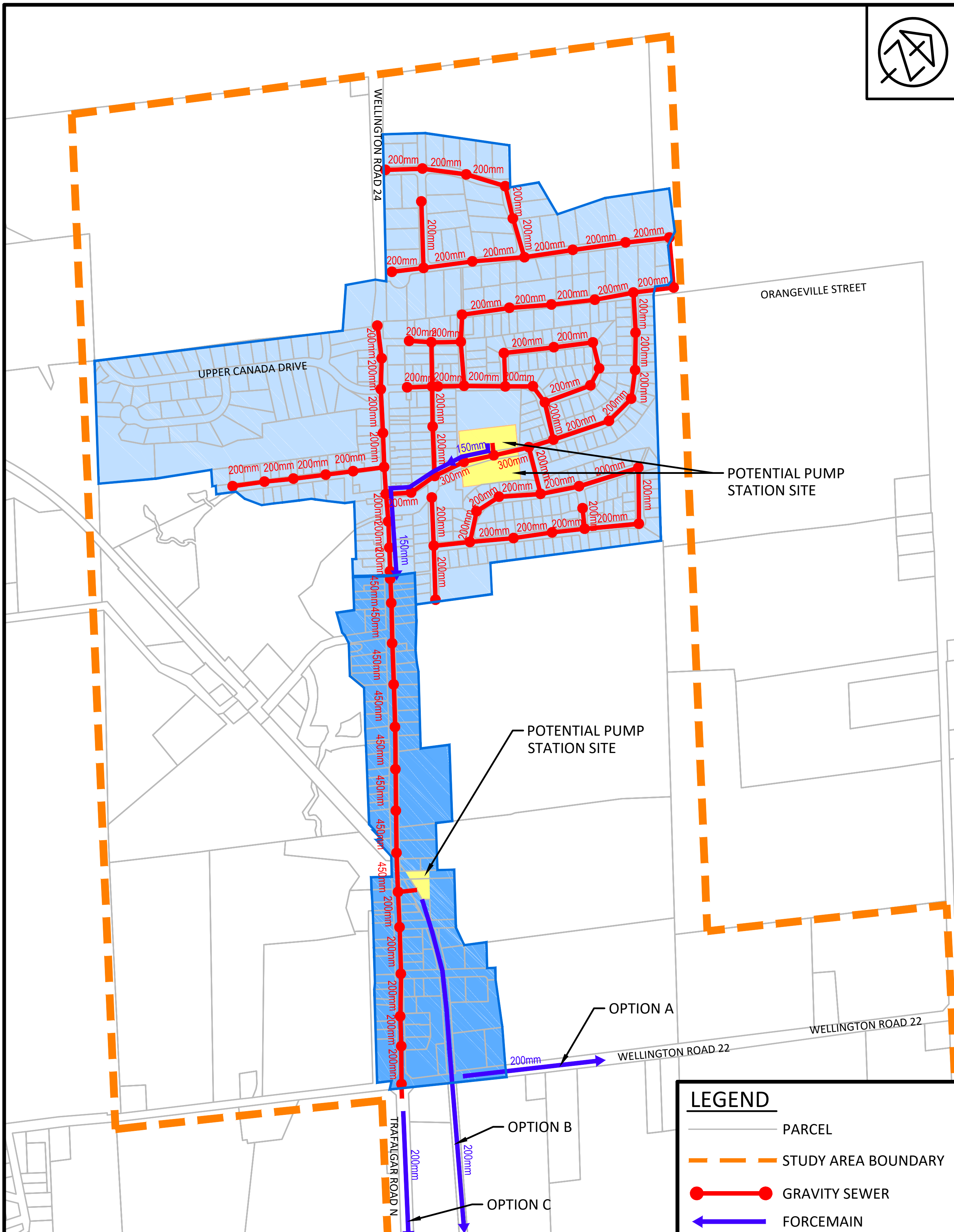
- In 2014 the Town of Erin completed a Servicing and Settlement Master Plan (SSMP) to address servicing, planning and environmental issues within the Town.
- The SSMP considered servicing and planning alternatives for wastewater and identified a centralised collection and treatment system as the preferred waste management alternative.
  - The SSMP concluded that the wastewater collection system will convey sewage to a single wastewater treatment plant located south east of the Erin Village with treated effluent being discharged to the West Credit River.
- The UCWS EA is a continuation of the Class EA process and aims to establish the preferred design alternative for wastewater collection for the existing urban areas of the Erin Village and Hillsburgh.
- In total, six different collection system alternatives are considered in the evaluation including:
  - Traditional Gravity Sewers
  - Modified Gravity Sewers
  - Blended Gravity/ LPS
  - Septic Tank Effluent Gravity Sewer (STEG) and Septic Tank Effluent Pump Sewer (STEP)
  - Low Pressure Sewer System
  - Vacuum Sewer System
- A detailed description of how each system alternative operates, the advantages and disadvantages of each system and the key issues affecting each system in the context of Erin is provided in Section 2.0.
- Modified gravity sewers were eliminated from the long list of alternatives on the basis that there would be difficulty accommodating deep basements with expansion of the collection system into new service areas. All other alternatives were carried forward for further evaluation.
- The evaluation criteria were established with the following weighting for the primary criteria:
  - Social/ Cultural Impacts – 15%
  - Environmental Impacts - 10%
  - Technical Aspects – 35%
  - Economics – 40%
- The capital costs, annual operation and maintenance costs, and net present value were calculated for each system and are presented below:

Table 13 – Capital and NPV Costs for System Alternatives

Collection Alternative	Capital Cost	Connection Cost (Home Owner)	Total Capital Cost	System Replacement and Operation NPV	Total Cost (Capital Cost + NPV)
Gravity Sewers	$44,830,000	$10,210,000	$55,692,000	$7,772,000	$63,464,000
Blended Alternative	$42,626,000	$8,930,000	$52,206,000	$7,535,000	$59,741,000
Pressure Sewers	$55,630,000	NIL	$56,130,000	$12,944,000	$69,074,000
Vacuum Sewers	$46,822,600	NIL	$50,852,800	$9,770,000	$60,622,800
STEP/STEG Collection	$52,002,400	NIL	$52,502,400	$8,999,000	$61,501,400

- Based on the overall evaluation of system alternatives under the evaluation criteria the "Blended Gravity/ LPS" alternative was selected.
- The blended system is the second most expensive on a capital cost basis however the annual operation and maintenance costs are the lowest overall.
- Mapping of the proposed system is available in Appendix A of this report.

Appendix A
Gravity Collection System Design Basis



Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

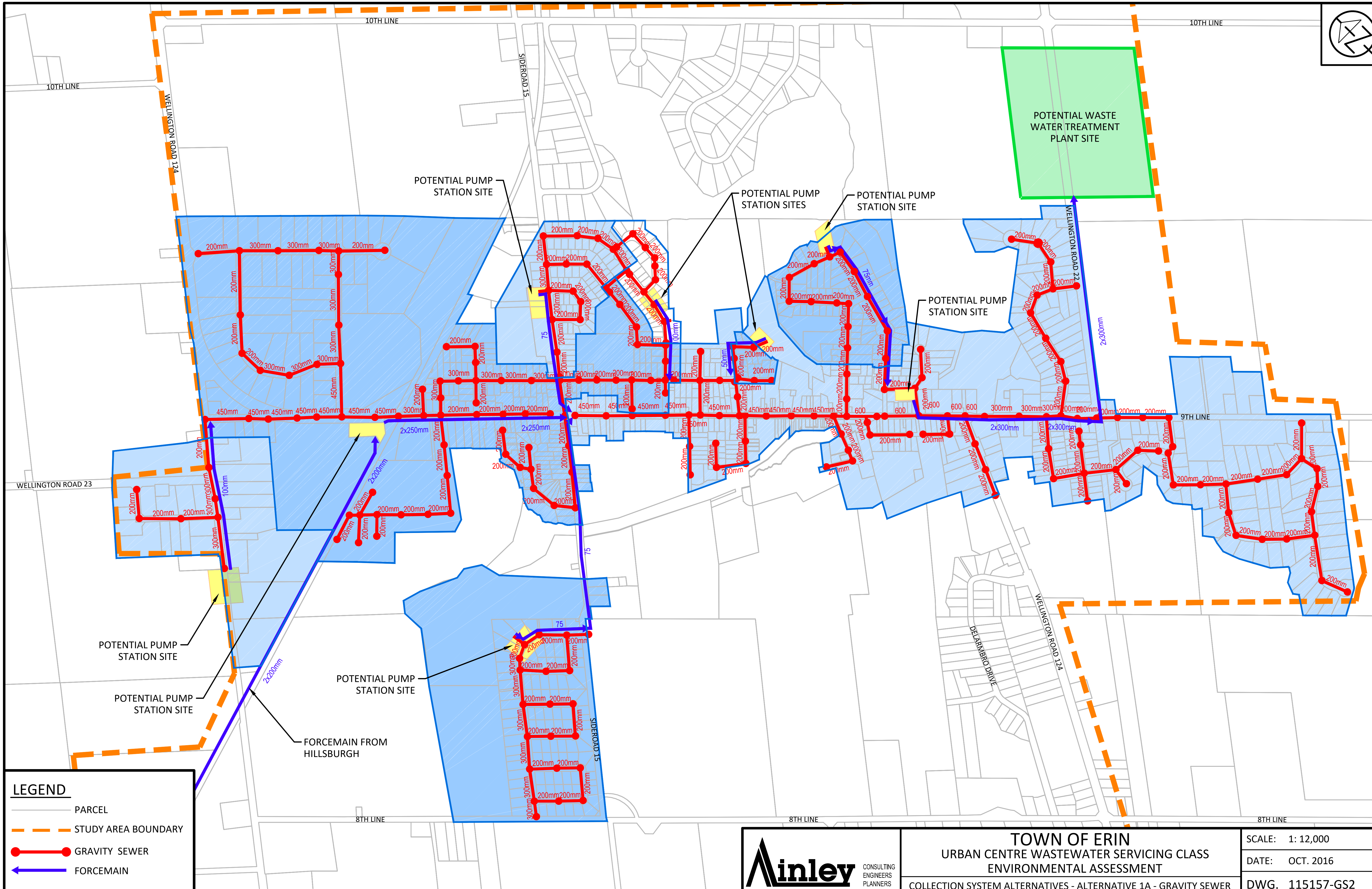
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1 - GRAVITY

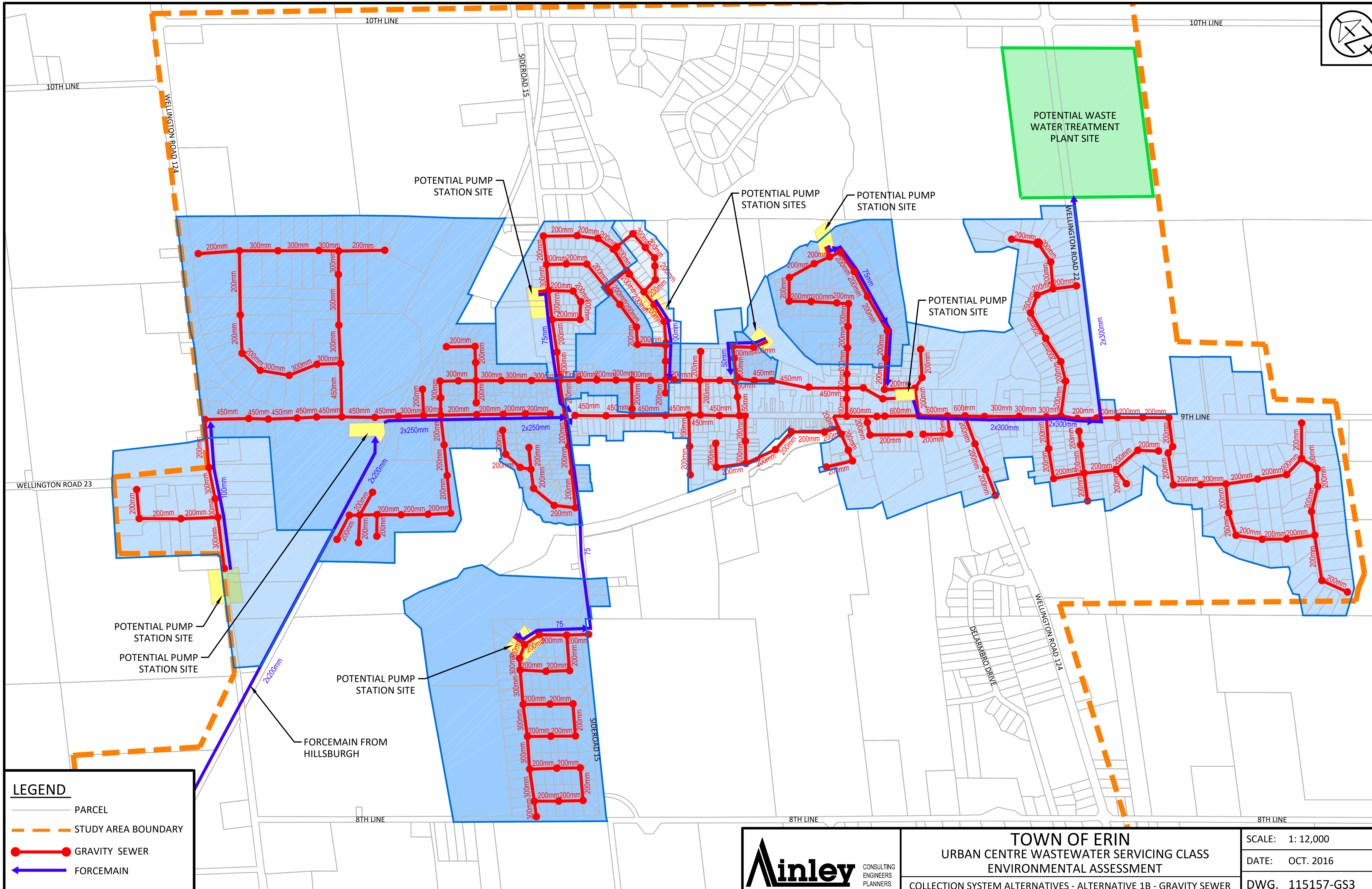
SCALE: 1: 12,500

DATE: MARCH 2017

DWG. 115157-GS1


10TH LINE
WELLINGTON ROAD 124
SIDEROAD 15
POTENTIAL WASTE WATER TREATMENT PLANT SITE
WELLINGTON ROAD 22
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITES
9TH LINE
WELLINGTON ROAD 23
FORCEMAIN FROM HILLSBURGH
DELARMBRO DRIVE
8TH LINE
LEGEND
PARCEL
STUDY AREA BOUNDARY
GRAVITY SEWER
FORCEMAIN
Ainley CONSULTING ENGINEERS PLANNERS
TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1A - GRAVITY SEWER
SCALE: 1: 12,000
DATE: OCT. 2016
DWG. 115157-GS2

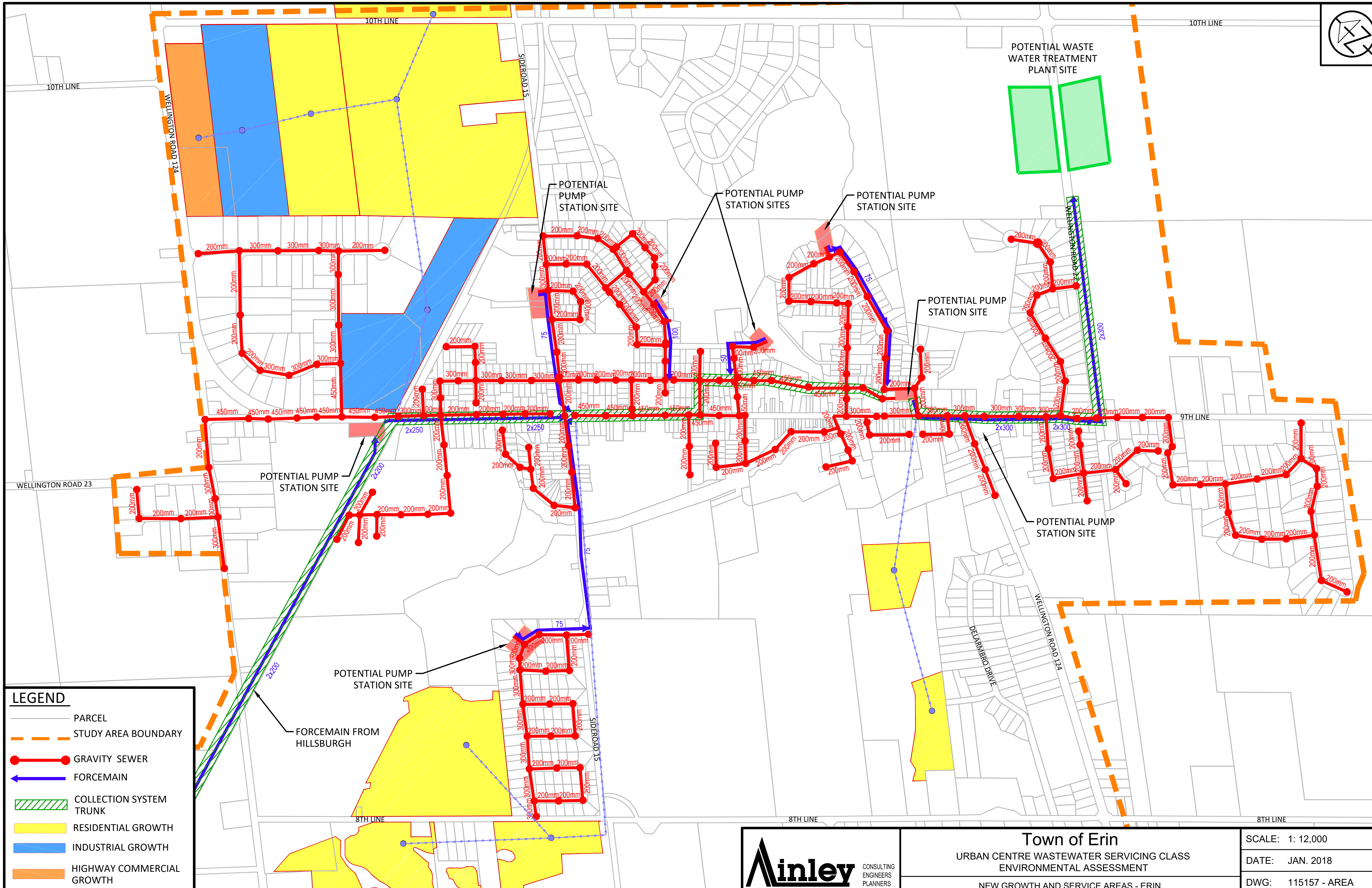
Appendix B
Collection System Trunk Network



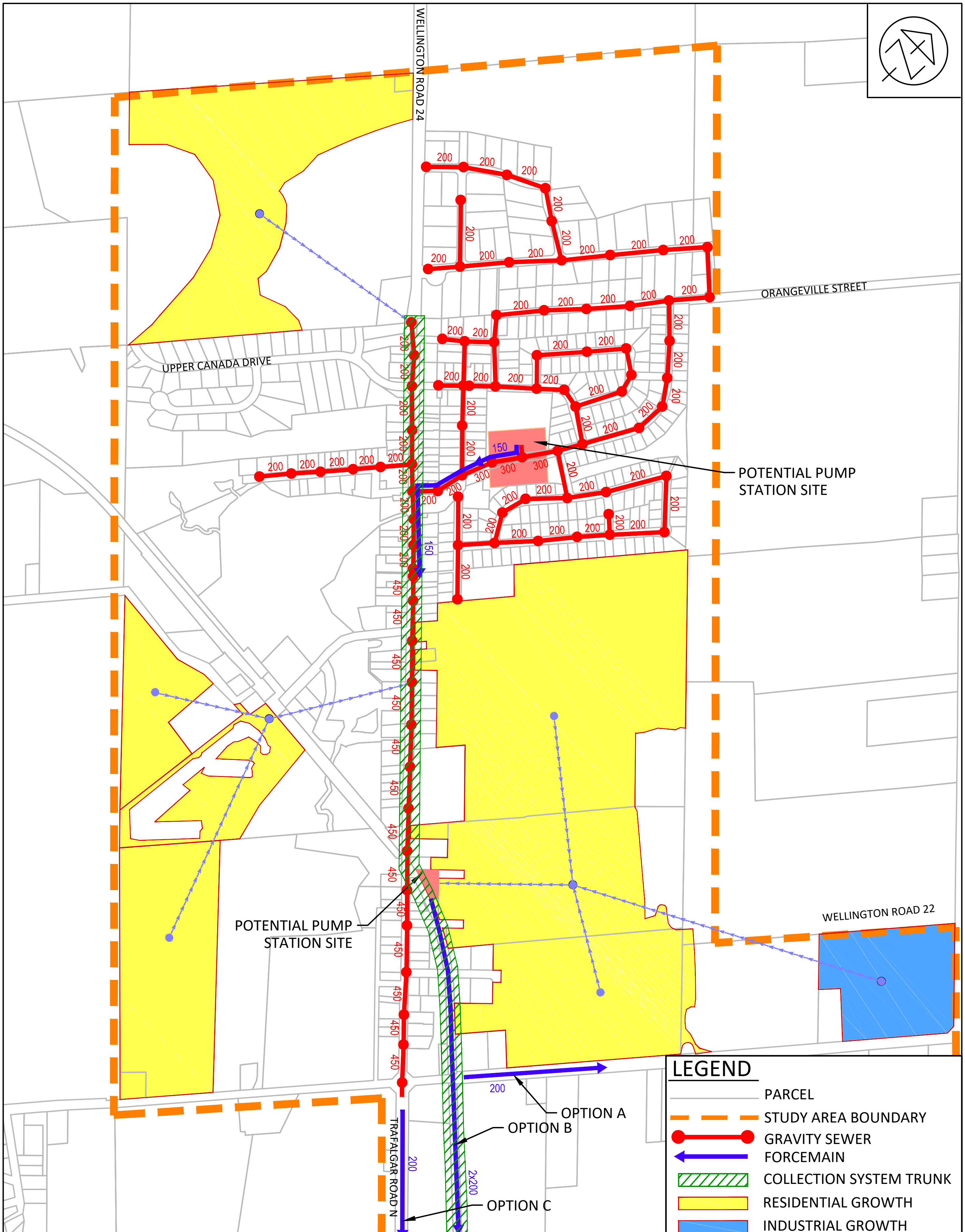
10TH LINE
10TH LINE
10TH LINE
SIDEROAD 15
WELLINGTON ROAD 124
WELLINGTON ROAD 22
WELLINGTON ROAD 23
9TH LINE
8TH LINE
8TH LINE
8TH LINE
SIDEROAD 15
DELARMBRO DRIVE
WELLINGTON ROAD 124
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITES
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
FORCEMAIN FROM HILLSBURGH
LEGEND
PARCEL
STUDY AREA BOUNDARY
GRAVITY SEWER
FORCEMAIN
Ainley
CONSULTING ENGINEERS PLANNERS
TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1B - GRAVITY SEWER
SCALE: 1: 12,000
DATE: OCT. 2016
DWG. 115157-GS3

Appendix C

Gravity Collection System – Alternative Downtown Servicing in Erin



10TH LINE
10TH LINE
10TH LINE
WELLINGTON ROAD 124
SIDEROAD 15
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITES
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
WELLINGTON ROAD 22
9TH LINE
WELLINGTON ROAD 23
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
FORCEMAIN FROM HILLSBURGH
DELARMBRO DRIVE
WELLINGTON ROAD 124
SIDEROAD 15
8TH LINE
8TH LINE
8TH LINE
LEGEND
PARCEL
STUDY AREA BOUNDARY
GRAVITY SEWER
FORCEMAIN
COLLECTION SYSTEM TRUNK
RESIDENTIAL GROWTH
INDUSTRIAL GROWTH
HIGHWAY COMMERCIAL GROWTH
Ainley
CONSULTING ENGINEERS PLANNERS
Town of Erin
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
NEW GROWTH AND SERVICE AREAS - ERIN
SCALE: 1: 12,000
DATE: JAN. 2018
DWG: 115157 - AREA



Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

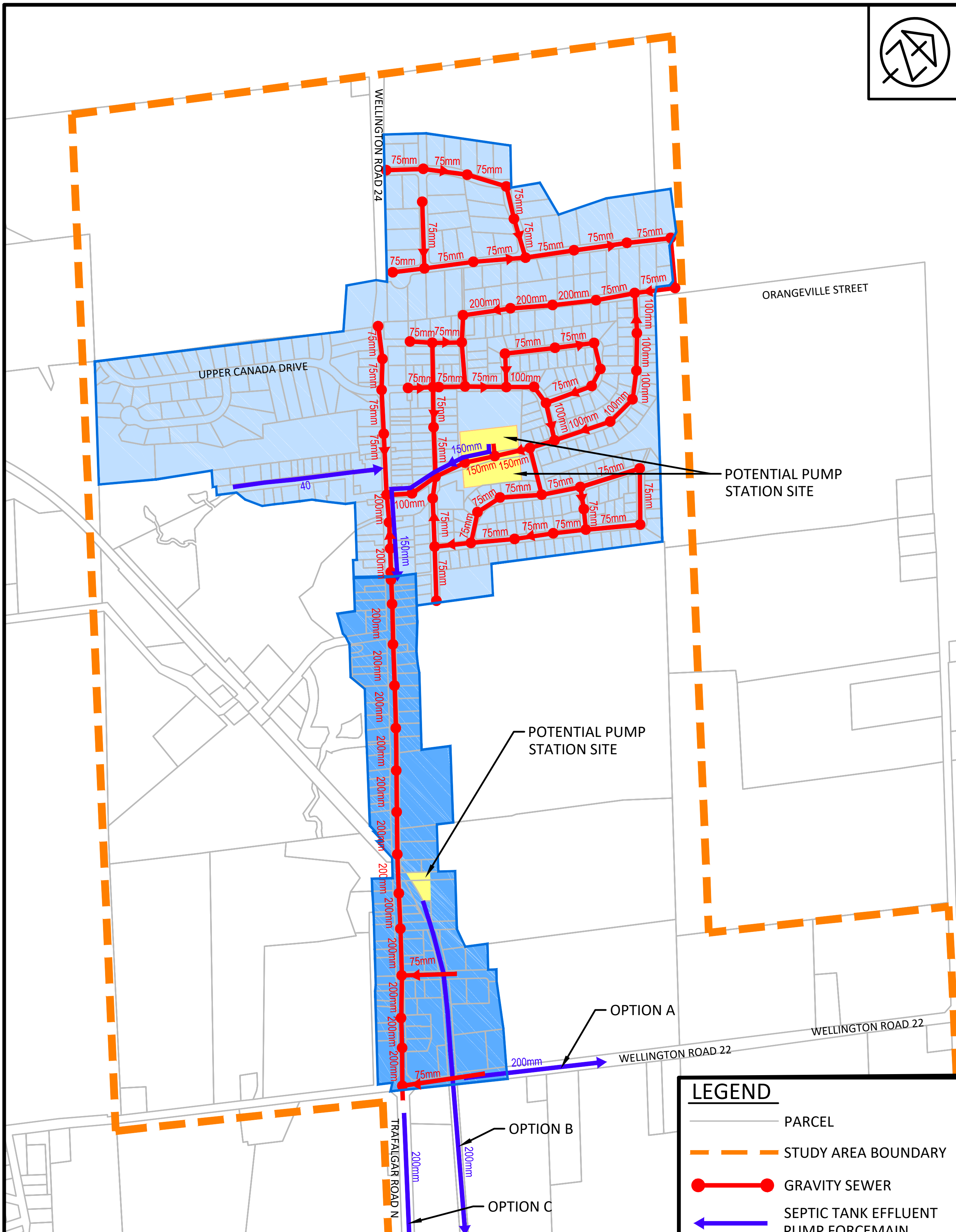
NEW GROWTH AND SERVICE AREAS - HILLSBURGH

SCALE: 1: 12,500

DATE: JAN. 2018

DWG. 115157-AREA

Appendix D
STEP/STEG Collection System Design Basis



Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

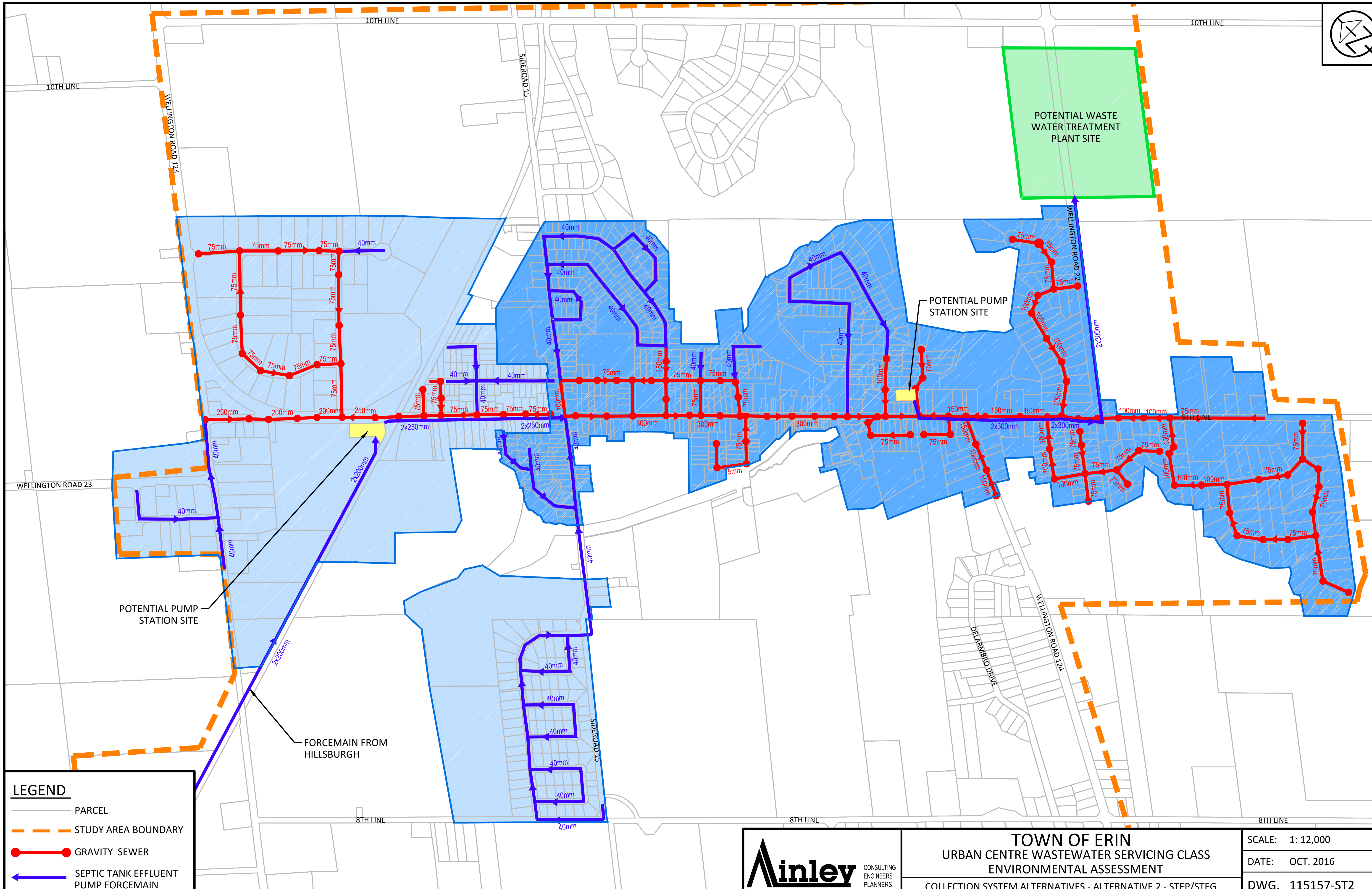
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 2 - STEP/STEG

SCALE: 1: 12,500

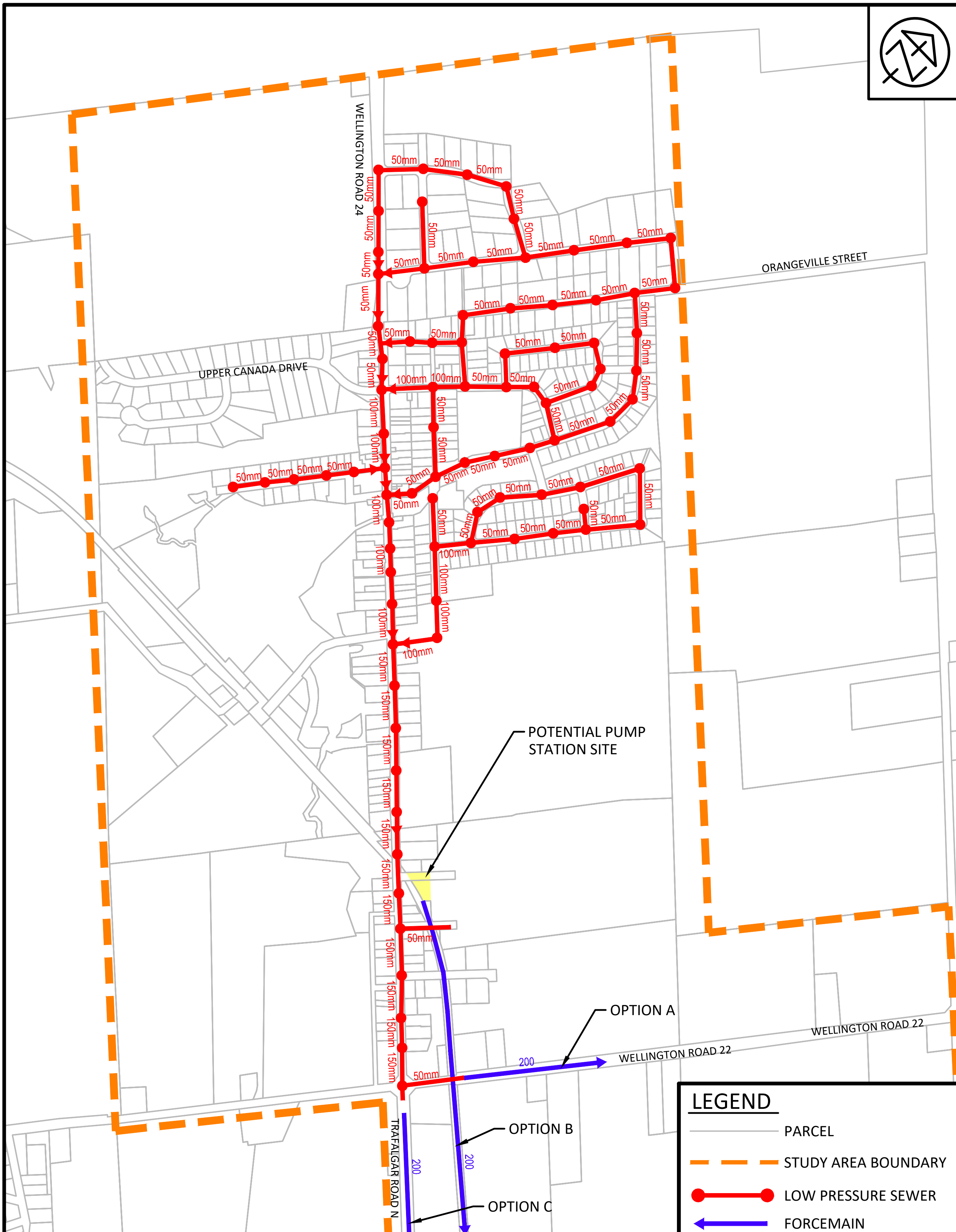
DATE: MARCH 2017

DWG. 115157-ST1

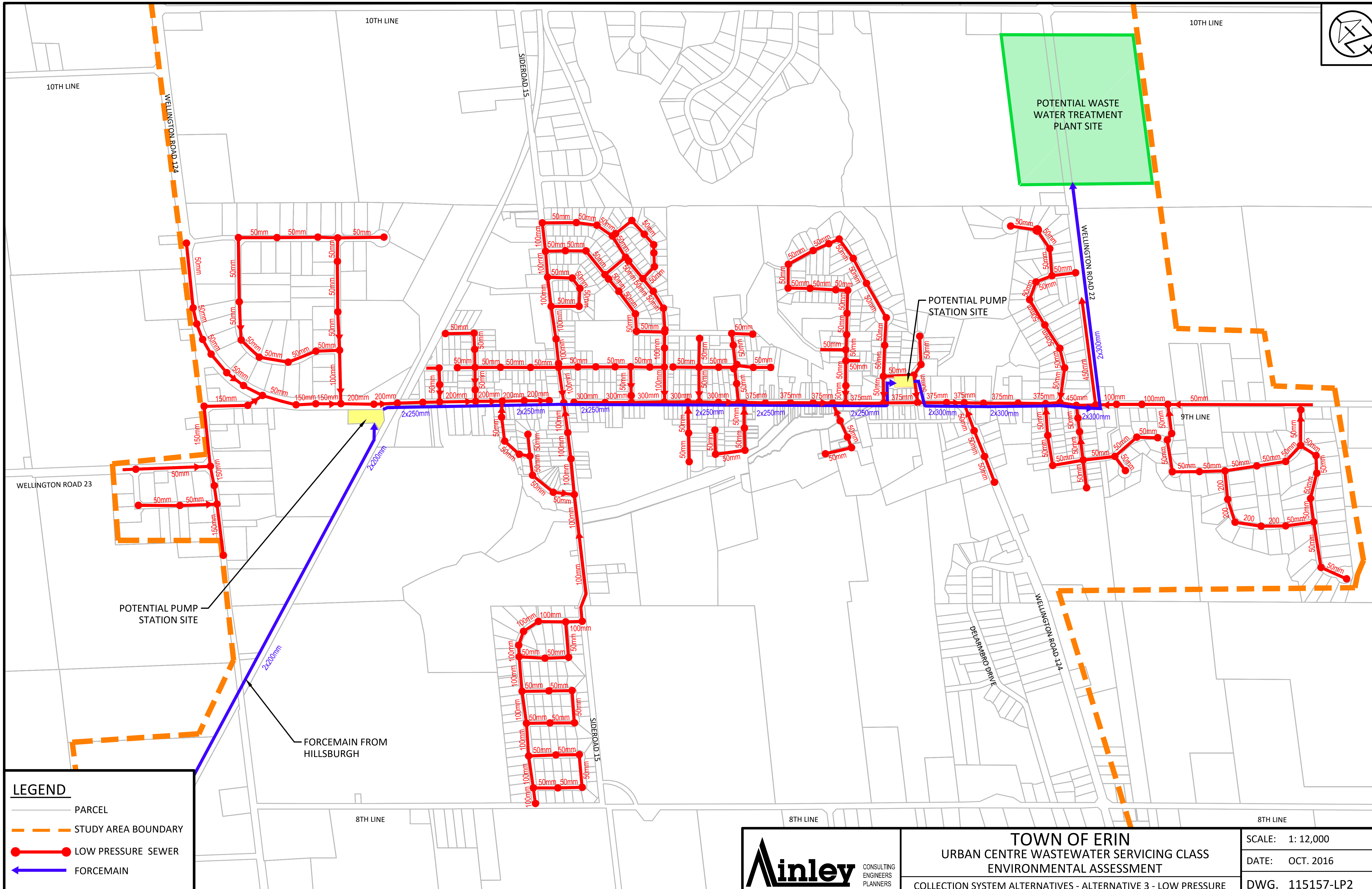


10TH LINE
SIDEROAD 15
WELLINGTON ROAD 124
WELLINGTON ROAD 23
WELLINGTON ROAD 22
9TH LINE
8TH LINE
DELARMBRO DRIVE
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
FORCEMAIN FROM HILLSBURGH
2x200mm
2x250mm
2x300mm
LEGEND
PARCEL
STUDY AREA BOUNDARY
GRAVITY SEWER
SEPTIC TANK EFFLUENT PUMP FORCEMAIN
Ainley CONSULTING ENGINEERS PLANNERS
TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 2 - STEP/STEG
SCALE: 1: 12,000
DATE: OCT. 2016
DWG. 115157-ST2

Appendix E
Low Pressure Collection System Design Basis



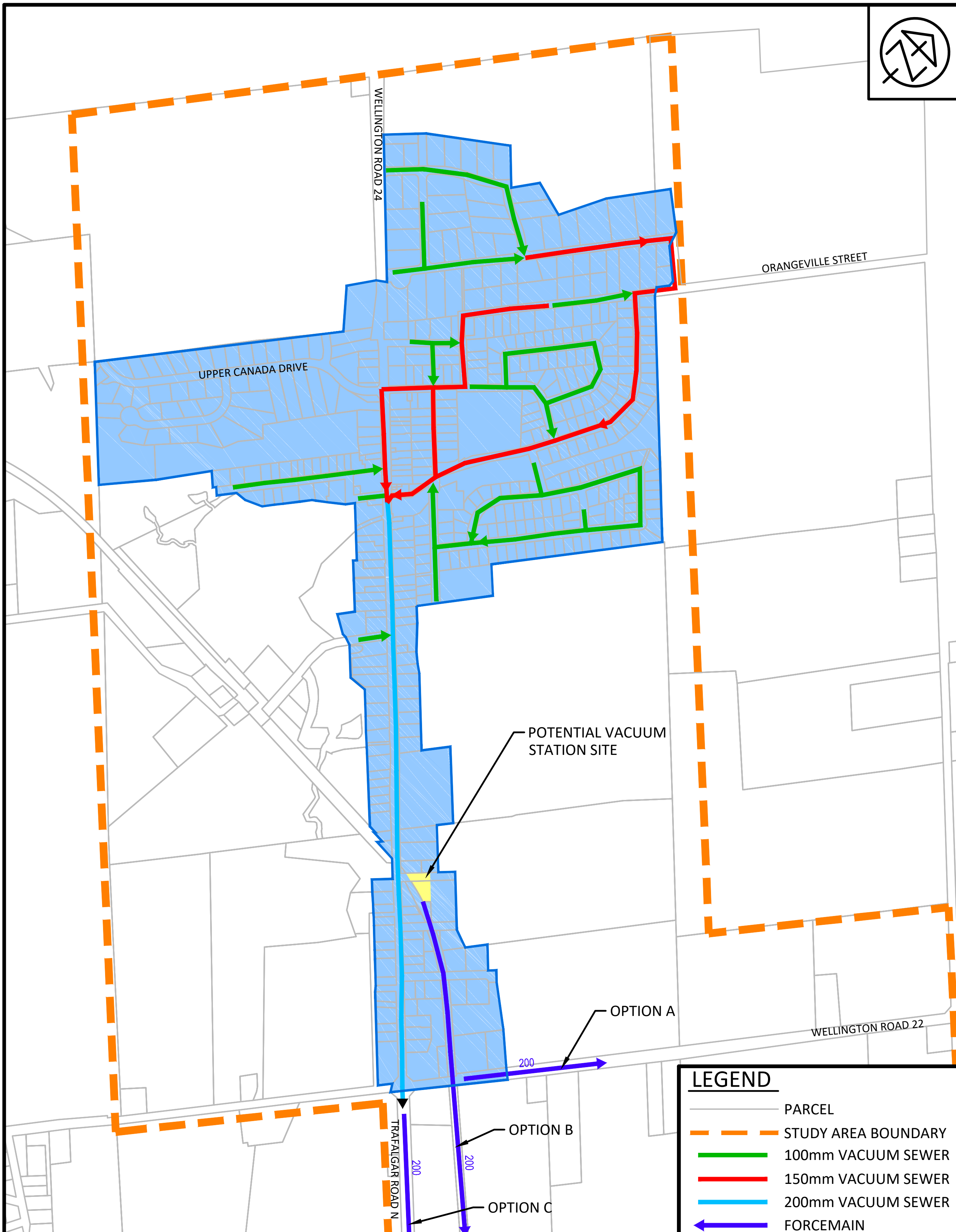
Ainley CONSULTING ENGINEERS PLANNERS	TOWN OF ERIN URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT	SCALE: 1: 12,500
		DATE: MARCH 2017
	COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 3 - LOW PRESSURE	DWG. 115157-LP1



10TH LINE
10TH LINE
10TH LINE
SIDEROAD 15
WELLINGTON ROAD 124
WELLINGTON ROAD 23
WELLINGTON ROAD 22
9TH LINE
DELARMBRO DRIVE
WELLINGTON ROAD 124
SIDEROAD 15
8TH LINE
8TH LINE
8TH LINE
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
FORCEMAIN FROM HILLSBURGH
2x200mm
2x250mm
2x300mm
LEGEND
PARCEL
STUDY AREA BOUNDARY
LOW PRESSURE SEWER
FORCEMAIN
Ainley CONSULTING ENGINEERS PLANNERS
TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 3 - LOW PRESSURE
SCALE: 1: 12,000
DATE: OCT. 2016
DWG. 115157-LP2

Appendix F

Vacuum Collection System Design Basis



Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

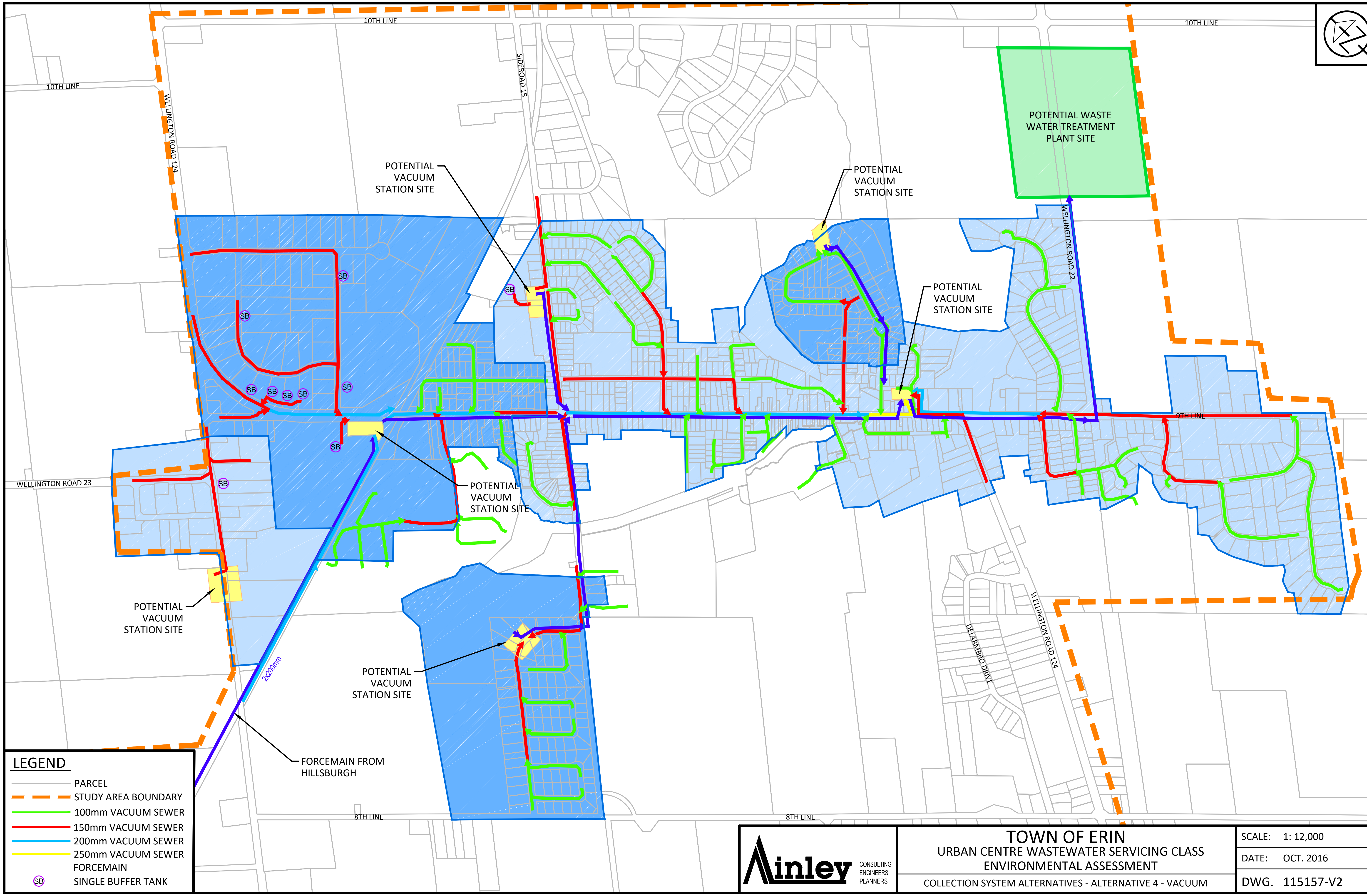
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 4 - VACUUM

SCALE: 1: 12,500

DATE: OCT. 2016

DWG. 115157-V1


10TH LINE
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SIDEROAD 15
WELLINGTON ROAD 124
WELLINGTON ROAD 23
WELLINGTON ROAD 22
WELLINGTON ROAD 124
DELARMBRO DRIVE
9TH LINE
8TH LINE
8TH LINE
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL VACUUM STATION SITE
POTENTIAL VACUUM STATION SITE
POTENTIAL VACUUM STATION SITE
POTENTIAL VACUUM STATION SITE
POTENTIAL VACUUM STATION SITE
POTENTIAL VACUUM STATION SITE
FORCEMAIN FROM HILLSBURGH
2x200mm
SB
LEGEND
PARCEL
STUDY AREA BOUNDARY
100mm VACUUM SEWER
150mm VACUUM SEWER
200mm VACUUM SEWER
250mm VACUUM SEWER
FORCEMAIN
SINGLE BUFFER TANK
Ainley CONSULTING ENGINEERS PLANNERS
TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 4 - VACUUM
SCALE: 1: 12,000
DATE: OCT. 2016
DWG. 115157-V2

Appendix G
Costs Memorandum

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Tel: (905) 452-5172 Fax: (705) 445-0968
E-mail: brampton@ainleygroup.com

April 24, 2018 File No. 115157

Triton Engineering Services Limited
105 Queen Street West Unit 14
Fergus, ON N1M 1S6

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

Ref: **Town of Erin, Urban Centre Wastewater Servicing Class EA**
Collection System Costing, Technical Memorandum

Dear Ms. Furlong:

We are pleased to present our Technical Memorandum for the "Collection System Costing" for the Urban Centre Wastewater Servicing Schedule 'C' Municipal Class Environmental Assessment (EA).

This Technical Memorandum provides an outline of the costing basis for the alternative sanitary collection systems. The estimated capital cost and net present value of the systems are presented within. The costs presented are developed on the basis of servicing the existing community including infill and intensification potential.

Should you have any questions or require clarifications, please contact the undersigned.

Yours truly,

AINLEY & ASSOCIATES LIMITED

Gary Scott, M.Sc., P.Eng.
Senior Project Advisor

Town of Erin

Urban Centre Wastewater Servicing
Class Environmental Assessment

Technical Memorandum
Collection System Costing

Final

April 2018

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum Collection System Costing

Project No. 115157

Prepared for:
The Town of Erin

Prepared By:

Simon Glass, P.Eng

Prepared By:

Gary Scott, P.Eng.

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Brampton, ON L6W 4P7

Phone: (905) 452 – 5172
www.ainleygroup.com

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Glossary of Terms

ADF	Average Daily Flow, typically presented through the report in units of cubic metres per day (m3/d).
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.
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.
Design Concept	A method of implementing an alternative solution(s).
Effluent	Liquid after treatment. Effluent refers to the liquid discharged from the WWTP to the receiving water.
Equivalent Population	Equivalent Population represents Residential Population plus Institutional/ Commercial/Industrial wastewater flow sources expressed as the equivalent number of residents, while Residential Population represents the "actual" population exclusive of Institutional/ Commercial/ Industrial wastewater flows.
Forcemain	A pressurized pipe used to convey pumped wastewater from a sewage pumping station.
Gravity sewer	A pipe that relies on gravity to convey sewage.
Harmon Peaking Factor	A standard formula used for the estimation peak day flows based on the average daily flow (ADF).
Horizontal Directional Drilling (HDD)	A trenchless technology method of pipeline construction that could be used for the construction of sewage forcemains or for small diameter sewer construction under watercourse crossings.
Infill	A process of development within urban areas that are already largely developed. Refers specifically to the development of vacant or underdeveloped lots.
Infiltration/Inflow (I&I)	Rainwater and groundwater that enters a sanitary sewer during wet weather events or due to leakages, etc.
Intensification	A process of development within existing urban areas that are already largely developed. Refers specifically to the redevelopment of lots to increase occupancy.
L/c/d	Litres per capita per day.
LPS System	Low-Pressure Sewer System refers to a network of grinder pump units

	installed at each property pumping into a common forcemain.
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.
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.
ROW	Right-of-way applies to lands which have an access right for highways, roads, railways or utilities, such as wastewater conveyance pipes.
Sanitary Sewer	Sewer pipe that conveys sewage to a sewage pumping station or sewage treatment plant. Part of the sewage collection system.
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.
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.
STEP/STEG	Septic Tank Effluent Pumping/ Septic Tank Effluent Gravity, refers to a method of wastewater collection which collects the liquid portion of waste from the septic tanks while the solids remain for removal and treatment by a separate method.
Study Area	The area under investigation in which construction may take place in order to provide servicing to the Service Area.
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
Trunk Sewer	A sewer that collects sewage from a number of tributary sewers.
UCWS Class EA	Urban Centre Wastewater Servicing Class Environmental Assessment
Wastewater	See Sewage

1.0 Introduction

This Technical Memorandum has been prepared as an appendix to the Wastewater Collection Alternatives Technical Memorandum. The information provided is in support of the Town of Erin Urban Centre Wastewater Servicing Environmental Assessment (UCWWS EA). Properties within the Village of Erin and Hillsburgh are currently serviced by individual private septic systems. The Servicing and Settlement Master Plan (SSMP), completed by B.M. Ross in 2014, selected a communal wastewater collection system for both communities as the preferred alternative solution to deal with issues related to the private systems. The SSMP completed part of Phase 1 and part of Phase 2 of the Class Environmental Assessment process and the Town is now engaged in completing these two phases and moving on to complete Phase 3 and Phase 4 of the Class EA process.

This Technical Memorandum outlines the costing basis for the alternative sanitary collection systems. The estimated capital cost and net present value of the systems are presented within. The costs presented are developed on the basis of servicing the existing community including infill and intensification potential.

2.0 Objectives

The objectives of this report are as follows:

- Define the basis for cost estimates
- Estimate cost of alternatives

3.0 Cost Estimation Basis

Table 1 provides installation cost for sewers at varying sizes and depths given the following assumptions:

- All costs are in 2017 dollars
- Excavation in overburden soils
- Moderate dewatering required
- Construction in one lane
- Prices include backfill to subgrade and restoration of road surface
- Full road reconstruction/ curb and sidewalk are not included
- Cost of rock excavation is extra over sanitary sewer cost per metre
- Where rock excavation is anticipated the assumption of cost is $200/m^3$
- The price for installation at depths not listed will be interpolated or extrapolated from this table
- $2000/ service to property line for gravity connections (city owned)
- $1400/ service to property line for pressure connections (city owned)

Table 1 – Open Cut Sewer Cost Estimating Basis (per metre costs)

	Diameter (mm)							
Depth (m)	**150**	**200**	**250**	**300**	**375**	**450**	**525**	**600**
2	$320	$360	$400	$440	$480	$520	$680	$840
3	$360	$400	$440	$480	$520	$560	$720	$880
4	$400	$440	$480	$520	$560	$600	$760	$920
5	$440	$480	$520	$560	$600	$640	$800	$960
6	$480	$520	$560	$600	$640	$680	$840	$1,000
7	$520	$560	$600	$640	$680	$720	$880	$1,040
8	$560	$600	$640	$680	$720	$760	$920	$1,080

The same general assumptions have also been made for the costing of forcemains. Table 2 provides installation cost for forcemain at varying sizes and depths used for cost estimation.

Table 2 – Forcemain Cost Estimation Basis (per metre costs)

Depth (m)	50/75	100	150	200	250	300	375	450
2	$300	$340	$380	$430	$480	$530	$580	$620
2.5	$315	$360	$405	$455	$505	$555	$603	$645
3	$330	$380	$430	$480	$530	$580	$625	$670
4	$380	$430	$480	$530	$575	$625	$670	$720

Table 3 provides the basis for the pricing of individual sanitary manholes. The price for installation at depths not listed will be interpolated or extrapolated from this table.

Table 3 – Sanitary Manhole (1200 mm diameter) Cost Estimation Basis

Depth (m)	Cost
3	$ 6,000
4	$ 7,500
5	$ 9,000
6	$ 10,500
7	$ 12,000

For reaches of sewer where open cut construction would not be feasible, it will be assumed that microtunneling will be used as the alternative construction method. This alternative is used for costing purposes due to the relatively high rock table in the community and the efficacy of this tunneling method in rock. Microtunneling requires both a launch and reception shaft for each section of sewer installation. For the purpose of the cost estimation, it will be assumed that 900 mm internal diameter (I.D.) concrete jacking pipe will be used for the tunnel casing which requires 5 m I.D. launch and reception shafts. Table 4 provides a list of costing benchmarks used through this report.

Table 4 – Sanitary Manhole (1200 mm diameter) Cost Estimation Basis

Component	Cost
Launch/Reception Shaft (4m to 8m depth)	$ 300,000 ea.
Launch/ Reception Shaft (8m to 12m depth)	$ 375,000 ea.
Launch Reception Shaft (> 12 m depth)	$ 550,000 ea.
900 mm I.D. Casing w/ Sewer Installed	$ 4,950/m

Directional drilling has been proposed as an inexpensive alternative to open cut construction for small bore sewers at shallow depths. For the purposes of comparison, contractors that perform this style of construction were contacted for typical unit rates of construction in overburden soils. Based on the feedback received, directional drilling is generally more expensive than open cut construction, particularly at shallow depths. It should be noted that, due to the climate in Erin, all sewers must be installed at sufficient depth to avoid freezing during the winter (>1.8 m depth).

Directional drilling is most advantageous where surface features would be impacted by construction that would be expensive to rehabilitate. Typical construction costs range between $600-$950/m for 100mm to 300mm pipes not including the launch pits or the pipe materials. As such, for sections of sewer where open cut construction is a feasible option, we have costed on that basis. Where river crossings are required, the respective tunneling rates will apply.

Figure 1 provides the basis for the pricing of the pumping stations based on design capacity. The capital costs for the construction of sewage pumping stations are based on historical tender cost for pumping stations ranging in capacity from 10 L/s to 250 L/s. A line of best fit was established to be used as a basis for estimating construction costs for the EA.

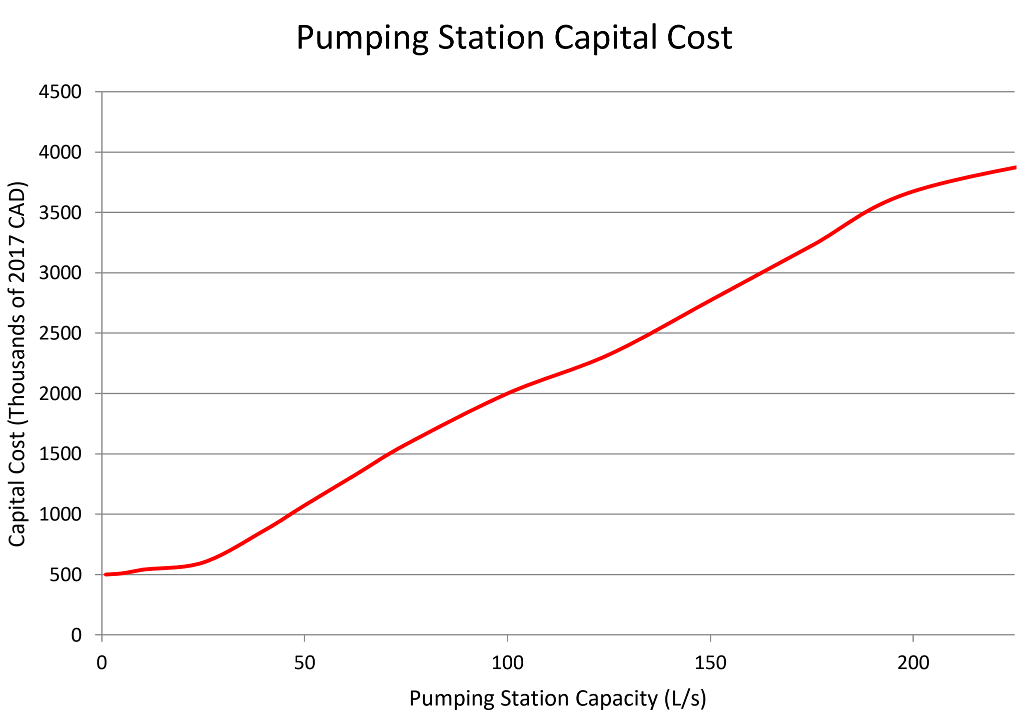


Figure 1 – Capital Cost of Pumping Stations Based on Capacity

Figure 2 provides the basis for the pricing of the operation and maintenance costs for pumping stations based on design capacity. Operations staff from several communities were consulted to determine approximate yearly O&M costs for pumping stations of various sizes. A line of best fit was established through the range of estimates to be used as a basis for estimating yearly O&M costs for the EA.

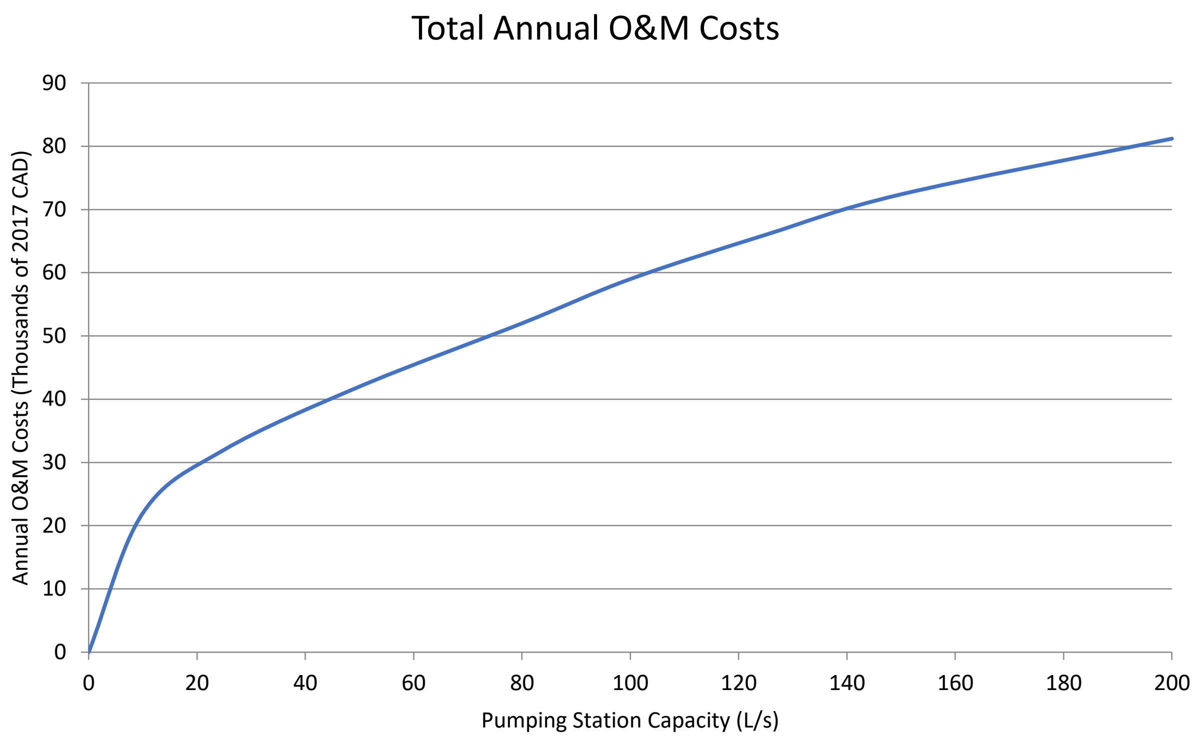


Figure 2 – Operation and Maintenance Costs of Pumping Stations Based on Capacity

4.0 Gravity System Alternative Capital and Operating Costs

The estimated capital costs for the gravity system are outlined in Table 5. A detailed summary of the sewer installation costing is provided in ***Appendix A***. A detailed summary of the pumping station and forcemain costing is also provided in ***Appendix A***. An assessment of connection costs to the system from each property was conducted and is provided in ***Appendix B***.

Table 5 – Gravity System Capital Cost Summary

System	Estimated Cost (2017 CAD$)
Gravity Sewer Installation	$ 12,910,000.00
Manhole Installation	$ 2,525,000.00
Service Connections (1550)	$ 3,100,000.00
Pumping Stations	$ 7,455,000.00
Forcemains	$ 4,750,000.00
Capital Cost Sum	**$ 30,740,000.00**

System	Estimated Cost (2017 CAD$)
Contractor Overhead & Profits (15%)	$ 4,611,000.00
Contingency (15%)	$ 4,611,000.00
Engineering/ Contract Administration (10%)	$ 3,740,000.00
Approvals	$ 500,000.00
Portable Generator	$ 150,000.00
Land Acquisition	$ 500,000.00
Utility Relocations	$ 630,000.00
Total Capital Cost (Town Responsibility)	**$ 45,482,000.00**
Connections (Property Owner Responsibility)	$ 10,210,000.00

The operational and replacement costs have been assessed over an 80-year life cycle and are presented in Table 6. The costs are expressed in terms of net present value in 2017 Canadian dollars. The 80-year life cycle was selected as this is the maximum expected useful life of a system component.

Net present value is calculated following Equation 1. For the purposes of calculation, an interest rate (i) of 4% was used in the calculation of net-present value. Where the lifecycle of a system component does not divide equally within the 80 year span assumed for the analysis, the “incurred cost” is proportionately reduced.

Equation 1 – Net-Present Value Calculation

$$NPV = \sum_{x}^{80} \frac{Incurred\ Cost}{(1+i)^x}$$

Example: Manholes with an assumed 50-year life.

NPV = $2,525,000.00 * $(1 + 0.04)^{-50}$ + (30/50)* $2,525,000.00 * $(1 + 0.04)^{-80}$ = $421,000.00

Table 6 – NPV of Gravity System Operation and Replacement

80 Year Lifecycle Analysis	Life / Maintenance Cycle	Present Value
Gravity Sewers	80	$ 560,000.00
Manholes	50	$ 421,000.00
Pumping Stations	60	$ 816,000.00
Forcemains	80	$ 206,000.00
CCTV/Flow Monitoring ($15/m)	10	$ 567,000.00
SPS Operation/ Maintenance	Yearly	$ 5,202,000.00
Operation and Replacement Net Present Value		**$ 7,772,000.00**

5.0 Blended Alternative Gravity/LPS

Using the gravity system design as a basis, a gravity system alternative utilizing low pressure systems for small catchments in low lying areas was developed. The blended alternative assumes full gravity servicing with the exception of Dundas St. E. Sub-catchment, Scotch St. Sub-catchment, Wheelock St. Sub-catchment, and Waterford Dr. Sub-catchment which would be serviced using low-pressure grinder pump systems. A detailed summary of the sewer installation costing is provided in ***Appendix A***. A detailed summary of the pumping station and forcemain costing is also provided in ***Appendix A***. An assessment of connection costs to the system from each property was conducted and is provided in ***Appendix B***.

5.1. Detailed Evaluation of Site Alternatives

The estimated capital costs for the Blended Collection System are outlined in Table 7.

Table 7 – Blended System Capital Cost Summary

System	Estimated Cost (2017 CAD$)
Gravity Sewer Installation	$ 12,350,000.00
Pressure Sewer Installation	$ 400,000.00
Service Connections (1497/53)	$ 3,070,000.00
Connections (53 –house to the curb)	$ 320,000.00
Manhole Installation	$ 2,060,000.00
Grinder Pump Stations (53)	$ 360,000.00
Pumping Stations	$ 6,450,000.00
Forcemains	$ 4,630,000.00
Capital Cost Sum	**$ 29,640,000.00**
Contractor Overhead & Profits (15%)	$ 4,446,000.00
Contingency (15%)	$ 4,446,000.00
Engineering/ Contract Administration (10%)	$ 2,964,000.00
Approvals	$ 500,000.00
Portable Generator	$ 150,000.00
Land Acquisition	$ 500,000.00
Utility Relocations	$ 630,000.00
Total Capital Cost	**$ 43,276,000.00**
Connections (to the curb)	$ 8,930,000.00

The operational and replacement costs have been assessed over an 80-year life cycle and are presented in Table 8. The costs are expressed in terms of net present value in 2017 Canadian dollars. The 80-year life cycle was selected as this is the maximum expected useful life of a system component.

Table 8 – NPV of Blended System Operation and Replacement

80 Year Lifecycle Analysis	Life / Maintenance Cycle	Present Value
Gravity Sewer	80	$ 536,000.00
Pressure Sewer	80	$ 17,000.00
Manholes	50	$ 343,000.00
Grinder Pump Stations	15	$ 144,000.00
Pumping Stations	60	$ 706,000.00
Forcemains	80	$ 201,000.00
CCTV/Flow Monitoring ($15/m)	10	$ 478,000.00
SPS Operation/ Maintenance	Yearly	$ 5,110,000.00
Operation and Replacement Net Present Value		**$ 7,535,000.00**

6.0 Vacuum System Alternative Design

6.1. Vacuum System Capital and Operating Costs

The estimated capital costs for the vacuum system are outlined in Table 9. A detailed summary of the sewer installation costing is provided in ***Appendix A***. A detailed summary of the pumping station and forcemain costing is also provided in ***Appendix A***. An assessment of connection costs to the system from each property was conducted and is provided in ***Appendix B***.

Table 9 – Vacuum Sewer Capital Cost Estimates

System	Estimated Cost (2017 CAD$)
Vacuum Sewers	$ 9,130,000.00
Isolation Valves (150)	$ 300,000.00
Vacuum Pits (1550)	$ 3,100,000.00
Service Connections	$ 2,170,000.00
Connections (house to the curb)	$ 9,250,000.00
Vacuum Stations	$ 2,940,000.00
Pumping Stations	$ 3,830,000.00
Forcemains	$ 4,582,000.00
Capital Cost Sum	**$ 35,302,000.00**
Contractor Overhead & Profits	$ 5,295,300.00
Contingency	$ 5,295,300.00
Engineering/ Contract Administration	$ 3,530,200.00
Approvals	$ 500,000.00
Land Acquisition	$ 500,000.00
Utility Relocations	$ 430,000.00
Total Capital Cost	**$ 50,852,800.00**

The operational and replacement costs have been assessed over an 80-year life cycle and are presented in Table 10. The costs are expressed in terms of net present value in 2017 Canadian dollars. The 80-year life cycle was selected as this is the maximum expected useful life of a system component.

Table 10 – NPV of Vacuum System Operation and Replacement

80 Year Lifecycle Analysis	Life / Maintenance Cycle	Present Value
Vacuum Sewers	80	$ 396,000.00
Isolation Valves	15	$ 359,000.00
Vacuum Pits	40	$ 780,000.00
Vacuum Stations	50	$ 490,000.00
Pumping Stations	60	$ 419,000.00
Forcemains	80	$ 199,000.00
SPS/ Vac Station Operation/ Maintenance	Yearly	$ 7,127,000.00
Operation and Replacement Net Present Value		**$ 9,770,000.00**

7.0 Low Pressure System Alternative Design

7.1. Low Pressure System Capital and Operating Costs

The estimated capital costs for the Low Pressure System are outlined in Table 11. A detailed summary of the sewer installation costing is provided in ***Appendix A***. A detailed summary of the pumping station and forcemain costing is also provided in ***Appendix A***. An assessment of connection costs to the system from each property was conducted and is provided in ***Appendix B***.

Table 11 – Low-Pressure Sewer Capital Cost Estimate

System	Estimated Cost (2017 CAD$)
Pressure Sewer Installation	$ 9,200,000.00
Grinder Pump Stations (1550)	$ 10,540,000.00
Service Connections (1550)	$ 2,170,000.00
Connections (house to the curb)	$ 9,250,000.00
Pump Stations	$ 3,930,000.00
Forcemains	$ 3,960,000.00
Capital Cost Sum	**$ 39,050,000.00**
Contractor Overhead & Profits	$ 5,857,500.00
Contingency	$ 5,857,500.00
Engineering/ Contract Administration	$ 3,905,000.00
Approvals	$ 500,000.00
Land Acquisition	$ 500,000.00
Utility Relocations	$ 460,000.00
Total Capital Cost	**$ 56,130,000.00**

The operational and replacement costs have been assessed over an 80-year life cycle and are presented in Table 12. The costs are expressed in terms of net present value in 2017 Canadian dollars. The 80-year life cycle was selected as this is the maximum expected useful life of a system component.

Table 12 – NPV of Low Pressure System Operation and Replacement

80 Year Lifecycle Analysis	Life / Maintenance Cycle	Present Value
Grinder Pump Stations	15	$ 4,206,000.00
Pressure Sewer	80	$ 399,000.00
Pumping Stations	60	$ 430,000.00
Forcemains	80	$ 160,000.00
SPS/LPS Operation/ Maintenance	Yearly	$ 7,749,000.00
Operation and Replacement Net Present Value		**$ 12,944,000.00**

8.0 STEP / STEG System Alternative Design

8.1. STEP / STEG System Capital and Operating Costs

The estimated capital costs for the STEP/STEG are outlined in Table 13. A detailed summary of the sewer installation costing is provided in ***Appendix A***. A detailed summary of the pumping station and forcemain costing is also provided in ***Appendix A***. An assessment of connection costs to the system from each property was conducted and is provided in ***Appendix B***.

Table 13 – STEP / STEG Collection Capital Cost Estimate

System	Estimated Cost (2017 CAD$)
STEP/STEG Collection Network	$ 10,900,000.00
Interceptor Tanks (1550)	$ 5,425,000.00
STEP Pumps (710)	$ 497,000.00
Service Connections (840/710)	$ 2,674,000.00
Connections (house to curb)	$ 9,250,000.00
Pump Stations	$ 3,930,000.00
Forcemains	$ 3,690,000.00
Capital Cost Sum	**$ 36,366,000.00**
Contractor Overhead & Profits	$ 5,454,900.00
Contingency	$ 5,454,900.00
Engineering/ Contract Administration	$ 3,636,600.00
Approvals	$ 500,000.00
Land Acquisition	$ 500,000.00
Utility Relocations	$ 590,000.00
Total Capital Cost	**$ 52,502,400.00**

The operational and replacement costs have been assessed over an 80-year life cycle and are presented in Table 14. The costs are expressed in terms of net present value in 2017 Canadian dollars. The 80-year life cycle was selected as this is the maximum expected useful life of a system component.

Table 14 – NPV of STEP / STEG System Operation and Replacement

80 Year Lifecycle Analysis	Life / Maintenance Cycle	Present Value
Collection Network	80	$ 473,000.00
Interceptor Tanks	50	$ 829,000.00
Pump Stations	50	$ 655,000.00
Forcemains	80	$ 160,000.00
Tank Cleanouts	10	$ 1,544,000.00
SPS Operation/ Maintenance	Yearly	$ 5,338,000.00
Operation and Replacement Net Present Value		**$ 8,999,000.00**

9.0 Capital Cost Comparison

An overall cost comparison is presented in Table 15. The vacuum sewer system has a low capital cost however due to the high energy use required to run the system the vacuum sewer also has the highest operation and system replacement NPV. In contrast, the gravity sewer system has the highest estimated capital cost but has a low operation and replacement NPV.

Table 15 – Cost Comparison of Alternative Collection Technologies

Collection Alternative	Capital Cost	Connection Cost (Home Owner)	Total Capital Cost	System Replacement and Operation NPV	Total Cost (Capital Cost + NPV)
Gravity Sewers	$45,482,000	$10,210,000	$55,692,000	$7,772,000	$63,464,000
Blended Alternative	$43,276,000	$8,930,000	$52,206,000	$7,535,000	$59,741,000
Pressure Sewers	$56,130,000	NIL	$56,130,000	$12,944,000	$69,074,000
Vacuum Sewers	$50,852,800	NIL	$50,852,800	$9,770,000	$60,622,800
STEP/STEG Collection	$52,502,400	NIL	$52,502,400	$8,999,000	$61,501,400

10.0 Full Build-Out Scenario Trunk Upgrades

The cost analysis for the collection system has been based on servicing the existing community of Erin, including infill and intensification potential. The UCWS EA has identified a full-build-out scenario which includes significant development that would impact the proposed infrastructure. The primary components affected by potential growth are listed in Table 16 below along with their associated capital cost.

Table 16 – Collection System Trunk Components Affected by Growth

System Component	Description of Component	Capital Cost to Service Existing Community
Erin Village Trunk Sewer (Dundas Street East to Water Street	1260 m of sewer including 140 m of tunneling. Sewer diameter 450 mm.	$ 1,250,000
Hillsburgh Village Trunk Sewer (Douglas Crescent to Elora Cataract Trail)	750m of sewer. Sewer diameter 250mm.	$ 330,000
Erin Industrial Area Sewer (Shamrock Road to Erin SPS 2)	250 m of sewer. Sewer diameter 200mm.	$ 90,000
Erin Heights Subdivision Sewer (along Erin Heights Drive)	600m of sewer. Sewer diameter 200mm.	$ 240,000
Hillsburgh SPS 1 (transmission to Erin)	Station capacity 24 L/s.	$ 550,000
Hillsburgh SPS 1 Forcemain (transmission to Erin along ECT)	4,650 m of forcemain. Forcemain diameter 200mm.	$ 2,110,000
Erin SPS 2 (transmission to Erin Village Trunk Sewer)	Station capacity 70 L/s.	$ 1,480,000
Erin SPS 2 Forcemain (transmission to Erin Village Trunk Sewer)	800 m of forcemain. Forcemain diameter 250mm.	$ 400,000
Erin SPS 3 (Erin Heights to Erin Village Trunk Sewer)	Station capacity 6 L/s.	$ 150,000
Erin SPS 3 Forcemain (Erin Heights to Erin Village Trunk Sewer)	1050m of forcemain. Forcemain diameter 75 mm.	$ 330,000
Erin SPS 1 (transmission station to the treatment facility)	Station capacity 91 L/s.	$ 1,900,000
Erin SPS 1 Forcemain (transmission station to the treatment facility)	1940 m of forcemain. Forcemain diameter 250mm.	$ 850,000
Sub-Total		$ 9,680,000
Engineering (10%)		$ $ 968,000
Contractor Overhead/ Profits (15%)		$ 1,452,000
Contingency (15%)		$ 1,452,000
Total		**$ 13,552,000**

In consideration of the upgrades required to service the full growth potential of the Town, Table 17 outlines the required upgrades to the trunk system components. The cost of the upgraded components is presented to provide an understanding of the incremental cost of upgrading the collection network to service the full build-out scenario. This cost does not include the costs associated with local sewers and pumping stations for each development. Developers would have a cost to connect to the trunk system.

Table 17 – Collection System Trunk Upgrades for Full Build-Out

System Component	Description of Upgrades	Capital Cost
Erin Village Trunk Sewer (Dundas Street East to Water Street	1260 m of sewer including 140 m of tunneling. Increasing sewer diameter from 450 mm to 600mm.	$ 2,050,000
Hillsburgh Village Trunk Sewer (Douglas Crescent to Elora Cataract Trail)	750m of sewer. Increase sewer diameter from 250mm to 375mm	$ 450,000
Erin Industrial Area Sewer (Shamrock Road to Erin SPS 2)	250 m of sewer. Increase sewer diameter from 200mm to 300mm.	$ 150,000
Erin Heights Subdivision Sewer (along Erin Heights Drive)	600m of sewer. Increase sewer diameter from 200mm to 300mm.	$ 320,000
Hillsburgh SPS 1 (transmission to Erin)	Increase capacity of the station from 24 L/s to 90 L/s.	$ 1,870,000
Hillsburgh SPS 1 Forcemain (transmission to Erin along ECT)	4,650 m of forcemain. Increase from single 200mm forcemain to 2 x 200mm forcemain.	$ 3,165,000
Erin SPS 2 (transmission to Erin Village Trunk Sewer)	Increase capacity of the station from 70 L/s to 152 L/s.	$ 2,800,000
Erin SPS 2 Forcemain (transmission to Erin Village Trunk Sewer)	800 m of forcemain. Increase diameter from 250mm to 400mm.	$ 980,000
Erin SPS 3 (Erin Heights to Erin Village Trunk Sewer)	Increase capacity of the station from 6 L/s to 39 L/s.	$ 900,000
Erin SPS 3 Forcemain (Erin Heights to Erin Village Trunk Sewer)	1050m of forcemain. Increase diameter from 75mm to 200mm.	$ 480,000
Erin SPS 1 (transmission station to the treatment facility)	Increase capacity of the station from 91 L/s to 228 L/s.	$ 3,870,000
Erin SPS 1 Forcemain (transmission station to the treatment facility)	1940 m of forcemain. Increase diameter from 250mm to 450mm.	$ 1,170,000
Sub-Total		$ 18,205,000
Engineering (10%)		$ 1,820,500
Contractor Overhead/ Profits (15%)		$ 2,730,750
Contingency (15%)		$ 2,730,750
Total		**$ 25,487,000**

Appendix A
Detailed Sewer Costing Information

Blended System Costing for Local Sewers

Area	Length of Pipe	Size of Pipe	Average Depth	Cost Estimate
Industrial to main SPS	581.1	200	3	$ 232,440.00
	160.9	200	5.25	$ 78,841.00
	475	300	3	$ 228,000.00
	135	300	5.5	$ 78,300.00
	256	300	7.25	$ 145,920.00
	301	450	3	$ 168,560.00
	420	200	3	$ 168,000.00
	485	300	3	$ 232,800.00
Town Core 1 to Main SPS	1360	200	3	$ 544,000.00
	223	200	3.5	$ 93,660.00
	119	200	3.8	$ 51,408.00
	422	200	4.1	$ 187,368.00
	125	200	4.65	$ 58,250.00
	65	200	5.5	$ 32,500.00
	54	200	5.9	$ 27,864.00
	93	200	6.5	$ 50,220.00
	297	200	7.3	$ 169,884.00
	60	300	5.6	$ 35,040.00
	90	300	6.2	$ 54,720.00
	330	300	6.5	$ 204,600.00
	200	300	7.1	$ 128,800.00
Dundas SPS Drainage area	580	200	3	$ 232,000.00
	247	200	3.1	$ 99,788.00
	163	200	3.3	$ 67,156.00
	165	200	3.8	$ 71,280.00
	139	200	4.2	$ 62,272.00
	87	200	4.4	$ 39,672.00
	91	300	3.9	$ 46,956.00
Earinlea Crescent Drainage	338	100	2	$ 94,640.00
	77	100	2.2	$ 22,176.00
	137	100	2.5	$ 41,100.00
	48	100	3	$ 15,360.00
Erin Heights	1443	200	3	$ 577,200.00
	605.4	300	3	$ 290,592.00
Waterford Drive Catchment	852	200	3	$ 340,800.00
	117	200	3.5	$ 49,140.00
	90	200	3.9	$ 39,240.00
Main St. Trunk	377	450	3.1	$ 212,628.00
	122	450	3.6	$ 71,248.00
	84	450	3.9	$ 50,064.00
	65	450	4.4	$ 40,040.00
	20	450	4.6	$ 12,480.00
	277	450	4.8	$ 175,064.00
	105	600	4.4	$ 81,480.00

	246	600	3.5	$	182,040.00
	129	600	3.8	$	97,008.00
Town Core 1 to Main St. Trunk	646	200	3	$	258,400.00
	78	200	3.8	$	33,696.00
	210	200	4.5	$	96,600.00
	191	200	4	$	84,040.00
Town Core 2 to Main St. Trunk	710	200	3	$	284,000.00
	107	200	3.6	$	45,368.00
	73	200	4.5	$	33,580.00
	98	200	4.2	$	43,904.00
South Erin	1143.2	200	3.7	$	489,289.60
	357	200	4	$	157,080.00
	851	200	3	$	340,400.00
	66	200	3.1	$	26,664.00
	70	200	4.3	$	31,640.00
	121	200	3.5	$	50,820.00
	508	200	3.3	$	209,296.00
	169	200	4.2	$	75,712.00
	92	200	4.4	$	41,952.00
	100	200	4.55	$	46,200.00
	89	200	5.4	$	44,144.00
	94	200	4.8	$	44,368.00
	112	200	5.9	$	57,792.00
	27	200	6.7	$	14,796.00
	102	200	6	$	53,040.00
	51	300	3.9	$	26,316.00
	215	300	4.6	$	116,960.00
Wheelock St Catchment	61	100	2.3	$	17,812.00
	62	100	3.3	$	20,584.00
	71	100	3	$	22,720.00
	114	100	2	$	31,920.00
Trailer Park to Main SPS	104.4	200	5.59	$	52,575.84
	107.2	200	4.26	$	48,282.88
	131.8	200	3.06	$	53,036.32
	79.1	200	3.09	$	31,924.76
	156.3	200	3.24	$	64,020.48
	36.3	200	3.41	$	15,115.32
	253	200	3	$	101,200.00
	90.6	200	3.24	$	37,109.76
	94.1	200	3.25	$	38,581.00
Hillsburgh - TownCore 1/2	5000.5	200	3	$	2,000,200.00
	586.2	200	3.5	$	246,204.00
	62.4	200	3.7	$	26,707.20
	535.5	200	3.2	$	218,484.00
	88.5	200	3.61	$	37,559.40
	95.4	200	4.21	$	42,777.36
	116.7	200	5.11	$	56,529.48

	76.1	200	4.26	$	34,275.44
	64.9	200	5.18	$	31,619.28
	101.1	200	5.59	$	50,913.96
	87.5	300	4.7	$	47,950.00
	79	300	4.02	$	41,143.20
	73.9	300	4.59	$	40,172.04
Trafalgar Trunk	731.6	450	3	$	409,696.00
	195.4	450	3.2	$	110,987.20
	202.9	450	3.5	$	117,682.00
	103.1	450	3.8	$	61,035.20
				$	12,797,474.72

Gravity System Costing for Local Sewers

Area	Length of Pipe	Size of Pipe	Average Depth		Cost Estimate
Industrial to main SPS	581.1	200	3	$	232,440.00
	160.9	200	5.25	$	78,841.00
	475	300	3	$	228,000.00
	135	300	5.5	$	78,300.00
	256	300	7.25	$	145,920.00
	301	450	3	$	168,560.00
	420	200	3	$	168,000.00
	485	300	3	$	232,800.00
Town Core 1 to Main SPS	1360	200	3	$	544,000.00
	223	200	3.5	$	93,660.00
	119	200	3.8	$	51,408.00
	422	200	4.1	$	187,368.00
	125	200	4.65	$	58,250.00
	65	200	5.5	$	32,500.00
	54	200	5.9	$	27,864.00
	93	200	6.5	$	50,220.00
	297	200	7.3	$	169,884.00
	60	300	5.6	$	35,040.00
	90	300	6.2	$	54,720.00
	330	300	6.5	$	204,600.00
	200	300	7.1	$	128,800.00
Dundas SPS Drainage area	580	200	3	$	232,000.00
	247	200	3.1	$	99,788.00
	163	200	3.3	$	67,156.00
	165	200	3.8	$	71,280.00
	139	200	4.2	$	62,272.00
	87	200	4.4	$	39,672.00
	91	300	3.9	$	46,956.00
Earinlea Crescent Drainage	338	200	3	$	135,200.00
	77	200	3.2	$	31,416.00
	137	200	3.5	$	57,540.00
	48	200	4	$	21,120.00
Erin Heights	1443	200	3	$	577,200.00
	605.4	300	3	$	290,592.00
Waterford Drive Catchment	852	200	3	$	340,800.00
	117	200	3.5	$	49,140.00
	90	200	3.9	$	39,240.00
Main St. Trunk	377	450	3.1	$	212,628.00
	122	450	3.6	$	71,248.00
	84	450	3.9	$	50,064.00
	65	450	4.4	$	40,040.00
	20	450	4.6	$	12,480.00
	277	450	4.8	$	175,064.00
	105	600	4.4	$	81,480.00

	246	600	3.5	$	182,040.00
	129	600	3.8	$	97,008.00
Town Core 1 to Main St. Trunk	646	200	3	$	258,400.00
	78	200	3.8	$	33,696.00
	210	200	4.5	$	96,600.00
	191	200	4	$	84,040.00
Town Core 2 to Main St. Trunk	710	200	3	$	284,000.00
	107	200	3.6	$	45,368.00
	73	200	4.5	$	33,580.00
	98	200	4.2	$	43,904.00
South Erin	1143.2	200	3.7	$	489,289.60
	357	200	4	$	157,080.00
	851	200	3	$	340,400.00
	66	200	3.1	$	26,664.00
	70	200	4.3	$	31,640.00
	121	200	3.5	$	50,820.00
	508	200	3.3	$	209,296.00
	169	200	4.2	$	75,712.00
	92	200	4.4	$	41,952.00
	100	200	4.55	$	46,200.00
	89	200	5.4	$	44,144.00
	94	200	4.8	$	44,368.00
	112	200	5.9	$	57,792.00
	27	200	6.7	$	14,796.00
	102	200	6	$	53,040.00
	51	300	3.9	$	26,316.00
	215	300	4.6	$	116,960.00
Wheelock St Catchment	61	200	3.3	$	25,132.00
	62	200	4.8	$	29,264.00
	71	200	4	$	31,240.00
	114	200	3	$	45,600.00
Trailer Park to Main SPS	104.4	200	5.59	$	52,575.84
	107.2	200	4.26	$	48,282.88
	131.8	200	3.06	$	53,036.32
	79.1	200	3.09	$	31,924.76
	156.3	200	3.24	$	64,020.48
	36.3	200	3.41	$	15,115.32
	253	200	3	$	101,200.00
	90.6	200	3.24	$	37,109.76
	94.1	200	3.25	$	38,581.00
Hillsburgh - TownCore 1/2	5000.5	200	3	$	2,000,200.00
	586.2	200	3.5	$	246,204.00
	62.4	200	3.7	$	26,707.20
	535.5	200	3.2	$	218,484.00
	88.5	200	3.61	$	37,559.40
	95.4	200	4.21	$	42,777.36
	116.7	200	5.11	$	56,529.48

	76.1	200	4.26	$	34,275.44
	64.9	200	5.18	$	31,619.28
	101.1	200	5.59	$	50,913.96
	87.5	300	4.7	$	47,950.00
	79	300	4.02	$	41,143.20
	73.9	300	4.59	$	40,172.04
Trafalgar Trunk	731.6	450	3	$	409,696.00
	195.4	450	3.2	$	110,987.20
	202.9	450	3.5	$	117,682.00
	103.1	450	3.8	$	61,035.20
				$	12,907,674.72

Low Pressure System Costing for Local Sewers

Area	Length of Pipe	Average Depth	Pipe Size	Cost
Industrial to main SPS	581.1	2	100	$ 162,708.00
	160.9	3.75	100	$ 56,315.00
	475	2	200	$ 133,000.00
	135	4.5	200	$ 62,100.00
	256	4.75	200	$ 120,320.00
	301	2	250	$ 120,400.00
	420	2	100	$ 117,600.00
	485	2	200	$ 174,600.00
Town Core 1 to Main SPS	1360	2	100	$ 380,800.00
	223	2.5	100	$ 66,900.00
	119	2.8	100	$ 37,128.00
	422	3.1	100	$ 136,728.00
	125	3.15	100	$ 40,750.00
	65	4	100	$ 23,400.00
	54	4.4	100	$ 20,304.00
	93	5	100	$ 37,200.00
	297	5.3	100	$ 122,364.00
	60	3.6	200	$ 25,440.00
	90	4.2	200	$ 40,320.00
	330	4.5	200	$ 151,800.00
	200	4.6	200	$ 92,800.00
Dundas SPS Drainage area	580	2	100	$ 162,400.00
	247	2.1	100	$ 70,148.00
	163	2.3	100	$ 47,596.00
	165	2.8	100	$ 51,480.00
	139	3.2	100	$ 45,592.00
	87	3.4	100	$ 29,232.00
	91	2.9	200	$ 36,036.00
Earinlea Crescent Drainage	338	2	100	$ 94,640.00
	77	2.2	100	$ 22,176.00
	137	2.5	100	$ 41,100.00
	48	3	100	$ 15,360.00
Erin Heights	1443	2	100	$ 404,040.00
	605.4	2	200	$ 217,944.00
Waterford Drive Catchment	852	2	100	$ 238,560.00
	117	2.5	100	$ 35,100.00
	90	2.9	100	$ 28,440.00
Main St. Trunk	377	2.1	250	$ 152,308.00
	122	2.6	250	$ 51,728.00
	84	2.9	250	$ 36,624.00
	65	3.4	250	$ 29,640.00
	20	3.6	250	$ 9,280.00
	277	3.8	250	$ 130,744.00
	105	3.4	300	$ 52,080.00

	246	2.5	300	$ 113,160.00
	129	2.8	300	$ 60,888.00
Town Core 1 to Main St. Trunk	646	2	100	$ 180,880.00
	78	2.8	100	$ 24,336.00
	210	3.5	100	$ 71,400.00
	191	3	100	$ 61,120.00
Town Core 2 to Main St. Trunk	710	2	100	$ 198,800.00
	107	2.6	100	$ 32,528.00
	73	3.5	100	$ 24,820.00
	98	3.2	100	$ 32,144.00
South Erin	1143.2	2.7	100	$ 352,105.60
	357	3	100	$ 114,240.00
	851	2	100	$ 238,280.00
	66	2.1	100	$ 18,744.00
	70	3.3	100	$ 23,240.00
	121	2.5	100	$ 36,300.00
	508	2.3	100	$ 148,336.00
	169	3.2	100	$ 55,432.00
	92	3.4	100	$ 30,912.00
	100	3.55	100	$ 34,200.00
	89	3.9	100	$ 31,684.00
	94	3.8	100	$ 33,088.00
	112	3.9	100	$ 39,872.00
	27	4.7	100	$ 10,476.00
	102	4	100	$ 36,720.00
	51	2.9	200	$ 20,196.00
	215	3.6	200	$ 91,160.00
Wheelock St Catchment	61	2.3	100	$ 17,812.00
	62	3.3	100	$ 20,584.00
	71	3	100	$ 22,720.00
	114	2	100	$ 31,920.00
Trailer Park to Main SPS	104.4	3.59	100	$ 35,871.84
	107.2	2.26	100	$ 31,130.88
	131.8	2.06	100	$ 37,220.32
	79.1	2.09	100	$ 22,432.76
	156.3	2.24	100	$ 45,264.48
	36.3	2.41	100	$ 10,759.32
	253	2	100	$ 70,840.00
	90.6	2.24	100	$ 26,237.76
	94.1	2.25	100	$ 27,289.00
Hillsburgh - TownCore 1/2	5000.5	2	100	$ 1,400,140.00
	586.2	2.5	100	$ 175,860.00
	62.4	2.7	100	$ 19,219.20
	535.5	2.2	100	$ 154,224.00
	88.5	2.61	100	$ 26,939.40
	95.4	3.21	100	$ 31,329.36
	116.7	3.61	100	$ 40,191.48

	76.1	2.76	100	$ 23,621.44
	64.9	3.68	100	$ 22,533.28
	101.1	4.09	100	$ 36,759.96
	87.5	3.2	200	$ 35,700.00
	79	2.52	200	$ 30,083.20
	73.9	3.09	200	$ 29,826.04
Trafalgar Trunk	731.6	2	250	$ 292,640.00
	195.4	2.2	250	$ 79,723.20
	202.9	2.5	250	$ 85,218.00
	103.1	2.8	250	$ 44,539.20
				$ 9,168,916.72

Existing Community Pumping Stations

Station (Existing Community)	Station Capacity (L/s)	Capital Cost	Forcemain Size	Length	Cost	O&M	Required for:
Transmission Station to Erin (H-SPS 1)	24.0	$ 550,000.00	200.00	4630.00	$ 2,110,000.00	$ 32,000.00	GRAV, LPS, VAC, STEP/STEG, GRAV+LPS
Main Station Hillsburgh (H-SPS 2)	20.1	$ 470,000.00	150.00	550.00	$ 230,000.00	$ 32,000.00	GRAV, STEP/STEG, GRAV+LPS
Main SPS to the WWTP (E-SPS 1)	90.6	$ 1,900,000.00	350.00	1400.00	$ 850,000.00	$ 57,000.00	GRAV, LPS, VAC, STEP/STEG, GRAV+LPS
Main SPS in Industrial Area (E-SPS 2)	69.8	$ 1,480,000.00	300.00	1300.00	$ 730,000.00	$ 49,000.00	GRAV, VAC, STEP/STEG, GRAV+LPS
Erin Heights Catchment (E-SPS 3)	5.2	$ 510,000.00	75.00	750.00	$ 240,000.00	$ 7,500.00	GRAV, GRAV+LPS
North-west Industrial Station (E-SPS 4)	7.8	$ 520,000.00	100.00	500.00	$ 180,000.00	$ 15,000.00	GRAV, GRAV+LPS
Dundas St E Catchment (E-SPS 5)	5.1	$ 510,000.00	75.00	400.00	$ 130,000.00	$ 7,500.00	GRAV, GRAV+LPS
Waterford Drive Catchment (E-SPS 6)	4.4	$ 510,000.00	75.00	500.00	$ 160,000.00	$ 7,500.00	GRAV, GRAV+LPS
Erinlea Crescent Catchment (E-SPS 7)	2.0	$ 505,000.00	50.00	150.00	$ 50,000.00	$ 5,000.00	GRAV
Wheelock St. Catchment (E-SPS 8)	0.9	$ 500,000.00	50.00	200.00	$ 70,000.00	$ 5,000.00	GRAV
		$ 7,455,000.00			$ 4,750,000.00		

Full Buildout Gravity System Pumping Stations

Station (Build-out Community)	Station Capacity (L/s)	Capital Cost	Forcemain Size	Length	Cost	O&M
Transmission Station to Erin (H-SPS 1)	89.2	$ 1,870,000.00	2 x 200.00	4630.00	$ 3,165,000.00	$ 57,000.00
Main Station Hillsburgh (H-SPS 2)	33.1	$ 730,000.00	200.00	550.00	$ 380,000.00	$ 35,000.00
Main SPS to the WWTP (E-SPS 1)	227.2	$ 3,870,000.00	2 x 300.00	1400.00	$ 1,170,000.00	$ 85,000.00
Main SPS in Industrial Area (E-SPS 2)	151.7	$ 2,800,000.00	2 x 250.00	1300.00	$ 980,000.00	$ 72,000.00
Erin Heights Catchment (E-SPS 3)	5.2	$ 510,000.00	75.00	750.00	$ 240,000.00	$ 7,500.00
North-west Industrial Station (E-SPS 4)	7.8	$ 520,000.00	100.00	500.00	$ 180,000.00	$ 15,000.00
Dundas St E Catchment (E-SPS 5)	5.1	$ 510,000.00	75.00	400.00	$ 130,000.00	$ 7,500.00
Waterford Drive Catchment (E-SPS 6)	4.4	$ 510,000.00	75.00	500.00	$ 160,000.00	$ 7,500.00
Erinlea Crescent Catchment (E-SPS 7)	2.0	$ 505,000.00	50.00	150.00	$ 50,000.00	$ 5,000.00
Wheelock St. Catchment (E-SPS 8)	0.9	$ 500,000.00	50.00	200.00	$ 70,000.00	$ 5,000.00
		$ 12,325,000.00			$ 6,525,000.00	

STEP/STEG Costing for Local Sewers

Area	Length of Pipe	Size of Pipe	Average Depth	Cost Estimate
Industrial to main SPS	581.1	100	2	$ 162,708.00
	160.9	100	3.75	$ 56,315.00
	475	200	2	$ 133,000.00
	135	200	4.5	$ 62,100.00
	256	200	4.75	$ 120,320.00
	301	250	2	$ 120,400.00
	420	100	2	$ 117,600.00
	485	200	2	$ 174,600.00
Town Core 1 to Main SPS	1360	100	2	$ 380,800.00
	223	100	2.5	$ 66,900.00
	119	100	2.8	$ 37,128.00
	422	100	3.1	$ 136,728.00
	125	100	3.15	$ 40,750.00
	65	100	4	$ 23,400.00
	54	100	4.4	$ 20,304.00
	93	100	5	$ 37,200.00
	297	100	5.3	$ 122,364.00
	60	200	3.6	$ 25,440.00
	90	200	4.2	$ 40,320.00
	330	200	4.5	$ 151,800.00
	200	200	4.6	$ 92,800.00
Dundas SPS Drainage area	580	200	3	$ 232,000.00
	247	200	3.1	$ 99,788.00
	163	200	3.3	$ 67,156.00
	165	200	3.8	$ 71,280.00
	139	200	4.2	$ 62,272.00
	87	200	4.4	$ 39,672.00
	91	300	3.9	$ 46,956.00
Earinlea Crescent Drainage	338	200	3	$ 135,200.00
	77	200	3.2	$ 31,416.00
	137	200	3.5	$ 57,540.00
	48	200	4	$ 21,120.00
Erin Heights	1443	100	2	$ 404,040.00
	605.4	200	2	$ 217,944.00
Waterford Drive Catchment	852	100	2	$ 238,560.00
	117	100	2.5	$ 35,100.00
	90	100	2.9	$ 28,440.00
Main St. Trunk	377	450	3.1	$ 212,628.00
	122	450	3.6	$ 71,248.00
	84	450	3.9	$ 50,064.00
	65	450	4.4	$ 40,040.00
	20	450	4.6	$ 12,480.00
	277	450	4.8	$ 175,064.00
	105	600	4.4	$ 81,480.00

	246	600	3.5	$	182,040.00
	129	600	3.8	$	97,008.00
Town Core 1 to Main St. Trunk	646	200	3	$	258,400.00
	78	200	3.8	$	33,696.00
	210	200	4.5	$	96,600.00
	191	200	4	$	84,040.00
Town Core 2 to Main St. Trunk	710	200	3	$	284,000.00
	107	200	3.6	$	45,368.00
	73	200	4.5	$	33,580.00
	98	200	4.2	$	43,904.00
South Erin	1143.2	200	3.7	$	489,289.60
	357	200	4	$	157,080.00
	851	200	3	$	340,400.00
	66	200	3.1	$	26,664.00
	70	200	4.3	$	31,640.00
	121	200	3.5	$	50,820.00
	508	200	3.3	$	209,296.00
	169	200	4.2	$	75,712.00
	92	200	4.4	$	41,952.00
	100	200	4.55	$	46,200.00
	89	200	5.4	$	44,144.00
	94	200	4.8	$	44,368.00
	112	200	5.9	$	57,792.00
	27	200	6.7	$	14,796.00
	102	200	6	$	53,040.00
	51	300	3.9	$	26,316.00
	215	300	4.6	$	116,960.00
Wheelock St Catchment	61	200	3.3	$	25,132.00
	62	200	4.8	$	29,264.00
	71	200	4	$	31,240.00
	114	200	3	$	45,600.00
Trailer Park to Main SPS	104.4	200	5.59	$	52,575.84
	107.2	200	4.26	$	48,282.88
	131.8	200	3.06	$	53,036.32
	79.1	200	3.09	$	31,924.76
	156.3	200	3.24	$	64,020.48
	36.3	200	3.41	$	15,115.32
	253	200	3	$	101,200.00
	90.6	200	3.24	$	37,109.76
	94.1	200	3.25	$	38,581.00
Hillsburgh - TownCore 1/2	5000.5	200	3	$	2,000,200.00
	586.2	200	3.5	$	246,204.00
	62.4	200	3.7	$	26,707.20
	535.5	200	3.2	$	218,484.00
	88.5	200	3.61	$	37,559.40
	95.4	200	4.21	$	42,777.36
	116.7	200	5.11	$	56,529.48

	76.1	200	4.26	$	34,275.44
	64.9	200	5.18	$	31,619.28
	101.1	200	5.59	$	50,913.96
	87.5	300	4.7	$	47,950.00
	79	300	4.02	$	41,143.20
	73.9	300	4.59	$	40,172.04
Trafalgar Trunk	731.6	450	3	$	409,696.00
	195.4	450	3.2	$	110,987.20
	202.9	450	3.5	$	117,682.00
	103.1	450	3.8	$	61,035.20
				$	11,686,588.72

Vacuum System Costing for Local Sewers

Area	Length of Pipe	Average Depth	Pipe Size	Cost
Industrial to main SPS	581.1	2	100	$ 162,708.00
	160.9	3.75	100	$ 56,315.00
	475	2	200	$ 133,000.00
	135	4.5	200	$ 62,100.00
	256	4.75	200	$ 120,320.00
	301	2	250	$ 120,400.00
	420	2	100	$ 117,600.00
	485	2	200	$ 174,600.00
Town Core 1 to Main SPS	1360	2	100	$ 380,800.00
	223	2.5	100	$ 66,900.00
	119	2.8	100	$ 37,128.00
	422	3.1	100	$ 136,728.00
	125	3.15	100	$ 40,750.00
	65	4	100	$ 23,400.00
	54	4.4	100	$ 20,304.00
	93	5	100	$ 37,200.00
	297	5.3	100	$ 122,364.00
	60	3.6	200	$ 25,440.00
	90	4.2	200	$ 40,320.00
	330	4.5	200	$ 151,800.00
	200	4.6	200	$ 92,800.00
Dundas SPS Drainage area	580	2	100	$ 162,400.00
	247	2.1	100	$ 70,148.00
	163	2.3	100	$ 47,596.00
	165	2.8	100	$ 51,480.00
	139	3.2	100	$ 45,592.00
	87	3.4	100	$ 29,232.00
	91	2.9	200	$ 36,036.00
Earinlea Crescent Drainage	338	2	100	$ 94,640.00
	77	2.2	100	$ 22,176.00
	137	2.5	100	$ 41,100.00
	48	3	100	$ 15,360.00
Erin Heights	1443	2	100	$ 404,040.00
	605.4	2	200	$ 217,944.00
Waterford Drive Catchment	852	2	100	$ 238,560.00
	117	2.5	100	$ 35,100.00
	90	2.9	100	$ 28,440.00
Main St. Trunk	377	2.1	250	$ 152,308.00
	122	2.6	250	$ 51,728.00
	84	2.9	250	$ 36,624.00
	65	3.4	250	$ 29,640.00
	20	3.6	250	$ 9,280.00
	277	3.8	250	$ 130,744.00
	105	3.4	300	$ 52,080.00

	246	2.5	300	$ 113,160.00
	129	2.8	300	$ 60,888.00
Town Core 1 to Main St. Trunk	646	2	100	$ 180,880.00
	78	2.8	100	$ 24,336.00
	210	3.5	100	$ 71,400.00
	191	3	100	$ 61,120.00
Town Core 2 to Main St. Trunk	710	2	100	$ 198,800.00
	107	2.6	100	$ 32,528.00
	73	3.5	100	$ 24,820.00
	98	3.2	100	$ 32,144.00
South Erin	1143.2	2.7	100	$ 352,105.60
	357	3	100	$ 114,240.00
	851	2	100	$ 238,280.00
	66	2.1	100	$ 18,744.00
	70	3.3	100	$ 23,240.00
	121	2.5	100	$ 36,300.00
	508	2.3	100	$ 148,336.00
	169	3.2	100	$ 55,432.00
	92	3.4	100	$ 30,912.00
	100	3.55	100	$ 34,200.00
	89	3.9	100	$ 31,684.00
	94	3.8	100	$ 33,088.00
	112	3.9	100	$ 39,872.00
	27	4.7	100	$ 10,476.00
	102	4	100	$ 36,720.00
	51	2.9	200	$ 20,196.00
	215	3.6	200	$ 91,160.00
Wheelock St Catchment	61	2.3	100	$ 17,812.00
	62	3.3	100	$ 20,584.00
	71	3	100	$ 22,720.00
	114	2	100	$ 31,920.00
Trailer Park to Main SPS	104.4	3.59	100	$ 35,871.84
	107.2	2.26	100	$ 31,130.88
	131.8	2.06	100	$ 37,220.32
	79.1	2.09	100	$ 22,432.76
	156.3	2.24	100	$ 45,264.48
	36.3	2.41	100	$ 10,759.32
	253	2	100	$ 70,840.00
	90.6	2.24	100	$ 26,237.76
	94.1	2.25	100	$ 27,289.00
Hillsburgh - TownCore 1/2	5000.5	2	100	$ 1,400,140.00
	586.2	2.5	100	$ 175,860.00
	62.4	2.7	100	$ 19,219.20
	535.5	2.2	100	$ 154,224.00
	88.5	2.61	100	$ 26,939.40
	95.4	3.21	100	$ 31,329.36
	116.7	3.61	100	$ 40,191.48

	76.1	2.76	100	$	23,621.44
	64.9	3.68	100	$	22,533.28
	101.1	4.09	100	$	36,759.96
	87.5	3.2	200	$	35,700.00
	79	2.52	200	$	30,083.20
	73.9	3.09	200	$	29,826.04
Trafalgar Trunk	731.6	2	250	$	292,640.00
	195.4	2.2	250	$	79,723.20
	202.9	2.5	250	$	85,218.00
	103.1	2.8	250	$	44,539.20
				$	9,168,916.72

Appendix B
Condition Costing Information

Appendix B

Connection Costing

In order to develop an accurate assessment of connection costs throughout Erin and Hillsburgh a street-by-street survey was conducted to assess the level of difficulty to connect homes to a collection system. Constructability aspects considered included the amount of landscaping which would be required to connect, the distance from the existing septic system to the street, tree and shrub removals/ replacement, and any driveway, curb and/or sidewalk repairs which would be necessary.

Each property was assessed for connection difficulty and rated on a five point scale for plumbing cost and for landscaping cost. The connection difficulty ratings for landscaping and plumbing are independent and are not inherently linked. For example, a property could receive a landscaping rating of 5 with a plumbing rating of 1.

The costs associated with each plumbing rating are summarized in Table 1. For the plumbing ratings a capital cost for both "gravity based systems" and "pressure based systems" are provided. For the purpose of the overall costing analysis the gravity based system cost will apply to the gravity collection alternative, STEG areas (within the overall STEP/STEG system), and vacuum sewer. The pressure system cost applies to the LPS alternative and STEP areas (within the overall STEP/STEG system).

Table 1 – Service Connection Costing for Plumbing

Plumbing Rating	Unit	Gravity Based System Cost	Pressure System Cost
1 – Simple Connection	15-20m of sanitary lateral Decommission existing tank	$ 3,200 $ 500	$ 2,700 $ 500
Total		**$ 3,700**	**$ 3,200**
2 – Through Driveway	15-20m of sanitary lateral Decommission existing tank Remove/Replace D/W Asphalt	$ 3,200 $ 500 $ 350	$ 2,700 $ 500 $ 350
Total		**$ 4,050**	**$ 3,550**
3 – Long Distance	21-30m of sanitary lateral Decommission existing tank	$ 4,200 $ 500	$ 3,500 $ 500
Total		**$ 4,700**	**$ 4,000**
4 – Long Distance, Through Driveway	21-30m of sanitary lateral Decommission existing tank Remove/Replace D/W Asphalt	$ 4,200 $ 500 $ 350	$ 3,500 $ 500 $ 350
Total		**$ 5,050**	**$ 4,350**
5 – Interior Replumbing (Commercial Area)	15-20m of sanitary lateral Decommission existing tank Remove/Replace D/W Asphalt Remove/Replace Curb Remove/ Replace Sidewalk Interior Replumbing to the front	$ 3,200 $ 500 $ 350 $ 390 $ 290 $ 10,000	$ 2,700 $ 500 $ 350 $ 390 $ 290 $ 10,000
Total		**$ 14,730**	**$ 14,230**

The costs associated with each landscaping rating are summarized in Table 2.

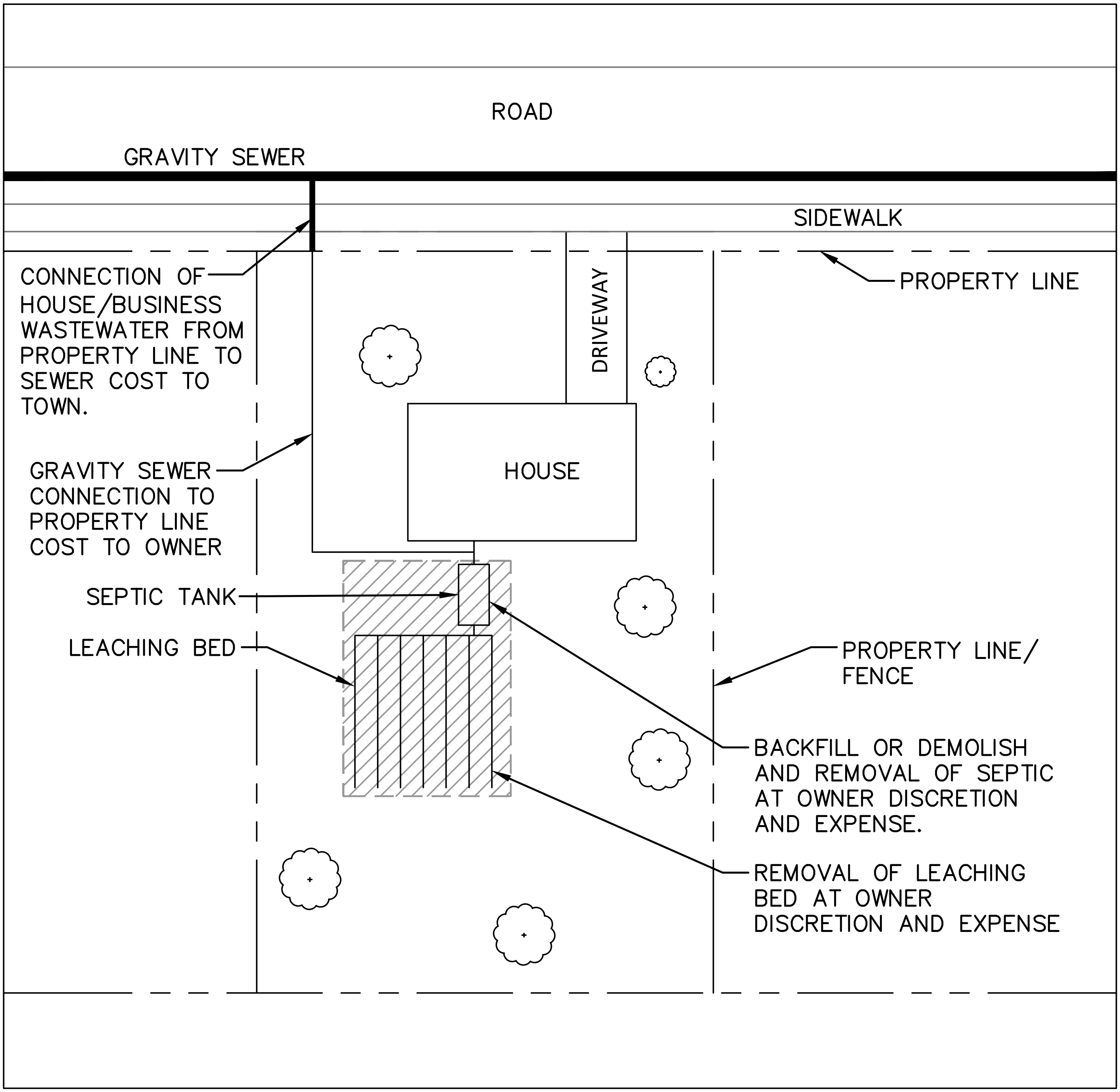
Table 2 – Service Connection Costing for Landscaping

Landscaping Rating	Unit	Gravity Based System Cost
1 – Minor Grass Replacement	30 m^2 – Sod and Topsoil	$ 540
Total		**$ 540**
2 – Major Grass Replacement	60 m^2 – Sod and Topsoil	$ 1,080
Total		**$ 1,080**
3 – Shrub/Garden Impacts	30 m^2 – Sod and Topsoil Shrub/Hedge Replacement	$ 540 $ 750
Total		**$ 1,290**
4 – Single Tree Replacement	30 m^2 – Sod and Topsoil Tree Removal/Replacement	$ 540 $ 2,500
Total		**$ 3,040**
5 – Multiple Tree Replacements	30 m^2 – Sod and Topsoil Multiple Tree Removal/Replacement	$ 540 $ 5,000
Total		**$ 5,540**

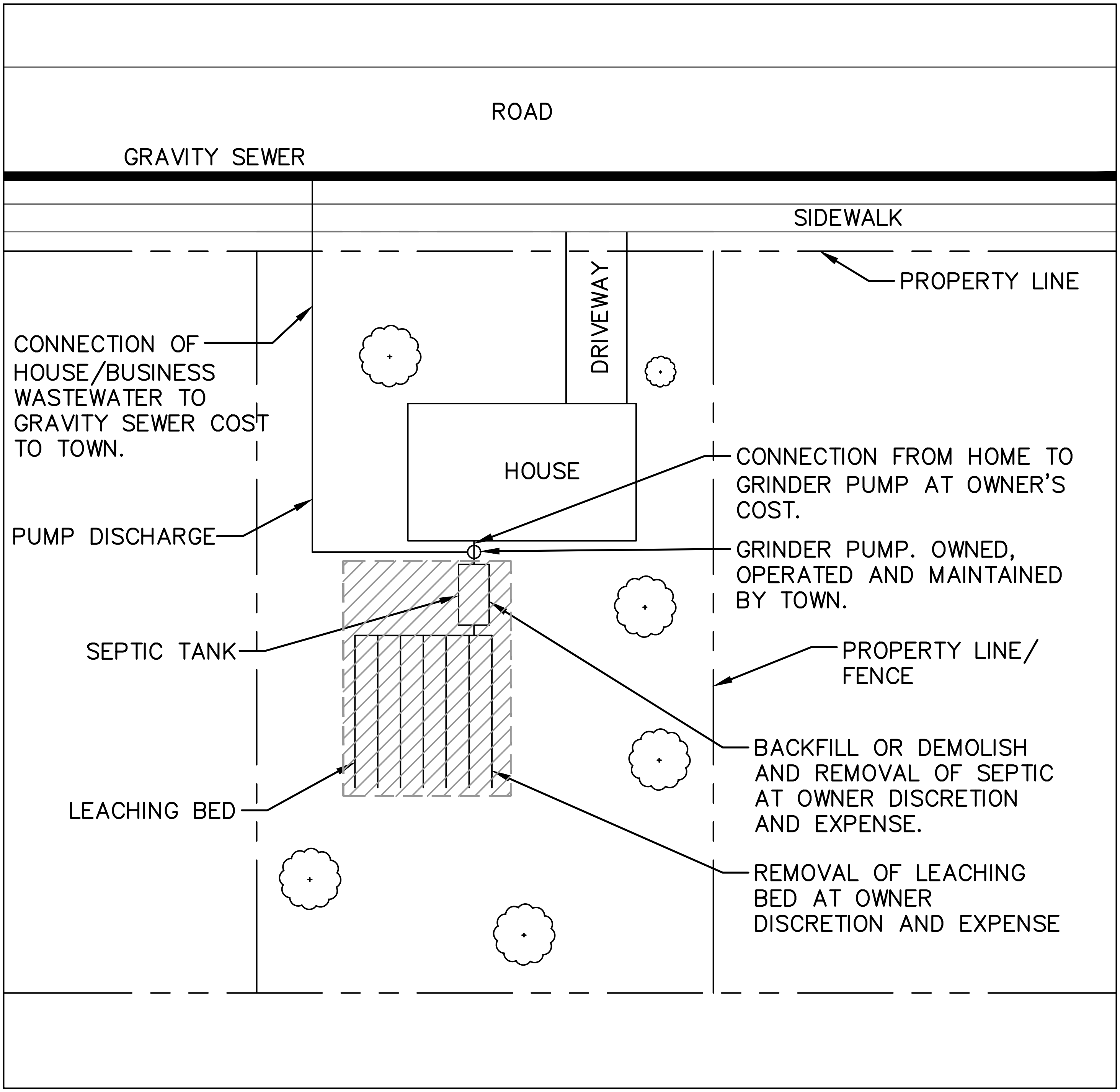
Following from the connection costing basis presented, a total capital cost for the connection of existing properties within the service area will be $ 10,210,000 for the gravity system or $9,250,000 for the pressure system or vacuum system.

With each collection system alternative there is some variation in the portion of the service connection for which each property owner will be responsible. A series of drawings are provided in overleaf which outline the Town and property owner portions of the service connection.

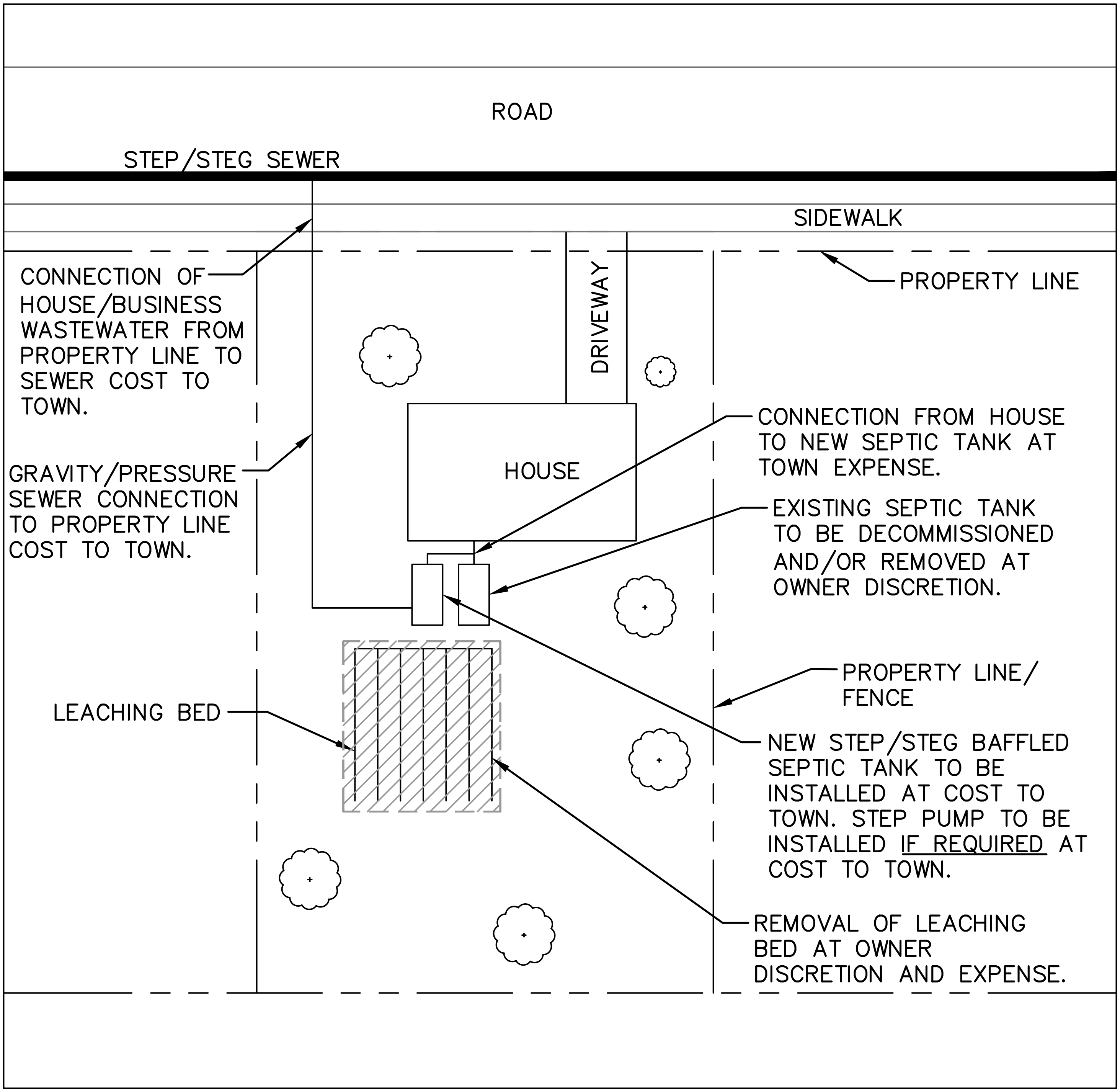
ALTERNATIVE 1
GRAVITY SYSTEM
GRAVITY CONNECTION



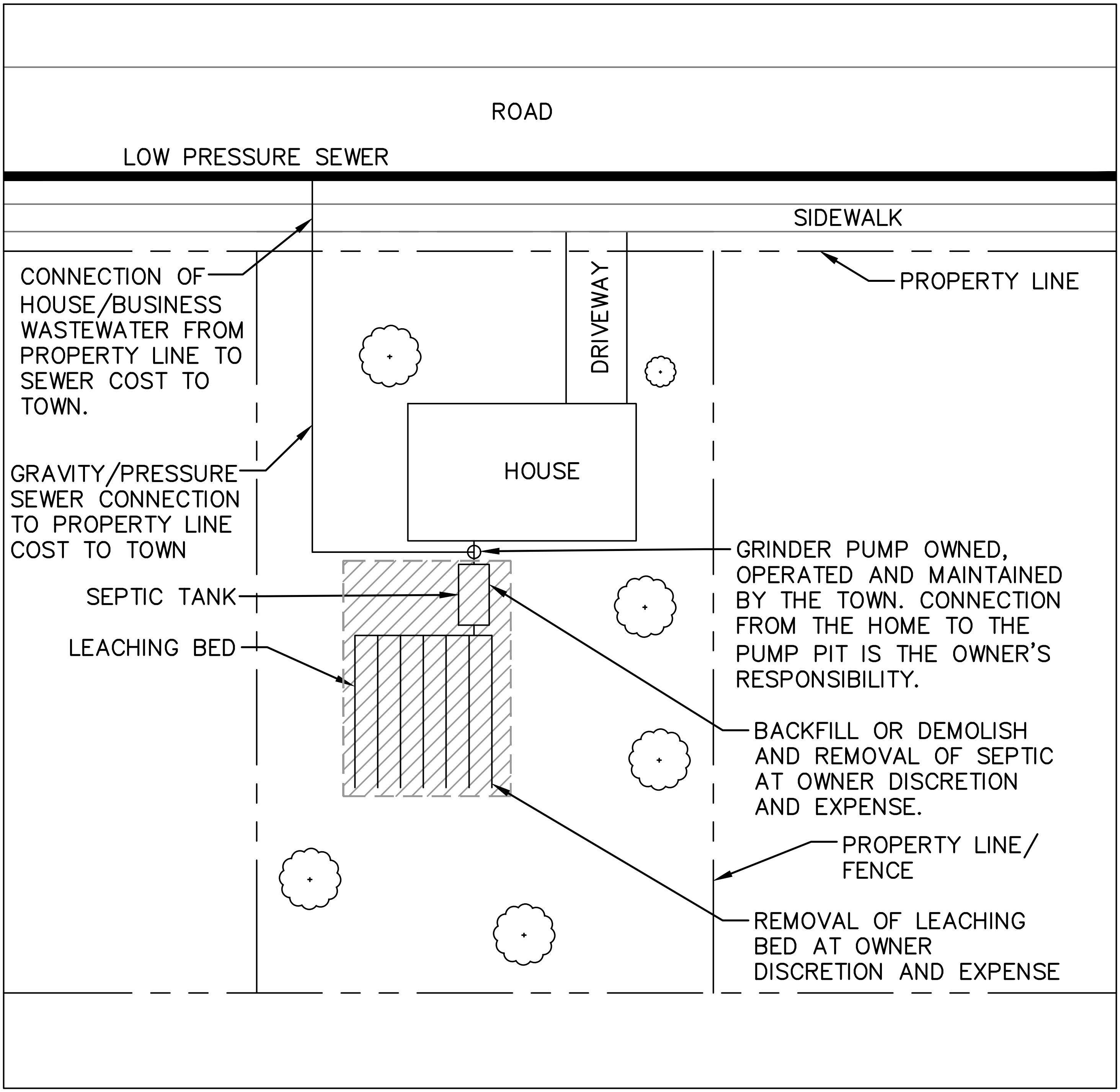
ALTERNATIVE 1
GRAVITY SYSTEM
PUMPED CONNECTION



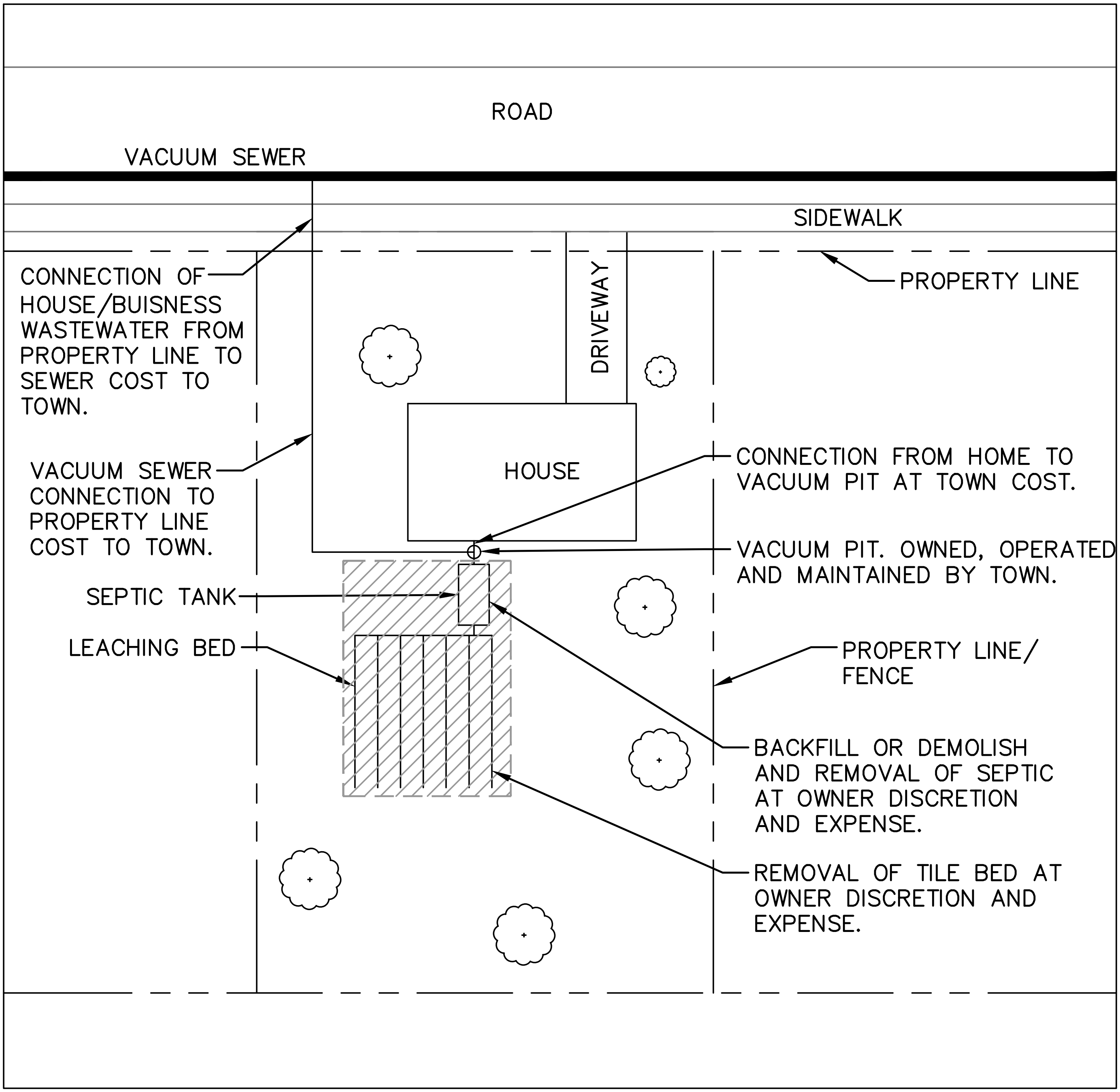
ALTERNATIVE 2
STEP/STEG SYSTEM



ALTERNATIVE 3
LOW PRESSURE SYSTEM



ALTERNATIVE 4
VACUUM SYSTEM



Appendix - L

Pumping Stations and Forcemains

Ainley & Associates Limited
195 County Court Boulevard, Suite 300, Brampton, ON L6W 4P7
Tel: (905) 452-5172 Fax: (705) 445-0968
E-mail: brampton@ainleygroup.com

April 24, 2018 File No. 115157

Triton Engineering Services Limited
105 Queen Street West Unit 14
Fergus, ON N1M 1S6

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

Ref: **Town of Erin, Urban Centre Wastewater Servicing Class EA**
Pumping Station and Forcemains, Technical Memorandum

Dear Ms. Furlong:

We are pleased to present our Technical Memorandum for the “Pumping Stations and Forcemains” for the Urban Centre Wastewater Servicing Schedule ‘C’ Municipal Class Environmental Assessment (EA).

This Technical Memorandum provides a review of the pumping station sites and forcemain alignment Alternatives and includes those alternatives identified in the Servicing and Settlement Master Plan (SSMP). The Technical Memorandum establishes and evaluates alternative pumping stations and forcemains as a component of Phase 3 of the Municipal Class EA process. The recommended preferred Alternative for all pumping stations and forcemains is presented in the Technical Memorandum.

Yours truly,

AINLEY & ASSOCIATES LIMITED

Joe Mullan, P.Eng.
Project Manager

Town of Erin

Urban Centre Wastewater Servicing
Class Environmental Assessment

Technical Memorandum
Pumping Stations and Forcemains

FINAL

April 2018

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum Pumping Station and Forcemains

Project No. 115157

Prepared for:
The Town of Erin

Prepared By:

Simon Glass, P.Eng.

Reviewed By:

Gary Scott, P.Eng.

Ainley Group
195 County Court Blvd., Suite 300
Brampton, ON L6W 4P7

Phone: (905) 452 – 5172
www.ainleygroup.com

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Glossary of Terms

ACS	Assimilative Capacity Study: see assimilative capacity.
ADF	Average Daily Flow, typically expressed throughout the report in units of cubic metres per day (m3/d)
Assimilative Capacity	Assimilative capacity refers to the ability of a body of water to cleanse itself; its capacity to receive waste waters or toxic substances without deleterious effects and without damage to aquatic life or humans who consume the water.
Ainley	Primary engineering consultant for the Class EA process.
Air Lock	Air lock occurs in pressurized pipes when a pocket of air develops and obstructs flow. The air pocket will not allow the water to flow freely through the pipe.
Air Release Valve	Air release valves function to release air pockets that collect at each high point of a full pressured pipeline.
Alternative Solution	A possible approach to fulfilling the goal and objective of the study or a component of the study.
Bore Hole	A deep, narrow hole made in the ground, used to determine the local geology and ground water elevations.
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.
Catchment	The collection of water over a drainage area due to the ground's natural topography.
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).
Dewatering	Remove water from an area under consideration, usually for construction purposes, in order to avoid potential contamination.
EA Act	*Environmental Assessment Act*, R.S.O. 1990, c.E.18 (Ontario)
Easement	An easement is a nonpossessory right to use and/or enter onto the real property of another without possessing it.
Effluent	Liquid after treatment. Effluent refers to the liquid discharged from the WWTP to the receiving water.
Environmental Impact Assessment (EIA)	Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a propsed project or development, taking into account interprelated socio-econmic, cultural and human-helath impacts, both benefical and adverse.
Evaluation Criteria	Criteria applied to assist in identifying the preferred solution(s).
Flood Plain	A flood plain is an area of land adjacent to a stream or river which stretches from the banks of its channel to the base of the enclosing valley walls and which experiences flooding during periods of high discharge.
Fluvial	Related to or found within a river.
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.
Grinder Pump	A grinder pump is a wastewater conveyance device. Once the wastewater inside the tank reaches a specific level, the pump will turn on, grind the waste into a fine slurry, and pump it to the central sewer system or septic tank. Grinder pumps can be installed in the basement or in the yard.
Horizontal Directional Drilling (HDD)	A trenchless technology method of pipeline construction that could be used for the construction of sewage forcemains or for small diameter sewer construction under watercourse crossings.
Hydrogeological	Study of the distribution and movement of groundwater in soil or bedrock.
Infill	A process of development within urban areas that are already largely developed. Refers specifically to the development of vacant or underdeveloped lots.
Infiltration/Inflow (I&I)	Rainwater and groundwater that enters a sanitary sewer during wet weather events or due to leakages, etc.
Intensification	A process of development within existing urban areas that are already largely developed. Refers specifically to the redevelopment of lots to increase occupancy.
Local Conservation Authority	A conservation authoriy is a local, community-based natural resource management agency based in Ontario, Canada. Conservation authorities are mandated to develop programs to further the conservation, restoration, development and management of Ontario's natural resources.
LPS System	Low-Pressure Sewer System refers to a network of grinder pump units installed at each property pumping into a common forcemain.
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.
O&M	Operation and maintenance
Official Plan (OP)	An official plan describes your upper, lower or single–tier municipal council's policies on how land in a community should be used. It is prepared with input from members in a community and helps to ensure that future planning and development will meet the specific needs of the community.
Obvert	The interior top of a pipe or culvert.
Open-cut Construction	Method of constructing a pipeline by open excavation of a trench, laying the pipe, and backfilling the excavation.
PDF	Peak Daily Flow, typically expressed throughout the report in units of cubic metres per day (m3/d)
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.
Scour	Hard rubbing of a surface with an abrasive.
Sewage Pumping Station (SPS)	A facility containing pumps to convey sewage through a forcemain to a higher elevation.
Receiving Pit	A shaft or vericle excavation used for receiving a dril in a tunneling operation.
Road Allowance	An allowance (normally 66 feet in width) for a road laid out by a Crown surveyor.

ROW	Right-of-way applies to lands which have an access right for highways, roads, railways or utilities, such as wastewater conveyance pipes.
Sanitary Sewer	Sewer pipe that conveys sewage to a sewage pumping station or sewage treatment plant. Part of the sewage collection system.
Septic Waste	Wastewater characterised by the absence of dissolved oxygen and high concentration of sulphides and odours.
Service Area	The area that will receive sewage servicing as a result of this study.
Sending Pit	A shaft or vericle excavation used for sending a dril in a tunneling operation.
Sewage	The liquid waste products of domestic, industrial, agricultural and manufacturing activities directed to the wastewater colleciton 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.
Storm Water Management Facility	A Facility that gathers rainfall and surface water runoff to help reduce the possibility of flooding and property damage. They are specifically designed to collect runoff from streets, the ground surface and storm sewers.
Study Area	The area under investigation in which construction may take place in order to provide servicing to the Service Area.
Surficial Geology	Surficial geology refers to the study of landforms and the unconsolidated sediments that lie beneath them.
SWD	Side wall depth – The depth of a particular process tank.
Thalweg	A line connecting the lowest points of successive cross-sections along the course of a valley or river.
Threatened Species	A species likely to become endangered in Canada if the factors affecting its vulnerability are not reversed.
Transient Pressure Condition	A pressure wave that is short lived (i.e. not static pressure or pressure differential due to friction/minor loss in flow)
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
Trunk Sewer	A sewer that collects sewage from a number of tributary sewers.
UCWS Class EA	Urban Centre Wastewater Servicing Class Environmental Assessment
Wastewater	See Sewage
Wastewater Treatment Plant (WWTP)	See Sewage Treatment Plant.
Wet Well	The basin of a sewage pumping station where wastewater is collected before pumping.

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 Town. The study area for the SSMP included Erin Village and Hillsburgh as well as a portion of the surrounding rural lands. The SSMP considered servicing and planning alternatives for wastewater and identified a preferred wastewater servicing strategy for existing and future development in the study area. The SSMP was conducted in accordance with the requirements of the Municipal Class Environmental Assessment (Class EA), which is an approved process under Ontario's Environmental Assessment Act and addressed Phase 1 & components of Phase 2 of the Class EA planning process.

Through the Urban Centre Wastewater Servicing Class EA (UCWS Class EA) the Town is now continuing with a review of Phase 2 and completing Phases 3 & 4 of the Class EA Planning Process to determine the preferred design alternative for wastewater collection for the existing urban areas of the Erin Village and Hillsburgh, and to accommodate future growth. The aforementioned SSMP concluded that the preferred solution for both communities is a municipal wastewater collection system conveying sewage to a single wastewater treatment plant located south east of Erin Village with treated effluent being discharged to the West Credit River servicing a population of 6,000. In completing Phase 2 activities within the UCWS Class EA, the preferred solution, remains as established under the SSMP, however, the serviced population has been increased to 14,559 persons to account for growth in accordance with the Town's Official Plan (OP).

The UCWS Class EA will outline a wastewater servicing plan for a population of 14,559, sufficient to service both existing communities and full build out growth to meet the development potential of future development lands identified in the present OP. Site selection for pumping stations must take into account the full build-out potential for the community to ensure adequate site space is considered in the selection of potential locations. This pumping station and forcemains alternatives technical memorandum is therefore presented on the basis of full build out growth.

1.1 Land Use Policies and Regulations

The following documents define the land use policies and regulations that control development within the Town of Erin.

- Provincial Policy Statement
- Greenbelt Plan
- Growth Plan for the Greater Golden Horseshoe
- County of Wellington Official Plan
- Town of Erin Official Plan
- The Town of Erin's Zoning Bylaw (No. 07-67)

Provincial Policy Statement provides policy direction on matters of provincial interest related to land use planning and development. As a key part of Ontario's policy-led planning system, the Provincial Policy Statement sets the policy foundation for regulating the development and use of land. This document works in tandem with locally-generated land-use planning documents with a focus on developing communities that foster a healthy environment and economic growth over the long term.

The Greenbelt is a band of permanently protected land within Ontario. The goal of the Greenbelt Plan is to protect against the loss and fragmentation of the agricultural land base and support agriculture as the predominant land use. The plan gives permanent protection to the natural heritage and water resource systems that sustain ecological and human health and provides for a diverse range of economic and social activities associated with rural communities, agriculture, tourism, recreation and resource uses. The project is in conformance with the requirements for Infrastructure servicing as outlined in Section 4.2 of the Greenbelt Plan in promoting local servicing of lands within the OP boundary.

The Growth Plan for the Greater Golden Horseshoe is a long-term plan to manage growth, build complete communities, curb sprawl and protect the natural environment. The plan sets out a structure for the type and location of development, outlines the future infrastructure needs, defines protective measures for natural and cultural resources, and provides an overarching implementation plan to achieve the stated goals.

County of Wellington Official Plan is a legal document intended to give direction over the next 20 years, to the physical development of the County, its local municipalities and to the long term protection of County resources. The plan outlines a long-term vision for Wellington County's communities and resources.

Town of Erin Official Plan is a component of the overarching County of Wellington Official Plan and details the growth allocation for Erin, planning densities, and land uses.

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.

2.0 Identification of Potential Pumping Station Sites

Prior to selecting pumping station sites for evaluation, the “Collection System Alternatives” Technical Memorandum compared a range of collection system alternatives and identified a “Blended Gravity and Low Pressure Pump System” as the recommended collection system alternative. The “Collection System Alternatives” technical memorandum compares the collection system technologies on the basis of servicing the existing communities including infill and intensification and shows the cost to service existing areas. In addition, the technical memorandum identifies the “oversizing” required to service growth to full build out. A suggested trunk system that services both existing areas and growth has been identified.

Additional pumping stations may be necessary within any new development areas to convey wastewater to the main system and these would be identified during the planning stages for these new developments.

Based on the topography of Erin Village and Hillsburgh, the need for a total of ten locations have been identified where wastewater needs to be pumped to service existing areas and to convey wastewater from growth areas to the Wastewater Treatment Plant. The general locations for the pumping stations required are outlined in the following sections. For further detail on why pumping stations have been deemed necessary in the locations listed in this section, please refer to the Collection System Alternatives Memorandum where the topography of each area is discussed in detail.

Each of the gravity drainage areas requiring a pumping station is outlined below.

2.1. Hillsburgh-Erin Connection (H-SPS 1)

A pumping station is required at the south end of Hillsburgh in order to convey wastewater to Erin. The boundary of the collection area for this pumping station are shown in ***Appendix A***. Several locations were considered for the pumping station location. Undeveloped properties exist surrounding the intersection of

Trafalgar Road and Wellington Road 22; however these properties were eliminated as potential locations due to the environmental constraints at these sites. Other site owners in this area were not willing to have their land considered for a SPS. Potential sites were examined between Gilbey Lane and Jane Street as well as at the junction of Trafalgar Road and the Elora-Cataract Trail. The junction of Trafalgar Road/ Elora-Cataract Trail joins on to a proposed development area and there is an unused road allowance available that would be suitable for a SPS. These potential areas are shown Figure 1. The Trafalgar Road/Elora-Cataract Trail was identified as the preferred site based on property considerations and the ability to service both existing and growth areas. This station will collect all wastewater produced in Hillsburgh for transmission to Erin. This pumping station would have a capacity of 89.2 L/s for the full build-out condition.

Although the elevation of this SPS in Hillsburgh is some 30 m above the proposed Main Street SPS in Erin and the connection is capable of operating under gravity flow, it is proposed to pump the wastewater all the way between Hillsburgh and Erin in order to be able to control the residence time of the wastewater in the system. The Erin – Hillsburgh connection SPS will be provided with an oversized wet well designed to optimise the residence time in the system.

Figure 1 – Hillsburgh to Erin Potential SPS Location

Based on a review of the potential SPS site area, the preferred location for the station is on the east side of Trafalgar Road, at the junction of the Elora-Cataract Trail and Trafalgar Road. Figure 2 presents a conceptual site layout for the station at this location. Sufficient space has been provided for standby power and for installation of odour control equipment. This location would also be suitable for an expanded car parking area as an entrance to the trailway.

2.1.1. Environmental

The consideration of the sites at the intersection of Trafalgar Road and Wellington Road 22 and subsequent dismissal of these alternatives due to the existing environmental constraints resulted in a missed opportunity to review the preferred site during the field season. As such, a full environmental review of the preferred site was not completed as a part of the UCWS Class EA. As the preferred site is a part of a larger lot with development plans, Ainley was able to obtain a Phase 1 Environmental Assessment and an Environmental Impact Study of these development lands from the land owner.

The previous studies identified the presence of thirty-seven bird species in the area. Fourteen of the bird species are considered to be species of conservation concern; however no nesting habitat was identified on the parcel being considered for the pumping station. In addition, there was no potentially significant wildlife habitat identified at the proposed site. The onsite woodland and onsite pond identified are located at the north end of the development parcel, well away from the proposed SPS site.

2.1.2. Heritage and Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.1.3. Geotechnical

Ainley was able to obtain an Environmental Impact Study and a Hydrogeological Report of the property from the land owner.

The previous studies identified that the surficial geology of the site is broadly characterized by a sand and gravel deposits of varying texture interlayered with silt and till. The southwestern portion of the property, close to the proposed SPS location is characterized by surface deposits of glacio-fluvial ‘outwash’ sand and gravel, frequently overlain by several feet of fine sand and silt. The hydrogeological report estimates that the static groundwater level at this location is approximately 4.3 m below grade. The site would provide a suitable foundation for construction of a wastewater pumping station.

2.1.4. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

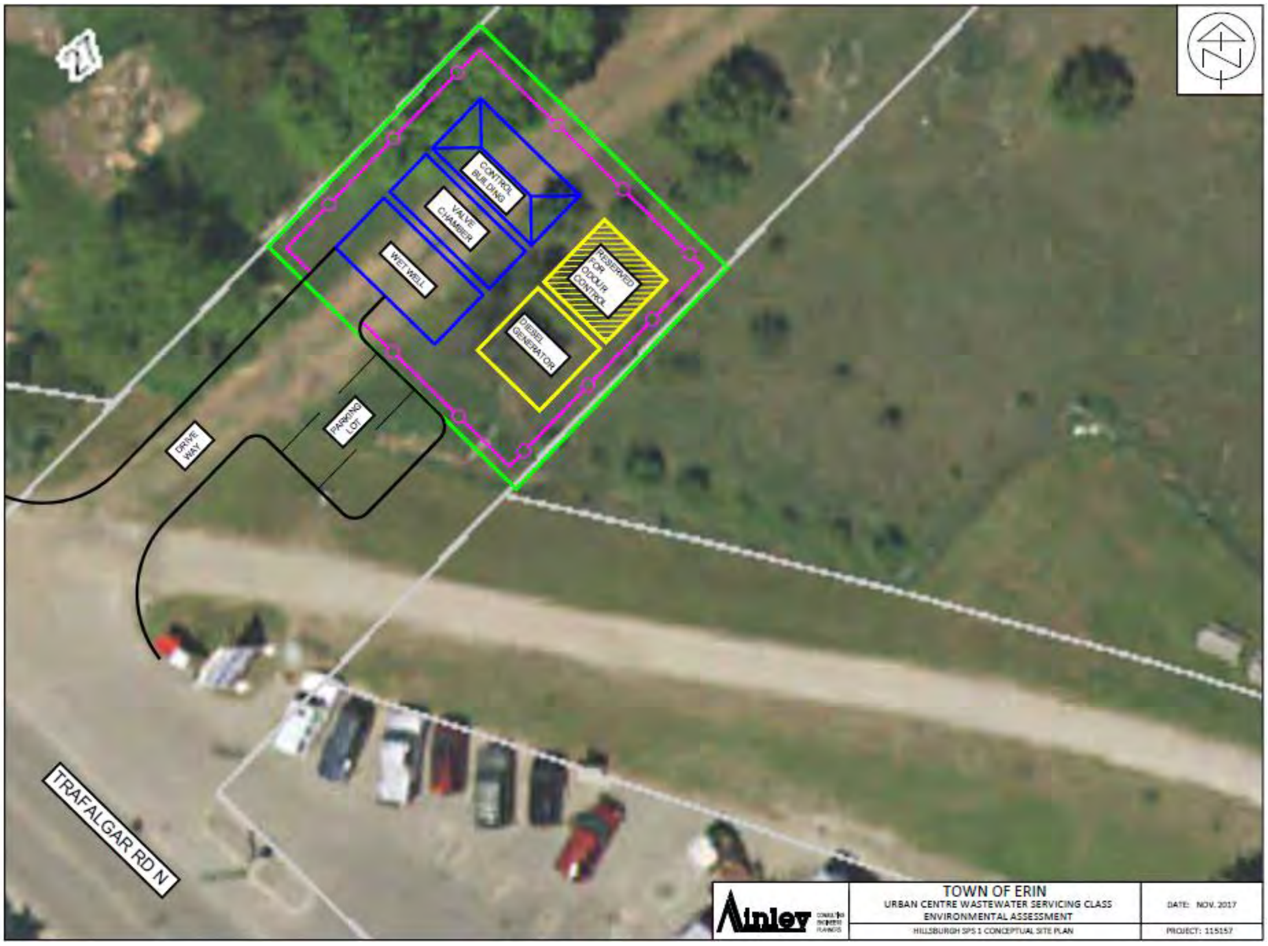


Figure 2 – H-SPS 1 Conceptual Site Plan

2.2. Hillsburgh Town Core (H-SPS 2)

A pumping station will be required for the core residential area in Hillsburgh to convey wastewater to Trafalgar Road. The boundary of the collection area for this pumping station are shown in ***Appendix A***. The potential location of the pumping station situated along Mill Street west of Covert Lane. Two potential areas were identified and are outlined in Figure 3; both of the potential sites are within 100m of a municipal well and potable water pumping station. The operation of a sewage pumping station in this area is not expected to have any impact of the existing well or the potable water pumping station. The forcemain route for this location can be seen in the overall system layout available in ***Appendix A***. A discharge location has been proposed along Trafalgar Road which represents a local high point, allowing for the wastewater to be conveyed by gravity to the main pumping station connecting Hillsburgh to Erin Village. This pumping station will need to have a capacity of 33.1 L/s for the full build-out condition.

Figure 3 – Hillsburgh Town Core Potential SPS Location

Based on a review of the potential SPS site area, the preferred location for the station is on the south side of Mill Street, west of the Health Centre. These lands are owned by the Town of Erin and will not impact existing recreational land use. Figure 4 presents a conceptual site layout for the station at this location. Sufficient space has been provided for standby power and for installation of odour control equipment.

Figure 4 – H-SPS 2 Conceptual Site Plan

2.2.1. Environmental

The Natural Environment Report, completed as a part of the UCWS Class EA describes this site as an urban park beside fresh-moist lowland deciduous forest. There is no wetland present at the site and no amphibian habitat was identified. The site is located in close proximity to a watercourse and, as such, the Natural Environment Report provides recommendations on construction timing and erosion and sediment controls. It is acknowledged that this site is located in the flood plain of the West Credit River and will require special construction to ensure that it is accessable during flood events. In order to manage the risk of flooding events at this site,the top of all chambers constructed at this location should be above the flood plain. During the design process, a closer evaluation of the floodplain impact on the proposed location should be undertaken to detmeine if the risk can be adequately mitigated. There is a potential alternative site across Mill Streetwithin the existing ball park which could be used if the proposed site is determined to be an unacceptable risk however this would impact the use of the park.

2.2.2. Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.2.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station

2.2.4. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

2.3. Lion's Park Pumping Station (E-SPS 1)

The proposed location for the final sewage pumping station that will pump all wastewater to the WWTP, is within the existing park at the intersection of Hillsview St. and Lions Park Ave. Following a general review of available lands at the South end of Erin the Lions Park area was identified as the preferred location due to the unavailability of other potential sites. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in ***Appendix A***. This station would receive all wastewater collected from both Hillsburgh and Erin Village and convey wastewater to the treatment plant. The potential area for this pumping station is shown in Figure 5. The forcemain route from this station is aligned south along Main Street before diverting east along Wellington Road 52 towards the proposed WWTP location. This pumping station will need to have a capacity of 227.2 L/s for the full build-out condition. The trunk sewer from the north end of the community will pass under the West Credit River just to the north of the proposed SPS site (See Figure 6). Figure 7 provides a photograph of the site.

Figure 5 – Main SPS Alternative 2 Potential Location

Figure 6 – Trunk Gravity Sewer Crossing Location

Figure 7 – E-SPS 1 Site Location Photograph (North Side)

Based on a review of the potential SPS site area, the preferred location for the station is on the west side of Lion's Park. Figure 8 presents a conceptual site layout for the station at this location. Sufficient space has been provided for standby power and for installation of odour control equipment.

An additional site for this station was considered at the intersection of Main Street and Wellington Road 124, however permission from the land owner to study the property was never received. As such, the additional location was removed from consideration.

2.3.1 Environmental

A portion of the West Credit River Wetland Complex is in close proximity (approximately 20m) to the proposed site. An existing road lies between the proposed site and the watercourse. There were no species of concern at the site or within the watercourse close to the site. The Natural Sciences Report specifies that the pumping station at this site should be designed so as to maintain the existing wetland hydrology. In addition, any tree removals necessary for the construction of an SPS at this site should be completed outside of the migratory bird season. This site is located in the flood plain of the West Credit River and will require special construction to ensure that it is accessable during flood events. The top of all chambers constructed at this location should be above the flood plain.

2.3.2 Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.3.3 Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

2.3.4 Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

Figure 8 – E-SPS 1 Conceptual Site Plan

2.4. North Erin Pumping Station (E- SPS 2)

A pumping station is required to convey wastewater from the north end of Erin to the high point at the intersection of Main Street and Dundas Street. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in the proposed system layout for Erin in ***Appendix A***. The potential location for this pumping station is shown in Figure 9. The forcemain route for this station is aligned along Main Street connecting to a gravity sewer in the area of Main Street and Dundas Street. This pumping station will need to have a capacity of 151.7 L/s for the full build-out condition. The build-out condition flow rate assumes that all the industrial and commercial development along Wellington Road 124 north of Dundas Street will be conveyed through this station.

Figure 9 – North Erin Potential SPS Location

Figure 10 presents a conceptual site layout for the station at this location. Sufficient space has been provided for standby power and for installation of odour control equipment.

2.4.1. Environmental

A portion of the West Credit River Wetland Complex is in close proximity to the proposed site. An open water vegetation community associated with the wetland complex is adjacent to the site and an amphibian habitat was located within 120m of the site. The Natural Sciences Report specifies that the pumping station at this site should be designed so as to maintain the existing surface water contribution to the wetland and that water quality should be maintained for any water discharged for dewatering.

2.4.2. Heritage and Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.4.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

2.1.5. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

Figure 10 – E-SPS 2 Conceptual Site Plan

2.5. Erin Heights Pumping Station (E-SPS 3)

A pumping station is required for the Erin Heights Drive area to convey wastewater from the subdivision under the river which separates this area from the downtown area of Erin Village and up to the Main Street sewer. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in ***Appendix A***. The potential location for this pumping station is shown in Figure 12. The proposed forcemain route for this station is aligned eastward along Dundas St W. and must cross the West Credit River before reaching Main Street (see Figure 11). This pumping station will need to have a capacity of 5.3 L/s for the full build-out condition. As this is a small pumping station it is proposed that the wetwell be oversized and a connection provided for a trailer mounted standby power generator in case of prime power loss. The build-out condition flow rate assumes that all the development along 8th Line will be conveyed to Main Street along Dundas and the forcemain would link into the forcemain from the Erin Heights subdivision. This would require a cost sharing agreement with the developer(s) for the river crossing and joint forcemain.

Figure 11 – West Credit River crossing with Dundas Street

Figure 12 – Erin Heights Potential SPS Location

Due to the highly constrained potential site area for the SPS, the preferred location for the station is within the unopened right-of-way at the east end of Erin Heights Drive. Figure 13 presents a conceptual site layout for the station at this location.

Figure 13 – E-SPS 3 Conceptual Site Plan

2.5.1. Environmental

There are no specific environmental concerns at this site. Any tree removals necessary for the construction of the station should be completed outside of the migratory bird season. The road allowance leads to a trail behind the homes, however it is not known if this trail crosses private lands. The station construction can allow the trail to remain open if necessary. In following with the recommendations of the Natural Environment Report, the proposed footing of the station has been modified in order to avoid mature trees as much as possible.

2.5.2. Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.5.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

2.5.4. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

2.6. Erin Industrial Area (E-SPS 4)

A pumping station is required to convey wastewater from the north end of the Erin industrial area along Sideroad 17 including Pioneer Drive. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in the proposed system layout for Erin in ***Appendix A***. The pumping station will be located on Sideroad 17 west of Pioneer Drive. The potential area is outlined in Figure 14. The forcemain route for this station is aligned eastward along Sideroad 17 and diverts south along Main Street to a local high point where the flow continues by gravity. This pumping station will need to have a capacity of 7.8 L/s for the full build-out condition. As this is a small pumping station it is proposed that the wetwell be oversized and a connection provided for a trailer mounted standby power generator in case of prime power loss.

Figure 14 – Erin Industrial Area Potential SPS Location

Based on a review of the potential SPS site area, the preferred location for the station is adjacent to the driveway to the Snow Brothers property. Figure 15 presents a conceptual site layout for the station at this location.

2.6.1. Environmental

There are no specific environmental concerns at this site.

2.6.2. Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.6.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

2.6.4. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

Figure 15 – Erin SPS 4 Conceptual Plan

2.7. Dundas St. E Pumping Station (E-SPS 5)

A pumping station is required along Dundas St. E., to convey wastewater from the surrounding residential area to a gravity main on Daniel St. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in ***Appendix A***. The potential location for this pumping station is shown in Figure 16. This pumping station will need to have a capacity of 5.1 L/s for the full build-out condition. As this is a small pumping station it is proposed that the wetwell be oversized and a connection provided for a trailer mounted standby power generator in case of prime power loss.

Figure 16 – Dundas Street East Potential SPS Location

Figure 17 presents a conceptual site layout for the station at this location.

2.7.1. Environmental

There are no specific environmental concerns at this site. Any tree removals necessary for the construction of the station should be completed outside of the migratory bird season.

2.7.2. Archaeological

This location has been identified as a site with potential archaeological significance. As such, a stage 2 test pit survey will be required prior to construction at the site.

2.7.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

2.7.4. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

Figure 17– Erin SPS 4 Conceptual Plan

2.8. Waterford Drive Pumping Station (E-SPS 6)

A pumping station is required at the north end of Waterford Drive, to convey wastewater from the low lying portion of this residential street. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in ***Appendix A***. The potential location for this pumping station is shown in Figure 18. This pumping station will need to have a capacity of 4.4 L/s for the full build-out condition. As this is a small pumping station it is proposed that the wetwell be oversized and a connection provided for a trailer mounted standby power generator in case of prime power loss.

Figure 18 – Waterford Drive Potential SPS Location

Figure 19 presents a conceptual site layout for the station at this location.

2.8.1. Environmental

A portion of the West Credit River Wetland Complex is within 120m of the proposed site. Due to accessibility issues, the presence of amphibian habitat was not assessed in the river reach close to the site. The Natural Sciences Report specifies that the pumping station at this site should be designed so as to maintain the wetland hydrology and that water quality should be maintained for any water discharged for dewatering. In addition, any tree removals necessary for construction at the site should be completed outside of the migratory season. Given the location of the site adjacent to the stormawater management pond, the station will require special construction to ensure that it is accessable during flood events. In order to manage the risk of flooding events at this site,the top of all chambers constructed at this location should be above the flood plain.

2.8.2. Archaeological

This location is part of a storm water management facility and has been previously disturbed. As such it is unlikely to have potential for archaeological resources.

2.8.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

2.8.4. Agricultural

Due to the location of the proposed pumping station within the urban boundary of the Town, there is no agricultural potential at the site. As such, there is no relative advantage of alternative sites from an agricultural perspective. There are no livestock facilities within the surrounding urban area and the minimum separation distance from livestock is not applicable. The selection of this site has no bearing on potential agricultural expansion in the surrounding areas and will not have a detrimental impact the operation of local agriculture.

Figure 19 – Erin SPS 6 Conceptual Plan

2.9. Scotch Street Pumping Station (E-SPS 7)

A pumping station is required along Scotch St., to convey wastewater from the surrounding residential area to a gravity main on Daniel St. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in ***Appendix A***. The potential location for this pumping station is shown in Figure 20. This pumping station would need to have a capacity of 2.0 L/s for the full build-out condition however this catchment has been identified as a good candidate location for use of low pressure sewers. The capital cost of the local gravity sewer, pumping station and forcemain is higher than the local grinder pumps and low pressure sewer. The pressure sewer catchment would outlet to the trunk sewer along Daniel Street. It is recommended that the grinder pumps be owned and serviced by the Town.

Figure 20 – Scotch Street Potential SPS Location

2.9.1. Environmental

The only site available for a centralized pumping station is within the existing ROW for this catchment. The grinder pump stations for the homes in this catchment will be located within private property however this area remains within 120m of the West Credit River Wetland Complex. As such, the design and construction of the low pressure system for this area should maintain the wetland hydrology and ensure water quality from any dewatering discharge.

2.9.2. Archaeological

The only site available for a centralized pumping station is within the existing ROW for this catchment. As the land has already been disturbed in this location due to the road construction this site is not considered to have any archaeological potential.

2.9.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station

2.10. Wheelock Street Pumping Station (E-SPS 8)

A pumping station is required along Wheelock St., to convey wastewater from a small number of surrounding homes on the low lying street to a gravity main on Daniel St. The boundary of the collection area for this pumping station and the proposed forcemain route are shown in ***Appendix A***. The potential location for this pumping station is shown in Figure 21. This pumping station would need to have a capacity of 0.9 L/s for the full build-out condition, however this catchment has been identified as a good candidate location for use of low pressure sewers. The capital cost of the local gravity sewer, pumping station and forcemain is higher than the local grinder pumps and low pressure sewer. The pressure sewer catchment would outlet to the trunk sewer along Daniel Street. It is recommended that the grinder pumps be owned and serviced by the Town.

Figure 21 – Wheelock Street Potential SPS Location

2.10.1. Environmental

Since this catchment has been identified as a good candidate for low pressure sewers, the grinder pump stations for the homes will be located within private property. The catchment area is in close proximity to the West Credit River. As such, the design and construction of the low pressure system for this area should maintain the wetland hydrology, amphibian habitat, and ensure water quality from any dewatering discharge. Part of this service area, including the sewage pumping station locations, is situated within a CVC regulated area.

2.10.2. Archaeological

A low pressure system has been recommended to service this catchment. As such, the system will be constructed within previously disturbed land within the existing ROW and on private properties and is not expected to have archaeological significance.

2.10.3. Geotechnical

Indications from borehole information are that this site provides suitable foundation conditions for a Sewage Pump Station.

3.0 River Crossings

There are several locations through Erin Village and Hillsburgh where the wastewater collection system will need to cross rivers. The key river crossing locations are shown in Figure 22 and Figure 24 for Erin Village and Hillsburgh respectively.

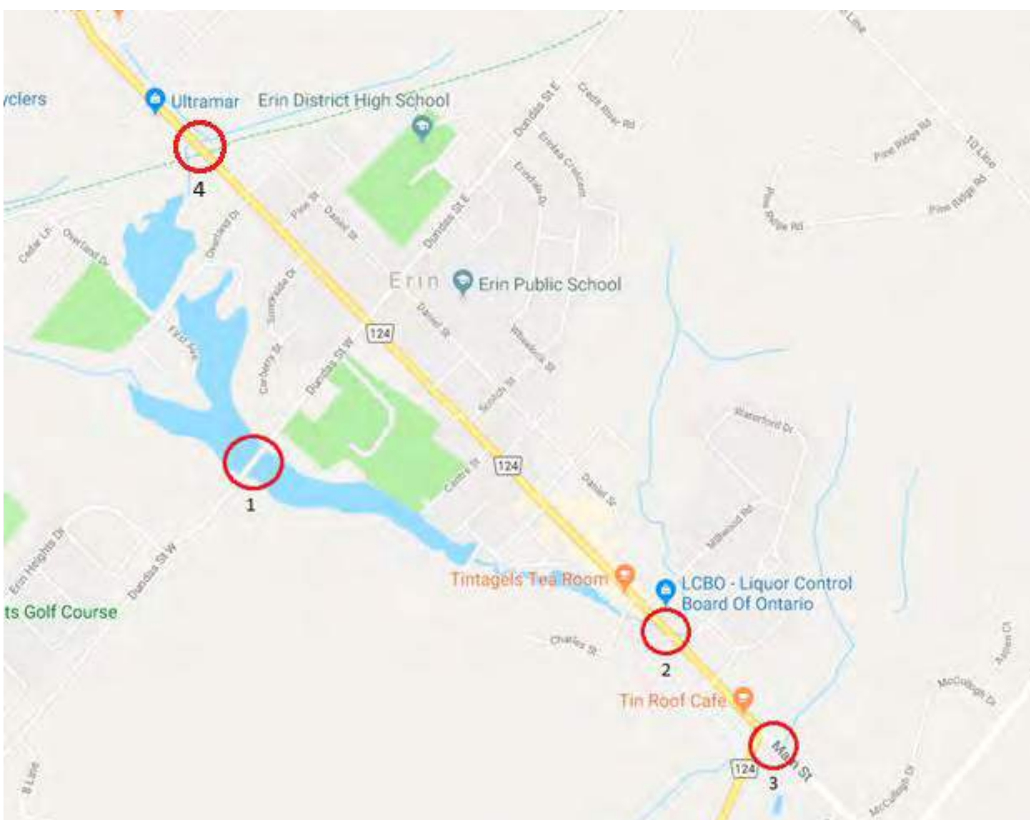


Figure 22 – Erin River Crossing Locations

Figure 23 – Sewer crossing, see crossing 3 in Figure 22

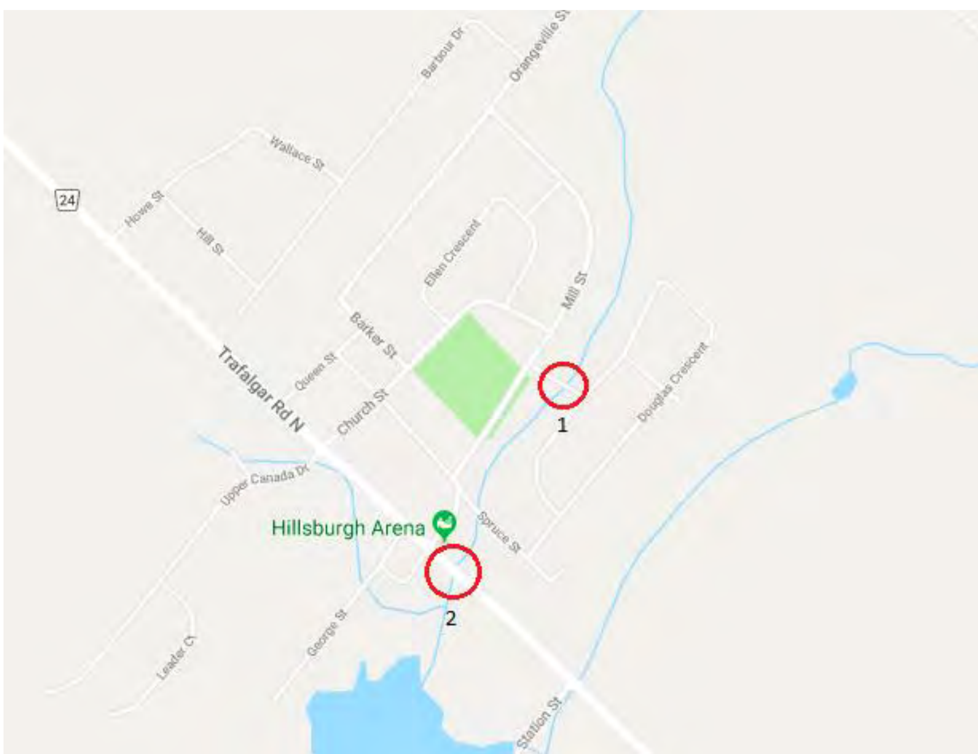


Figure 24 – Hillsburgh River Crossing Locations

In general, construction across rivers is regulated by the local conservation authority. The Credit Valley Conservation Authority (CVC) provides mapping showing the general extent of the regulated areas within the Credit River watershed. The river crossings identified in Figure 22 and Figure 24 are all within areas regulated by the CVC. The extent of the regulated areas is shown in Figure 25 and 26 for Erin Village and Hillsburgh respectively.

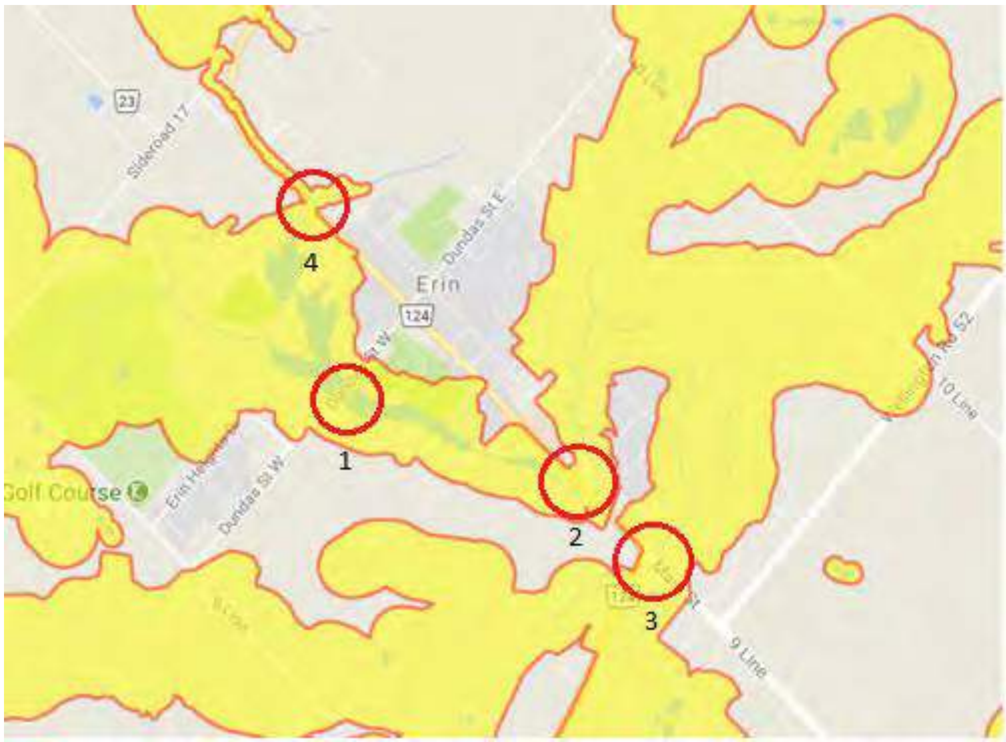


Figure 25 - CVC Regulated Areas in Erin

Figure 26 – CVC Regulated Areas in Hillsburgh

Typically the CVC requires a unique permit for each crossing, the application form for a river crossing permit is provided in ***Appendix B***. In general, a specific method of crossing is not prescribed by the conservation authority however open cut construction is generally not permitted or is severely restricted making it cost prohibitive. As such, a tunneling method will need to be selected during the detailed design for each river crossing. A suitable setback from the watercourse must be provided for the tunnel sending and receiving pits however the specific requirements are typically based on the local requirements.

Adequate separation between the sewer/forcemain obvert and the thalweg of the stream must be maintained. The separation requirements are site specific and are dependent on the scour potential of the watercourse. Depending on available information and the proposed depth, the CVC may require a scour assessment to be prepared by a qualified professional to establish the scour potential. In addition, an erosion and sedimentation plan will be required.

4.0 Forcemain Route Selection Erin Village-Hillsburgh Connection

Three forcemain routes were identified in the SSMP to connect Hillsburgh to Erin Village shown graphically in Figure 27; the first is along the Elora-Cataract Trail for a total length of 5.2 km, the second route is aligned east along Wellington Road 22 and diverts south along 8th Line towards Erin Village for a total length of 6.9 km, the final route option is aligned south on Trafalgar Road and diverts east along Sideroad 17 towards Erin Village for a total length of approximately 7.0 km.

Figure 27 – Hillsburgh to Erin Connection Forcemain Routes

5.1. Forcemain Design Considerations

Based on the review of growth areas and the findings of the updated ACS, there is considerable growth potential for Hillsburgh. In total, the anticipated flow rates for the community could quadruple from the current day to when the community is fully developed. The flow rates are outlined in Table 1.

Table 1 – Hillsburgh Expected Flow Rates, Existing to Build-Out

	Existing Development	Full Build-Out Development
Average Day Flow (m^3/d)	599.4	2,405.1
Peak Day Flow (m^3/d)	2457.5	7,623.9
Peak Day Flow (L/s)	28.5	88.3

The selection of forcemain size and pump sizing will have a significant impact on the capital cost of the system and on the ongoing operational costs. Forcemains are sized to maintain a minimum flow velocity of 0.8 m/s to facilitate scouring inside the pipe and prevent the accumulation of solids. MOECC Guidelines specify a maximum flow velocity of 3.0 m/s however there is an exponential relationship between flow velocity and pumping head (energy) required; maintaining a maximum velocity below 2.0 m/s, an average velocity of 1.2 m/s and minimum velocity of 0.8 m/s is preferred to minimize pumping costs. The forcemain and pumps should therefore be sized to provide a velocity between 0.8 – 2.0 m/s at the build-out condition and at the existing condition.

For long forcemains of this nature, security and performance are important issues. It is typically recommended to install twin forcemains each designed for half capacity to ensure minimum residence time in the forcemains under most flow scenarios. Twin forcemains also support the need for routine maintenance and the need to keep the system operational while cleaning/repairing one of the forcemains. Twin forcemains would be constructed within the existing right of way likely at the same time during Phase 1.

If a single forcemain is installed between the Erin and Hillsburgh systems, security could be maintained by establishing sufficient off-line storage for an average day at full built-out. A tank with the capacity for a single average day flow at build-out would provide sufficient time for an operations team to locate and repair a forcemain break and return the pumping station to normal operation. A 23m x 23m x 4.7m SWD off-line tank with the necessary valves, piping and transfer pumps would cost approximately $2,800,000. This is greater than the anticipated incremental cost of selecting dual forcemains over a single forcemain.

Based on the above, a twin 200mm forcemain is recommended to provide operational flexibility, particularly with respect to maintaining scouring velocities while development is ongoing. The ability to operate with just one of the two 200mm forcemains would reduce the amount of time wastewater remains in the forcemain and subsequently, reduce the time for septicity to develop. Also, a dual forcemain would provide additional system security; system operation could continue if a break were to occur without additional contingency measures such as off-line storage. Should the Town proceed with a dual forcemain design it is recommended that both forcemains be built concurrently to minimize construction costs.

To prevent leakage from joints it is recommended that the forcemains be constructed of welded polyethylene (PE) pipe. In addition, sufficient pressure control should be provided to prevent transient pressure conditions and to provide on line operational data to identify any operational issues.

5.2. Route Evaluation

5.1.1. Alternative 1 - Elora Cataract Trail

The trail is owned by Credit Valley Conservation (CVC). CVC are open to providing an easement to the Town for this infrastructure construction, see **Appendix C**. The Elora-Cataract Trail is an approximately 9 m wide former railway corridor that has been repurposed as a hiking trail. The former railway bed is approximalty 3.5 m wide and is situated in the centre of the cleared area. The hiking trail consists of approximately 3.0 m wide path, topped with limestone chips. The route provides a gentle downhill slope from Hillsburgh to Erin Village at a total distance of 5.2 km. The 30 m drop means that the pumping station will require minimal energy to convey the wastewater to Erin Village. A geotechnical investigation of the trail identified a relatively consistent makeup of the trail bed from silty sands at the surface to a coarser sand and gravel mixture at depths greater than 3 m. A sample borehole log is provided in **Appendix D**.

Figure 28 – Typical road crossing with ECT

The Natural Sciences Report identified the presence of Western Chorus Frogs within the cattail mineral shallow marsh adjacent to the trail between Side Road 17 and Main Street in Erin Village. The Western Chorus Frog has been identified as a threatened species and therefore care should be taken to ensure that their habitat is maintained. In addition, the habitat surrounding the forcemain route is home to a wide range of bird species. Most notably, the Eastern Wood-peewee which is designated as a species of special concern, and the Golden-winged Warbler and Barn Swallow which are both listed as threatened species. Species at risk within the habitat surrounding the trail includes the Jefferson's Salamander, Eastern Ribbonsnake, Blanding's Turtle, Red Shouldered Hawk, Short-eared Owl, Wood Thrush, Canada Warbler, Hooded Warbler, Yellow-breasted Chat, Henslow's Sparrow, Grasshopper Sparrow, Gypsy Cuckoo Bumblebee, Rusty-patched Bumblebee, and Monarch Butterfly.

Figure 29 – Typical section of the ECT

While it is imperative to protect the habitat of the threatened species, the main anticipated impacts to the terrestrial environment and species would be associated with site preparation, and construction and would involve temporary habitat disruption while avoiding long-term habitat loss. The proposed route is located within an existing right of way and thus both infrastructure and associated impacts are not expected to extend into surrounding natural habitats. To ensure minimal impact to the surrounding habitat and water quality in the area surrounding the trail, construction activities must be maintained on the travelled trailway and confined to periods that minimize impact on all of the species at risk, particularly within the spring period from April-June. The increased presence of humans, as well as machine noise, dust and activity, may disturb amphibians and birds during the sensitive breeding period, potentially causing them to avoid or abandon breeding in a disturbed area during construction. It is therefore recommended that construction activites be strictly controlled to avoid impacts.

Construction of twin 200 mm forcemains along the trail can likely be accomplished in a single trench down the centre of the existing hiking trail. Open cut trenches can be used either using conventional trenches or using trenching machines. Interim air release chambers may be required at creek/culvert crossings and isolation valves would be spaced along the trail, however these would not interfere with the use of the trail after construction. Sections of the trail would be closed during construction for safety reasons given the narrow width of the hiking trail. While it does not appear that any trees would have to be removed, some overhanging branch trimming may be required. While there would be minimal traffic impact, material delivery trucks and excess spoil removal will generate truck traffic during construction. Due to the distance between public roads along the trail, it may be necessary to create truck turning/staging areas along the trail. These can be selected to prevent impacts to the natural environment and can be removed after construction or retained if beneficial to trail use.

Figure 30 is a conceptual cross section of the forcemain construction on the ECT including the recommended mitigation measures from the Natural Sciences Report.

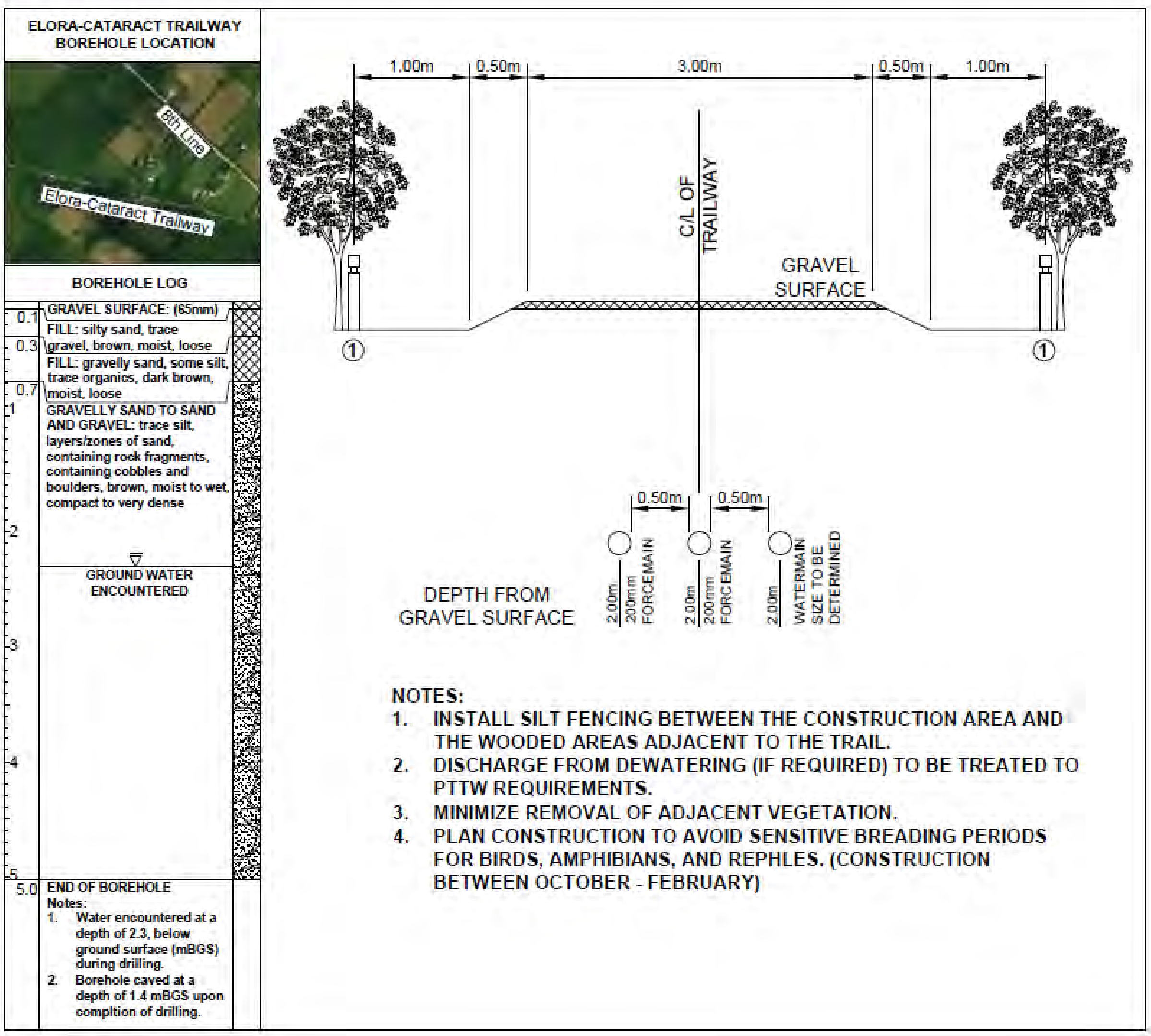


Figure 30 – Forcemain Cross Section on the ECT

5.1.2. Alternative 2 – Wellington Road 22

Approvals for an easement along this route would be required from Wellington County as well as the Town of Erin. The Wellington Road 22/ 8th Line route is a 2-lane ROW with above ground hydro and telephone lines run primarily along the south side of Wellington Road 22 and the west side of 8th Line. The hydro and telephone lines are set well back from the ROW along Wellington Road 22. While Wellington Road 22 is a paved 2-lane road, 8th Line is a narrow gravel sideroad, requiring a lane closure. As such, construction along this ROW will have an impact on local traffic.

This route has significant topographical variability, the intersection of Wellington Road 22 and 8th Line is 37 m higher than the intersection of Wellington Road 22 and Trafalgar Road. The elevation drops off steeply south of Wellington Road 22 along 8th Line and then rises again approximaltty 21.5 m. After this hill, elevations drop off consistently towards Sideroad 17. As with Alternative 3, Sideroad 17 is primarily sloped downwards towards Erin Village with the exception of a 7.5 m elevation change as Sideroad 17 approaches Main Street in Erin Village. A minimum of 4 air release chambers will be required along this route to prevent vacuum/airlock in the forcemain. There is one river crossing along this route on 8th Line at the intersection with Sideroad 17. Required pumping energy would be substantially higher than with Alternative 1.

The Natural Sciences Report did not identify the presence of any species of concern along this potential route.

As with Route 3, this alternative will involve the construction of twin forcemains in a common trench within the road allowance, likely as close to the property line as possible consistant with constructibility. Materials handling would likely necessitate a single lane closure over the length of construction.

5.1.3. Alternative 3 - Trafalgar Road

The Trafalgar Road/ Sideroad 17 route is a 2-lane ROW with above ground hydro and telephone lines running primarily along the west side of Trafalgar Road and the south side of Sideroad 17. The hydro and telephone lines are on the East side of Trafalgar Road for an 800 m span north of Sideroad 17. Trafalgar Road is a heavily traveled roadway and construction along this corridor would likely have significant traffic impacts. Trafalgar Road is a County road; Approvals for this alternative would be required from both the County and the Town of Erin.

This route has significant topographical variability between the pumping station location, and Sideroad 17 along Trafalgar Road. There are two significant hills with changes in elevation of 21 m and 28 m. The larger hill crests near the intersection of Trafalgar Road and Sideroad 17. Sideroad 17 is primarily sloped downwards towards Erin Village with the exception of a 7.5 m elevation change as Sideroad 17 approaches Main Street in Erin Village. A minimum of 5 air release chambers will be required along this route to prevent vacuum/airlock in the forcemain. There are two stream crossings along this route, one is located on Trafalgar Road approximately 660m north of Sideroad 17 and the other is located on Sideroad 17 at the intersection with 8th Line. Required pumping energy would be substantially higher than with Alternative 1.

The Natural Sciences Report identified the presence of Western Chorus Frogs within the lowland creek crossing on Trafalgar Road. The Western Chorus Frog has been identified as a threatened species and therefore care should be taken to ensure that their habitat is maintained. In contrast to the Elora-Cataract Trail route, there were no additional species of risk identified along this route.

5.1.4. Comparison of Alternatives

The advantages and disadvantages of each route option are presented in Table 2.

Table 2 – Advantages and Disadvantages of Forcemain Routes from Hillsburgh to Erin Village

Route	Advantages	Disadvantages
Elora-Cataract Trail (Route Option 1)	▪ CVC willing to entertain easement for mains ▪ Continuous downhill slope ▪ Reduced pumping distance	▪ More environmentally sensitive areas adjacent to the route requiring mitigation ▪ Trail would likely need to be

Route	Advantages	Disadvantages
	▪ Substantially lower energy requirements ▪ Lower capital cost	closed during construction ▪ Multiple species of concern identified in the area surrounding the trail. ▪ 1 culvert crossing required
Wellington Road 22 (Route Option 2)	▪ Along an existing ROW ▪ Minimal environmental impact for construction	▪ Will require approval from Wellington County ▪ Increased pumping distance ▪ Significant topographical variability ▪ Higher capital cost ▪ Increased long term energy costs ▪ 1 river crossing required
Trafalgar Road (Route Option 3)	▪ Along an existing ROW ▪ Lower environmental impact for construction	▪ Will require approval from Wellington County on Trafalgar Road ▪ Increased pumping distance ▪ Significant topographical variability ▪ Higher capital cost ▪ Increased long term energy costs ▪ Western Chorus Frogs identified along the route. ▪ 2 river crossings required

A capital cost comparison of the potential forcemain routes is provided in Table 3, each assumes a twin 200 mm forcemain.

Table 3 – Capital Cost of Forcemain Alternatives

Alternative	Capital Cost Estimate
Alternative 1 – Elora-Cataract Trail	$ 3,165,000
Alternative 2 – Wellington Road 22	$ 4,440,000
Alternative 3 – Trafalgar Road	$ 4,830,000

5.0 Evaluation Methodology

The evaluation methodology used to select the preferred forcemain alignment option 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 forcemain route.

In developing the decision model, relevant and specific evaluation criteria were identified and compared distinguishing features between the routes. Whereas other components of the UCWS Class EA place a higher emphasis on Technical Criteria, for the forcemain route evaluation, all of the main categories including Environmental, Social/Heritage, Technical and Economic Criteria all play an important role.

Based on the above, the three (3) Alternative Routes will be evaluated against the specific evaluation criteria described in Table 4.

Table 4 – Forcemain Route Alternatives Evaluation Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social/Culture	10%	Impacts During Construction	50%
		Traffic Disruption	20%
		Effect on Residential Properties	10%
		Effect on Commercial Properties	10%
		Effect on Industrial Properties	10%
Technical	30%	Operational Performance	20%
		Energy Requirements	30%
		Suitability for Phasing	10%
		Constructability	20%
		Operation and Maintenance Impacts	20%
Environmental	30%	Effect on Surface Water/ Fisheries	30%
		Effect on Vegetation/ Wetlands	30%
		Effect on Groundwater	10%
		Effect on Habitat/ Wildlife	30%
Economic	30%	Capital Cost	70%
		Operational Costs	30%

5.1. Screening Criteria Definitions

5.1.1. 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.

5.1.2. Social/Culture, Traffic Disruption

This criterion captures the level of impact to traffic flow during the construction process and after construction is complete.

5.1.3. Social/Culture, Effect on Residential Properties

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

5.1.4. Social/Culture, Effect on Commercial Properties

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

5.1.5. Social/Culture, Effect on Industrial Properties

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

5.1.6. Technical, Operational Performance

This criteria compares the methods of conveying the wastewater from Hillsburgh to Erin Village and the probability of a forcemain break or blockage.

5.1.7. Technical, Energy Requirements

This criterion captures the total energy required to construct and operate the alternative.

5.1.8. Technical, Suitability for Phasing

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

5.1.9. Technical, Constructability

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

5.1.10. 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 forcemain route and level of effort required by operations staff to operate and maintain the forcemain.

5.1.11. Environmental, Effect on Surface Water/ Fisheries

The criterion captures the impact that the establishment and operation of the forcemain 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.

5.1.12. 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.

5.1.13. 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.

5.1.14. 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.

5.1.15. Economic, Capital Cost

The criterion captures the estimated cost to construct the alternative.

5.1.16. Economic, Operational Cost

The criterion captures the estimated cost to operate the system on a yearly basis.

5.2. Evaluation of Alternatives

5.2.1. Overview

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

- Alternative 1 – Along the Elora-Cataract Trail
- Alternative 2 – Along Wellington Road 22/ 8th Line
- Alternative 3 – Along Trafalgar Road/ Side Road 17

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

5.3. Detailed Evaluation of Forcemain Route Alternatives

The evaluation of each of the forcemain 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 – Forcemain Route Decision Matrix

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	ECT		Trafalgar Road		Wellington Road 22	
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE	WT SCORE	SCORE	WT SCORE	SCORE	WT SCORE
Social/Culture	10%	Impacts During Construction	50	5	2	2	4	4	5	5
		Traffic Disruption/ Truck Traffic	20	2	4	1.6	3	1.2	3	1.2
		Effect on Residential Properties	10	1	5	1	4	0.8	4	0.8
		Effect on Businesses/ Commercial Properties	10	1	5	1	4	0.8	4	0.8
		Effect on Industrial Properties	10	1	5	1	4	0.8	4	0.8
Technical	30%	Operational Performance	20	6	5	6	3	3.6	3	3.6
		Energy Requirements	30	9	5	9	2	3.6	2	3.6
		Suitability for Phasing	10	3	5	3	5	3	5	3
		Constructibility	20	6	2	2.4	4	4.8	4.5	5.4
		Operation and Maintenance Impacts	20	6	3.5	4.2	3	3.6	3	3.6
Environmental	30%	Effect on Surface Water/ Fisheries	30	9	3	5.4	4	7.2	4	7.2
		Effect on Vegetation/ Wetlands	30	9	3	5.4	5	9	5	9
		Effect on Groundwater	10	3	4	2.4	4	2.4	5	3
		Effect on Habitat/ Wildlife	30	9	2	3.6	4	7.2	5	9
Economic	30%	Capital Cost	70	21	5	21	3	12.6	3.5	14.7
		Operational Costs	30	9	5	9	3	5.4	3	5.4
			TOTAL SCORE	100		78		70		76.1

Based on the detailed evaluation of the alternatives, Alternative1 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	1 - Elora Cataract Trail	2 - Wellington Road 22	3 - Trafalgar Road
Social/ Culture - Impacts During Construction	▪ Potential impact to the homes along Laurel Lane and Heather Avenue that are in close proximity to the trail. Sections of trail closed off during construction.	▪ Forcemain open cut construction along Wellington Road 22 and 8th Line. Potential impact on over 20 homes and several businesses.	▪ Forcemain open cut construction along Trafalgar Road and Sideroad 17. Potential impact on over 20 homes and several businesses.
Social/ Culture - Traffic Disruption	▪ Minimal traffic impact with the exception of locations where the trail intersects local roads.	▪ Single lane closures anticipated over construction area. Traffic impacts anticipated along the route.	▪ Single lane closures anticipated over construction area. Traffic impacts anticipated along the route including busy County 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 – Operational Performance	▪ Use of twin forcemain to improve performance security . ▪ Consistent downhill slope ideal for avoiding air locks, minimizing the need for vacuum/air release chambers along the route.	▪ Use of twin forcemain to improve performance security. ▪ Route has several rolling hills that will require vacuum/air release chambers, complicating operations	▪ Use of twin forcemain to improve performance security.. ▪ Route has several rolling hills that will require vacuum/air release chambers and complicating operations.
Technical – Energy Requirements	▪ Minimal energy use due to the downhill slope of the trail and the shorter pumping distance	▪ Higher energy use due to the hilly terrain along the route and the longer pumping distance.	▪ Higher energy use due to the hilly terrain along the route and the longer pumping distance.
Technical - Suitability for Phasing	▪ Twin forcemain design supports proper operation and adequate forcemain velocities throughout the growth process.	▪ Twin forcemain design supports proper operation and adequate forcemain velocities throughout the growth process.	▪ Twin forcemain design supports proper operation and adequate forcemain velocities throughout the growth process.
Technical - Constructability	▪ Fairly easy to construct but with timing and space restrictions to minimize impacts on environmental features.	▪ Fairly easy to construct with one river crossing.	▪ Trafalgar Road presents more difficult construction and this alternative includes two river crossings.
Technical - Operation and Maintenance Impacts	▪ Best hydraulic performance ▪ Minimal access for maintenance needed along route (no valve chambers to inspect)	▪ Could present hydraulic operational issues with multiple air valves ▪ Easy access for maintenance	▪ Could present hydraulic operational issues with multiple air valves ▪ Easy access for maintenance
Environmental - Effect on Surface Water/ Fisheries	▪ Natural environment habitat adjacent to trail, sensitive to construction activities. ▪ Western chorus frogs identified along the route. ▪ Timing of construction needs to be carefully planned to minimize impacts.	▪ No major impacts anticipated	▪ Western chorus frogs identified along the route. ▪ Impact can be mitigated with construction timing and proper construction practices.
Environmental - Effect on Vegetation/ Wetlands	▪ May require tree branch trimming which will need to be scheduled to avoid bird breeding season ▪ Wetlands adjacent trail should not be affected. Existing culverts will be tunneled to mitigate potential impact on wetlands.	▪ No major impacts anticipated	▪ No major impacts anticipated
Environmental - Effect on Groundwater	▪ Little impact anticipated	▪ No major impacts anticipated	▪ No major impacts anticipated
Environmental - Effect on Habitat/ Wildlife	▪ Several sensitive bird species identified aloing trail. ▪ Impact can be mitigated with construction timing and proper construction practices.	▪ No major impacts anticipated	▪ No major impacts anticipated
Economic - Capital Cost	▪ Least cost	▪ Approximately 40% more costly than Alternative 1.	▪ Approximately 50% more costly than Alternative 1.
Economic – Operational Cost	▪ Lowest operational cost	▪ Sustantially higher operational costs	▪ Sustantially higher operational costs

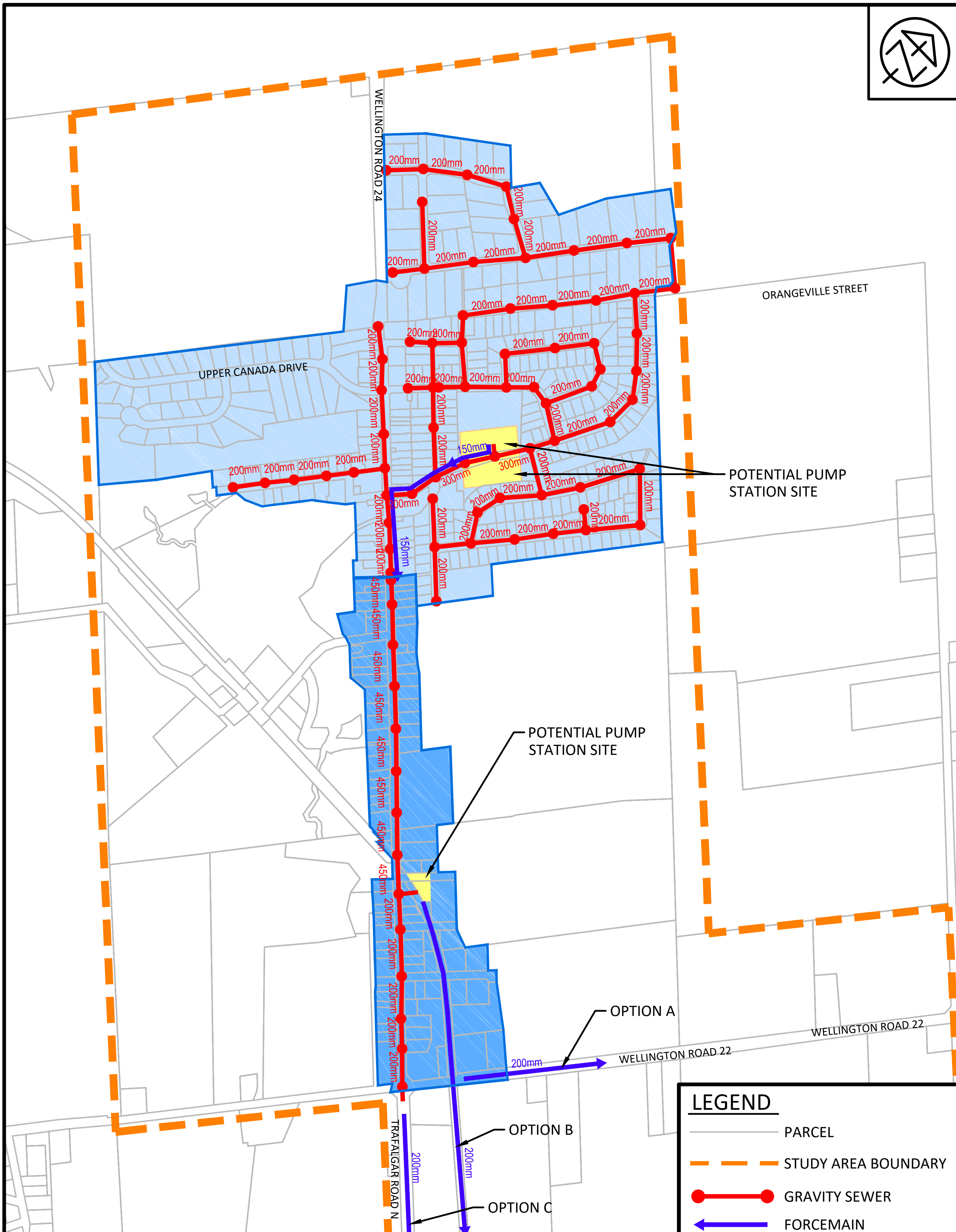
6.0 Conclusions and Recommendations

- The 2014 Servicing and Settlement Master Plan (SSMP) identified that the wastewater from both Erin Village and Hillsburgh would be collected at a single site for treatment and discharge to the West Credit River.
- The UCWS EA is a continuation of the Class EA process and aims to establish the preferred design alternative for the wastewater system servicing of Erin Village and Hillsburgh.
- The Collection System Alternatives Technical Memorandum identified a blended Gravity and Low Pressure Sewer solution as the preferred collection system. This Pumping Stations and Forcemains Technical Memorandum should be read in conjunction with the Collection System Alternatives Technical Memorandum.
- A series of catchment areas were identified throughout both Erin Village and Hillsburgh on the basis of the existing topography. A suggested trunk sewer system was identified to interconnect catchment areas and to convey all sewage to the areas identified for the WWTP. Based on this, some ten (10) catchments were identified as requiring pumping stations.
- A review of the low lying areas where sewage pumping station would be necessary was conducted and actual candidate sites were identified.
- All candidate sites for sewage pumping stations were evaluated for environmental and archaeological significance and geotechnical evaluations were conducted at each site.
- Conceptual design of each station was conducted and this confirmed the need for four (4) large stations with standby power, four (4) smaller stations and two small catchments that would be serviced by a low pressure sewer system.
- A geotechnical evaluation was also conducted for key collection system routes, including forcemain routes to determine potential impacts on constructability.
- The connection of the Hillsburgh collection area to Erin Village is a key aspect of the proposed system and three potential routes for this connection were evaluated:
    - Alternative 1 – Along the Elora-Cataract Trail
    - Alternative 2 – Along Wellington 22 and 8th Line
    - Alternative 3 – Along Trafalgar Road and Sideroad 17
- The Forcemain Alternatives were sized, conceptually designed and costed.
- The evaluation criteria were established with the following weighting for the primary criteria reflecting a balanced approach between Technical, Environmental and Cost:
    - Social/ Cultural Impacts – 10%
    - Technical Impacts – 30%
    - Environmental Impacts - 30%
    - Economic Impacts– 30%
- The relative capital costs for each alternative are summarized as follows:

Alternative	Capital Cost Estimate
Alternative 1 – Elora-Cataract Trail	$ 3,165,000
Alternative 2 – Wellington Road 22	$ 4,440,000
Alternative 3 – Trafalgar Road	$ 4,830,000

- In addition to the costs outlined above, Alternative 2 and Alternative 3 will require larger pumps to pump the wastewater for a longer distance and up to higher elevations resulting in higher long term operating costs.
- Environmental impacts:
    - o Western Chorus Frogs were identified in the wooded area beside the Elora-Cataract Trail and along Trafalgar Road. This species of frog was not found along Wellington Road 22.
- Geotechnical impacts are summarized as follows:
    - o Generally indicates that the entire area does not present constructibility issues for forcemains.
- Archaeological impacts are not expected to be significant for any of the forcemain alternatives.
    - o Since all of the works will take place in established road allowances, or within previously disturbed lands, it is not anticipated that archaeological resources will be encountered.
- Phase 2 archaeological investigations are required for some of the sewage pumping station locaitons.
- The results of the evaluation process indicate that, ***Alternative 1 (Elora-Cataract Trail)*** has the highest score and is the preferred forcemain route alternative.
- The primary reasons for this are:
    - o Best technical solution
    - o Lowest capital cost for construction
    - o Lowest operational costs
    - o Potential for mitigation of the environmental concerns for construction.
- In examining the sensitivity of the scoring to changes in the criteria weightings, it should be noted that a 3% decrease in the Economic weighting and corresponding 3% increase in the Environmental weighting would result in Alternative 2 being the preferred alternative. Likewise a 4% decrease in the Technical weighting and 4% increase in Environmental weighting results in Alternative 2 being the preferred alternative. The decision is sensitive to the weightings but is considered valid because of the potential for mitigation of the environmental concerns for construction along the trail. The forcemain will be constructed down the centre of the trail and construction timing can be coordinated to avoid negative impacts of the Western Chorus Frogs and birds.

Appendix A
Gravity Collection System



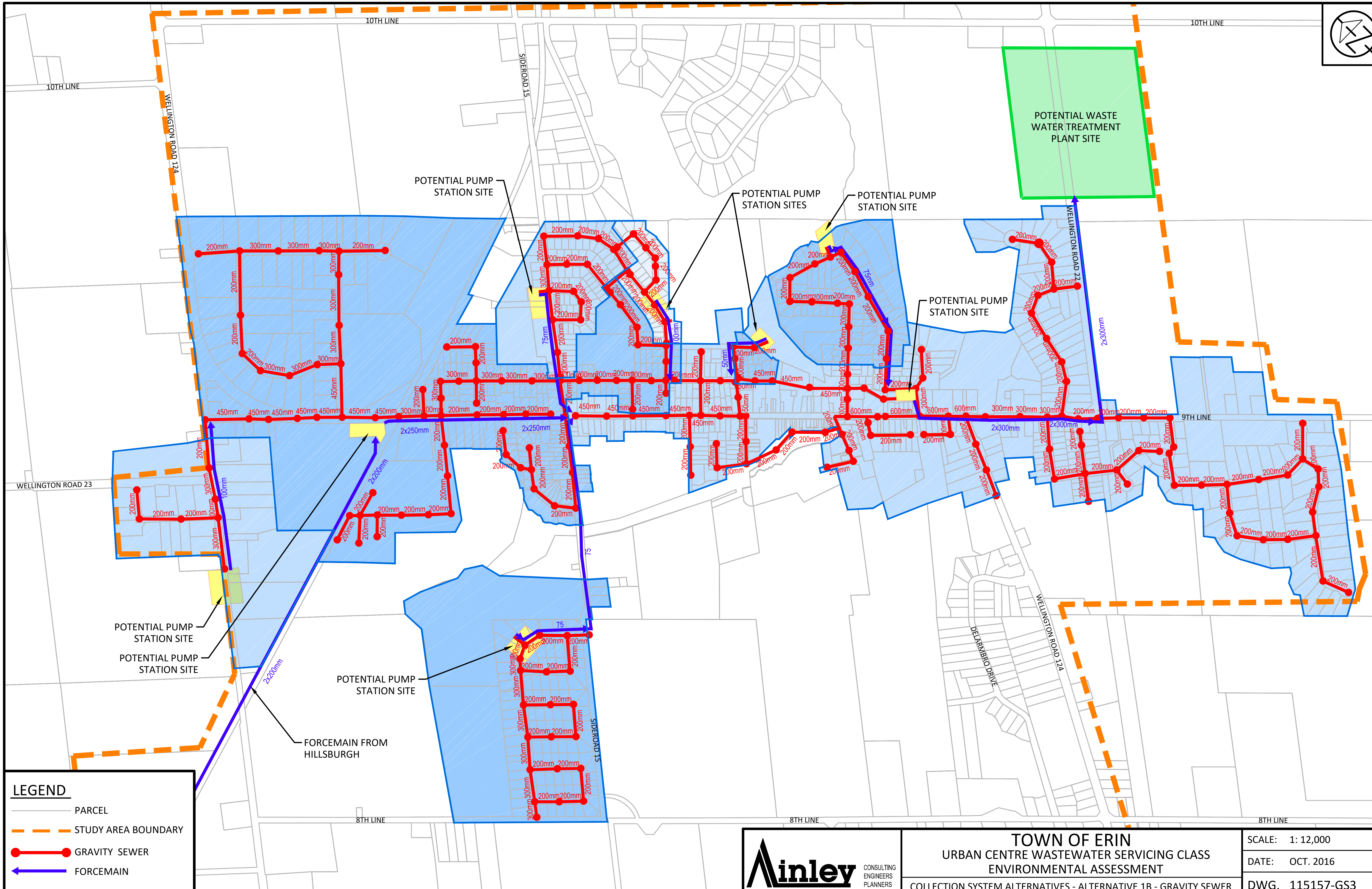
Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1 - GRAVITY

SCALE:	1: 12,500
DATE:	MARCH 2017
DWG.	115157-GS1



Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1B - GRAVITY SEWER

SCALE: 1: 12,000

DATE: OCT. 2016

DWG. 115157-GS3

Appendix B
River Crossing Application

1255 Old Derry Road, Mississauga, ON L5N 6R4
Tel: (905) 670-1615 or 1-800-668-5557, Fax: (905) 670-2210
www.creditvalleyca.ca, e-mail: planning@creditvalleyca.ca

For office use only:

File # ______________________

Fee Received ______________

APPLICATION FOR DEVELOPMENT, INTERFERENCE WITH WETLANDS AND ALTERATIONS TO SHORELINES AND WATERCOURSES (Pursuant to Ontario Regulation 160/06)

PLEASE SEE REVERSE SIDE FOR INSTRUCTIONS FOR SUBMITTING PLANS

Ownership Details

Owner's Name ______________________________ Email ______________________________

Organization ______________________________ City/Town ______________________________

Mailing Address ________________________ Postal Code __________ Phone # ____________

Agent's Name ______________________________ Email ______________________________

Organization ______________________________ City/Town ______________________________

Mailing Address ________________________ Postal Code __________ Phone # ____________

Property Location Details

Municipal Street Address ____

Lot ________ Concession/Range ____________ City/Town ____________________________

Description of Type of Development / Work Proposed

☐ Development (new structure, replacement structure, addition, site grading/fill placement, pool, deck)

☐ Interference with a Wetland/Alteration of Watercourse

Proposed Start Date: ____________________ Anticipated Completion Date: __________________

Terms and Conditions

1. Any false or misleading statement made on this application will render null and void any permission granted.
2. Authorized representatives of Credit Valley Conservation will be granted entry at any time onto lands which are the subject of this permit application in order to make such surveys, investigations, inspections or other arrangements which such representatives deem necessary.
3. This permit does not absolve the applicant of the responsibility of obtaining necessary permission from applicable federal and provincial agencies or local municipalities.

I, ______________________________ solemnly declare that to the best of my knowledge and belief, all of the above information to be true.

Signature of Owner: ______________________________ Date: ______________________
Note: Signature or written authorization from the owner is mandatory.

Signature of Agent: ______________________________ Date: ______________________

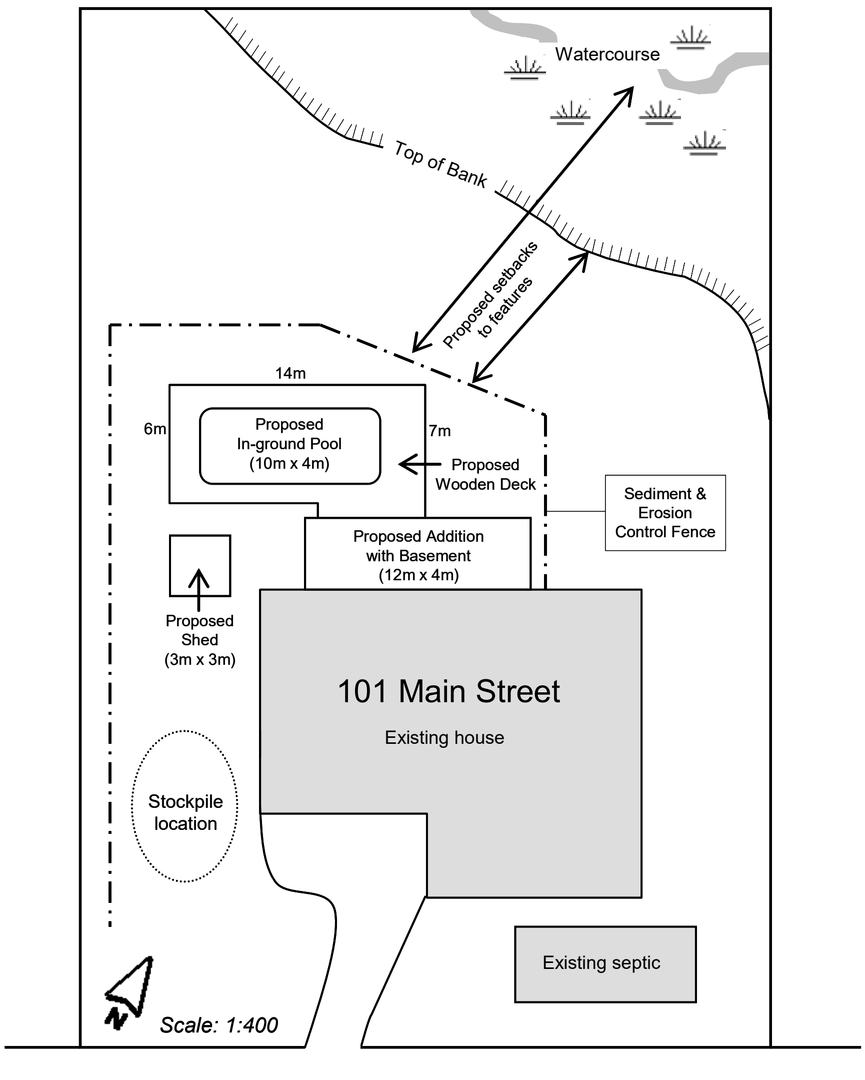
INSTRUCTIONS

Please submit three (3) copies of the following information with this application:

1. Location map of property, in relation to surrounding buildings, roads, lands etc.
2. Site plan indicating the property boundary and the proposed location of development/work.
3. Cross-section(s) of the proposed development/work showing existing and final grades as required.
4. Final stamped engineering drawings of proposed development/work as required.
5. Final stamped technical reports in support of proposal as required.
6. **An application fee will be charged based upon type and scale of project (see most recent fee schedule www.creditvalleyca.ca or contact CVC office at 905-670-1615).**

ALL PLANS SUBMITTED MUST BE FOLDED

Sample Site Plan



NOTICE OF COLLECTION

Pursuant to section 29(2) of the Municipal Freedom of Information and Protection of Individual Privacy Act, 1989, the personal information contained on this form is collected under the legal authority of the Conservation Authorities Act, R.S.O. 1990, c27, as amended. This information is used to assess applications for and, where approved, issue the Permit. Information on this form may be disclosed to Government and Municipal Agencies for review and comment and to members of the public through the Freedom of Information process. The name of the applicant, location of the work and a description of the project may be published in CVC documents including agendas, reports and meeting minutes which may be posted on CVC's website. Questions about the collection of personal information should be directed to the Freedom of Information Coordinator, Credit Valley Conservation Authority, 1255 Old Derry Road, Mississauga, Ontario, L5N 6R4, (905) 670-1615.

Appendix C
CVC Letter

Credit Valley Conservation
inspired by nature

October 30, 2017

Town of Erin
5684 Trafalgar Rd,
Hillsburgh, Ontario N0B1Z0

Via Email

Attn: Nathan Hyde, CAO
Town of Erin

Ref: Town of Erin, Urban Centre Wastewater and Water Servicing Class EA's Proposed Use of the Elora Cataract Trail for Underground Wastewater and Water Pipe Infrastructure

Dear Nathan,

Further to your letter addressed to Jen Dougherty, I understand that a Municipal Class Environmental Assessment is underway. Moreover, the added option of the Elora Cataract Trailway (ECT) as a potential alternative alignment for a wastewater sewer/forcemain connecting Hillsburgh and Erin Village is being included, and with CVC support. To date, CVC staff have issued an Access Permit for CVC Conservation Lands to enter for reconnaissance and study of this route.

It is my understanding that CVC staff are waiting for the EA report to review and provide comment. Once the preferred option is selected, and if that alternative includes using the ECT, then CVC staff will be happy to discuss with the Town of Erin the conditions related to granting a permanent easement.

Regards,

Jeff Payne
Director, Corporate Services
Credit Valley Conservation

Appendix D
Elora Cataract Trail Borehole Logs

LOG OF BOREHOLE BHT1

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-07
REF. NO.: 16-1255
ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (90 mm)			
0.1	**FILL:** sandy silt, trace to some clay, trace gravel, trace organics, layers of clayey silt, brown, moist, very loose to compact	1	SS	10
		2	SS	4
1.4	**FILL:** sand and silt to silty sand, trace clay, trace gravel, pockets of clayey silt, brown, moist, very loose to compact	3	SS	5
		4	SS	3
		5A	SS	
3.2	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist to wet, compact to dense	5B	SS	26
	--- wet	6	SS	46
5.0	**END OF THE BOREHOLE**			

Column headings: SOIL PROFILE (ELEV DEPTH (m), DESCRIPTION, STRATA PLOT); SAMPLES (NUMBER, TYPE, "N" BLOWS/0.3m); GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL).

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.5 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.5 mBGS upon completion of drilling.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: + 3, ✕ 3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BHT2

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-11-17
REF. NO.: 16-1255
ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER / INSTALLATION
0.0	**TOPSOIL:** (170 mm)				Concrete
0.2	**FILL:** silty sand, some gravel, trace to some clay, containing rock fragments, containing cobbles and boulders, brown, moist, loose to compact	1	SS	11	
		2	SS	9	Bentonite
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to dense	3	SS	24	
	--- wet	4	SS	27	
		5	SS	34	Sand, Screen
		6	SS	31	Natural Pack
5.0	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Column headings: STRATA PLOT; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10, 20, 30, 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

DRAFT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BHT4

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-16
REF. NO.: 16-1255
ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)
0.0	**TOPSOIL:** (65 mm)				
0.1	**FILL:** silty sand, trace gravel, brown, moist, loose	1A	SS	7	7
0.3	**FILL:** gravelly sand, some silt, trace organics, containing cobbles and boulders, dark brown, moist, loose	1B	SS		
0.7	**GRAVELLY SAND TO SAND AND GRAVEL:** trace silt, layers/zones of sand, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to very dense	2	SS	39	39
		3	SS	27	27
		4	SS	27	27
		5	SS	24	24
		6	SS	59	59
5.0	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 1.4 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

DRAFT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE BHT5

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 205 mm

DATE: 2017-11-16

REF. NO.: 16-1255

ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)
0.0	**TOPSOIL:** (70 mm)					
0.1	**FILL:** silty sand, some gravel, trace clay, brown, moist, loose	1	SS	8	Concrete	8
0.7	**FILL:** sandy silt, trace to some clay, trace gravel, trace organics, trace rootlets, pockets of clayey silt, dark brown to brown, moist, very loose to loose	2	SS	3	Bentonite	3
	--- brown	3	SS	7		7
2.1	**FINE SAND AND SILT TO FINE SANDY SILT:** layers of silt, brown, wet, compact	4	SS	16		16
		5	SS	19	Sand; Screen	19
4.0	**GRAVELLY SAND:** some silt, trace clay, containing cobbles and boulders, brown, wet, dense	6	SS	31	Natural Pack	31
5.0	**END OF BOREHOLE**					

Notes:
1)Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; STRATA PLOT; ELEVATION; DYNAMIC PENETRATION TEST (SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

DRAFT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BHT6

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-07
REF. NO.: 16-1255
ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (75 mm)			
0.1	**FILL:** silty sand, trace to some gravel, trace clay, grey to brown, moist, loose --- brown	1	SS	6
0.7	**FILL:** sandy silt, trace clay, trace gravel, brown, moist, loose	2	SS	7
1.4	**FILL:** silty sand, trace to some gravel, trace clay, brown, moist, loose	3	SS	9
2.1	**FILL:** sandy silt, trace to some clay, trace to some gravel, some organics, dark brown, moist to wet, very loose to loose --- wet	4	SS	2
		5A	SS	7
3.4	**ORGANIC SILT:** trace to clay, trace rootlets, black, moist, loose	5B	SS	
4.0	**SAND:** trace silt, brown, wet, compact	6A	SS	27
4.7	**GRAVELLY SAND:** trace clay, trace silt, containing cobbles and boulders, brown, wet, compact	6B	SS	
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.7 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.4 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

DRAFT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BHT7

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer; DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin, Ontario	FIELD ENGINEER: KL; DATE: 2017-11-08
DATUM: N/A	SAMPLE REVIEW: TY; REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL; ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (150 mm)			
0.2	**FILL:** silty sand, trace to some gravel, trace clay, brown, moist, loose to dense	1	SS	9
		2A	SS	46
1.1	**FILL:** sandy silt, trace to some gravel, trace clay, trace organics, trace rootlets, brown, moist, very loose to dense	2B	SS	
		3A	SS	3
1.7	**PEAT:** black, moist, very loose to compact	3B	SS	
		4A	SS	13
2.4	**SAND:** trace silt, trace gravel, brown, wet, loose to compact	4B	SS	
		5	SS	10
4.0	**GRAVELLY SAND:** some clay, some silt, layers of clayey silt, grey, wet, dense	6	SS	34
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 0.8 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.2 mBGS upon completion of drilling.
3) Borehole caved at a depth of 1.2 mBGS upon completion of drilling.

Column headings: GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

DRAFT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BHT9

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-07
REF. NO.: 16-1255
ENCL. NO.:

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)
0.0	**TOPSOIL:** (100 mm)					
0.1	**FILL:** silty sand, trace to some clay, trace to some gravel, trace organics, dark brown, moist, very loose to compact	1	SS	11	Concrete	11
		2	SS	7		7
		3	SS	3	Bentonite	3
2.1	**ORGANIC SILT:** trace clay, trace gravel, trace rootlets, black, moist, loose	4	SS	6		6
2.9	**FINE SAND AND SILT:** trace clay, brown, moist, loose	5	SS	7	Sand, Screen	7
4.0	**SAND:** trace silt, brown, wet, compact	6	SS	19	Natural Pack	19
5.0	**END OF BOREHOLE**					

Notes:
1) Water encountered at a depth of 3.1 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.1 mBGS upon completion of drilling.
3) Borehole caved at a depth of 4.1 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; STRATA PLOT; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

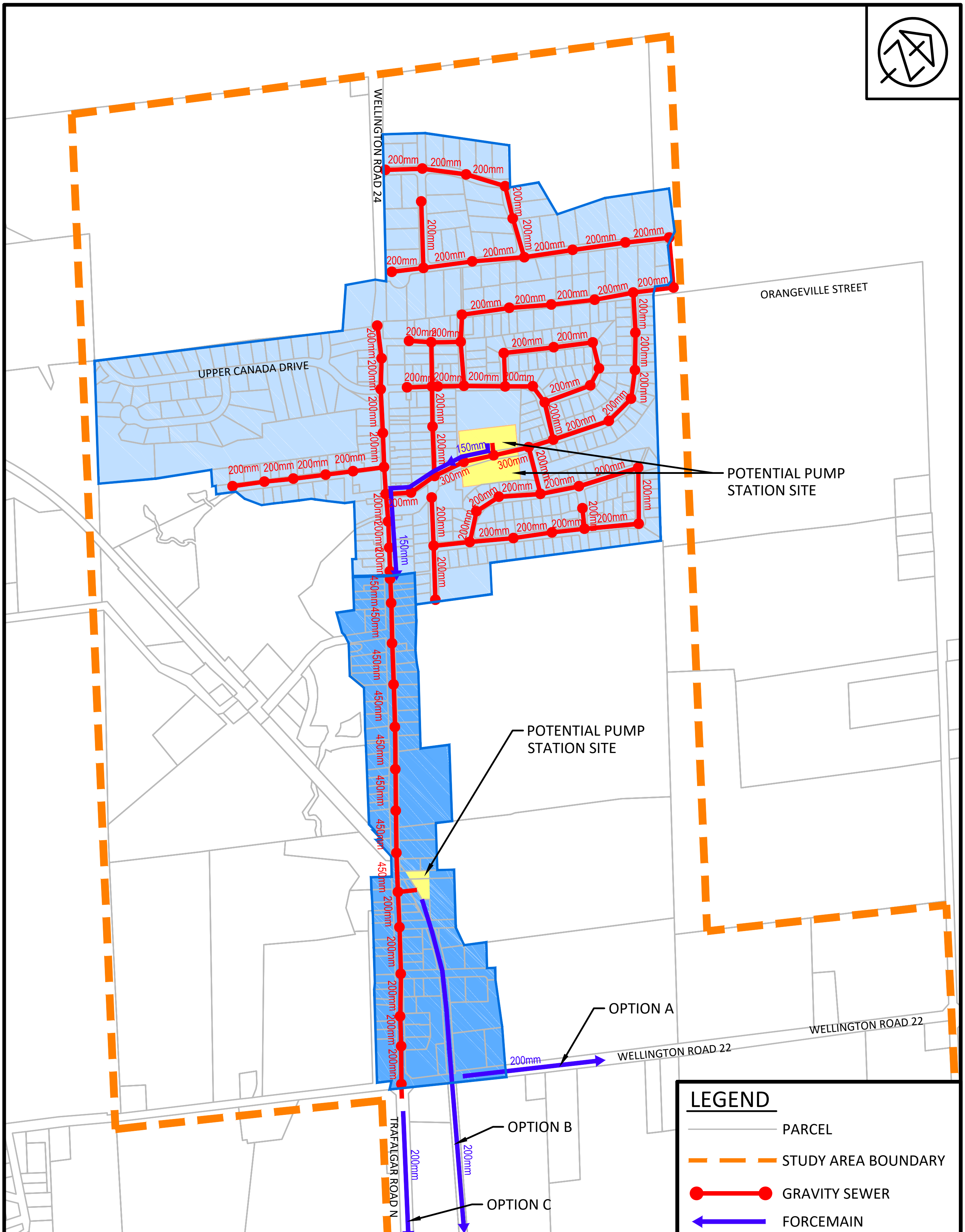
DRAFT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity
▲ ε=3% Strain at Failure

Appendix - M

Collection System Layouts



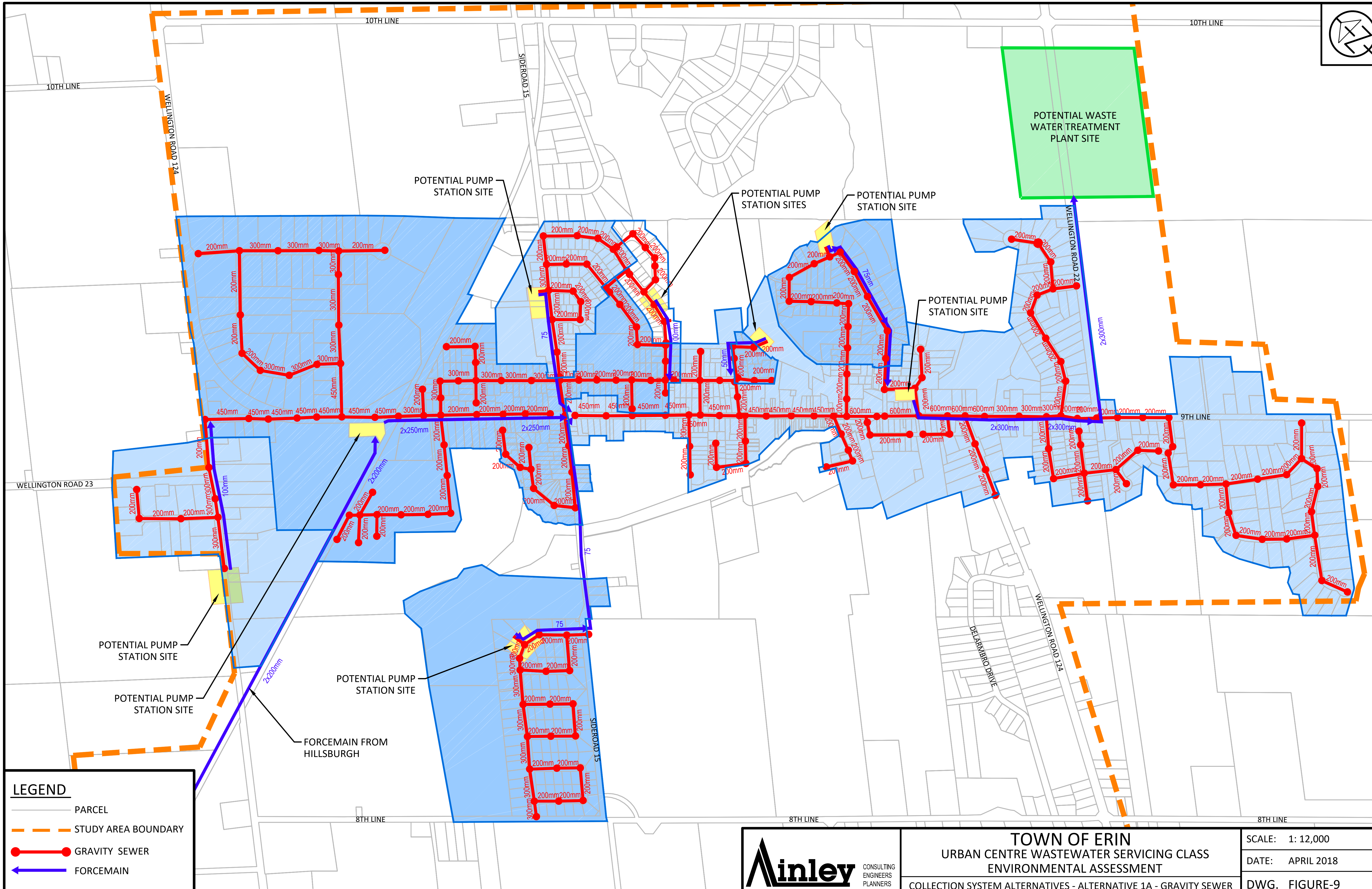
Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

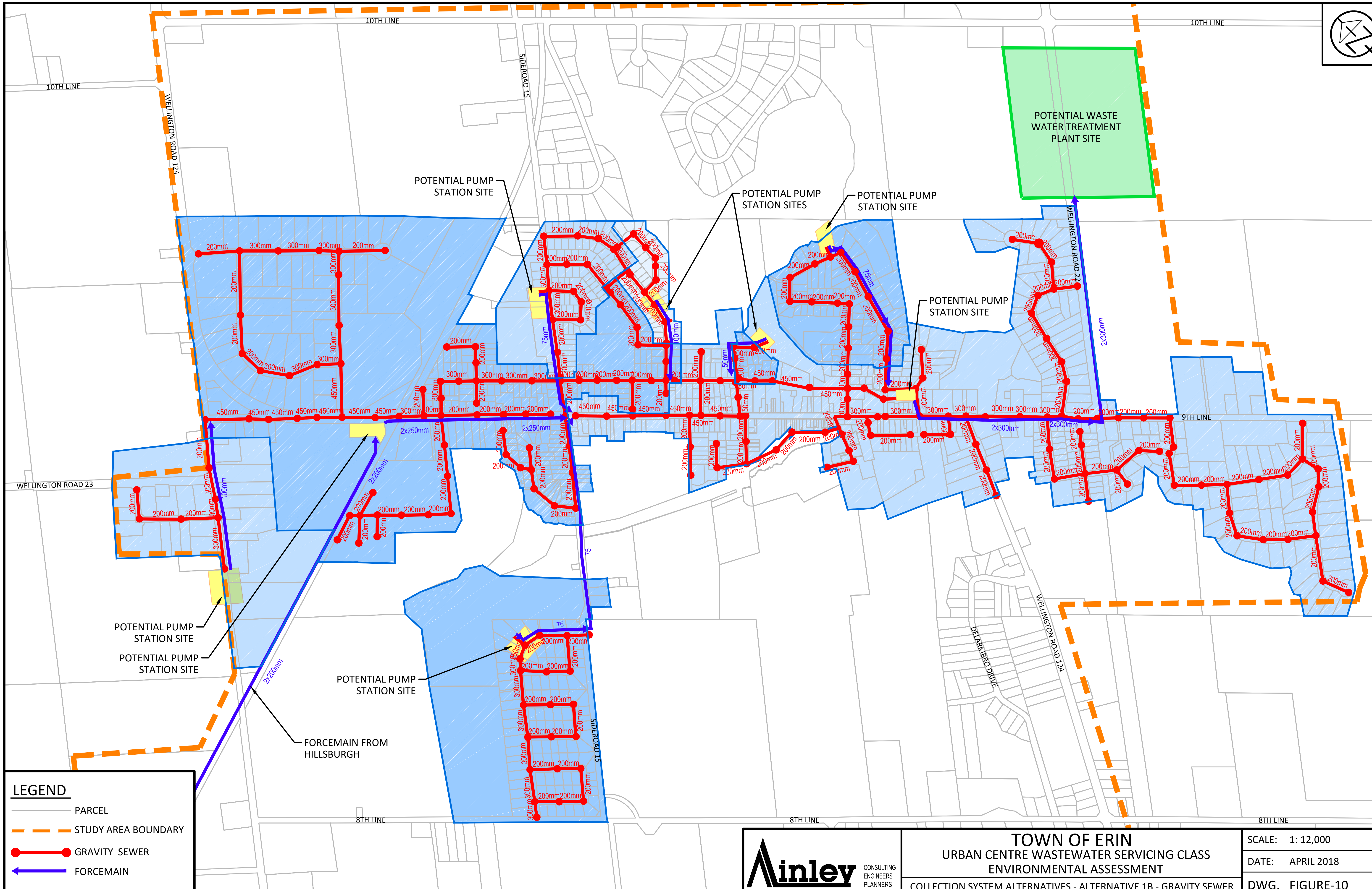
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1 - GRAVITY

SCALE:	1: 12,500
DATE:	APRIL 2018
DWG.	FIGURE-8



10TH LINE
SIDEROAD 15
WELLINGTON ROAD 124
WELLINGTON ROAD 22
WELLINGTON ROAD 23
9TH LINE
8TH LINE
DELARMBRO DRIVE
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITES
FORCEMAIN FROM HILLSBURGH
LEGEND
PARCEL
STUDY AREA BOUNDARY
GRAVITY SEWER
FORCEMAIN
Ainley CONSULTING ENGINEERS PLANNERS
TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1A - GRAVITY SEWER
SCALE: 1: 12,000
DATE: APRIL 2018
DWG. FIGURE-9



TOWN OF ERIN

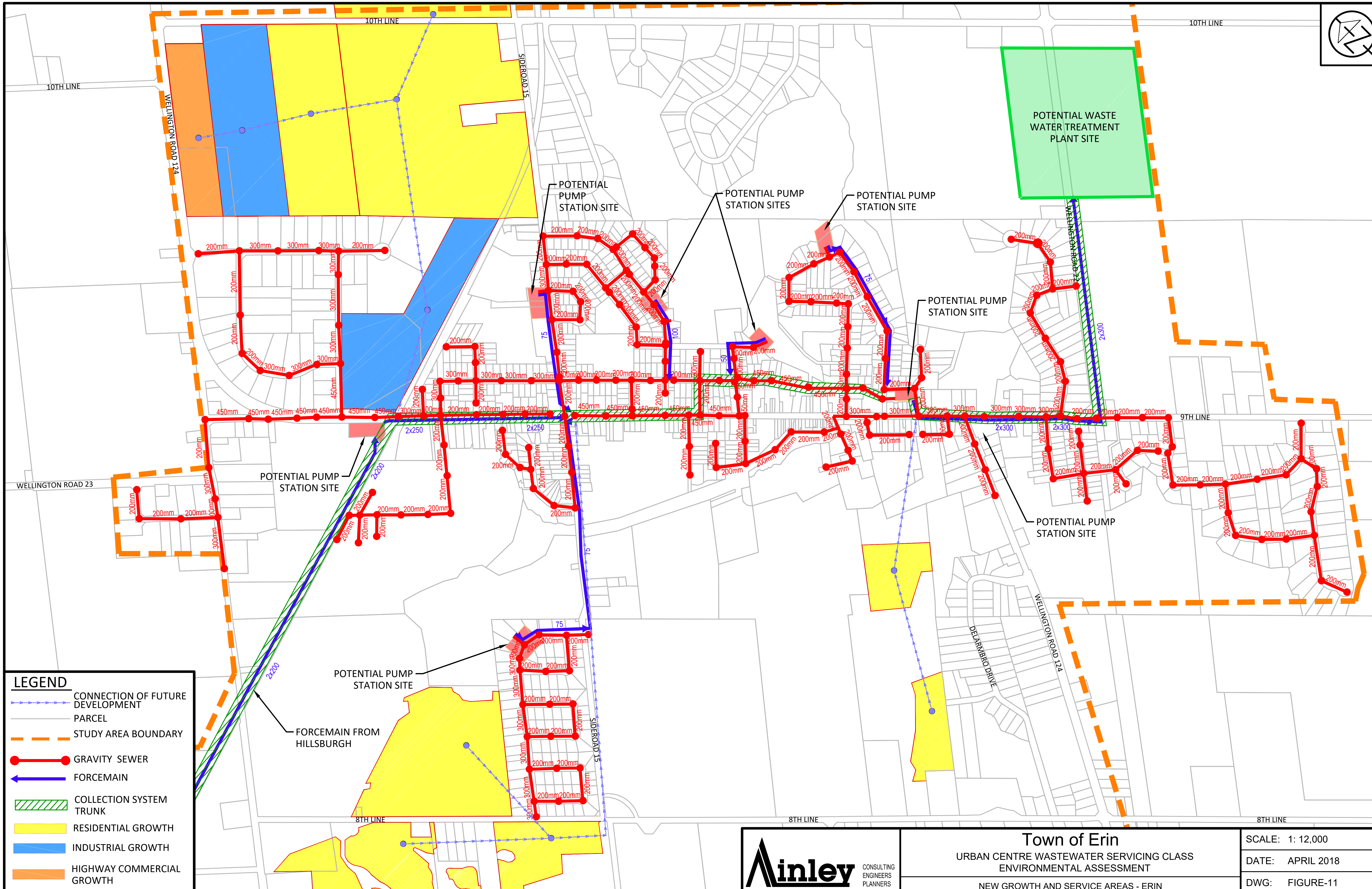
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1B - GRAVITY SEWER

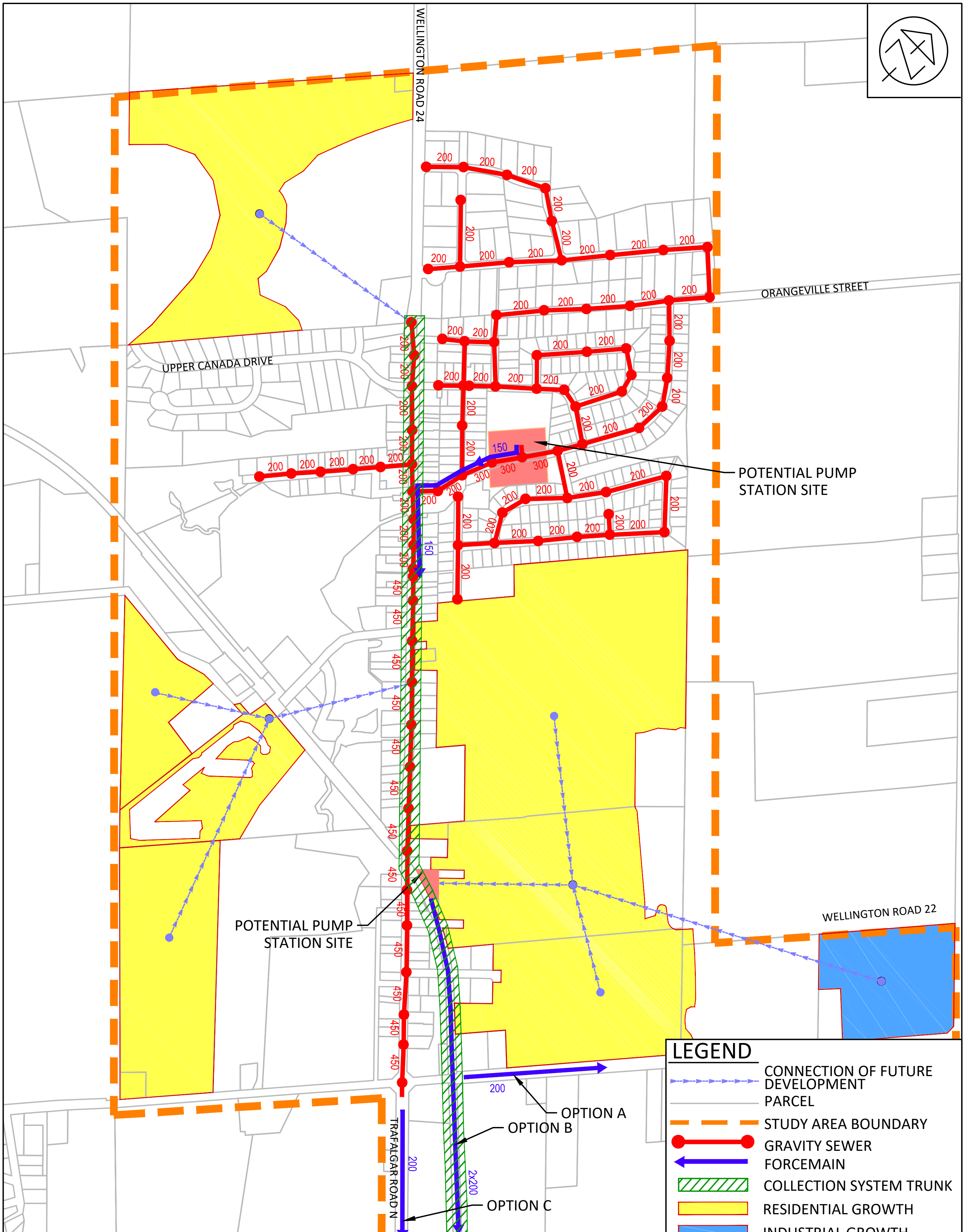
SCALE: 1: 12,000

DATE: APRIL 2018

DWG. FIGURE-10



10TH LINE
10TH LINE
10TH LINE
WELLINGTON ROAD 124
SIDEROAD 15
POTENTIAL WASTE WATER TREATMENT PLANT SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITES
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
WELLINGTON ROAD 22
9TH LINE
WELLINGTON ROAD 23
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
POTENTIAL PUMP STATION SITE
FORCEMAIN FROM HILLSBURGH
DELARMBRO DRIVE
WELLINGTON ROAD 124
SIDEROAD 15
8TH LINE
8TH LINE
8TH LINE
LEGEND
CONNECTION OF FUTURE DEVELOPMENT
PARCEL
STUDY AREA BOUNDARY
GRAVITY SEWER
FORCEMAIN
COLLECTION SYSTEM TRUNK
RESIDENTIAL GROWTH
INDUSTRIAL GROWTH
HIGHWAY COMMERCIAL GROWTH
Ainley
CONSULTING ENGINEERS PLANNERS
Town of Erin
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
NEW GROWTH AND SERVICE AREAS - ERIN
SCALE: 1: 12,000
DATE: APRIL 2018
DWG: FIGURE-11



Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN

URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT

NEW GROWTH AND SERVICE AREAS - HILLSBURGH

SCALE: 1: 12,500

DATE: APRIL 2018

DWG. FIGURE-12

Appendix - N

Agency and Stakeholder Consultation

Credit Valley Conservation
inspired by nature

October 30, 2017

Town of Erin
5684 Trafalgar Rd,
Hillsburgh, Ontario N0B1Z0

Via Email

Attn: Nathan Hyde, CAO
Town of Erin

Ref: Town of Erin, Urban Centre Wastewater and Water Servicing Class EA's Proposed Use of the Elora Cataract Trail for Underground Wastewater and Water Pipe Infrastructure

Dear Nathan,

Further to your letter addressed to Jen Dougherty, I understand that a Municipal Class Environmental Assessment is underway. Moreover, the added option of the Elora Cataract Trailway (ECT) as a potential alternative alignment for a wastewater sewer/forcemain connecting Hillsburgh and Erin Village is being included, and with CVC support. To date, CVC staff have issued an Access Permit for CVC Conservation Lands to enter for reconnaissance and study of this route.

It is my understanding that CVC staff are waiting for the EA report to review and provide comment. Once the preferred option is selected, and if that alternative includes using the ECT, then CVC staff will be happy to discuss with the Town of Erin the conditions related to granting a permanent easement.

Regards,

Jeff Payne
Director, Corporate Services
Credit Valley Conservation

Ainley & Associates Limited
195 County Court Blvd, Suite 300, Brampton, ON L6W 4P7
Tel: (905) 452-5172
E-mail brampton@ainleygroup.com

April 10, 2018 File No. 115157

Credit Valley Conservation
1255 Old Derry Road,
Mississauga, Ontario
L5N 6R4

Attention: Liam Marray, Senior Manager, Planning Ecology

Subject: Town of Erin Urban Centre Wastewater Servicing
Response to CVC Comments on Project Supporting Studies

Thank you for your comments on the supporting studies for the above-noted project. We are pleased to provide our response below.

1 Natural Environment Report and Assimilative Capacity Study

Please find attached a letter from Hutchinson Environmental Sciences Ltd providing a response to all CVC comments on the above-noted reports. Please also note that this response contains a thermal impact assessment as appendix A to the letter.

The responses include a commitment to prepare an Environmental Management Plan during the implementation stage for use in designing and constructing the project. In recognition of the sensitivity of the entire project area, the Environmental Study Report (ESR) will also recommend the use of a third party Environmental Inspector employed by the Town separate from the project team to look after the Town's interest in compliance with recommendations of the Environmental Management Plan and all approvals.

2 Preliminary Geotechnical Investigation

CVC Comments:

CVC staff have reviewed the above-noted report and find it satisfactory. We note that no provisions or recommendations are made in the report for mitigating the impact to the vulnerable features.

The following is the recommendations for the consultant or proponents in order to address the above concerns in the next step:

1. Conduct a detailed hydrogeological assessment for the project area to characterize groundwater conditions, to assess surface water-groundwater linkages, to design dewatering, and to address CVC's concerns re: potential impacts to wetland, and stream discharge;
2. Per the vulnerable areas related to municipal groundwater sources – WHPA, SGRA and HVA - the County of Wellington should be afforded the opportunity to review / comment on the site selection process.
3. Develop a Soil Management Plan to ensure the excess soil generated from excavation and imported materials (such as engineered fills) have no adverse impact to surrounding soil and groundwater. Close attention should be paid to the well head protection areas;

4. The outfall structure involves large volume of excavation in valley land area. A valley land protection plan might be needed in addition to all the other regulations to control erosion caused by construction;
5. Develop a spill management plan in accordance with well head protection policies and other policies.

CVC wants to highlight the following items. Five categories of vulnerable landscape occur within or near the project area: well head protection areas (WHPAs), significant recharge area (SGRA), Highly Vulnerable Aquifer (HVA), West Credit River and West Credit River Wetland complex.

Over half of the sewage collection system in Hillsburgh will be located in the two WHPA-A, Bs and over one quarter of sewage collection system in Erin will be located in the three WHPA-A, Bs. Sewage conveying pipe will cut though a WHPA-A. The whole project area is wholly enclosed in the significant recharge area.

The County of Wellington is responsible for the implementation of the provisions of the source protection plan, on behalf of the Town of Erin. As such, they should be invited to review / comment on the site selection process.

Response:

The Preliminary Geotechnical Report was completed primarily to assist with siting of facilities and to identify cost impacts related to soil and groundwater conditions. It is recognised that much of the project area is characterised by vulnerable aquifers and well head protection areas. Hydrogeological conditions in the area have been characterised as part of ongoing investigations into future water supplies. Additional municipal wells will be developed to support growth and these will also need to be taken into consideration.
While the preliminary report provided information on groundwater levels, and monitoring wells will continue to be monitored, the information is not intended to support design of trenching or tunneling for pipes or for facility construction. As part of implementation, a comprehensive geotechnical/hydrogeological assessment will be carried out to identify potential impacts on groundwater and surface waters. This will assist with mitigation and with approvals for any dewatering required.
A soil management plan will be prepared as part of detailed design.
Design of the outfall pipe on Winston Churchill Boulevard to the river will likely require trench plugs to prevent groundwater flow down the valley.
The ESR will contain an assessment of the potential for spills and require preparation of a spills contingency plan prior to system commissioning. A technical memorandum on Overflow Risk Management is attached to this letter.
In addition to an area wide hydrogeological study, a project Environmental Management Plan will also outline mitigation required to minimise impacts from the project.
The County of Wellington has been provided with all of the background reports and studies and has provided comments to the project team.

3 Technical Memorandum Treated Effluent Outfall Site Selection

CVC Comments:

Overall based on the presented information, CVC has no objection to the selected outfall location. However, the impacts from the outfall location on the natural environment need to be carefully assessed. For example, what is the impact of the effluent on spawning redds. The study needs to asses quality of habitat and the impact of the effluent. The report should also consider the risk from bypasses.

We note that it is not clear why Alternative 2 requires twin 300 mm PVC pipe.

Response:

The Technical Memorandum will be revised to include additional assessment of the impact of the effluent on the natural environment. As noted above, the ESR will contain an assessment of the potential for spills and require preparation of a spills contingency plan prior to system commissioning.
Twin 300 mm forcemains are suggested for full build out peak flow of 227 L/s and to minimise energy use at average flow.

4 Technical Memorandum Pumping Stations and Forcemains

CVC Comments:

It is not clear how the natural hazards were addressed. No Pumping station should be located within the area of a natural hazard (i.e. flooding and erosion).

The impact to significant woodlands for the pumping station and forcemains should be assessed.

It should be note that some of the drainage features shown at site 4 are not watercourses.

Response:

The Pumping Stations and Forcemains Technical Memorandum will be revised to clarify potential impacts on natural hazard lands and woodland.
SPS Site 1 in Hillsburgh is within the floodplain. This site was selected as it is Town land and already contains a water pumping station and reservoir and is unused. The station floor level would need to be built above the flood level similar to the reservoir. The other alternative site across the road would impact use of the park. The potential impact on the floodplain would be evaluated as part of approvals during design. If the impact on the floodplain cannot be mitigated, the station could be relocated to the park.
SPS Site 1 in Erin is on the edge of the floodplain area and siting during detailed design will take this into consideration.
SPS Site 3 in Erin as described in the Natural Environment Report was relocated closer to the street line to avoid mature trees.
SPS Site 6 in Erin is on the edge of a stormwater management pond. Again, siting during detailed design will take this into consideration.
SPS Sites 7 and 8 in Erin as described in the Natural Environment Report, are not required as the recommended alternative identifies grinder pumps for these small areas.

CVC Comments:

It is our understanding that as part of the Route Evaluation Alternative 1 has 2 different options. It appears that only one option was reviewed. Please clarify. As Landowner of Alternative 1

(Elora Cataract Trail, CVC staff have also reviewed this route and have no objection for this route for the forcemain.

CVC lands staff reviewed the option specifically that abuts the Elora Cataract Trail (ECT) (Route Alternative 1) which identified that siting and construction of the forcemain along the trail would not cause significant disturbance to bird species if the construction footprint is limited to the existing trail area itself, and timing of construction is restricted to outside the breeding bird period. The report also recommends implementing the proper sediment and erosion management and control measures.

Mitigation measures and BMPs should be defined for the specific features of the preferred alternatives when they are selected and during detailed design. These should be incorporated into the site preparation, construction and maintenance of all infrastructure to minimize and avoid negative impacts on natural features and their ecological functions.

Lands staff have no objection to an EA option of Alternative 1 for the forcemain through the ECT. A permanent easement from CVC to the Town would be required; and through such negotiation for an easement CVC and the Town would need to address appropriate compensation for any impacts associated with the physical construction of the watermain and ongoing maintenance, as well as indemnification for CVC related to any potential impacts to CVC lands.

Response:

For the Elora Cataract Trail alternative the Natural Environment Report examined two alternative routings using the trail. As an alternative to using the trail all the way to Main Street, the report suggests using Sideroad 17 to Main Street to avoid the PSW area. The Pumping Stations and Forcemains Technical Memorandum will be revised to clarify why it was recommended to use the trail all the way to Main Street. Due to the short duration of the construction period it is possible to time the work to avoid harm to sensitive species adjacent to the trail through the PSW area. As noted, all potential impacts and mitigation requirements will be identified in an "Environmental Management Plan".

Sincerely,

AINLEY & ASSOCIATES LIMITED

Gary Scott, P.Eng.
Senior Project Advisor

cc. J Dougherty, CVC (via email)
B Slattery, MOECC (via email)
C. Furlong Triton Engineering (via email)

April 4, 2018 HESL Job #: J160005

Liam Marray
Credit Valley Conservation
1255 Old Derry Road
Mississauga, ON L5N 6R4

Dear Mr. Marray:

Re: Draft Town of Erin Urban Centre Waste Water Class EA and Draft supporting studies - Response to CVC Comments

Credit Valley Conservation provided a variety of comments on *Town of Erin EA Natural Environment Report* (Hutchinson Environmental Sciences Limited (HESL) 2017) and associated technical memorandums focused on site selection of different types of proposed infrastructure. Our responses focused on explaining rationale for the characterization of natural heritage features and functions, and the assessment developed to select preferred locations for various infrastructure, and acknowledging CVC comments that will improve the completeness of this portion of the EA and better align the work with relevant policies.

We will finalize the Natural Environment Report based on the responses and comments provided here-in but please contact Brent Parsons if you have any further questions or concerns.

Sincerely,
Hutchinson Environmental Sciences Ltd.

Brent Parsons, M.Sc.
brent.parsons@environmentalsciences.ca

The Credit Valley Conservation (CVC) provided a variety of comments on *Town of Erin EA Natural Environment Report* (Hutchinson Environmental Sciences Limited (HESL) 2017), *Wastewater Treatment Plant Site Selection Technical Memorandum* (Ainley Group 2017), *Effluent Outfall Site Selection Technical Memorandum* (Ainley Group 2017), and *Pumping Stations and Forcemains Technical Memorandum* (Ainley Group 2017). Our responses to the comments can be found on the following pages in *italics*. Some of the comments responses, as identified, are more appropriately addressed by the Ainley Group.

Natural Environment Report

Benthic Invertebrates

Comment #1:
Page 7 – Indicates OBB protocol followed, however goes on to indicate 'all samples were therefore collected from riffle or shallow run habitat'; OBBN protocol is to sample 2 riffles and one pool (and this is also consistent with CVC's approach). Please clarify.

The areas that could be most impacted by the installation of an effluent diffuser and conveyance of treated effluent were sampled for benthic invertebrates and compared to determine site sensitivity. There were no pools in those areas, so they weren't sampled. Sampling methodology will be clarified in the final Natural Environment Report to reflect this.

Comment #2:
Page 18 – (Chp 3.1.2.1): Sampling done through CVC's Integrated Watershed Monitoring Program (not Integrated Management Plan)

The change in terminology will be reflected in the final Natural Environment Report.

Comment #3:
Page 19 – (Table 3): % Chironomid at station halfway between 10th Line and Winston Churchill Blvd – in the Erin SSMP Phase 1 report, value reported at this station is 40% (not 10%)

% Chironomidae will be changed from 10% to 40% in the final Natural Environment Report.

Comment #4:
Page 21 – (Table 5 and associated text): Would be more appropriate to combine the three subsamples from each location for analysis purposes, i.e. in Table 5 rather than taking an average of each of the subsamples, metrics should be calculated from the summed taxa counts of the three subsamples. Discussion in text should focus on the overall site's results, not an average of the three subsamples.

The subsamples will be combined and analyzed in the final Natural Environment Report.

Aquatic Ecology

Comment #5:

Figure 5 – The start and finish of the spawning surveys should be shown. It would also be beneficial to show the mixing zones (e.g. nitrate, DO and temperature). The spawning surveys should extend beyond the mixing zones.

The mixing zone was predicted to be 152m long based on exceedance of the ammonia Provincial Water Quality Objective (PWQO) in West Credit River Assimilative Capacity Study (HESL 2017). No other water quality parameters were predicted to exceed the PWQO or Canadian Water Quality Guidelines and therefore 152m represents the end of the mixing zone as it is commonly defined. The spawning survey extended 500m downstream of Winston Churchill Blvd., or approximately 550m downstream of the proposed outfall, which is well beyond the mixing zone. The extent of the mixing zone for ammonia will be shown on a figure in the final Natural Environment Report.

The study should assess the impact of effluent on all life stages of brook trout (assumed most sensitive aquatic species and for all seasons). For example, water temperature should be assessed for all seasons.

The ACS compared water quality to the guidelines of CCME and MOECC, all of which are intended to protect the most sensitive life stage of the most sensitive species during indefinite exposure (i.e. all seasons). An evaluation of the impacts of effluent temperature on stream water temperature and brook trout in the West Credit River is provided in Appendix A.

<u>Terrestrial Ecology</u>
Comment #6:
Page 10 – it is recognized that Hillsburgh SPS #1 was not surveyed due to being identified after field season. This site should be surveyed as soon as possible.

Potential SPS were not compared and selected based on environmental sensitivities as were the other types of infrastructure because options were constrained due to various engineering considerations. Environmental features were still characterized at all SPS sites except #1 so that mitigation measures could be developed. Environmental features at SPS #1 should be characterized during detailed design so that mitigation measures can be developed.

The Hillsburgh SPS #1 site is located on an unopened road allowance in an urban area that is relatively disturbed, characterized by a few trees and shrubs. It is also in a proposed development area that will be subjected to further study before approvals. We recommend that a breeding bird survey be carried out at the site during detailed design. A characterization of its Ecological Land Classification community can likely be completed based on aerial photography. The site does not appear to provide suitable habitat for breeding amphibians.

Comment #7:
Page 29 – The NAI are based on current surveys (i.e. less than 20 years old). Although the surveys may identify ESA reports, wetland evaluations and Forest Resource Inventories (FRI) they were not the main source of information. The report should be revised accordingly. Location of the NAI survey should be shown on a Figure.

An identification of any Significant Wildlife Habitat (Candidate or Confirmed) within this study area based on Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E should be undertaken. As well as any significant woodlands should be identified.

Mapping reference to the location(s) of NAI areas will be added to the report. This information will be added to the ELC mapping if shapefiles are available through CVC. If not available, copies of the CVC mapping will be added to the report. The report will further discuss that the NAI mapping was reviewed as part of the background and then limits were refined were applicable at the site specific level (i.e., in areas adjacent to the survey sites).

We discussed several confirmed Significant Wildlife Habitats (based on our field surveys) in the report (i.e., Area-Sensitive Bird Breeding Habitat, Open Country Bird Breeding Habitat, Shrub/Early Successional Bird Breeding Habitat). We will add text to indicate that other candidate Significant Wildlife Habitat may also be present, as identified by the presence of specific ELC communities (e.g., Raptor Wintering Area, Woodland Raptor Nesting Habitat, Bat Maternity Colonies) and identify recommended mitigation measures to avoid negative impacts on these features.

Comment #8:
Page 34 – The location of the rare/uncommon plants should be shown on a Figure.

Rare/uncommon plants will be added to figures. Those species with accurate UTMs will be represented by point data, others will be referenced by ELC community.

Comment #9:
Page 51 – Further discussion is needed with respect to the location of WWTP with respect to SAR and the proposed pit for Site 2. The information from the proposed pit should be used to supplement the information already collected.

WWTP 1, 2A and 2B were assessed in the Natural Environment Report, while 1, 2A, 2B and 2C were considered in the WWTP Technical Memorandum. Site 2C was not assessed in the Natural Environment Report because it was added for consideration after completion of the report. Existing documentation exists that was used to characterize natural heritage features on the site but a comparison of historic conditions with conditions characterized during field surveys completed in 2017 does not represent a like-for-like comparison during site selection.

Site 2C appears to contain many of the same features as Sites 2A and 2B so similar mitigation measures will be required to minimize impacts. If Site 2C is ultimately selected as the preferred site, opportunity exists to characterize natural heritage features through background review and field surveys as part of the detailed design. The limitations associated with the assessment of 2C will be included in the final Natural Environment Report.

Comment #10:

Page 53 – Please confirm if the trailway is a break in woodland communities (i.e. greater than 20 metre) between tree branches. If not then the woodland should be map as one contiguous feature.

The report identifies mitigation measures for impacts to wetland characteristics but not for rare or uncommon species. The report should use a consistent approach.

Linear breaks in areas of woodlands (e.g., rail trail) will be reviewed to determine whether there is a recognized break based on a 20 m width. This will be reviewed in conjunction with the County of Wellington significant woodland mapping. The ELC mapping will be updated in areas where there are contiguous woodlands that are not divided or fragmented by a linear corridor and the mapping will reflect that these woodlands are connected (e.g., an arrow linking the adjacent ELC polygons)

Further mitigation recommendations will be provided, such as rare plant transplanting, for all significant natural heritage features (i.e., not only wetlands). For example, for significant woodlands this may include the need for edge management.

Comment #11:
Page 55 – For Forceman Alternative #2 and Forcemain #3 although they may be in the ROW this does not mean that there will not be impacts to wetlands, woodlands and associated functions (i.e. these features may be within the ROW). The report needs to be updated to address this issue.

Forcemain Alternative #1 was the preferred forcemain route selected in Pumping Stations and Forcemains Technical Memorandum (Ainley Group 2017) *so the impact assessment associated with Forcemain Alternatives #2 and #3 is not likely to be realized. Nonetheless, installation of the Forcemains would likely occur within the shoulder of the road because of various engineering considerations. If installation occurred outside of this area more impacts would be anticipated and would need to be addressed during detailed design. These qualifications will be included in the final Natural Environment Report.*

Comment #12:
Page 57 – As part of the mitigation options more discussion is needed with respect to location of the SPS and forcemains, restoration plans, construction techniques, etc.

Potential SPS were not compared and selected based on environmental sensitivities as were the other types of infrastructure but environmental features were still characterized so that mitigation measures could be developed. Additional mitigation options will be discussed in the final Natural Environment Report such as rare plant transplanting, for all significant natural heritage features (i.e., not only wetlands) but it should be noted that detailed mitigation requirements should be developed during detailed design and captured in an "Environmental Management Plan" for the project in order to obtain all required permits.

Comment #13:
Page 58 – The removal of the SPS should be through the EA process not just through Natural Environment Report.

The Owner of Site 1A did not grant access for the geotechnical work and so Site 1A was removed from consideration. Ainley will clarify this in the Sewage Pumping Station Technical Memorandum.

Comment #14:
Page 60 – Environmental Criteria should include Significant Woodlands. Impacts for the SPS should include construction access and area of impact, maintenance access. Did any other criteria be screened for the pumping stations for e.g. natural hazards.

Potential SPS were not compared and selected based on environmental sensitivities as were the other types of infrastructure but environmental features were still characterized so that mitigation measures could be developed.

Significant woodlands will be assessed per mapping and criteria listed in the County of Wellington Official Plan (County of Wellington 2017), and included as a criterion where applicable.

Impacts associated with maintenance access and other details is best determined during detailed design as those construction details have yet to be developed. Ainley has indicated that SPS sites were generally identified as suitable based on topographical (lowest elevation supporting gravity flow) and property considerations. Floodplain mapping was also considered. Property requirements were identified, however access and site development will all be based on a more detailed Environmental Management Plan prepared in support of approvals from MOECC and CVC.

<u>Monitoring</u>

Comment #15:
Section 4.4 states:

Effluent will be treated to the limits proposed in HESL (2017) following approval by MOECC and will be regulated through Environmental Compliance Approval (ECA) for the Erin WWTP. This will assure that effluent is not acutely lethal at the point of discharge, that water quality in the West Credit River meets water quality objectives, will minimize the mixing zone and ultimately avoid impacts to aquatic life.

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.

Further discussion is recommended to determine the objectives, goals, and time lines for this instream monitoring program. It is recommended that impact levels for key monitoring parameters be determined during the monitoring design and mitigated actions be clearly understood.

Details associated with the monitoring program will be developed during the ECA process with MOECC and will include consultation with CVC.

West Credit Assimilative Capacity Study Final – December 2017

Comment #16:
Staff have worked with Hutchinson Environmental Sciences on previous drafts of the documents. We would just like to reiterate that the results show that under full build out effluent flows, instream chloride concentrations will exceed aquatic guidelines for chronic exposure. At the present time, it is not technically feasible to remove chloride in the treatment process; therefore the emphasis should be placed on controlling the input of chloride at the source. It is recognized that water softeners are a significant source of chloride/salts in the wastewater stream specifically in areas on groundwater drinking water supply.

It is recommended that the Erin Urban Centre Wastewater Servicing Class Environmental Assessment Environmental Study include conditions such as:

- New Developments: Subdivision agreements for new development areas to include conditions to require the installation of high efficiency water softeners.
- Existing Developments: There is a potential for funding to be available to private residents to upgrade plumbing infrastructure on private property to tie into the new sewer lines. It is recommended that the installation of high efficiency water softeners be part of the plumbing upgrades included in the funding model.
- Education Program: There will be the need for continuous education to Erin residents during the implementation of new wastewater servicing in the Town. CVC can provide information in different media formats on how residents can minimize their environmental impacts on their own property including the installation of high efficiency water softeners.

MOECC have commented on the chloride issue, most recently in Review of December 6, 2017 Assimilative Capacity Study Town of Erin Proposed Wastewater Treatment Plant (March 9, 2018) under Comment #2:

"An effluent criterion for chloride will not be required. However, we intend to advise our approvals staff to include a condition in any future approval under Section 53 of the Ontario Water Resources Act that chloride be monitored in the influent, effluent, and receiving water. The Ministry recommends that a contingency plan be developed for the management of chloride when it exceeds the long-term Canadian Water Quality Guideline of 120 mg/L in the receiving water. Costs associated with the implementation of the contingency plan should be estimated and included as part of the total project cost. The Ministry also supports the recommendations provided by Credit Valley Conservation in their May 10, 2017 memo suggesting the use of high efficiency water softeners at the household level as a means of reducing chloride loads at source."

Chloride concerns were previously addressed in West Credit River Assimilative Capacity Study (HESL 2017) on page 49-50:

"The predicted downstream fully mixed chloride concentrations in the West Credit River are 121 mg/L and 180 mg/L for Phase 1 and Full Build Out respectively using the maximum effluent chloride concentration of 534 mg/L and 7Q20 conditions. The Phase 1 concentration is just above the chronic (long-term) CWQG of 120 mg/L, and the Full Build Out concentration of 180 mg/L is 60 mg/L above the chronic CWQG. Using

average effluent chloride concentrations, the predicted chloride concentrations in the West Credit River are below the CWQG of 120 mg/L for Phase 1 (100 mg/L, Table 20), and 22 mg/L above the CWQG for Full Build Out (142 mg/L, Table 20). Under both conditions, the predicted receiver concentrations are well below the acute toxicity threshold of 640 mg/L.

These Cl concentrations were predicted using 7Q20 flows and so do not represent expected concentrations for the long-term indefinite exposures that are relevant to the CCME guideline of 120 mg/L. Exposure to the predicted concentrations (slightly above CCME) would be for brief periods (7 days every 20 years) and aquatic life would be exposed at concentrations well below the short-term exposure CCME guideline of 640 mg/L. We recommend that chloride concentrations in the WWTP influent and effluent be voluntarily monitored by the Town and, if these concentrations approach those used for the mass balance calculations, that the Town consider implementing a public education program focusing on the use of water softeners to mitigate chloride discharge to the sewage system as water softeners are the primary source of chloride levels in wastewater in these areas.

The Town may also consider a road salt and de-icing management and education program. While this would not address chloride source control, it may have a beneficial impact on background chloride concentrations in the West Credit River."

Relevant parties are well aware of the chloride issue and the opportunity exists to implement appropriate monitoring and mitigation measures during the ECA process.

<u>Thermal Impact Assessment</u>

Comment #17:
Page 45 – The original 2016 Assimilative Capacity Study (ACS) workplan refers to water temperature QUAL2K modelling that will be completed as part of the ACS final assessment. The Final Assimilative Capacity Study (December 2017) includes a brief assessment of summer conditions. It is recommended that year round thermal impact assessment be completed to determine the potential impacts during critical life stages in the winter/spring/fall periods in addition to summer conditions. This should also include the determination of the thermal mixing zone at both proposed outfall locations and an assessment of impacts.

An assessment of the thermal impacts of effluent on the West Credit River and Brook Trout is provided in Appendix A. It concludes that the temperature changes resulting from the WWTP discharge will not "significantly change the distribution and abundance of plant and animal life" per the Provincial Water Quality Objective.

Appendix A – West Credit River Temperature Assessment

Hutchinson
Environmental Sciences Ltd.

1-5 Chancery Lane, Bracebridge, ON P1L 2E3 │705-645-0021
202-501 Krug Street, Kitchener, ON N2B 1L3
www.environmentalsciences.ca

Memorandum

Date: **April 4, 2018**

To: **Gary Scott, Ainley Group**

From: **Brent Parsons, Deborah Sinclair and Neil Hutchinson**

Re: **HESL J160005 – Thermal Assessment of Erin WWTP on West Credit River**

The reach of the West Credit River between 10th Line and Winston Churchill Blvd. contains a cold-water thermal regime and aquatic habitat that supports a robust population of sensitive coldwater fish species and critical Brook Trout spawning habitat (HESL 2017a). The purpose of this technical memorandum is to provide an assessment of the potential effect of the Erin WWTP effluent on water temperatures in the West Credit River during all times of the year for both Phase 1 (near term) and Full Build Out ((FBO) 20-year horizon) of the Wastewater Treatment Plant (WWTP) project to assess potential impacts to Brook Trout.

Temperature Thresholds for Brook Trout in West Credit River

Brook Trout are ranked as the most sensitive fish species in Toronto-area streams (Wichert and Regier 1998), they are the indicator species for coldwater habitat in the Credit River watershed (MNR and CVC 2002) and were therefore selected as the sentinel species to assess potential impacts of the Erin WWTP effluent on water temperature in the West Credit River. Temperature thresholds for various life stages were reviewed and two temperature “thresholds” (optimum and upper tolerance) associated with spawning, egg development and adult behaviour (i.e. growth) were defined (Table 1). Optimum water temperatures for spawning, egg development and general adult behaviour were defined as 10.7°C, 6.1°C and 14.2°C, respectively, as reported in Key Ecological Temperature Metrics for Canadian Freshwater Fishes (Hasnain et al. 2010). Upper tolerance temperatures for spawning, egg production and adult behaviour were defined as 16°C (Hokanson et al. 2001), 11.7°C (Hokanson et al. 2001) and 19°C (various citations – Table 1), respectively.

Table 1. Water Temperature Considerations for Brook Trout at Various Life Stages. Note that bold values are carried forward into the assessment.

Life Stage	Water Temperature Considerations
Spawning	- Ovulation and spawning occur at **16°C** or lower (Hokanson et al. 2001) - Optimal spawning temperature = **10.7°C** (Hasnain et al. 2010)
Egg Development	- Optimum egg development temperature = **6.1°C** (Hasnain et al. 2010) - Egg viability decreases above **11.7°C** (Hokanson et al. 2001)

Adult	- Optimum growth temperature = **14.2°C** (Hasnain et al. 2010) - Optimum growth rate at 14 °C (Baldwin 1951) - Brook Trout do poorly in streams where water temperatures exceed 20°C for extended periods (McAfee 1966) - Brook Trout are sensitive to changes in water temperature because they do not tolerate water temperatures greater than **19°C** - 20°C for long (Creaser 1930; Burton and Odum 1945; Gibson 1966) - A general upper tolerance of **19°C** - 20°C is evident throughout the literature (Kerr 2000). - **19°C** is critical as temperatures above this are considered suboptimum (Hokanson et al. 1973) - When temperatures reach 20°C non-indigenous Brown Trout will outcompete Brook Trout (Taniguchi et al. 1998)

Brook Trout life stages and associated water temperature thresholds are presented for each month in Table 2. In the West Credit River, growth occurs throughout the year, with spawning in October/November (active spawning was observed on November 1, 2016 (HESL 2017a)), and egg development from November through to March of the following year. Egg development has the lowest temperature preference, so these values were applied as thresholds for November to March, spawning temperatures were applied to October, and growth temperatures were applied as thresholds for the rest of the year (April to September), when spawning and egg development are not occurring (Table 2).

Temperature thresholds were compared to continuous water temperature data collected by CVC at Winston Churchill Blvd. from 2009-2015 (station 501150002; Table 2, Figure 1). Existing 75th percentile and maximum water temperatures exceed the optimal temperature preference of 14.2°C for Brook Trout growth from May to September (Table 2, Figure 1) and the 10.7°C optimal temperature preference for spawning in October. Maximum recorded water temperatures also exceeded the upper tolerance thresholds of 19°C for growth from May to September, and the upper tolerance threshold for spawning of 16°C in October. The 75th percentile July temperature of 19.3°C also exceeds the upper tolerance threshold for growth.

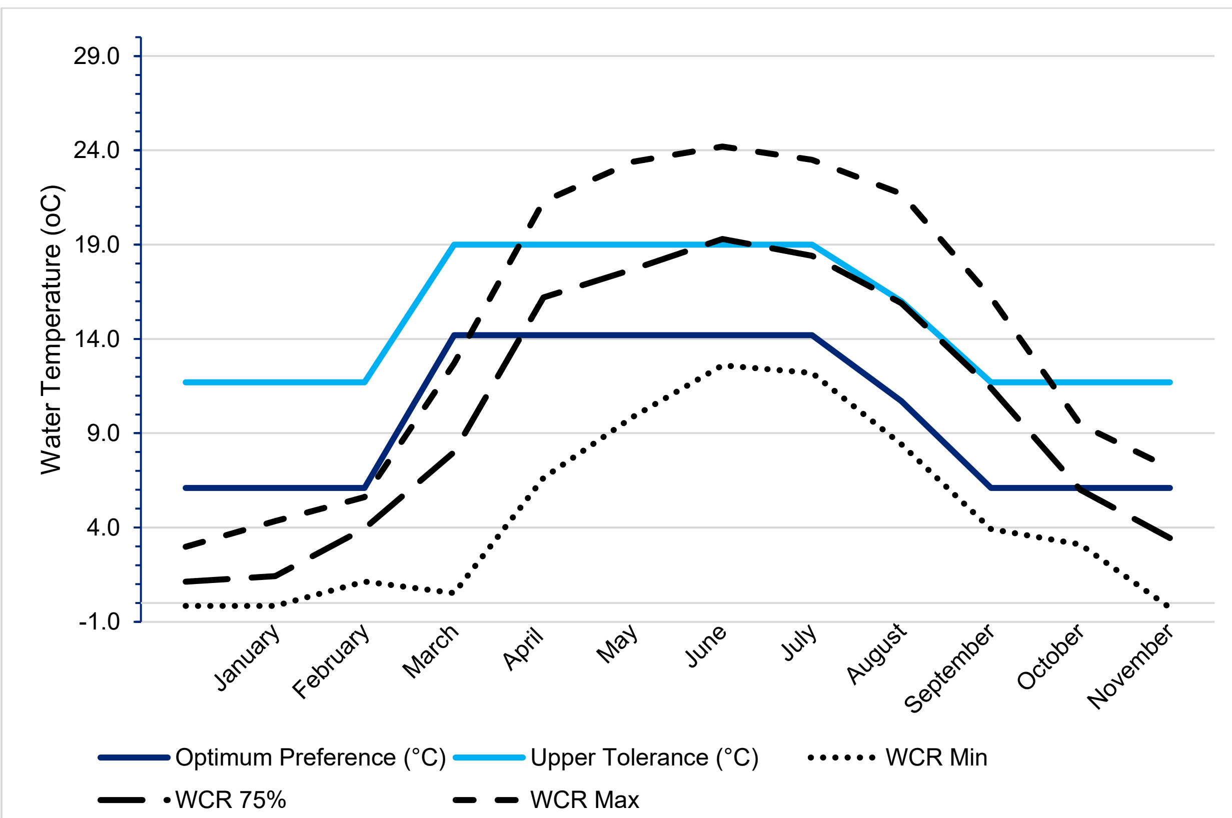
Table 2. Monthly Temperature Thresholds for Brook Trout in the West Credit River.

Month	Life Stage with Lowest Temperature Requirement	Optimal Temperature Preference (°C)	Upper Tolerance Temperature (°C)	Existing West Credit River Temperatures (°C)		
				Minimum	75th Percentile	Maximum
January	Egg Development	6.1	11.7	-0.2	1.1	3.0
February				-0.2	1.4	4.4
March				1.1	4.0	5.6

April	Growth	14.2	19	0.5	8.0	12.7
May				6.6	16.2	**21.3**
June				9.9	17.7	**23.4**
July				12.6	**19.3**	**24.2**
August				12.2	18.4	**23.5**
September				8.42	15.9	**21.7**
October	Spawning	10.7	16	3.9	11.4	**16.2**
November	Egg Development	6.1	11.7	3.1	6.0	9.5
December				-0.3	3.4	7.2

Notes: There was no temperature data for the months of January, February and December at station 501150002. Values for these months are based on continuous water temperatures collected at Belfountain at station 14526010 by CVC (Correlation between Belfountain and Winston Churchill data: r = 0.99; p<0.001). Shaded values exceeded optimal temperature preference values and bold values exceed upper tolerance temperatures.

Figure 1. Brook trout temperature requirements and water temperatures of West Credit River at Winston Churchill (2009-2015)



The Brook Trout population in the West Credit River near Winston Churchill Blvd. appeared to be thriving based on numbers of fish and spawning redds observed during surveys (HESL 2017a) even though existing 75th percentile water temperatures exceed optimal temperature preference for growth and spawning becase:

1. Water temperature is only one habitat component of many required to support robust populations;
2. Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001);
3. Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations; and
4. Groundwater upwellings are ubiquitous in the study area and they provide a consistent source of cold, oxygen-rich water for egg and sac-fry development.

Therefore, for the purposes of the temperature assessment, upper threshold water temperatures were used to assess any effects of the Erin WWTP on the Brook Trout life stages in the West Credit River.

Approach

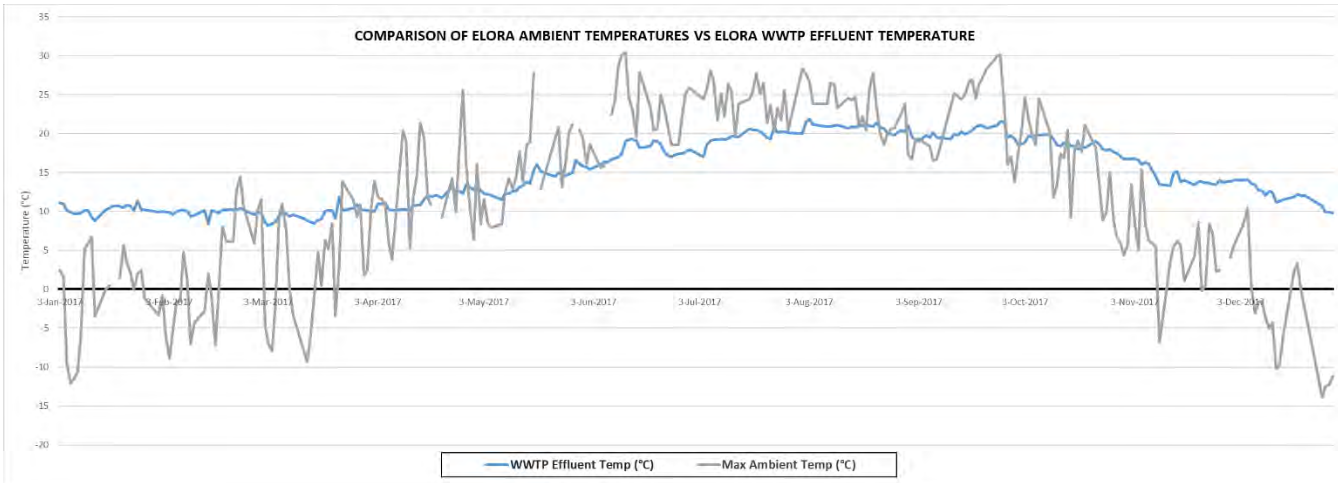
The effect of the Erin WWTP effluent on water temperatures in the West Credit River was calculated using:

1. A mass balance model (i.e., conservative approach) to estimate water temperatures after complete mixing of effluent within the creek; and
2. A CORMIX model to predict the size and shape of the thermal mixing zone.

Water temperature data for the West Credit River were obtained from CVC's station located at Winston Churchill Blvd (2009 through 2015 data; station 501150002), which was supplemented with water quality data collected by CVC at Belfountain (station 14526010). The 75th percentile, minimum and maximum water temperatures were calculated for each month (Table 2) as input into the models.

Monthly 75th percentile effluent temperatures were provided by Ainley Group (Preya Balgobin pers. communication, March 13, 2018) based on 2017 effluent temperatures for the Elora WWTP. The Elora WWTP effluent temperatures were used as it is close to Erin, and similar water sources and climate would result in similar effluent temperatures. It should be noted however that the Elora WWTP uses an extended air process which has higher retention time and longer exposure to ambient air temperatures compared to the treatment process that is proposed at Erin, which means that the use of Elora WWTP effluent temperatures represents a conservative approach of higher effluent temperatures than will likely be recorded at the Erin WWTP. These values were corrected for heat loss through the 1.7 km forcemain between the WWTP and the outfall to the West Credit River. Except for May, it is predicted that effluent will always be warmer than the creek (Table 3). Figure 2 presents ambient air temperatures in Elora compared to Elora WWTP effluent temperatures. The ambient temperatures show much greater fluctuations than the WWTP effluent temperature. The WWTP effluent temperatures gradually increase in warmer weather, and slowly decrease in cooler weather, and are not affected by swings in ambient air temperature.

Figure 2. Comparison of Elora Ambient Air Temperatures with Elora WWTP Effluent Temperatures.



Monthly 7Q20 flows for the West Credit River at 10th Line were the same as those used in the ACS (HESL 2017b). They were calculated by CVC (CVC 2016) and corrected for climate change (10% reduction as per the annual 7Q20 estimate by CVC) and used as input into the models. The lowest 7Q20 value occurs in September, followed by the other summer monthly flows (August, June and July). Highest 7Q20 values occur in the spring (April and March) and late fall/early winter (December/November; Table 3).

Models were run for both Phase 1 (39 L/s) and Full Build Out (83 L/s) effluent flows. It should be noted that Phase 1 is predicted to occur in the near term (next 3 to 5 years), and Full Build Out conditions will not occur for 20 or more years. Therefore, Full Build Out predictions may be validated and refined with future site-specific data (e.g. Erin WWTP effluent temperatures).

The CORMIX model inputs were those detailed in the *West Credit River Assimilative Capacity Study* (HESL 2017b) with addition of a surface heat exchange coefficient for modelling temperature. The CORMIX user manual (Doneker and Jirka 2014) suggests that, for conservative models, a value of 10 W/m^2,°C be used at low water temperatures and a value of 20 W/m^2,°C be used at high water temperatures. These values correspond to a wind speed of 0-2 m/sec - heat exchange would be greater at higher wind speeds. Following this, a surface heat exchange coefficient of 20 W/m^2,°C was used for the months of June through August, and a coefficient of 10 W/m^2,°C was used for all other months.

Mass Balance Model Results

The resulting water temperatures in the West Credit River downstream of the proposed WWTP discharge as calculated by the mass balance (at both Phase 1 and Full Build Out effluent flows of 39 L/s and 83 L/s) are presented in Table 3.

Table 3. Monthly Fully-Mixed Water Temperatures in West Credit River by Mass Balance Modelling

Month	75th Effluent Temp (°C)	75th % West Credit River Temp (°C)	Monthly 7Q20 (L/s)	Phase 1 Mixed Temp (°C)	Phase 1 Temp Increase (°C)	Full Build Out Mixed Temp (°C)	Full Build Out Temp Increase (°C)	Upper Tolerance Temperature (°C)
January	10.8	1.1	374	2.0	0.9	2.9	1.8	11.7
February	10.3	1.43	357	2.3	0.9	3.1	1.7	11.7
March	10.3	4.0	464	4.4	0.5	4.9	1.0	11.7
April	12.2	8.0	568	8.3	0.3	8.5	0.5	19.0
May	14.8	16.2	416	16.1	-0.1	16.0	-0.2	19.0
June	18.0	17.7	306	17.7	0.0	17.8	0.1	19.0
July	19.6	19.3	319	19.3	0.0	19.4	0.1	19.0
August	20.3	18.4	275	18.6	0.2	18.8	0.4	19.0
September	20.0	15.9	244	16.5	0.6	16.9	1.0	19.0
October	18.4	11.4	338	12.1	0.7	12.8	1.4	16.0
November	15.7	6.0	460	6.8	0.8	7.5	1.5	11.7
December	12.7	3.4	464	4.2	0.7	4.8	1.4	11.7

Note: Shaded values exceed both 75th percentile background and upper tolerance threshold for Brook Trout

During Phase 1, fully mixed 75th percentile water temperatures are predicted to decrease in May by 0.1ºC, not change in June and July, and increase between 0.2 to 0.9ºC in August to April. The largest increase in water temperatures will be in the late fall (November) and winter (December, January and February), with water temperature increases of 0.7 to 0.9ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The existing 75th percentile water temperature in July (19.3ºC) is above the upper tolerance threshold for growth (19ºC). Under Phase 1 effluent flows, July water temperature is predicted to stay the same (i.e. 19.3ºC), therefore, there is no predicted change from current conditions. Fully mixed water temperatures during the sensitive periods for Brook Trout spawning (October) and egg development (November through to March) will remain well below the upper tolerance temperatures (Table 3) although groundwater inflows will isolate eggs from the changes.

During Full Build Out, fully mixed 75th percentile water temperatures are predicted to decrease in May by 0.2ºC and increase between 0.1 to 1.8ºC between June and April. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. In July, the 75th percentile water temperature is predicted to be 19.4ºC, above the threshold of 19ºC, but only 0.1ºC above the existing 75th percentile water temperature of 19.3ºC.

CORMIX Model Results

During Phase 1, the upper tolerance threshold temperatures are met at the diffuser from January to June. In July, background 75th percentile West Credit River water temperatures exceed the upper tolerance threshold value of 19ºC (see mass-balance modeling results), therefore the threshold will not be met downstream. From August to December the distance to the point where effluent temperature declines to the upper tolerance threshold ranges from -2.5 m (backflow from diffuser) to 32 m. These distances are within the 152 m size of the mixing zone predicted for other water quality parameters in the effluent (HESL 2017b).

Table 3 Distance (m) to meet Upper Tolerance Thresholds in West Credit River.

Month	Effluent Temp (°C)	75th % WCR Temp (°C)	Monthly 7Q20 (L/s)	Upper Tolerance Temperature (°C)	Distance (m) downstream to Upper Tolerance - Phase 1	Distance (m) downstream to Upper Tolerance - Full Build-Out
January	10.8	1.13	374	11.7	0	0
February	10.3	1.43	357	11.7	0	0
March	10.3	3.95	464	11.7	0	3
April	12.2	8.00	568	19.0	0	0
May	14.8	16.20	416	19.0	a	
June	18.0	17.70	306	19.0	0	0
July	19.6	19.30	319	19.0	b	
August	20.3	18.40	275	19.0	32	84
September	20.0	15.90	244	19.0	3	3
October	18.4	11.40	338	16.0	3	715
November	15.7	6.00	460	11.7	7	12
December	12.7	3.44	464	11.7	-2.5	3

Notes: a – effluent is cooler than West Credit River, therefore the Upper Tolerance Threshold is never exceeded; b – existing 75th percentile West Credit River water temperatures exceed the Upper Tolerance Threshold

During Full Build Out, the upper tolerance threshold temperatures are met at the diffuser in January, February, April, and June. Again, in July, background 75th percentile West Credit River water temperatures exceed the upper tolerance threshold value of 19ºC, therefore the threshold will not be met downstream. In March, September, November, and December, the distance for temperature to decrease to the upper tolerance threshold ranges are less than 40 m. In August and October, the distance to upper tolerance threshold temperatures are 84 and 715 m respectively. We note that the large increase in October is an artifact that relates to the transition from a growth tolerance temperature of 19ºC to a spawning tolerance of 16ºC, which will not occur on October 1 but will depend on when fish actually spawn. The actual affected

distance in the river will be much less than the 715 m predicted. At 35 m downstream of the diffuser, water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development.

Thermal Impact on Fish and Other Aquatic Species

The proposed effluent outfall diffuser will be placed approximately 2 m upstream (i.e. south) of the large culvert that transmits flows beneath Winston Churchill Blvd. The culvert is approximately 45 m long and represents degraded habitat because it is permanently shaded, doesn't permit macrophyte growth and limits the form of the stream bed and width of the channel.

The predicted increases in temperature in the West Credit River downstream of the outfall as predicted through mass balance modeling are minimal. In the short-term (Phase 1), fully mixed water temperatures are predicted to stay the same (July) or increase by 0.9ºC. Fully mixed water temperatures during Brook Trout spawning (October) and egg development (November to March) will remain well below their upper tolerance temperatures.

In the longer-term (Full Build Out, > 20 years), fully mixed water temperatures are predicted to increase by a maximum of 1.7ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The nominal increase (0.2ºC) in July water temperature is not expected to affect the growth life stage of the local Brook Trout population for the following reasons:

1. Brook Trout in this reach have acclimatized to water temperatures up to 24.3ºC (maximum water temperature of Winston Churchill),
2. Brook Trout routinely experience water temperatures of 19.3ºC in the study area,
3. Temperature predictions are conservative since they are focused on 7Q20 flows (which are exceeded 99.5 to 99.9% of the time; Pyrce 2004) and 75th percentile water temperatures,
4. Brook Trout commonly seek out thermal refugia (Ebersole et al. 2001),
5. Seasonal temperature cycles provide an acclimatization period for Brook Trout (Raleigh 1982), and
6. Fully mixed water temperatures during sensitive spawning (October) and egg growth development (November to March) life stages will remain well below their upper tolerance temperatures.

The maximum predicted distance to upper threshold temperatures in the West Credit River downstream of the outfall during Phase 1 as predicted through CORMIX modeling is 32 m in August so increased temperatures will be constrained to degraded habitat located in the culvert. Predicted distances to upper threshold temperatures during Full Build Out are 84 m in August and 715 m in October but, the October distance of 715 m is considered artificially high. By 35 m downstream of the diffuser (within the culvert) water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October, respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development. Any effects on Brook Trout populations will be partially mitigated in August by their ability to seek out thermal refugia, and from November - March egg and sac-fry development will not be impacted because Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore

water temperatures near these spawning and development areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the change to water temperatures.

There are several qualifications mentioned throughout this assessment that made it conservative. Qualifications include:

1. These predictions were made for 7Q20 low flow conditions as a conservative estimate of change - flows will be higher and temperature changes smaller 99.5% of the time,
2. Seasonal temperature cycles from summer highs to winter lows provide an acclimatization period to temperature extremes for Brook Trout (Raleigh 1982),
3. Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001),
4. Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations, and
5. Most importantly, Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore water temperatures near these spawning areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the effect of change to water temperatures.

Conclusions

The Provincial Water Quality Objective for water temperature is, “The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.” (MOE 1994). Based on the results of the thermal assessment on Brook Trout, including the various conservative qualifications, we predict that the temperature changes resulting from the WWTP discharge will not “significantly change the distribution and abundance of plant and animal life” per the Provincial Water Quality Objective.

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TOWN OF ERIN

Town of Erin
Urban Centre Wastewater Servicing
Class Environmental Assessment

Technical Memorandum
Overflow Risk Management

April 2018

Ainley GROUP
CONSULTING ENGINEERS & PLANNERS

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum
Overflow Risk Management

Project No. 115157

Prepared for:
The Town of Erin

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1.0 System Overview

The recommended alternative wastewater system for Erin and Hillsburgh will consist of local and trunk sewers, sewage pumping stations and forcemains, a wastewater treatment plant and an outfall extending to the West Credit River. The wastewater system will extend from the North end of Hillsburgh through to south of Erin Village. As outlined in the Natural Environment Report, a considerable portion of the lands in Hillsburgh and Erin are environmentally sensitive. The West Credit River with tributaries and wetland areas also extend from the north end of Hillsburgh through Erin Village. The proposed infrastructure can experience malfunctions from time to time resulting in the potential for a wastewater spill to the river system.

The wastewater collection system will be completely separate from the stormwater system and will not be connected to roof down pipes or sump pumps. None the less, the flow capacity of the system will include an allowance for inflow and infiltration which is often the cause of spills. As the system ages, there will be opportunities for groundwater and storm water to enter the sanitary sewers. The sanitary sewage system, including pipes and sewage pumping stations, will also be designed for peak flows of 2.7 times the design capacity in accordance with Ministry of Environment and Climate Change (MOECC) design guidelines using the Harmon Peaking Factor. It is noted that all system pipes and pumping station wet wells will be sized and built for their ultimate capacity which will not be reached until full build out and this provides additional storage capacity in the sewer system over the short term. Critical unit processes in the wastewater treatment plant will also be designed for peak flows as per MOECC guidelines. While the plant will undergo a phased construction, each phase will be designed for peak flow. As such, it is unlikely that flows in the system will exceed the system capacity.

Due to the sensitivity of the local environment, overflow pipes from sewage pumping stations or overflow chambers that would permit by-passes or spills of untreated or partially treated wastewater to the natural environment throughout the system are not recommended. Ideally, all flows will be contained in the system until discharge of the treated effluent to the river. However, the trade-off with no overflow outlets to the environment and retaining sewage in the collection system is that the potential for flooding basements in areas serviced by pumping stations increases. This makes design and management of the system more important in order to ensure that sufficient system storage is provided for all flow scenarios.

The effluent disinfection system, in the recommended sewage treatment alternative evaluation, is UV which eliminates the risk of a spill to the river for chlorination and dechlorination chemicals.

2.0 Overflow Risks

While the system will be designed to minimize the risk of overflows or spills to the natural environment, or back-ups into private properties, there does still exist some degree of risk. Overflows could potentially arise from:

- Main Breaks
- Main Blockages
- Capacity Exceedances from Infiltration and Inflow during storm events
- Equipment Failure

- Power Failure
- Control/Communications System failure
- Upgrade and expansion projects

2.1 Dealing with Potential Main Breaks

The highest risk of spills from wastewater pipe systems is from forcemain breaks as the pressure from pumps can result in spills to the surface similar to what is visible during watermain breaks. The recommended collection system alternative is based on using twin forcemains from sewage pumping stations except the smallest local stations. Leaks in manholes and sewers are more likely to allow groundwater into the system rather than causing a spill. Other measures to be considered in the design to minimize the risk of spills from main breaks include:

- Quality control during all aspects of construction including on development lands
- Use of heat welded polyethylene pipe for all forcemains
- Use of line valves for isolation of forcemain sections
- Use of pump pressure control to indicate leaks, send alarms and stop pump operation
- Implementing a preventative maintenance program including regular inspections using CCTV

2.2 Dealing with Potential for Main Blockages

Spills from wastewater pipe systems can also result from blockages of the sewer or pump intakes. This can be caused by illegal discharges of grease or large items. The recommended collection system alternative is based on using minimum sized sewers of 200 mm and non-clog sewage pumps. In addition, the entire system will be monitored using a computer control system that will alarm on pump failure or rising liquid levels in the pumping stations. Under normal conditions sewage collection systems operate continuously without blockages. Permitted discharges are defined within a sewer use by-law. Measures to be considered to minimize the risk of spills from blockages include:

- Implementation of a sewer use by-law that prevents discharge of materials likely to block the sewers or damage pumps
- Education leaflets on sewer use aimed at eliminating illegal discharges
- Regular inspections of industrial, commercial and school properties to prevent illegal discharges
- Careful hydraulic design of all elements to prevent sedimentation and deposits/build ups in the system
- Implementing a preventative maintenance program including regular inspections using closed circuit television (CCTV)

2.3 Dealing with Potential for Capacity Exceedances

Overflow events can occur when the volume of water entering the collection system exceeds the capacity of the sewers, pumping stations, or the treatment facility. In such events, the excess sewage can be by-passed through overflow discharges (typically to surface waters) or collected within holding tanks. Without overflows or peak flow storage, excess sewage can also back-up within the collection system ultimately leading to basement flooding.

As noted above, the preferred alternative will be isolated from extraneous flows entering the system and consideration will be given to not allowing overflows out of the system. The system will be designed to contain flow events within collection system capacity, pumping station capacity and treatment capacity.

The potential for capacity exceedances will be greater as the collection system ages. The connection of roof downspouts, sump pump discharges, and stormwater catch basins to the sanitary system are common examples of past practices that have been discontinued and must be prevented. Deteriorated systems can experience flow peaks over 5 times the average flow. This must be prevented through maintenance and inspections. Newer systems and systems without the improper connections would exhibit peak flows as low as 2 times the average flow.

Fully eliminating all sources of system inflow and infiltration is not feasible; however, best practices can significantly reduce the scale of the issue. In a system without improper connections, extraneous flow will still enter the collection system through manhole covers, loose joints, or breaks caused by roots. The sewer use by-law, that is enforced, should address the issue of illegal connections.

Another source of extraneous flows in new collection systems is improper installation of sewer mains and laterals. In order to ensure new installations are completed correctly, testing of installed sewers should include flow monitoring before connections and CCTV inspections. Contractors should be required to repair all deficiencies identified through the monitoring program. Other inflow and infiltration minimizing measures, such as leak-free manhole lids in low-lying areas, should also be adopted.

Often, the installation of sewer laterals on private property can be a significant source of infiltration to the municipal collection system. It is recommended that the Town Building Department only allow the use of pipe materials that are typically specified for use on the municipal side of the collection system. Most municipalities require the use of DR 28 PVC pipe with gasketed joints.

As the system ages, the potential or risk of high flows exceeding the peak capacity of the wastewater treatment plant or pumping stations will increase. This can be managed by increasing storage throughout the system either by constructing additional wet wells at pumping station sites or storage tanks at critical locations such as the last pumping station before the wastewater treatment plant. The volume of storage necessary to manage peak flow events would need to be determined through focused risk assessments to determine the best location for the storage. In establishing sites for sewage pump stations and the treatment plant, provision should be made for the future construction of additional wet well capacity or storage tanks. Risk assessment would include risks associated with system back up and the potential for basement flooding. In the future, if the risk of basement flooding cannot be mitigated using increased storage or system capacity increases, it may be necessary to construct overflows from pumping stations to the river.

The suggested approach to establish the need for peak flow storage is as follows:

- Monitor daily wastewater flow averages and peaks at the treatment facility and track the scale and frequency of peak flow events

- Compare peak flow events to peak flow capacity in the collection system and treatment facility
- Quantify the risk (probability and consequence) of overflow events occurring
- Where the quantified risk is determined to be unacceptable:
  - First:
    - Identify I/I sources through wastewater flow monitoring of the collection system
    - Enact inflow and infiltration reduction measures (pipe relining/ replacement, manhole rehabilitation, etc.)
    - Quantify the impact of inflow and infiltration reduction measures
  - Second:
    - Conduct risk analysis of overflow in each collection area
    - Establish peak flow retention within collection areas where risk exceeds acceptable levels

2.4 Dealing with Potential for Equipment or Pump Failure

Equipment or pump failure also have the potential to result in overflows or spills from wastewater systems. Pumps are a critical component in wastewater systems and are used to convey wastewater from pump stations to the treatment plant. A large number of pump systems also exist in treatment plants to operate many of the processes and finally to convey effluent to the river. Their failure can lead to a rapid build-up of wastewater with the potential for a spill. Likewise, the failure of chemical feed pumps, screens, air blowers, UV systems and other equipment in the treatment plant can result in process failures. The Ministry of Environment and Climate Change (MOECC) provides design guidelines for pumping stations and treatment plant design in Ontario that requires the use of dual or standby equipment for all pumping stations and treatment systems. The use of dual pumps and multiple treatment trains minimize the risk of pump or equipment failure resulting in a spill or discharge of partially treated wastewater. Measures that should be considered in the design and operation of the system to minimize the risk of spills from pump or equipment failure include:

- Installation of a minimum of dual systems for all pumps and equipment at sewage pumping stations and the treatment plant sufficient to ensure continuous operation of all systems
- Design for plant operational flexibility such that pump systems can have multiple duties
- Conduct a risk assessment and develop a contingency and response plan to deal with equipment failures
- Implement a Maintenance Management System (MMS) that prevents equipment failure
- Adopt a proactive approach to fixing any piece of equipment that is out of operation.
- Develop a contingency plan to by-pass pumping stations
- Maintain an inventory of critical spare parts on site

2.5 Dealing with Potential for Power Failure

Wastewater systems must have a continuous and reliable supply of power for the safe operation of the system. The preferred treatment plant alternative has a wide range of equipment, instruments and control devices that require continuous and stable power. Treatment plants and pumping stations are built in strict compliance with electrical codes that ensure all electrical systems are safe and reliable. Measures that should be considered in the design and operation of the system to minimize the risk of spills from power failure include:

- Negotiate multiple power feeds to sewage pumping stations and treatment plant with the power authority
- Consider using twin power transformers to ensure a more robust supply
- Install standby power with automatic transfer from the prime power source sufficient to maintain the entire facility in operation during prime power failure
- Select a fuel supply for standby power based on the security of the supply (gas or diesel)
- Protect all electrical systems against the threat of lightning strikes

2.6 Dealing with Potential for Control/Communication Failure

Continuous operation of the wastewater system will rely on the System Control and Data Acquisition (SCADA) System. This is the system that will automatically control the operation of all equipment throughout the system 24 hours a day. It automatically starts and stops equipment as necessary and provides alarms to the operators in the event of any failure. Typically, operators can remotely investigate any issues with the operation and either remotely start a standby system, or go to the facility and take manual control of the particular system. The control system consists of sensing instruments, controllers and computers using control software customized for the particular system operation.
A system wide communications system that allows all facilities to be interconnected to the control system must also be robust and secure to support system reliability.
SCADA systems improve the reliability of the operation and greatly reduce the response time needed to deal with operational issues. Measures that should be considered in the design and operation of the system to minimize the risk of spills resulting from a control/communications system failure include:

- Design the SCADA system with dual controllers and computers
- Ensure protection and back up of all sensitive controls and computer networks using Un-interruptible Power Supply (UPS)
- Develop a contingency plan for manual operation in the event of control system failure
- Regularly maintain all sensing instruments

2.7 Upgrade and Expansion Projects

Upgrade and expansion projects can often be a source of planned bypasses if systems require to be taken out of operation to facilitate installation of new or replacement equipment. Measures that should be considered in the design to eliminate the need for bypassing during construction include:

- Conceptually design full build-out of the plant during the first phase and develop a constructability plan for all phases that eliminates the need to remove units from operation during future construction phases.
- Ensure sufficient isolation valves are constructed in the first phase.
- Provide for connection to future expansions during Phase 1.
- Provide for the replacement of all equipment while maintaining system capacity.

Ainley & Associates Limited
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April 16, 2018 File No. 115157

County of Wellington
Planning and Development Department
Administration Centre, 74 Woolwich Street
Guelph, Ontario
N1H 3T9

Attention: Sarah Wilhelm, Manager of Development Planning

Subject: Town of Erin Urban Centre Wastewater Servicing
Response to the County of Wellington Comments on Project Supporting Studies

Thank you for your comments on the supporting studies for the above-noted project. We are pleased to provide our response below.

1 Cultural Heritage Resource Assessment

County Comment:
Figure 17 – This map should identify the Village of Hillsburgh not Erin.

Response:
- *The report will be updated to fix this error.*

2 Natural Environment Report

County Comment:
General Comment
- The report does not contain any mention of the Greenbelt Plan. As a result it is unclear whether the study meets the requirements of the Greenbelt Plan in general, and Section 4.2 of the Plan in particular.
- The requirements for infrastructure should be discussed and the report should include some indication as to whether these requirements are addressed in the consideration of alternatives, their impacts, and mitigation.

Response:
- *The report will be updated to address the broader set of land use policies and regulations applicable to development in the Town of Erin.*
- *Environmental impacts and mitigation measures at each individual site have been addressed separately within the Pumping Stations and Forcemains, Outfall, and WWTP technical memoranda respectively.*

County Comment:
Section 3.2.1.
- The Natural Heritage Designations section does not reference the County or Town Official Plan Greenlands System designations. In particular, we note that the identification of Significant Woodlands is a municipal planning authority responsibility.
- The extent of, and requirements for, development adjacent to the Greenlands System should be discussed and the report should include some indication as to whether these

requirements are addressed in the consideration of alternatives, their impacts, and mitigation.

Response:

- *The report will be updated to cover mitigation measures for impacts to the Greenlands System.*

3 Wastewater Treatment Plant Site Selection Technical Memorandum

County Comment:
Section 1.0

- Additional discussion is needed regarding whether the general area for the location of a WWTP was identified in the SSMP by map or text. Clarification would be helpful regarding why the general area is under consideration and why other lands were rejected.

Response:

- *The general area for the WWTP site was determined through the SSMP. The Wastewater Treatment Plant Site Selection Technical Memorandum will be updated to expand on the historical rationale for the general area selected.*

County Comment:
Section 1.2

- The document is limited to a brief discussion of the Zoning By-law. As a result, it is unclear as to whether the study meets the general requirements of the applicable policy documents.
- Under the heading of "Land Use Policies and Regulations" (rather than "Zoning By-law") the following documents need to be addressed:
    - Growth Plan for the Greater Golden Horseshoe (2017) – including new Agricultural System and Natural Heritage System mapping issued February 9, 2018
    - Greenbelt Plan (2017)
    - Provincial Policy Statement (2014)
    - County of Wellington Official Plan (November 9, 2017 consolidation)
    - Town of Erin Official Plan (May 2013 consolidation)
    - Town of Erin Zoning By-law 07-67

Response:

- *The report will be updated to address the broader set of land use policies and regulations applicable to development in the Town of Erin.*

County Comment:
Section 2.0

- The last paragraph needs to provide a broader policy discussion (not just zoning) and why other areas were eliminated.
- The last sentence is incorrect in stating "Per the Zoning By-law, the study area is primarily agricultural, secondary agricultural, greenlands and core greenlands". The

terms listed are not zones from the Zoning By-law. They are Official Plan land use designations and should be indicated as such.

- Agricultural designations throughout the document should be updated according to Agricultural System mapping issued February 9, 2018 under the Growth Plan for the Greater Golden Horseshoe, which identifies all alternative sites as Prime Agricultural (rather than Secondary Agricultural).

Response:

- *The rationale for the elimination of potential sites for the WWTP is not limited to a discussion on zoning. As discussed throughout Section 2.0, the selection of the general area was determined through the SSMP based on the available discharge location and the natural topographic relief of the study area which drove the design of the overall collection system. The impacts to existing residents and environmental concerns were also prime considerations in the selection of potential sites.*
- *The report will be updated to accurately reflect the source of the land use designations.*
- *The report will be updated to reflect the latest agricultural designations listed in the recently updated Growth Plan for the Greater Golden Horseshoe.*

County Comment:
Section 3.0

- Each alternative site should include an assessment of Agricultural Impacts.

Response:

- *The potential agricultural impacts at each site will be addressed in an update to the Technical Memorandum.*

County Comment:
Section 3.1.1.

- Page 9 has an incorrect reference to a secondary agricultural zone. The Prime Agricultural designation now applies and the word “zone” should be replaced with “designation”.
- The top of page 10 refers to a 200 acre farm property. More information should be provided about the farm, such as how much of the land is arable and what crops have been planted.
- Agricultural impacts should be given the same degree of consideration as other evaluation criteria for WWTP sites.
- Table 2 on page 12 refers to the need for entrance permits onto Wellington Road 52. We would suggest that you ask County Engineering Services about entrance permits for all sites so that the question isn’t left unanswered.

Response:

- *The report will be updated to fix the improper nomenclature.*
- *A general discussion on the nature of the agricultural potential and history at the site will be added to the report and consideration will be given to the impact this has on the evaluation of the alternative sites.*
- *Entrance permits will be obtained at the implementation stage of the project.*

County Comment:
Section 3.1.2.

- Page 13 includes an incorrect reference to a secondary agricultural zone. The Prime Agricultural designation now applies and the word "zone" should be replaced with "designation".
- Information should be included about the size of the land holding, how much of the land is arable and what crops have been planted.
- Agricultural impacts should be given the same degree of consideration as other evaluation criteria for WWTP sites.

Response:
- *The report will be updated to fix the improper nomenclature.*
- *A general discussion on the nature of the agricultural potential and history at the site will be added to the report and consideration will be given to the impact this has on the evaluation of the alternative sites. .*

County Comment:

Section 4.0 & Section 5.0

- Agricultural impacts should be included in the analysis and evaluation of alternatives.

Response:
- *The potential agricultural impacts at each site will be addressed in an update to the Technical Memorandum.*

4 Effluent Outfall Site Selection Technical Memorandum

County Comment:
Section 1.2.

- For consistency, the heading "Land Use Policies and Regulations" should be used (rather than "Zoning By-law").
- In this case, the discussion can be limited to the Zoning By-law, but should address aspects relevant to the topic of Treated Effluent Outfall Site Selection. This should include revisions to refer to Section 4.45.2 of the Town of Erin Comprehensive Zoning By-law.
- In our opinion, effluent outfall sites and related works are permitted as-of-right in the Town's Zoning By-law. This is consistent with our opinion regarding SPS sites (see attached).

Response:
- *The report will be updated to reflect the broader set of land use policies.*

County Comment:
Section 3.0, 4.0 and 5.0

- We note that discharge locations are to be fully accessible from public road allowances and the treated effluent outfall could be constructed in the public right of way. Although agricultural impacts are unlikely, for consistency with the other Technical Memorandums, we would recommend that agricultural impacts be included in the analysis and evaluation of alternatives.

Response:

- *Our opinion is that the outfall locations will have no impact on agriculture.*

5 Pumping Stations and Forcemains Technical Memorandum

County Comment:
Table of Contents

- For consistency, the heading and discussion of "Land Use Policies and Regulations" should be included in the document.
- In this case, the discussion can be limited to the Zoning By-law, but should address aspects relevant to the topic of pumping stations and forcemains. This should include revisions to refer to Section 4.45.2 of the Town of Erin Comprehensive Zoning By-law.
- In our February 1, 2017 opinion letter, we advised that pumping stations and forcemains are permitted as-of-right in the Town's Zoning By-law (see attached).

Response:

- *The report will be updated to reflect the broader set of land use policies.*

County Comment:
Section 4.0

- We note that the pumping stations and forcemains are within the urban areas and in the case of the Erin Village – Hillsburgh connection, forcemain routes in the rural area would be within the Elora Cataract Trail allowance or within road rights of way. Although agricultural impacts are unlikely, for consistency with the other Technical Memorandums, we would recommend that agricultural impacts be included in the analysis and evaluation of alternatives.

Response:

- *Our opinion is that the outfall locations will have no impact on agriculture.*

County Comment:
We have raised the need to address agricultural impacts as it relates to the Technical Memorandums and that these impacts should be the same degree of consideration as other site impact analysis and evaluation. The best way to address agricultural impacts in a comprehensive and consistent manner would be to prepare an Agricultural Impact Assessment. We have attached Section 4.6.5 of the County Official Plan and Section 4.2 of the Greenbelt Plan for policy guidance.

Response:

- *We will prepare an Agricultural Impact Assessment for relevant components of the project. The policy documents provided will be used as reference.*

Sincerely,

AINLEY & ASSOCIATES LIMITED

Gary Scott, P.Eng.
Senior Project Advisor

cc C. Furlong Triton Engineering (via email)

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April 10, 2018 File No. 115157

Ministry of Environment and Climate Change
119 King Street West
12th Floor
Hamilton, Ontario
L8P 4Y7

Attention: Barbara Slattery, EA/Planning Coordinator

Subject: Town of Erin Urban Centre Wastewater Servicing
Response to MOECC Comments on Assimilative Capacity Study

Thank you for your March 9, 2018 comments on the Assimilative Capacity Study, Natural Environment Report and Effluent Outfall Selection Report for the above-noted project. We are pleased to provide our response below.

1 Response from Hutchinson Environmental Sciences Ltd

Please find attached a letter from Hutchinson Environmental Sciences Ltd providing a response to MOECC comments related to their work on the Assimilative Capacity Study and the Natural Environment Report. Please also note that their response contains a thermal impact assessment as appendix A to the letter.

2 Response from Ainley and Associates Ltd

MOECC Comment:

(vii) To discharge effluent at Winston Churchill Blvd., an additional 1.6 km long forcemain will be required to pump sewage against gravity. This would require considerable amounts of energy during the lifespan of the project. The associated carbon footprint of this energy expenditure would be significant and should be included as a cost associated with this discharge.

Response:

We have based the design on twin 300 mm forcemains sufficient to accommodate full build out peak flow. Peak flow events are short duration, while most of the time the flow will be closer to average flow. Using twin 300 mm forcemains the velocity under peak flow will be 1.6 m/s whereas under average flow the velocity will be under 0.6 m/s requiring substantially less energy.
We recognize that there will be added energy cost to pump effluent from the WWTP to the outfall location at Winston Churchill Blvd versus 10th Line. The preferred WWTP site will require an effluent pumping station so the effluent would be pumped from this location no matter where the discharge to the river is located. The capital cost of the effluent pumping station was included in the WWTP Treatment Process Selection Technical Memorandum. For WWTP Site 1 (Solmar) the effluent would be pumped to an elevation on Wellington Road 52 that is above the

outfall pipe all the way to Winston Churchill Boulevard. Pumping along this outfall will require only 2.5 m of additional dynamic head under average flow condition. At full build, this results in an energy requirement of 76 KWh/day which represents $4,000/year energy cost. The 80 year NPV for this extra energy cost is $95,000.
In the Outfall Site Selection Technical Memorandum we have compared the capital costs of each alternative from a common point at the intersection of Wellington Road 52 and 10th Line and used this in the evaluation (refer to Table 5 in the technical memo). We assigned 20% weighting to the Economic Criteria and on the basis of Alternatives 1A/1B costing $0.4 million and Alternative 2 costing $1.6 million we assigned 5 points to Alternative 1A/1B and 1 point to Alternative 2. Adding the NPV of operating costs to the evaluation matrix would not significantly affect the scoring. However, the Outfall Site Selection Technical Memorandum did point out that the preferred site is sensitive to the weightings between Environment and Economic. A 4% change in the weightings would result in the 10th Line Alternatives having a higher score.

Our team continues to recommend the weightings and scoring outlined in our technical memorandum. Based on the results of the Natural Environment Assessment, the team considers that the protection of water quality in the West Credit River between 10th Line and Winston Churchill Boulevard is the prime governing consideration in selecting an outfall location to ensure protection of the brook trout population which is a significant resource within the watershed. While the effluent limits will also protect the water quality, there does exist the risk of a spill to the river which, though extremely unlikely, could have a negative impact on the fishery.

Sincerely,

AINLEY & ASSOCIATES LIMITED

Gary Scott, P.Eng.
Senior Project Advisor

cc. J Dougherty and Liam Marray, CVC (via email)
T. McKenna, MNRF (via email)
R Neubrand, MOECC (via email)
S Khan, MOECC (via email)
C. Furlong Triton Engineering (via email)

Hutchinson
Environmental Sciences Ltd.

1-5 Chancery Lane, Bracebridge, ON P1L2E3 │ 705-645-0021

April 11, 2018 HESL Job #: J160005

Barbara Slattery
Ministry of Environment and Climate Change, West Central Region
119 King Street West
12th Floor
Hamilton, Ontario L8P 4Y7

Dear Ms. Slattery:

Re: Review of Town of Erin Class EA Proposed Wastewater Treatment Plant Supporting Studies

The Ministry of Environment and Climate Change provided a variety of comments on *West Credit River Assimilative Capacity Study – Final Report – December 2017 Update* (HESL 2017), *Town of Erin EA Natural Environment Report* (Hutchinson Environmental Sciences Limited (HESL) 2017) and *Effluent Outfall Site Selection Technical Memorandum* (Ainley Group 2017).

Our responses focus on increasing MOECC's understanding of the objectives and scope of the Class EA and explaining the assessment developed to select preferred locations for various infrastructure.

We will finalize the Natural Environment Report based on the comments and responses provided here-in but please contact either of the undersigned if you have any further questions or concerns.

Sincerely,
Hutchinson Environmental Sciences Ltd.

Brent Parsons, M.Sc.
brent.parsons@environmentalsciences.ca

Deborah Sinclair, M.A.Sc.
Deborah.sinclair@environmentalsciences.ca

The Ministry of Environment and Climate Change provided a variety of comments on *West Credit River Assimilative Capacity Study – Final Report – December 2017 Update* (HESL 2017), *Town of Erin EA Natural Environment Report* (Hutchinson Environmental Sciences Limited (HESL) 2017) and *Effluent Outfall Site Selection Technical Memorandum* (Ainley Group 2017) on March 9, 2018. Our responses to the comments can be found on the following pages in *italics*. Some of the responses, as identified, are more appropriately addressed by the Ainley Group.

Comment #1: Our position is that the assessment of thermal effects resulting from the proposed effluent discharge on the receiving water is inadequate. To date, no detailed thermal effects were analyzed as to the potential impacts on growth, survival and reproduction of Brook Trout since each stage of the life cycle of Brook Trout requires a distinct thermal regime. As the thermal effects analysis was restricted to the month of August, it did not provide a complete understanding of the effects of the effluent discharge on the various life stages of Brook Trout populations throughout the years. Accordingly, the Ministry recommends that the current evaluation of thermal impacts be expanded to capture impacts at other crucial times of the year. The evaluation should also include the development of reasonable and effective mitigation measures that can be implemented if changes in ambient temperatures are determined to have the potential to impair established Brook Trout resources.

An assessment of the thermal impacts of effluent on the West Credit River and Brook Trout is provided in Appendix A. The following conclusions were made in the assessment.

The proposed effluent outfall diffuser will be placed approximately 2m upstream (i.e. south) of the large culvert that transmits flows beneath Winston Churchill Blvd. The culvert is approximately 45m long and represents degraded habitat because it is permanently shaded, doesn't permit macrophyte growth and limits the form of the stream bed and width of the channel.

The predicted increases in temperature in West Credit River downstream of the outfall as predicted through mass balance modeling are minimal. In the short-term (Phase 1), fully mixed water temperatures are predicted to stay the same (July) or increase up to 0.9ºC. Fully mixed water temperatures during Brook Trout spawning (October) and egg development (November to March) will remain well below their upper tolerance temperatures.

In the longer-term (Full Build out, > 20 years), fully mixed water temperatures are predicted to increase by a maximum of 1.7ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The nominal increase (0.2ºC) in July water temperature is not expected to affect the growth life stage of the local Brook Trout population for the following reasons:

1. *Brook Trout in this reach have acclimatized to water temperatures up to 24.3ºC (maximum water temperature of Winston Churchill),*
2. *Brook Trout routinely experience water temperatures of 19.3ºC in the study area,*
3. *Temperature predictions are conservative since they are focused on 7Q20 flows (which are exceeded 99.5 to 99.9% of the time; Pyrce 2004) and 75th percentile water temperatures,*
4. *Brook Trout commonly seek out thermal refugia (Ebersole et al. 2001),*

5. *Seasonal temperature cycles provide an acclimatization period for Brook Trout (Raleigh 1982), and*

6. *Fully mixed water temperatures during the sensitive spawning (October) and egg growth development (November to March) life stages will remain well below their upper tolerance temperatures.*

The maximum predicted distance to upper threshold temperatures in the West Credit River downstream of the outfall during Phase 1 as predicted through CORMIX modeling is 32m in August so increased temperatures will be constrained to degraded habitat located in the culvert. Predicted distances to upper threshold temperatures during Full Build Out are 84m in August and 715m in October but, the October distance of 715m is considered artificially high. By 35 m downstream of the diffuser (within the culvert) water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October, respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development. Any effects on Brook Trout populations will be partially mitigated in August by their ability to seek out thermal refugia, and from November - March egg and sac-fry development will not be impacted because Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore water temperatures near these spawning and development areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the change to water temperatures.

There are several qualifications mentioned throughout this assessment that made it conservative. Qualifications include:

1. *These predictions were made for 7Q20 low flow conditions as a conservative estimate of change - flows will be higher and temperature changes smaller 99.5% of the time.*
2. *Seasonal temperature cycles from summer highs to winter lows provide an acclimatization period to temperature extremes for Brook Trout (Raleigh 1982),*
3. *Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001),*
4. *Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations,*
5. *Most importantly, Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore water temperatures near these spawning areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the effect of change to water temperatures.*

The Provincial Water Quality Objective for water temperature is, "The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, *the diversity, distribution and abundance of plant and animal life shall not be significantly changed." (MOE 1994). Based on the results of the thermal assessment on Brook Trout, including the various conservative qualifications, we predict that these temperature changes resulting from the WWTP discharge will not "significantly change the distribution and abundance of plant and animal life" per the Provincial Water Quality Objective.*

Comment #2: An effluent criterion for chloride will not be required. However, we intend to advise our approvals staff to include a condition in any future approval under Section 53 of the Ontario Water Resources Act that chloride be monitored in the influent, effluent and receiving water. The Ministry recommends that a contingency plan be developed for the management of chloride when it exceeds the long-term Canadian Water Quality Guideline of 120 mg/L in the receiving water. Costs associated with the implementation of the contingency plan should be estimated and included as part of the total project cost. The Ministry also supports the recommendations provided by Credit Valley Conservation in their May 10, 2017 memo suggesting the use of high efficiency water softeners at the household level as a means of reducing chloride loads at source.

It is unlikely that chloride concentrations will exceed the Canadian Water Quality Guideline of 120 mg/L in the receiving water because predictions were calculated using 7Q20 flows and so do not represent expected concentrations for the long-term indefinite exposures that are relevant to the CCME guideline of 120 mg/L. Exposure to the predicted concentrations (slightly above CCME) would be for brief periods (7 days every 20 years) and aquatic life would be exposed at concentrations well below the short-term exposure CCME guideline of 640 mg/L.

We recommend that monitoring of chloride concentrations in the WWTP influent, effluent and receiver be included in the ECA and if these concentrations approach problematic levels in the West Credit River that the Town consider implementing a public education program focusing on the use of water softeners to mitigate chloride discharge to the sewage system as water softeners are the primary source of chloride levels in wastewater in these areas.

Comment #3: At this time MOECC is not able to concur with the preferred effluent outfall location being proposed for the west side of Winston Churchill Blvd for the following reasons:

i) Very limited data/information is available for the immediate downstream reach of the preferred discharge location (i.e. the approximately 1.5 km long reach from Winston Churchill Blvd. to Belfountain). All fisheries, benthic invertebrates, aquatic habitat, Brook Trout spawning survey and other river data are available from 10th Line to Winston Churchill Blvd (this reach is approximately 1.5 km long). The status of the fisheries, benthic invertebrates, aquatic habitat, Brook Trout spawning and other river data between Winston Churchill Blvd to Belfountain is not known to enable a like-for-like comparison with the upper reach.

The reach of the West Credit River between 10th Line and Winston Churchill Blvd. was previously selected as the location for a WWTP treated effluent outfall through the Town of Erin Servicing and Settlement Master Plan Final Report and in consultation with MOECC and CVC (BM Ross 2014). The purpose of the EA, as per the Request for Proposal, was to compare the environmental sensitivities between three candidate effluent outfall sites between 10th Line and Winston Churchill Blvd and to prepare an ACS to recommend effluent quality. HESL's Natural Environment Work plan[1] reviewed by Credit Valley

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[1] Memorandum dated March 28, 2016 from Brent Parsons HESL to Shannon Dougherty, Credit Valley Conservation

Conservation stated that "The assessment of aquatic ecology will be focused on the West Credit River between the 10th Line of Erin and Winston Churchill Boulevard with emphasis on the stretch between each of the three potential discharge locations and the end of the mixing zones as identified by CORMIX modelling."

The Brook Trout spawning survey was extended 500m downstream of Winston Churchill Blvd (outside of the study area) since preliminary Assimilative Capacity Study results indicated that the near-field mixing zone, as defined by ammonia, was <500m. Characterization of further downstream reaches was unnecessary because PWQOs would not be exceeded and therefore would not influence site selection. Aquatic habitat and benthic invertebrates were characterized near the proposed effluent outfalls to typify conditions that could be impacted through installation of a diffuser and near-field impacts associated with effluent, consistent with our work plan. Therefore, our conclusions were made on the basis of like-for-like comparisons of habitat and mixing zone characteristics.

ii) Brook Trout spawning survey and red counts were limited to the area 500 m downstream of Winston Churchill Blvd, and that data was compared with the redd counts surveyed for the 1.5 km long reach from 10th Line to Winston Churchill Blvd. That was not a like-for-like comparison.

See answer to i)

iii) The number of redds counted in an approximately 250 m long mixing zone downstream of 10th Line in November, 2016 (3 redds but no observance of spawning fish) was compared with the zero redds counted in the similar-sized mixing zone downstream of Winston Churchill Blvd. This information was considered as a strong argument to relocate the outfall to Winston Churchill Blvd. The MInistry does not see this as a strong argument as it was based on a single survey data point and no spawning fish presence was noted at the redds below 10th Line. Observing redds at a single point in time cannot prove/disprove that fish would congregate there for spawning. We suggest that data from a more robust spawning survey is needed to support the preferred location.

The assessment completed to determine the most appropriate outfall location was robust as the assessment included an evaluation of aquatic habitat, water quality, benthic invertebrates, fisheries and a spawning assessment. Brook Trout redds were weighted heavily in the assessment since MNR and CVC (2002[2]) identify the protection of Brook Trout as a fisheries objective in the Credit River and they are an indicator of high quality, coldwater habitat. The three redds under question were assigned category 1 status per CVC protocol (definite redd, confirmed, fish may be seen on redd) as opposed to category 2 (probable but not 100% sure) or 3 (possible), and although no fish were seen, as noted on page 26 of the Natural Environment Report, "Fish presence at individual redds is likely under-representative because of disturbance from the presence of the biologists". The reach was also noted as having >10 redds in CVC et al 2011[3], and habitat was ideal for Brook Trout spawning. Additional spawning surveys were discussed with CVC but it was agreed that the spawning survey completed on November 1, 2016 successfully characterized redd locations, and further stress on the Brook Trout assemblage was not warranted given

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[2] *Ministry of Natural Resources and Credit Valley Conservation. 2002. A Cooperative Management Planning Initiative for the Credit River Fishery.*

[3] *Credit Valley Conservation, Aquafor Beech Inc. and Blackport Hydrogeology Inc. 2011. Erin Servicing and Settlement Master Plan – Phase 1 – Environmental Component, Existing Conditions Report.*

the number of redds observed during the November 1, 2016 survey. We therefore conclude that our methods were robust and that an outfall location at Winston Churchill Blvd. will pose less of a potential threat to Brook Trout than 10th Line.

iv) According to the biologic metric results from Hutchinson's field sampling of benthic invertebrates in August, 2017, both sites appear to be very similar.

Our report states that %EPT (37.87%) and Diversity (2.66) were higher on average at the 10th Line sampling locations than at Winston Churchill Blvd (%EPT = 32.45%, Diversity = 2.26), indicating that the benthic environment at Winston Churchill Blvd supports a less sensitive invertebrate assemblage and, when considering benthic invertebrates as a bioassessment tool, poorer water quality conditions, and should therefore be the preferred location for an effluent outfall.

v) Habitat characteristics in the mixing zone (depth, width, substrates, canopy coverage etc.) are also very similar in both locations.

Habitat is similar and was not selected as a screening criterion to assess potential effluent outfall locations as a result. However, the 45m culvert located beneath Winston Churchill Blvd. limits the form of the stream bed and the width of the channel and as a result provides poorer habitat than the habitat located beneath the clear span bridge at the 10th Line, which is largely unaffected by the presence of the bridge.

vi) Effluent criteria agreed upon to date, would be protective of all forms of aquatic life and all aspects of aquatic life cycles during indefinite exposure irrespective of where it is discharged (temperature effects yet to be analyzed).

We agree that effluent criteria are designed to be protective of all life forms and all aspects of aquatic life cycles in the receiving environment, but the EA must also extend beyond effluent criteria to consider other aspects of the natural environment and, this case, considered an effluent outfall location that had fewer environmental sensitivities. Through the examination of a variety of different features, the least sensitive location in the study area was determined to be Winston Churchill Blvd.

vii) To discharge effluent at Winston Churchill Blvd, an additional 1.6 km long forcemain will be required to pump sewage against gravity. This would require considerable amounts of energy during the lifespan of the project. The associated carbon foot print of this energy expenditure would be significant and should be included as a cost associated with this discharge location.

Please refer to response by Ainley.

viii) Credit Valley Conservation had no objection to the 10th Line discharge in their January 31, 2017 letter.

The ACS was completed for a 10th Line discharge because this was the most conservative location from the perspective of flow and water quality, not aquatic habitat. Flows increased between 10th Line and Winston Churchill Blvd in 2016 by 9 - 32% due to groundwater discharge (HESL 2017). Water quality at Winston Churchill was also of higher quality (lower nutrients), also as result of groundwater discharge. It was decided at the Assimilative Capacity Pre-Consultation Meeting (meeting minutes appended) that the ACS would be completed for 10th Line, and results could be conservatively applied at Winston Churchill Blvd due to the higher flows and better water quality conditions. It is our understanding that CVC's January

31, 2017 letter is approval of the ACS from a water quality perspective, and not preference of the 10th Line over Winston Churchill Boulevard from an aquatic habitat perspective.

Summary

A proposed outfall at Winston Churchill Blvd is preferred over the 10th Line for a number of sound environmental reasons as discussed in the Natural Environment Report and ACS, including:

1. *It provides greater dilution (9-32% higher flows) than 10th Line;*
2. *Has greater ability to assimilate treated effluent and avoid thermal impacts to aquatic biota due to lower nutrient concentrations and cooler water temperatures;*
3. *Supports less Brook Trout spawning habitat and a lower quality benthic assemblage; and*
4. *The 45m long culvert directly downstream of the proposed outfall at Winston Churchill Blvd. represents degraded habitat compared to a location at the 10th Line. The culvert is permanently shaded and limits the form of the stream bed and width of the channel, and 30% of the near-field mixing zone will be contained within culvert.*

We completed a thorough assessment of thermal impacts and have reviewed comments from MOECC, CVC, MNRF and the County of Wellington on the Natural Environment Report, and continue to recommend that Winston Churchill Blvd is the more appropriate effluent outfall location.

Meeting Minutes

Date: **May 30, 2016**

Location: MOECC, 1 Stone Road, 3rd Floor, Room 305, Guelph

Re: J160005 – Erin Class EA – Assimilative Capacity Study Pre-Consultation Meeting

Present:

Barbara Slattery (MOECC)
Craig Fowler (MOECC)
Manpreet Dhesi (MOECC)
Jennifer Dougherty (CVC)
Liam Murray (CVC)
John Sinnige (CVC)
Christine Furlong (Triton)
Ray Blackport (Blackport)
Gary Scott (Ainley)
Deborah Sinclair (HESL)
Neil Hutchinson (HESL)
Tara Roumeliotis (HESL)

Regrets: Tim Mereu (CVC), Joe Mullan (Ainley)

The purpose of the meeting was to review the ACS work plan with stakeholders and discuss any questions or concerns with the proposed approach (modelling, field investigations and analyses).

AGENDA

1. Introductions
2. Background
3. Review ACS work plan and tasks
4. Feedback and agreement on approach
5. Schedule and meetings
6. Additional items

ACTION ITEMS

Item	Description	Action
1	• Check the *Erin Servicing and Settlement Master Plan; Phase 1 – Environmental Component – Existing Conditions Report* ("Existing Conditions" report), May 2011, for raw data needed.	HESL
2	• Provide HESL with raw water quality data for 10th Line and Winston Churchill Blvd. that was used in the BM Ross preliminary ACS. Provide HESL with any additional water quality data acquired since that report (i.e., 2013 and onward)	CVC (Jennifer Dougherty)
3	• Provide group with updated 7Q20 memorandum within approximately 2 weeks.	CVC (John Sinnige)
4	• Confirm wastewater effluent flow for ACS - expected by end of summer	Ainley (Gary Scott)
5	• Measure flows at Winston Churchill and 10th Line during water quality sampling events for comparison • Evaluate need for to add chloride analyses to future water quality sampling events • Evaluate need to deploy pH logger in Credit River for diurnal pH cycle.	HESL

DISCUSSION NOTES

- Regarding additional data for the 10th Line (at West Credit River) station – CVC reported that there was no new water quality data for this station in 2013 through 2015. Only new water quality data is for the PQWMN station at Winston Churchill Blvd.
- CVC reported that they have a temperature gauge at 10th Line and at Winston Churchill Blvd.
- Septic Impact chapter in the *Erin Servicing and Settlement Master Plan; Phase 1 – Environmental Component – Existing Conditions Report* ("Existing Conditions" report), May 2011 provides flows measured by CVC at 10th Line and Winston Churchill Blvd. HESL to review report for raw flow data.
- Jennifer Dougherty (CVC) will provide HESL with any other raw data that BM Ross used in their preliminary ACS and that is not provided in the Existing Conditions report.
- John Sinnige provided an update on the 7Q20 calculation:
    - The rating curve for the 10th Line flow station is continually updated.

- CVC are using the 8th Line gauge as well as transposing the 10th Line data with the Belfountain WSC station, which has about 15 years' worth of data.
  - The two gauges will give a lot more comfort in the 10th Line 7Q20.
  - CVC are currently in the process of revising the extrapolation.
  - Currently looking like the 7Q20 will remain the same or go up slightly.
  - CVC hope to have the 7Q20 memorandum ready for peer review in two weeks and will email this out to the group. Ray Blackport to provide review. MOECC may potentially comment.
- HESL asked if anyone had completed water quantity measurements at 10th Line and Winston Churchill in order to better understand the rates of groundwater discharge to the West Credit River within this reach. Ray Blackport reported collecting some spot flow measurements at both 10th Line and Winston Churchill.
- HESL recommended that water quality be modelled at 10th Line, since this will be a more conservative location than Winston Churchill Blvd (which has higher flows due to groundwater inputs and has been shown to have better water quality).
- Craig Fowler asked if HESL intended to start the ACS process over. HESL responded that the intention was to build on the preliminary ACS work completed by BM Ross.
- Craig Fowler inquired about the wastewater flow predictions in the BM Ross preliminary ACS of 435 L/person/day, including I/I.
  - Christine Furlong explained that BM Ross looked at water taking records to estimate wastewater flows; that 435 L/person/day is a conservative estimate. Also noted that 450 L/person/day is the MOECC maximum recommended design wastewater flow.
  - HESL asked Gary Scott to confirm the wastewater effluent flow that should be used in the ACS.
  - Gary Scott noted that the starting point for deriving the effluent flow is 2,610 m^3/d for 6,000 people, and that it will be an iterative process.
  - MOECC requested that the ACS is not submitted for review until the final effluent flows are confirmed.
  - CVC requested to Ainley to be a part of the discussion on population serviced, who will remain on septic, etc.
  - Town of Erin would like some growth in Hillsburgh on partial services – on municipal water and private septic.
- HESL raised question as to whether modelling seasonal discharge at proposed WWTP was still desired. Christine Furlong clarified that seasonal discharge was recommended for consideration during the SSMP and therefore it needed to be included in the ACS.
- CVC suggested that HESL complete diurnal pH monitoring in West Credit River, in addition to the DO and temperature monitoring that is already planned.
  - CVC noted that they had completed continuous pH monitoring in West Credit River, which may be presented in the Existing Conditions report. If not, HESL will request this data from CVC, and assess need to deploy pH logger
- HESL noted that dye tracer study will be conducted at 10th Line. Group requested that HESL also conduct the dye tracer study at Winston Churchill station and HESL agreed.

- In preparation for the dye tracer study, agencies and media will be notified. HESL will prepare a media release, which will be provided to Ainley and Triton for distribution. HESL to let Craig Fowler know when dye tracer study will take place.

- CVC suggested that chloride be added as a parameter of interest to the ACS modelling exercises.
  - HESL to review need to analyse water samples collected at 10th Line for chloride analysis
- HESL noted that there is not much value in completing the ACS for three discharge locations since results will not vary significantly. CORMIX modelling will be completed for a 10th Line discharge, as the most conservative location. If future discharge location recommendations change, the CORMIX modelling can be re-run easily.
- HESL noted that the Orangeville WWTP (which discharges to the Credit River) includes denitrification of wastewater and has a TN limit of 15 mg/L.
- Group approved the ACS work plan put forward by HESL, with the following comments:
  - The MOECC recommended against any radical changes in the ACS from what BM Ross has completed. The MOECC had approved in principal what BM Ross had put forward in the preliminary ACS. West Credit River is a Policy 1 receiver.
  - CVC supports the proposed diurnal DO studies.
- Ainley noted that the first PIC meeting is scheduled for mid-November and will cover the following items:
  - Service area
  - Type of collection system
  - Population numbers
  - Discharge and plant location (3 options)
- MOECC noted that they would prefer to not be involved in the whole ACS process, but would rather just review the finalized ACS report.
- With respect to the draft effluent limits, to be recommended in the draft ACS, MOECC requested that they be sent a copy of these for possible comment, but do not necessarily need to come to a meeting on the limits.
  - MOECC noted that they do not need to peer review the 7Q20 if the number was calculated based on sound science and peer-reviewed by Ray Blackport.
- CVC raised a concern regarding the potential cumulative effects of septic system discharge to the watershed from the planned partial servicing at Hillsburgh. CVC noted that the Hillsburgh reach of the West Credit River is very small with elevated nitrate concentrations. Discussion included:
  - the observation that the net effect of the EA was to remove septic systems from the watershed by servicing the Town of Erin
  - the suggestion was that any septic servicing at Hillsburgh would require state of the art tertiary treatment and that developers would be informed of this.
- CVC requested a separate meeting to discuss/address cumulative impact of new septic systems within Erin and Hillsburgh since it was identified in the meeting that it was outside the scope of the current EA.
- Liam Murray asked the group if it would be an issue to the ACS predictions if the Erin and Hillsburgh ponds are taken offline. HESL responded that water quality would be expected to improve if the ponds were taken offline.

- Liam Murray noted that there is a new gravel pit in Peel, near Winston Churchill Blvd. To the group’s knowledge, there are no water taking operations occurring at the new gravel pit.
- Christine Furlong noted that that next project meeting should include the CORE Management Team.
- The meeting was adjourned at 1215 PM.

Appendix A – West Credit River Temperature Assessment

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202-501 Krug Street, Kitchener, ON N2B 1L3
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Memorandum

Date: **April 4, 2018**

To: **Gary Scott, Ainley Group**

From: **Brent Parsons, Deborah Sinclair and Neil Hutchinson**

Re: **HESL J160005 – Thermal Assessment of Erin WWTP on West Credit River**

The reach of the West Credit River between 10th Line and Winston Churchill Blvd. contains a cold-water thermal regime and aquatic habitat that supports a robust population of sensitive coldwater fish species and critical Brook Trout spawning habitat (HESL 2017a). The purpose of this technical memorandum is to provide an assessment of the potential effect of the Erin WWTP effluent on water temperatures in the West Credit River during all times of the year for both Phase 1 (near term) and Full Build Out ((FBO) 20-year horizon) of the Wastewater Treatment Plant (WWTP) project to assess potential impacts to Brook Trout.

Temperature Thresholds for Brook Trout in West Credit River

Brook Trout are ranked as the most sensitive fish species in Toronto-area streams (Wichert and Regier 1998), they are the indicator species for coldwater habitat in the Credit River watershed (MNR and CVC 2002) and were therefore selected as the sentinel species to assess potential impacts of the Erin WWTP effluent on water temperature in the West Credit River. Temperature thresholds for various life stages were reviewed and two temperature "thresholds" (optimum and upper tolerance) associated with spawning, egg development and adult behaviour (i.e. growth) were defined (Table 1). Optimum water temperatures for spawning, egg development and general adult behaviour were defined as 10.7°C, 6.1°C and 14.2°C, respectively, as reported in Key Ecological Temperature Metrics for Canadian Freshwater Fishes (Hasnain et al. 2010). Upper tolerance temperatures for spawning, egg production and adult behaviour were defined as 16°C (Hokanson et al. 2001), 11.7°C (Hokanson et al. 2001) and 19°C (various citations – Table 1), respectively.

Table 1. Water Temperature Considerations for Brook Trout at Various Life Stages. Note that bold values are carried forward into the assessment.

Life Stage	Water Temperature Considerations
Spawning	- Ovulation and spawning occur at **16°C** or lower (Hokanson et al. 2001) - Optimal spawning temperature = **10.7°C** (Hasnain et al. 2010)
Egg Development	- Optimum egg development temperature = **6.1°C** (Hasnain et al. 2010) - Egg viability decreases above **11.7°C** (Hokanson et al. 2001)

Adult	- Optimum growth temperature = **14.2°C** (Hasnain et al. 2010) - Optimum growth rate at 14 °C (Baldwin 1951) - Brook Trout do poorly in streams where water temperatures exceed 20°C for extended periods (McAfee 1966) - Brook Trout are sensitive to changes in water temperature because they do not tolerate water temperatures greater than **19°C** - 20°C for long (Creaser 1930; Burton and Odum 1945; Gibson 1966) - A general upper tolerance of **19°C** - 20°C is evident throughout the literature (Kerr 2000). - **19°C** is critical as temperatures above this are considered suboptimum (Hokanson et al. 1973) - When temperatures reach 20°C non-indigenous Brown Trout will outcompete Brook Trout (Taniguchi et al. 1998)

Brook Trout life stages and associated water temperature thresholds are presented for each month in Table 2. In the West Credit River, growth occurs throughout the year, with spawning in October/November (active spawning was observed on November 1, 2016 (HESL 2017a)), and egg development from November through to March of the following year. Egg development has the lowest temperature preference, so these values were applied as thresholds for November to March, spawning temperatures were applied to October, and growth temperatures were applied as thresholds for the rest of the year (April to September), when spawning and egg development are not occurring (Table 2).

Temperature thresholds were compared to continuous water temperature data collected by CVC at Winston Churchill Blvd. from 2009-2015 (station 501150002; Table 2, Figure 1). Existing 75th percentile and maximum water temperatures exceed the optimal temperature preference of 14.2°C for Brook Trout growth from May to September (Table 2, Figure 1) and the 10.7°C optimal temperature preference for spawning in October. Maximum recorded water temperatures also exceeded the upper tolerance thresholds of 19°C for growth from May to September, and the upper tolerance threshold for spawning of 16°C in October. The 75th percentile July temperature of 19.3°C also exceeds the upper tolerance threshold for growth.

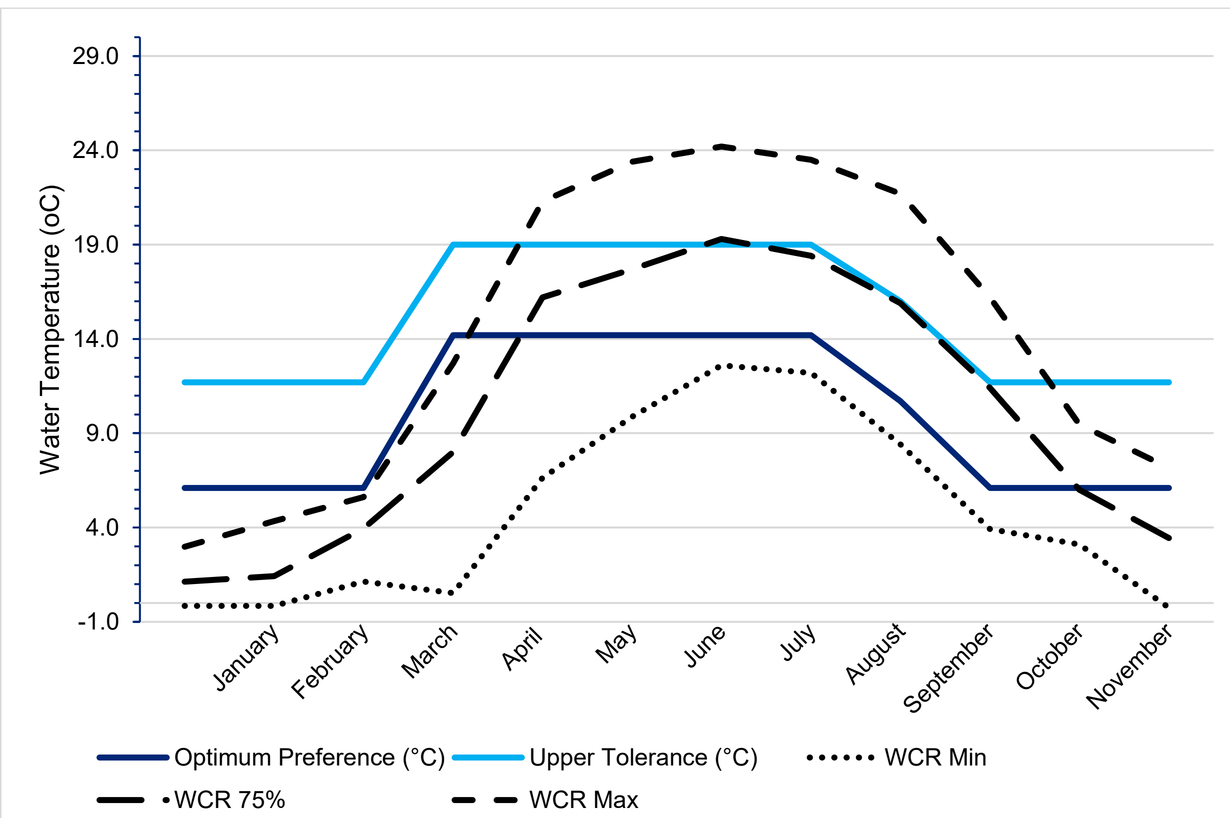
Table 2. Monthly Temperature Thresholds for Brook Trout in the West Credit River.

Month	Life Stage with Lowest Temperature Requirement	Optimal Temperature Preference (°C)	Upper Tolerance Temperature (°C)	Existing West Credit River Temperatures (°C)		
				Minimum	75th Percentile	Maximum
January	Egg Development	6.1	11.7	-0.2	1.1	3.0
February				-0.2	1.4	4.4
March				1.1	4.0	5.6

April	Growth	14.2	19	0.5	8.0	12.7
May				6.6	16.2	**21.3**
June				9.9	17.7	**23.4**
July				12.6	**19.3**	**24.2**
August				12.2	18.4	**23.5**
September				8.42	15.9	**21.7**
October	Spawning	10.7	16	3.9	11.4	**16.2**
November	Egg Development	6.1	11.7	3.1	6.0	9.5
December				-0.3	3.4	7.2

Notes: There was no temperature data for the months of January, February and December at station 501150002. Values for these months are based on continuous water temperatures collected at Belfountain at station 14526010 by CVC (Correlation between Belfountain and Winston Churchill data: r = 0.99; p<0.001). Shaded values exceeded optimal temperature preference values and bold values exceed upper tolerance temperatures.

Figure 1. Brook trout temperature requirements and water temperatures of West Credit River at Winston Churchill (2009-2015)



The Brook Trout population in the West Credit River near Winston Churchill Blvd. appeared to be thriving based on numbers of fish and spawning redds observed during surveys (HESL 2017a) even though existing 75th percentile water temperatures exceed optimal temperature preference for growth and spawning becase:

1. Water temperature is only one habitat component of many required to support robust populations;
2. Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001);
3. Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations; and
4. Groundwater upwellings are ubiquitous in the study area and they provide a consistent source of cold, oxygen-rich water for egg and sac-fry development.

Therefore, for the purposes of the temperature assessment, upper threshold water temperatures were used to assess any effects of the Erin WWTP on the Brook Trout life stages in the West Credit River.

Approach

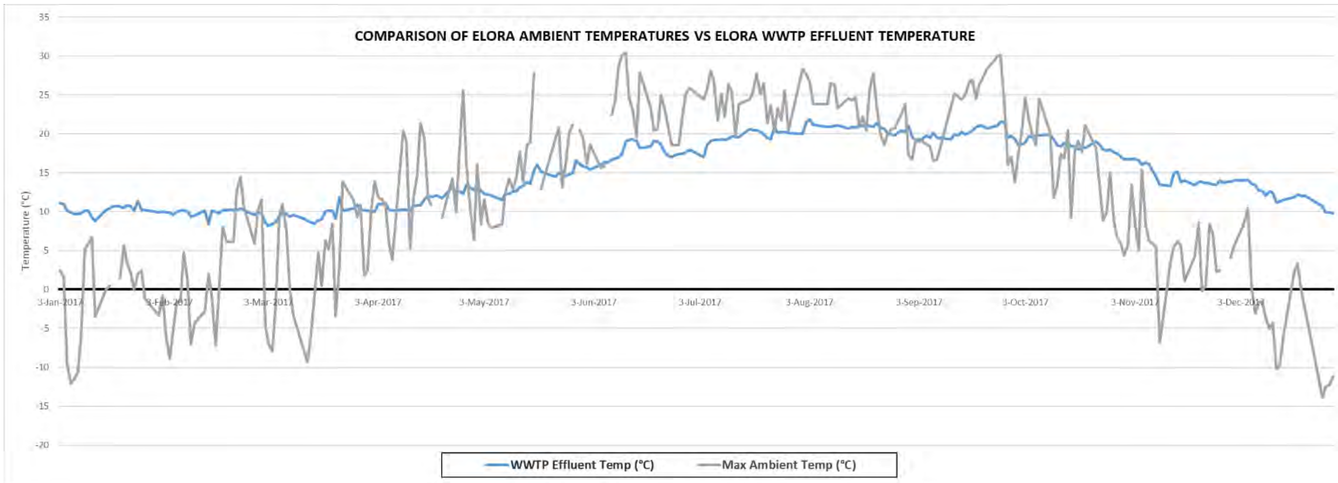
The effect of the Erin WWTP effluent on water temperatures in the West Credit River was calculated using:

1. A mass balance model (i.e., conservative approach) to estimate water temperatures after complete mixing of effluent within the creek; and
2. A CORMIX model to predict the size and shape of the thermal mixing zone.

Water temperature data for the West Credit River were obtained from CVC's station located at Winston Churchill Blvd (2009 through 2015 data; station 501150002), which was supplemented with water quality data collected by CVC at Belfountain (station 14526010). The 75th percentile, minimum and maximum water temperatures were calculated for each month (Table 2) as input into the models.

Monthly 75th percentile effluent temperatures were provided by Ainley Group (Preya Balgobin pers. communication, March 13, 2018) based on 2017 effluent temperatures for the Elora WWTP. The Elora WWTP effluent temperatures were used as it is close to Erin, and similar water sources and climate would result in similar effluent temperatures. It should be noted however that the Elora WWTP uses an extended air process which has higher retention time and longer exposure to ambient air temperatures compared to the treatment process that is proposed at Erin, which means that the use of Elora WWTP effluent temperatures represents a conservative approach of higher effluent temperatures than will likely be recorded at the Erin WWTP. These values were corrected for heat loss through the 1.7 km forcemain between the WWTP and the outfall to the West Credit River. Except for May, it is predicted that effluent will always be warmer than the creek (Table 3). Figure 2 presents ambient air temperatures in Elora compared to Elora WWTP effluent temperatures. The ambient temperatures show much greater fluctuations than the WWTP effluent temperature. The WWTP effluent temperatures gradually increase in warmer weather, and slowly decrease in cooler weather, and are not affected by swings in ambient air temperature.

Figure 2. Comparison of Elora Ambient Air Temperatures with Elora WWTP Effluent Temperatures.



Monthly 7Q20 flows for the West Credit River at 10th Line were the same as those used in the ACS (HESL 2017b). They were calculated by CVC (CVC 2016) and corrected for climate change (10% reduction as per the annual 7Q20 estimate by CVC) and used as input into the models. The lowest 7Q20 value occurs in September, followed by the other summer monthly flows (August, June and July). Highest 7Q20 values occur in the spring (April and March) and late fall/early winter (December/November; Table 3).

Models were run for both Phase 1 (39 L/s) and Full Build Out (83 L/s) effluent flows. It should be noted that Phase 1 is predicted to occur in the near term (next 3 to 5 years), and Full Build Out conditions will not occur for 20 or more years. Therefore, Full Build Out predictions may be validated and refined with future site-specific data (e.g. Erin WWTP effluent temperatures).

The CORMIX model inputs were those detailed in the *West Credit River Assimilative Capacity Study* (HESL 2017b) with addition of a surface heat exchange coefficient for modelling temperature. The CORMIX user manual (Doneker and Jirka 2014) suggests that, for conservative models, a value of 10 W/m^2,°C be used at low water temperatures and a value of 20 W/m^2,°C be used at high water temperatures. These values correspond to a wind speed of 0-2 m/sec - heat exchange would be greater at higher wind speeds. Following this, a surface heat exchange coefficient of 20 W/m^2,°C was used for the months of June through August, and a coefficient of 10 W/m^2,°C was used for all other months.

Mass Balance Model Results

The resulting water temperatures in the West Credit River downstream of the proposed WWTP discharge as calculated by the mass balance (at both Phase 1 and Full Build Out effluent flows of 39 L/s and 83 L/s) are presented in Table 3.

Table 3. Monthly Fully-Mixed Water Temperatures in West Credit River by Mass Balance Modelling

Month	75th Effluent Temp (°C)	75th % West Credit River Temp (°C)	Monthly 7Q20 (L/s)	Phase 1 Mixed Temp (°C)	Phase 1 Temp Increase (°C)	Full Build Out Mixed Temp (°C)	Full Build Out Temp Increase (°C)	Upper Tolerance Temperature (°C)
January	10.8	1.1	374	2.0	0.9	2.9	1.8	11.7
February	10.3	1.43	357	2.3	0.9	3.1	1.7	11.7
March	10.3	4.0	464	4.4	0.5	4.9	1.0	11.7
April	12.2	8.0	568	8.3	0.3	8.5	0.5	19.0
May	14.8	16.2	416	16.1	-0.1	16.0	-0.2	19.0
June	18.0	17.7	306	17.7	0.0	17.8	0.1	19.0
July	19.6	19.3	319	19.3	0.0	19.4	0.1	19.0
August	20.3	18.4	275	18.6	0.2	18.8	0.4	19.0
September	20.0	15.9	244	16.5	0.6	16.9	1.0	19.0
October	18.4	11.4	338	12.1	0.7	12.8	1.4	16.0
November	15.7	6.0	460	6.8	0.8	7.5	1.5	11.7
December	12.7	3.4	464	4.2	0.7	4.8	1.4	11.7

Note: Shaded values exceed both 75th percentile background and upper tolerance threshold for Brook Trout

During Phase 1, fully mixed 75th percentile water temperatures are predicted to decrease in May by 0.1ºC, not change in June and July, and increase between 0.2 to 0.9ºC in August to April. The largest increase in water temperatures will be in the late fall (November) and winter (December, January and February), with water temperature increases of 0.7 to 0.9ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The existing 75th percentile water temperature in July (19.3ºC) is above the upper tolerance threshold for growth (19ºC). Under Phase 1 effluent flows, July water temperature is predicted to stay the same (i.e. 19.3ºC), therefore, there is no predicted change from current conditions. Fully mixed water temperatures during the sensitive periods for Brook Trout spawning (October) and egg development (November through to March) will remain well below the upper tolerance temperatures (Table 3) although groundwater inflows will isolate eggs from the changes.

During Full Build Out, fully mixed 75th percentile water temperatures are predicted to decrease in May by 0.2ºC and increase between 0.1 to 1.8ºC between June and April. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. In July, the 75th percentile water temperature is predicted to be 19.4ºC, above the threshold of 19ºC, but only 0.1ºC above the existing 75th percentile water temperature of 19.3ºC.

CORMIX Model Results

During Phase 1, the upper tolerance threshold temperatures are met at the diffuser from January to June. In July, background 75th percentile West Credit River water temperatures exceed the upper tolerance threshold value of 19ºC (see mass-balance modeling results), therefore the threshold will not be met downstream. From August to December the distance to the point where effluent temperature declines to the upper tolerance threshold ranges from -2.5 m (backflow from diffuser) to 32 m. These distances are within the 152 m size of the mixing zone predicted for other water quality parameters in the effluent (HESL 2017b).

Table 3 Distance (m) to meet Upper Tolerance Thresholds in West Credit River.

Month	Effluent Temp (°C)	75th % WCR Temp (°C)	Monthly 7Q20 (L/s)	Upper Tolerance Temperature (°C)	Distance (m) downstream to Upper Tolerance - Phase 1	Distance (m) downstream to Upper Tolerance - Full Build-Out
January	10.8	1.13	374	11.7	0	0
February	10.3	1.43	357	11.7	0	0
March	10.3	3.95	464	11.7	0	3
April	12.2	8.00	568	19.0	0	0
May	14.8	16.20	416	19.0	a	
June	18.0	17.70	306	19.0	0	0
July	19.6	19.30	319	19.0	b	
August	20.3	18.40	275	19.0	32	84
September	20.0	15.90	244	19.0	3	3
October	18.4	11.40	338	16.0	3	715
November	15.7	6.00	460	11.7	7	12
December	12.7	3.44	464	11.7	-2.5	3

Notes: a – effluent is cooler than West Credit River, therefore the Upper Tolerance Threshold is never exceeded; b – existing 75th percentile West Credit River water temperatures exceed the Upper Tolerance Threshold

During Full Build Out, the upper tolerance threshold temperatures are met at the diffuser in January, February, April, and June. Again, in July, background 75th percentile West Credit River water temperatures exceed the upper tolerance threshold value of 19ºC, therefore the threshold will not be met downstream. In March, September, November, and December, the distance for temperature to decrease to the upper tolerance threshold ranges are less than 40 m. In August and October, the distance to upper tolerance threshold temperatures are 84 and 715 m respectively. We note that the large increase in October is an artifact that relates to the transition from a growth tolerance temperature of 19°C to a spawning tolerance of 16°C, which will not occur on October 1 but will depend on when fish actually spawn. The actual affected

distance in the river will be much less than the 715 m predicted. At 35 m downstream of the diffuser, water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development.

Thermal Impact on Fish and Other Aquatic Species

The proposed effluent outfall diffuser will be placed approximately 2 m upstream (i.e. south) of the large culvert that transmits flows beneath Winston Churchill Blvd. The culvert is approximately 45 m long and represents degraded habitat because it is permanently shaded, doesn't permit macrophyte growth and limits the form of the stream bed and width of the channel.

The predicted increases in temperature in the West Credit River downstream of the outfall as predicted through mass balance modeling are minimal. In the short-term (Phase 1), fully mixed water temperatures are predicted to stay the same (July) or increase by 0.9ºC. Fully mixed water temperatures during Brook Trout spawning (October) and egg development (November to March) will remain well below their upper tolerance temperatures.

In the longer-term (Full Build Out, > 20 years), fully mixed water temperatures are predicted to increase by a maximum of 1.7ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The nominal increase (0.2ºC) in July water temperature is not expected to affect the growth life stage of the local Brook Trout population for the following reasons:

1. Brook Trout in this reach have acclimatized to water temperatures up to 24.3ºC (maximum water temperature of Winston Churchill),
2. Brook Trout routinely experience water temperatures of 19.3ºC in the study area,
3. Temperature predictions are conservative since they are focused on 7Q20 flows (which are exceeded 99.5 to 99.9% of the time; Pyrce 2004) and 75th percentile water temperatures,
4. Brook Trout commonly seek out thermal refugia (Ebersole et al. 2001),
5. Seasonal temperature cycles provide an acclimatization period for Brook Trout (Raleigh 1982), and
6. Fully mixed water temperatures during sensitive spawning (October) and egg growth development (November to March) life stages will remain well below their upper tolerance temperatures.

The maximum predicted distance to upper threshold temperatures in the West Credit River downstream of the outfall during Phase 1 as predicted through CORMIX modeling is 32 m in August so increased temperatures will be constrained to degraded habitat located in the culvert. Predicted distances to upper threshold temperatures during Full Build Out are 84 m in August and 715 m in October but, the October distance of 715 m is considered artificially high. By 35 m downstream of the diffuser (within the culvert) water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October, respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development. Any effects on Brook Trout populations will be partially mitigated in August by their ability to seek out thermal refugia, and from November - March egg and sac-fry development will not be impacted because Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore

water temperatures near these spawning and development areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the change to water temperatures.

There are several qualifications mentioned throughout this assessment that made it conservative. Qualifications include:

1. These predictions were made for 7Q20 low flow conditions as a conservative estimate of change - flows will be higher and temperature changes smaller 99.5% of the time,
2. Seasonal temperature cycles from summer highs to winter lows provide an acclimatization period to temperature extremes for Brook Trout (Raleigh 1982),
3. Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001),
4. Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations, and
5. Most importantly, Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore water temperatures near these spawning areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the effect of change to water temperatures.

Conclusions

The Provincial Water Quality Objective for water temperature is, “The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.” (MOE 1994). Based on the results of the thermal assessment on Brook Trout, including the various conservative qualifications, we predict that the temperature changes resulting from the WWTP discharge will not “significantly change the distribution and abundance of plant and animal life” per the Provincial Water Quality Objective.

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April 10, 2018 File No. 115157

Ministry of Natural Resources and Forestry
Guelph District
1 Stone Road West
Guelph, Ontario
N1G 4Y2

Attention: Tara McKenna, District Planner

Subject: Town of Erin Urban Centre Wastewater Servicing
Response to MNRF Comments on Project Supporting Studies

Thank you for your comments on the supporting studies for the above-noted project. We are pleased to provide our response below.

1 Natural Environment and Assimilative Capacity Comments

Please find attached a letter from Hutchinson Environmental Sciences Ltd providing a response to all natural environment comments on the above-noted reports. Please also note that this response contains a thermal impact assessment as appendix A to their letter.

In addition to these responses, the Environmental Study Report (ESR) will recommend preparation of an Environmental Management Plan during the implementation stage for use in designing and constructing the project. In recognition of the sensitivity of the entire project area, the ESR will also recommend the use of a third party Environmental Inspector as part of the project team to look after the Town's interest in compliance with recommendations of the Environmental Management Plan and all approvals.

2 Comments Related to the Siting of Facilities and Outfall and the Potential For Spills

MNRF Comment:

Location of WWTP Alternatives

> The treatment plant alternatives are limited to three sites located at the same intersection – 10th Line and Regional Road 52. MNRF recommends that alternatives at different intersections across the subwatershed, with different aquatic sensitivities, be explored. MNRF staff would appreciate further clarification and discussion regarding the assessment undertaken for the location options.

Response:

The Servicing and Settlement Master Plan (SSMP) completed in 2014, reviewed a wide range of wastewater treatment and discharge location alternatives for the communities and selected the stretch of river between 10th Line and Winston Churchill Boulevard as the preferred alternative for a discharge to the West Credit River. This area has been the focus of attention as the best river stretch for an outfall for some years, the Credit Valley Conservation (CVC), Ministry of Environment and Climate Change (MOECC), and the Town have agreed that this stretch of the river is the preferred discharge location. Both CVC and the MOECC have been involved in the project through the SSMP and through this Class EA. CVC conducted a 7Q20 *flow analysis at 10th Line in support of the project during the SSMP and for this Class EA. The 7Q20 flow was based on CVC flow data from the 10th Line monitoring station. The terms of reference for Phase 3 and 4 of the Class EA were therefore based on the preferred alternative established during the SSMP (Class EA Phase 1 and 2) involving a discharge to the West Credit River between 10th Line and Winston Churchill Boulevard. This stretch of the river was recommended and agreed to by CVC and MOECC as the existing water quality was better (Policy 1 receiver) and the 7Q20 flow was higher allowing the potential for a higher discharge. Under this Class EA, a site specific discharge has been formulated such that the addition of a WWTP discharge with the effluent criteria set by MOECC does not exceed the Provincial Water Quality Objective for total phosphorus following mixing.*

The preferred alternative for the WWTP site was based on the preferred outfall location. The SSMP identified an area along County Road 52 as the preferred general alternative location and this was incorporated into the terms of reference for this Phase 3 and 4 Class EA.

During this Class EA, questions were raised regarding the validity of the SSMP preferred alternative. As a result, the Class EA team reviewed additional alternative solutions involving subsurface disposal fields throughout the communities as well as a two plant solution with one WWTP south of Erin and one WWTP in Hillsburgh. Both of these approaches were found to be either not viable or significantly more costly. As a result of these studies and additional work to delineate the required service area, the preferred general alternative identified in the SSMP was confirmed and the project moved to Phase 3 of the Class EA process on that basis.

In identifying potential WWTP sites in the general area identified in the SSMP, an overview of the area was conducted considering potential impacts on existing properties, avoidance of hazard lands and property considerations. This resulted in identification of four sites for more detailed consideration.

MNRF Comment:

MNRF staff is of the opinion that more details are needed on by-pass events, and that potential impacts should be more thoroughly quantified.

Response:

The ESR will address the risk of overflow and spills. A technical memorandum that will form part of the ESR is attached to this response.

MNRF Comment:

Multiple SPS are to be located within 120 m of Provincially Significant Wetland or other wetlands; they should be constructed as per the recommendations to maintain wetland hydrology and water quality. Any SPS's that are located near amphibian habitat should avoid construction from March to October.

Response:

During the design stage of the project, a hydrogeological study will be undertaken covering the entire project area to assist with design of the SPSs and pipelines. The study will identify the need for any dewatering during construction and delineate all mitigations needed to maintain water quality. The project Environmental Management Plan will identify all construction restrictions necessary to protect all aspects of the natural environment. Further, permits will be required from CVC and the project team is confident that they will ensure that construction within the Provincially Significant Wetland setbacks will include protection of sensitive features.

Sincerely,

AINLEY & ASSOCIATES LIMITED

Gary Scott, P.Eng.
Senior Project Advisor

cc J Dougherty and Liam Marray, CVC (via email)
B Slattery, MOECC (via email)
C. Furlong Triton Engineering (via email)

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April 11, 2018 HESL Job #: J160005

Tara McKenna
Ministry of Natural Resources and Forestry, Guelph District
1 Stone Road West
Guelph, ON N1G 4Y2

Dear Ms. McKenna:

Re: Town of Erin Urban Centre Wastewater Servicing Class Environmental Assessment – Draft Natural Environment Report – Town of Erin, County of Wellington – Response to MNRF Comments

The Ministry of Natural Resources and Forestry provided a variety of comments on *Town of Erin EA Natural Environment Report* (Hutchinson Environmental Sciences Limited (HESL) 2017) and associated technical memoranda focused on site selection of different types of proposed infrastructure. Our responses focused on:

1) Increasing MNRF's understanding of the objectives and scope of the EA through written responses and by providing *West Credit River Assimilative Capacity Study – Final Report – December 2017 Update* (HESL 2017).

2) Explaining rationale for the characterization of natural heritage features and functions, and the assessment developed to select preferred locations for various infrastructure.

3) Acknowledging MNRF comments that will improve the completeness of this portion of the EA and better align the work with relevant policies.

We will finalize the Natural Environment Report based on the comments and responses provided here-in but please contact Brent Parsons if you have any further questions or concerns.

Sincerely,
Hutchinson Environmental Sciences Ltd.

Brent Parsons, M.Sc.
brent.parsons@environmentalsciences.ca

The Ministry of Natural Resources and Forestry (MNRF) provided a variety of comments on *Town of Erin EA Natural Environment Report* (Hutchinson Environmental Sciences Limited (HESL) 2017[1]), *Technical Memorandum Wastewater Treatment Plant Site Selection* (Ainley Group 2017[2]), *Technical Memorandum Effluent Outfall Site Selection* (Ainley Group 2017[3]), *and Pumping Stations and Forcemains Technical Memorandum* (Ainley Group 2017[4]). Our responses to the comments can be found on the following pages in *italics*. Some of the MNRF comments, as identified, are more appropriately addressed by the Ainley Group.

Location of WWTP Alternatives

Comment #1:
The treatment plant alternatives are limited to three sites located at the same intersection – 10th Line and Regional Road 52. MNRF recommends that alternatives at different intersections across the subwatershed, with different aquatic sensitivities, be explored. MNRF staff would appreciate further clarification and discussion regarding the assessment undertaken for the location options.

Ainley Group has provided a response to this.

Brook Trout Habitat Assessment

Comment #2:
It is understood that the spawning assessment surveys completed for brook trout only went 500m downstream of Winston Churchill Boulevard. MNRF staff recommends that surveying 1.5 km would make for a better comparison.

The near-field mixing zone where water quality parameters have been modelled to exceed Provincial Water Quality Objectives (PWQO) was predicted to be 152 m long and occupy 40% of the channel width over this distance (HESL 2017[5]). PWQO are designed to be protective of all aquatic species at all life stages, including brook trout. The determination of the near-field mixing zone was also based on utilization of 7Q20 flows which are exceeded 99.5 – 99.9% of the time (Pyrce 2004[6]). The spawning assessment survey characterized the number of redds throughout the near-field mixing zone at all potential effluent outfall locations where PWQO could be exceeded during 7Q20 flows. This assessment is conservative and although a survey which includes assessment 1.5 km downstream of Winston Churchill Blvd. would be interesting from a research nature, it would not be overly informative for the selection of a preferred effluent outlet location as part of the Class EA because the 152m zone of water

[1] *Hutchinson Environmental Sciences Ltd. 2017. Town of Erin EA Natural Environment Report. Prepared for the Ainley Group.*

[2] *Ainley Group. 2017. Town of Erin Urban Centre Wastewater Servicing Class Environmental Assessment Technical Memorandum Wastewater Treatment Plant Site Selection Draft. Prepared for the Town of Erin.*

[3] *Ainley Group. 2017. Town of Erin Urban Centre Wastewater Servicing Class Environmental Assessment Technical Memorandum Treated Effluent Outfall Site Selection Draft. Prepared for the Town of Erin.*

[4] *Ainley Group. 2017. Town of Erin Urban Centre Wastewater Servicing Class Environmental Assessment Technical Memorandum Treated Effluent Outfall Site Selection Draft. Prepared for the Town of Erin.*

[5] *Hutchinson Environmental Sciences Ltd. 2017. West Credit River Assimilative Capacity Study Final Report – December 2017 Update. Prepared for the Ainley Group.*

[6] *Pyrce, R.S. 2004. Considering baseflow as a low flow or instream flow. WSC Report No.04-2004 Appendix, Watershed Science Centre, Peterborough Ontario, 17 p.*

quality impact from the proposed outfall lies entirely within the 500m portion of the river surveyed at each location.

Comment #3:
Emphasis in the reporting is placed on the use of brook trout spawning assessments to assist in the location of an outfall. MNRF staff note that brook trout rely on groundwater upwelling during incubation, not surface water. However, brook trout fry, fingerlings and adults are very sensitive to ammonia and nitrates from an outfall. See the Canadian Council of Ministers of the Environment guides for ammonia and nitrate (attached in the email). Alternative locations of outfalls that avoid use of mixing zones in brook trout reaches should be considered.

PWQO are designed to be protective of all aquatic species at all life stages, including the impacts of ammonia and nitrate on brook trout fry, fingerlings and adults. Our ACS was completed with full consideration of the CCME guidelines and showed that guidelines would be met within 152m of the outfall.

The reach of the West Credit River between 10th Line and Winston Churchill was previously approved by MOECC and CVC as the preferred location of an effluent outfall because of water volumes and water quality in this area. Our field work showed brook trout spawning throughout the preferred reach of river, and our analysis was focused on selecting an outfall location between the 10th Line and Winston Churchill Blvd that was the least sensitive based on environmental features.

In addition, the MOECC approved effluent criteria for ammonia and nitrate were established through the Assimilative Capacity Study and the proposed treatment plant technology includes nitrification and denitrification to remove ammonia and nitrate from the effluent.

Also, see Ainley Response to #1.

Comment #4:
Table 2 lists the fish species of the West Credit. Atlantic salmon have not been included. MNRF staff note that this species is stocked annually as fry at Winston Churchill, and should be included. In addition, the table is limited to thermal sensitivity. MNRF staff recommends that Table 2 should be expanded to include chronic sensitivity to ammonia, nitrate and chloride.

Atlantic salmon will be added to Table 2.

All resident fish species will be protected through the effluent criteria recommended in the ACS. Effluent treatment criteria were determined through the ACS and comparison with PWQO and the Canadian Water Quality Guideline for chloride. These water quality guidelines are designed to be protective of all aquatic species at all life stages, and any impacts of ammonia, nitrate and chloride on Atlantic Salmon, as well as brook trout fry, fingerlings and adults were inherently considered in our analyses.

Comment #5:
The maximum summer water temperatures of effluent proposed is 19C, which is over the optimum for brook trout growth but within the maximum tolerance levels. Based on temperature data from Credit

Valley Conservation (CVC) dated February 5, 2018, this would increase the temperature slightly at Winston Churchill Boulevard throughout the summer months and increase the temperature at 10th Line in May and June but decrease it in July and August. Please clarify what the effluent temperature is proposed to be during the spawning season for brook trout (i.e. October to December).

An assessment of the thermal impacts of effluent on the West Credit River and Brook Trout is provided in Appendix A. It concludes that the temperature changes resulting from the WWTP discharge will not "significantly change the distribution and abundance of plant and animal life" per the Provincial Water Quality Objective.

Comment #6:
MNRF staff is of the opinion that more details are needed on by-pass events, and that potential impacts should be more thoroughly quantified.

Ainley has provided a response to this.

Comment #7:
The report notes a 0.045mg/L limit of phosphorus, however, it was noted in the West Credit River Subwatershed Study that the criteria should be no not net increase in total phosphorus to the Lower Great Lakes. MNRF recommends that the EA should address whether this limit meets this constraint.

The statement from the West Credit River Subwatershed Study should also be considered in light of the recent Environment and Climate Change Canada[7] finding that "Phosphorus levels are too low in the offshore waters of Lake Ontario, Lake Huron and Georgian Bay. Since 1972, levels have decreased to a point where preyfish populations are declining."

The ACS was completed to the requirements of MOECC Policy as outlined in MOE (1994a, 1994b). MOECC Policy 1 for surface water quality allows alteration of a river up to the PWQO of 0.03 mg/L for total phosphorus. The proposed effluent limit of 0.045 mg/L will only increase total phosphorus concentration in the river from the current value of 0.016 mg/L to 0.024 mg/L. The scope of the Assimilative Capacity Study/effluent requirements in relation to the Policy 1 status on the West Credit River was confirmed with MOECC at the Core Management Team Kick Off Meeting on March 8, 2016 (meeting minutes attached).

The recommendations from the ACS therefore represent a conservative and protective approach to water quality in the West Credit River and its receiver, Lake Ontario.

Comment #8:
The habitat in this area has also already been impacted by the culvert, and the initial mixing zone would be within the culvert. It would be beneficial to know how long the culvert is and the percentage of mixing zone that would be within the culvert.

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[7] Environment and Climate Change Canada (2017) Canadian Environmental Sustainability Indicators: Phosphorus levels in the offshore waters of the Great Lakes. Available at: www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=A5EDAE56-1.

The culvert is approximately 45 m long and would occupy 30% of the 152 m near-field mixing zone at full build-out as defined by ammonia modeling in the Assimilative Capacity Study (HESL 2017[8]). We agree that the culvert does not represent ideal habitat and this supports our recommendation to locate the outfall at Winston Churchill Blvd.

Significant Wildlife Habitat

Comment #9:
The NER appears to be missing mapping of deer wintering areas in the study area, which would represent Significant Wildlife Habitat (SWH). The West Credit River between Erin and Belfountain is considered a deer wintering area. This should be included in the report, with consideration of any potential impacts.

We anticipate that little impact to deer wintering habitat will be projected since the sewage pumping stations and sewers are all located in urban environments and along roads. The forcemain is proposed to be located along the Cataract Trail, the WWTP within altered fields, and the outfall at Winston Churchill Boulevard. Deer wintering areas will however be assessed per requirements in Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E (MNRF 2015[9]) in the final Natural Environment Report.

Comment #10:
All three sites reviewed in the NER also provide Savannah Sparrow habitat (SWH Open Country Bird Breeding Habitat), and should be considered in the report.

Savannah Sparrow was recorded during breeding bird surveys in Sites 1 and 2B and in the fields adjacent to Forcemain Alternative 1. The species, its conservation status and habitat requirements, as well as proposed mitigation measures to avoid impacts on it, are discussed in the following sections of the NER: Section 3.2.5 Breeding Birds, Section 4.1.2 Terrestrial Ecology, Section 4.3.2 Potential WWTP, Section 4.3.3.1 Forcemain Alternative 1, Section 4.4.2.3 Landscaping and Restoration, and Section 5.2 Impact Assessment and Preferred Alternatives.

Species at Risk

Comment #11:
The SAR section of the NER does not appear to have considered SAR bats. A number of maps in Appendix B include candidate Ecological Land Classification communities that would support SAR bats. However, if the outfall site is constructed full within the right-of-way as proposed, MNRF does not anticipate impacts to the habitat. MNRF would appreciate clarification whether tree removal will be required, and if so, how much.

SAR bats were not reported by MNRF in the Wellington Region or during NHIC review, so habitat requirements of these species were not assessed. Potential habitat for SAR bats includes mixed wood or

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[8] Hutchinson Environmental Sciences Ltd. 2017. West Credit River Assimilative Capacity Study – Final Report – December 2017 Update
[9] Ministry of Natural Resources and Forestry. 2015. Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E.

deciduous trees and treed swamps that contain many large diameter cavity trees. The locations of the proposed infrastructure contains very little appropriate habitat, partly because infrastructure will be constructed within disturbed areas or meadows, and as a result, consideration of SAR bat habitat would not have swayed site selection. Nonetheless, SAR bat habitat will be assessed per requirements in Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E (MNRF 2015[10]) in the final Natural Environment Report.

An arborist report of all affected areas will be prepared as part of an overall Environmental Management Plan for the project during the design stage.

Comment #12:
MNRF note that the NER has included a mitigation measure of construction outside of the breeding period for birds. MNRF recommends that the timing window include the roost season for bats in this mitigation measure (i.e. no tree removal from April 30th to Sept. 30th) and to limit construction to daylight hours during the same period.

The construction timing windows will be expanded to include the roosting season for bats in the NER.

Comment #13:
MNRF staff agrees that where possible, all SPS should be located close to the road to limit habitat impacts.

Comment #14:
MNRF note that Site 1 may be considered Eastern Meadowlark habitat as the NER notes that this species was heard calling on the first site visit. It is recommended that either another Eastern Meadowlark survey should take place or registration under O. Reg. 424/08 s.23.6 should be considered.

Site 1 consists of a variety of open habitats, including fields with shrub vegetation close to the road and grassland further back from the road. At this point it is not clear where the proposed footprint for the WWTP would be located on Site 1 (if this site is selected). If the WWTP is located close to the road then the development footprint will likely not overlap with the grassland habitat that provides suitable habitat for Eastern Meadowlark. However, if it is sited further to the east, it will likely overlap with potential Eastern Meadowlark habitat. Once the exact location is known we propose conducting additional bird surveys in the affected habitat to document whether any species at risk and sensitive species are present (such as Eastern Meadowlark, Bobolink, Savannah Sparrow) and formulate potential mitigation plans should they be required.

The NER was part of the Class EA process to compare alternative sites for the WWTP and the level of detail provided is considered sufficient to support the conclusions. A more detailed assessment of the selected site (including screening of sensitivities in relation to the actual footprint of the WWTP) will occur at the next stage.

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[10] Ministry of Natural Resources and Forestry. 2015. Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E.

Comment #15:
It is unclear from the NER whether surveys were completed for Gypsy Cuckoo Bumblebee or Rusty-patched Bumblebee, which were noted in the report as having potential to occur in the study area. MNRF would appreciate clarification.

Surveys were not completed for Gypsy Cuckoo Bumblebee or Rusty-patched Bumblebee. The Rusty-patched Bumblebee was reported in the Wellington Region but not in the study area while Gypsy Cuckoo Bumblebee was noted in the study area, but not since 1979. Both species have suffered rapid, severe population declines as only three "recent" Gypsy Cuckoo Bumble Bee sites are known to occur in Ontario (MNRF 2017[11]) and one sighting of Rusty-patched Bumblebee in Canada since 2002 at the Pinery Provincial Park on Lake Huron despite widespread surveys in Ontario (Colla and Taylor-Pinder 2011[12]).

Instead, we assessed the habitat requirements of each species and considered these habitat requirements during site selection but unfortunately both species are habitat generalists, so habitat preferences did not dictate site selection. Site-specific surveys could be completed in the future during detailed design if warranted.

Other Comments

Comment #16:
Multiple SPS are to be located within 120m of Provincially Significant Wetland or other wetlands; they should be constructed as per the recommendations to maintain wetland hydrology and water quality. Any SPS that are to be located near amphibian habitat should avoid construction from March to October.

Agreed and already included in the NER.

Comment #17:
MNRF staff would appreciate receiving a copy of the West Credit River Assimilative Capacity Study (HESL, 2017) and the Assimilative Capacity Study (B.M. Ross, 2014) which were referenced in the NER.

The ACS has been sent as requested.

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[11] *Ministry of Natural Resources and Forestry. 2017. Gypsy Cuckoo Bumble Bee in Ontario. Ontario Recovery Strategy Series.*

[12] *Colla, S.R. and Taylor-Pinder, A. 2011. Recovery Strategy for the Rusty-patched Bumble Bee (*Bombus affins*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. Vi + 21 pp.*

Hutchinson
Environmental Sciences Ltd.

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Meeting Minutes

Date: **May 30, 2016**

Location: **MOECC, 1 Stone Road, 3rd Floor, Room 305, Guelph**

Re: **J160005 – Erin Class EA – Assimilative Capacity Study Pre-Consultation Meeting**

Present:

Barbara Slattery (MOECC)
Craig Fowler (MOECC)
Manpreet Dhesi (MOECC)
Jennifer Dougherty (CVC)
Liam Murray (CVC)
John Sinnige (CVC)
Christine Furlong (Triton)
Ray Blackport (Blackport)
Gary Scott (Ainley)
Deborah Sinclair (HESL)
Neil Hutchinson (HESL)
Tara Roumeliotis (HESL)

Regrets: **Tim Mereu (CVC), Joe Mullan (Ainley)**

The purpose of the meeting was to review the ACS work plan with stakeholders and discuss any questions or concerns with the proposed approach (modelling, field investigations and analyses).

AGENDA

1. Introductions
2. Background
3. Review ACS work plan and tasks
4. Feedback and agreement on approach
5. Schedule and meetings
6. Additional items

ACTION ITEMS

Item	Description	Action
1	• Check the *Erin Servicing and Settlement Master Plan; Phase 1 – Environmental Component – Existing Conditions Report* ("Existing Conditions" report), May 2011, for raw data needed.	HESL
2	• Provide HESL with raw water quality data for 10th Line and Winston Churchill Blvd. that was used in the BM Ross preliminary ACS. Provide HESL with any additional water quality data acquired since that report (i.e., 2013 and onward)	CVC (Jennifer Dougherty)
3	• Provide group with updated 7Q20 memorandum within approximately 2 weeks.	CVC (John Sinnige)
4	• Confirm wastewater effluent flow for ACS - expected by end of summer	Ainley (Gary Scott)
5	• Measure flows at Winston Churchill and 10th Line during water quality sampling events for comparison • Evaluate need for to add chloride analyses to future water quality sampling events • Evaluate need to deploy pH logger in Credit River for diurnal pH cycle.	HESL

DISCUSSION NOTES

- Regarding additional data for the 10th Line (at West Credit River) station – CVC reported that there was no new water quality data for this station in 2013 through 2015. Only new water quality data is for the PQWMN station at Winston Churchill Blvd.
- CVC reported that they have a temperature gauge at 10th Line and at Winston Churchill Blvd.
- Septic Impact chapter in the *Erin Servicing and Settlement Master Plan; Phase 1 – Environmental Component – Existing Conditions Report* ("Existing Conditions" report), May 2011 provides flows measured by CVC at 10th Line and Winston Churchill Blvd. HESL to review report for raw flow data.
- Jennifer Dougherty (CVC) will provide HESL with any other raw data that BM Ross used in their preliminary ACS and that is not provided in the Existing Conditions report.
- John Sinnige provided an update on the 7Q20 calculation:
    - The rating curve for the 10th Line flow station is continually updated.

- CVC are using the 8th Line gauge as well as transposing the 10th Line data with the Belfountain WSC station, which has about 15 years' worth of data.
- The two gauges will give a lot more comfort in the 10th Line 7Q20.
- CVC are currently in the process of revising the extrapolation.
- Currently looking like the 7Q20 will remain the same or go up slightly.
- CVC hope to have the 7Q20 memorandum ready for peer review in two weeks and will email this out to the group. Ray Blackport to provide review. MOECC may potentially comment.

- HESL asked if anyone had completed water quantity measurements at 10th Line and Winston Churchill in order to better understand the rates of groundwater discharge to the West Credit River within this reach. Ray Blackport reported collecting some spot flow measurements at both 10th Line and Winston Churchill.
- HESL recommended that water quality be modelled at 10th Line, since this will be a more conservative location than Winston Churchill Blvd (which has higher flows due to groundwater inputs and has been shown to have better water quality).
- Craig Fowler asked if HESL intended to start the ACS process over. HESL responded that the intention was to build on the preliminary ACS work completed by BM Ross.
- Craig Fowler inquired about the wastewater flow predictions in the BM Ross preliminary ACS of 435 L/person/day, including I/I.
  - Christine Furlong explained that BM Ross looked at water taking records to estimate wastewater flows; that 435 L/person/day is a conservative estimate. Also noted that 450 L/person/day is the MOECC maximum recommended design wastewater flow.
  - HESL asked Gary Scott to confirm the wastewater effluent flow that should be used in the ACS.
  - Gary Scott noted that the starting point for deriving the effluent flow is 2,610 m^3/d for 6,000 people, and that it will be an iterative process.
  - MOECC requested that the ACS is not submitted for review until the final effluent flows are confirmed.
  - CVC requested to Ainley to be a part of the discussion on population serviced, who will remain on septic, etc.
  - Town of Erin would like some growth in Hillsburgh on partial services – on municipal water and private septic.
- HESL raised question as to whether modelling seasonal discharge at proposed WWTP was still desired. Christine Furlong clarified that seasonal discharge was recommended for consideration during the SSMP and therefore it needed to be included in the ACS.
- CVC suggested that HESL complete diurnal pH monitoring in West Credit River, in addition to the DO and temperature monitoring that is already planned.
  - CVC noted that they had completed continuous pH monitoring in West Credit River, which may be presented in the Existing Conditions report. If not, HESL will request this data from CVC, and assess need to deploy pH logger
- HESL noted that dye tracer study will be conducted at 10th Line. Group requested that HESL also conduct the dye tracer study at Winston Churchill station and HESL agreed.

- In preparation for the dye tracer study, agencies and media will be notified. HESL will prepare a media release, which will be provided to Ainley and Triton for distribution. HESL to let Craig Fowler know when dye tracer study will take place.

- CVC suggested that chloride be added as a parameter of interest to the ACS modelling exercises.
  - HESL to review need to analyse water samples collected at 10th Line for chloride analysis
- HESL noted that there is not much value in completing the ACS for three discharge locations since results will not vary significantly. CORMIX modelling will be completed for a 10th Line discharge, as the most conservative location. If future discharge location recommendations change, the CORMIX modelling can be re-run easily.
- HESL noted that the Orangeville WWTP (which discharges to the Credit River) includes denitrification of wastewater and has a TN limit of 15 mg/L.
- Group approved the ACS work plan put forward by HESL, with the following comments:
  - The MOECC recommended against any radical changes in the ACS from what BM Ross has completed. The MOECC had approved in principal what BM Ross had put forward in the preliminary ACS. West Credit River is a Policy 1 receiver.
  - CVC supports the proposed diurnal DO studies.
- Ainley noted that the first PIC meeting is scheduled for mid-November and will cover the following items:
  - Service area
  - Type of collection system
  - Population numbers
  - Discharge and plant location (3 options)
- MOECC noted that they would prefer to not be involved in the whole ACS process, but would rather just review the finalized ACS report.
- With respect to the draft effluent limits, to be recommended in the draft ACS, MOECC requested that they be sent a copy of these for possible comment, but do not necessarily need to come to a meeting on the limits.
  - MOECC noted that they do not need to peer review the 7Q20 if the number was calculated based on sound science and peer-reviewed by Ray Blackport.
- CVC raised a concern regarding the potential cumulative effects of septic system discharge to the watershed from the planned partial servicing at Hillsburgh. CVC noted that the Hillsburgh reach of the West Credit River is very small with elevated nitrate concentrations. Discussion included:
  - the observation that the net effect of the EA was to remove septic systems from the watershed by servicing the Town of Erin
  - the suggestion was that any septic servicing at Hillsburgh would require state of the art tertiary treatment and that developers would be informed of this.
- CVC requested a separate meeting to discuss/address cumulative impact of new septic systems within Erin and Hillsburgh since it was identified in the meeting that it was outside the scope of the current EA.
- Liam Murray asked the group if it would be an issue to the ACS predictions if the Erin and Hillsburgh ponds are taken offline. HESL responded that water quality would be expected to improve if the ponds were taken offline.

- Liam Murray noted that there is a new gravel pit in Peel, near Winston Churchill Blvd. To the group’s knowledge, there are no water taking operations occurring at the new gravel pit.
- Christine Furlong noted that that next project meeting should include the CORE Management Team.
- The meeting was adjourned at 1215 PM.

TOWN OF ERIN

Town of Erin
Urban Centre Wastewater Servicing
Class Environmental Assessment

Technical Memorandum
Overflow Risk Management

April 2018

Ainley GROUP
CONSULTING ENGINEERS & PLANNERS

Urban Centre Wastewater Servicing Class Environmental Assessment

Technical Memorandum
Overflow Risk Management

Project No. 115157

Prepared for:
The Town of Erin

Prepared By:

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Simon Glass, B.A.Sc

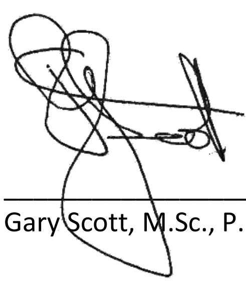

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Table of Contents

1.0 System Overview

The recommended alternative wastewater system for Erin and Hillsburgh will consist of local and trunk sewers, sewage pumping stations and forcemains, a wastewater treatment plant and an outfall extending to the West Credit River. The wastewater system will extend from the North end of Hillsburgh through to south of Erin Village. As outlined in the Natural Environment Report, a considerable portion of the lands in Hillsburgh and Erin are environmentally sensitive. The West Credit River with tributaries and wetland areas also extend from the north end of Hillsburgh through Erin Village. The proposed infrastructure can experience malfunctions from time to time resulting in the potential for a wastewater spill to the river system.

The wastewater collection system will be completely separate from the stormwater system and will not be connected to roof down pipes or sump pumps. None the less, the flow capacity of the system will include an allowance for inflow and infiltration which is often the cause of spills. As the system ages, there will be opportunities for groundwater and storm water to enter the sanitary sewers. The sanitary sewage system, including pipes and sewage pumping stations, will also be designed for peak flows of 2.7 times the design capacity in accordance with Ministry of Environment and Climate Change (MOECC) design guidelines using the Harmon Peaking Factor. It is noted that all system pipes and pumping station wet wells will be sized and built for their ultimate capacity which will not be reached until full build out and this provides additional storage capacity in the sewer system over the short term. Critical unit processes in the wastewater treatment plant will also be designed for peak flows as per MOECC guidelines. While the plant will undergo a phased construction, each phase will be designed for peak flow. As such, it is unlikely that flows in the system will exceed the system capacity.

Due to the sensitivity of the local environment, overflow pipes from sewage pumping stations or overflow chambers that would permit by-passes or spills of untreated or partially treated wastewater to the natural environment throughout the system are not recommended. Ideally, all flows will be contained in the system until discharge of the treated effluent to the river. However, the trade-off with no overflow outlets to the environment and retaining sewage in the collection system is that the potential for flooding basements in areas serviced by pumping stations increases. This makes design and management of the system more important in order to ensure that sufficient system storage is provided for all flow scenarios.

The effluent disinfection system, in the recommended sewage treatment alternative evaluation, is UV which eliminates the risk of a spill to the river for chlorination and dechlorination chemicals.

2.0 Overflow Risks

While the system will be designed to minimize the risk of overflows or spills to the natural environment, or back-ups into private properties, there does still exist some degree of risk. Overflows could potentially arise from:

- Main Breaks
- Main Blockages
- Capacity Exceedances from Infiltration and Inflow during storm events
- Equipment Failure

- Power Failure
- Control/Communications System failure
- Upgrade and expansion projects

2.1 Dealing with Potential Main Breaks

The highest risk of spills from wastewater pipe systems is from forcemain breaks as the pressure from pumps can result in spills to the surface similar to what is visible during watermain breaks. The recommended collection system alternative is based on using twin forcemains from sewage pumping stations except the smallest local stations. Leaks in manholes and sewers are more likely to allow groundwater into the system rather than causing a spill. Other measures to be considered in the design to minimize the risk of spills from main breaks include:

- Quality control during all aspects of construction including on development lands
- Use of heat welded polyethylene pipe for all forcemains
- Use of line valves for isolation of forcemain sections
- Use of pump pressure control to indicate leaks, send alarms and stop pump operation
- Implementing a preventative maintenance program including regular inspections using CCTV

2.2 Dealing with Potential for Main Blockages

Spills from wastewater pipe systems can also result from blockages of the sewer or pump intakes. This can be caused by illegal discharges of grease or large items. The recommended collection system alternative is based on using minimum sized sewers of 200 mm and non-clog sewage pumps. In addition, the entire system will be monitored using a computer control system that will alarm on pump failure or rising liquid levels in the pumping stations. Under normal conditions sewage collection systems operate continuously without blockages. Permitted discharges are defined within a sewer use by-law. Measures to be considered to minimize the risk of spills from blockages include:

- Implementation of a sewer use by-law that prevents discharge of materials likely to block the sewers or damage pumps
- Education leaflets on sewer use aimed at eliminating illegal discharges
- Regular inspections of industrial, commercial and school properties to prevent illegal discharges
- Careful hydraulic design of all elements to prevent sedimentation and deposits/build ups in the system
- Implementing a preventative maintenance program including regular inspections using closed circuit television (CCTV)

2.3 Dealing with Potential for Capacity Exceedances

Overflow events can occur when the volume of water entering the collection system exceeds the capacity of the sewers, pumping stations, or the treatment facility. In such events, the excess sewage can be by-passed through overflow discharges (typically to surface waters) or collected within holding tanks. Without overflows or peak flow storage, excess sewage can also back-up within the collection system ultimately leading to basement flooding.

As noted above, the preferred alternative will be isolated from extraneous flows entering the system and consideration will be given to not allowing overflows out of the system. The system will be designed to contain flow events within collection system capacity, pumping station capacity and treatment capacity.

The potential for capacity exceedances will be greater as the collection system ages. The connection of roof downspouts, sump pump discharges, and stormwater catch basins to the sanitary system are common examples of past practices that have been discontinued and must be prevented. Deteriorated systems can experience flow peaks over 5 times the average flow. This must be prevented through maintenance and inspections. Newer systems and systems without the improper connections would exhibit peak flows as low as 2 times the average flow.

Fully eliminating all sources of system inflow and infiltration is not feasible; however, best practices can significantly reduce the scale of the issue. In a system without improper connections, extraneous flow will still enter the collection system through manhole covers, loose joints, or breaks caused by roots. The sewer use by-law, that is enforced, should address the issue of illegal connections.

Another source of extraneous flows in new collection systems is improper installation of sewer mains and laterals. In order to ensure new installations are completed correctly, testing of installed sewers should include flow monitoring before connections and CCTV inspections. Contractors should be required to repair all deficiencies identified through the monitoring program. Other inflow and infiltration minimizing measures, such as leak-free manhole lids in low-lying areas, should also be adopted.

Often, the installation of sewer laterals on private property can be a significant source of infiltration to the municipal collection system. It is recommended that the Town Building Department only allow the use of pipe materials that are typically specified for use on the municipal side of the collection system. Most municipalities require the use of DR 28 PVC pipe with gasketed joints.

As the system ages, the potential or risk of high flows exceeding the peak capacity of the wastewater treatment plant or pumping stations will increase. This can be managed by increasing storage throughout the system either by constructing additional wet wells at pumping station sites or storage tanks at critical locations such as the last pumping station before the wastewater treatment plant. The volume of storage necessary to manage peak flow events would need to be determined through focused risk assessments to determine the best location for the storage. In establishing sites for sewage pump stations and the treatment plant, provision should be made for the future construction of additional wet well capacity or storage tanks. Risk assessment would include risks associated with system back up and the potential for basement flooding. In the future, if the risk of basement flooding cannot be mitigated using increased storage or system capacity increases, it may be necessary to construct overflows from pumping stations to the river.

The suggested approach to establish the need for peak flow storage is as follows:

- Monitor daily wastewater flow averages and peaks at the treatment facility and track the scale and frequency of peak flow events

- Compare peak flow events to peak flow capacity in the collection system and treatment facility
- Quantify the risk (probability and consequence) of overflow events occurring
- Where the quantified risk is determined to be unacceptable:
    - First:
        - Identify I/I sources through wastewater flow monitoring of the collection system
        - Enact inflow and infiltration reduction measures (pipe relining/ replacement, manhole rehabilitation, etc.)
        - Quantify the impact of inflow and infiltration reduction measures
    - Second:
        - Conduct risk analysis of overflow in each collection area
        - Establish peak flow retention within collection areas where risk exceeds acceptable levels

2.4 Dealing with Potential for Equipment or Pump Failure

Equipment or pump failure also have the potential to result in overflows or spills from wastewater systems. Pumps are a critical component in wastewater systems and are used to convey wastewater from pump stations to the treatment plant. A large number of pump systems also exist in treatment plants to operate many of the processes and finally to convey effluent to the river. Their failure can lead to a rapid build-up of wastewater with the potential for a spill. Likewise, the failure of chemical feed pumps, screens, air blowers, UV systems and other equipment in the treatment plant can result in process failures. The Ministry of Environment and Climate Change (MOECC) provides design guidelines for pumping stations and treatment plant design in Ontario that requires the use of dual or standby equipment for all pumping stations and treatment systems. The use of dual pumps and multiple treatment trains minimize the risk of pump or equipment failure resulting in a spill or discharge of partially treated wastewater. Measures that should be considered in the design and operation of the system to minimize the risk of spills from pump or equipment failure include:

- Installation of a minimum of dual systems for all pumps and equipment at sewage pumping stations and the treatment plant sufficient to ensure continuous operation of all systems
- Design for plant operational flexibility such that pump systems can have multiple duties
- Conduct a risk assessment and develop a contingency and response plan to deal with equipment failures
- Implement a Maintenance Management System (MMS) that prevents equipment failure
- Adopt a proactive approach to fixing any piece of equipment that is out of operation.
- Develop a contingency plan to by-pass pumping stations
- Maintain an inventory of critical spare parts on site

2.5 Dealing with Potential for Power Failure

Wastewater systems must have a continuous and reliable supply of power for the safe operation of the system. The preferred treatment plant alternative has a wide range of equipment, instruments and control devices that require continuous and stable power. Treatment plants and pumping stations are built in strict compliance with electrical codes that ensure all electrical systems are safe and reliable. Measures that should be considered in the design and operation of the system to minimize the risk of spills from power failure include:

- Negotiate multiple power feeds to sewage pumping stations and treatment plant with the power authority
- Consider using twin power transformers to ensure a more robust supply
- Install standby power with automatic transfer from the prime power source sufficient to maintain the entire facility in operation during prime power failure
- Select a fuel supply for standby power based on the security of the supply (gas or diesel)
- Protect all electrical systems against the threat of lightning strikes

2.6 Dealing with Potential for Control/Communication Failure

Continuous operation of the wastewater system will rely on the System Control and Data Acquisition (SCADA) System. This is the system that will automatically control the operation of all equipment throughout the system 24 hours a day. It automatically starts and stops equipment as necessary and provides alarms to the operators in the event of any failure. Typically, operators can remotely investigate any issues with the operation and either remotely start a standby system, or go to the facility and take manual control of the particular system. The control system consists of sensing instruments, controllers and computers using control software customized for the particular system operation.
A system wide communications system that allows all facilities to be interconnected to the control system must also be robust and secure to support system reliability.
SCADA systems improve the reliability of the operation and greatly reduce the response time needed to deal with operational issues. Measures that should be considered in the design and operation of the system to minimize the risk of spills resulting from a control/communications system failure include:

- Design the SCADA system with dual controllers and computers
- Ensure protection and back up of all sensitive controls and computer networks using Un-interruptible Power Supply (UPS)
- Develop a contingency plan for manual operation in the event of control system failure
- Regularly maintain all sensing instruments

2.7 Upgrade and Expansion Projects

Upgrade and expansion projects can often be a source of planned bypasses if systems require to be taken out of operation to facilitate installation of new or replacement equipment. Measures that should be considered in the design to eliminate the need for bypassing during construction include:

- Conceptually design full build-out of the plant during the first phase and develop a constructability plan for all phases that eliminates the need to remove units from operation during future construction phases.
- Ensure sufficient isolation valves are constructed in the first phase.
- Provide for connection to future expansions during Phase 1.
- Provide for the replacement of all equipment while maintaining system capacity.

Appendix A – West Credit River Temperature Assessment

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Memorandum

Date: **April 4, 2018**

To: **Gary Scott, Ainley Group**

From: **Brent Parsons, Deborah Sinclair and Neil Hutchinson**

Re: **HESL J160005 – Thermal Assessment of Erin WWTP on West Credit River**

The reach of the West Credit River between 10th Line and Winston Churchill Blvd. contains a cold-water thermal regime and aquatic habitat that supports a robust population of sensitive coldwater fish species and critical Brook Trout spawning habitat (HESL 2017a). The purpose of this technical memorandum is to provide an assessment of the potential effect of the Erin WWTP effluent on water temperatures in the West Credit River during all times of the year for both Phase 1 (near term) and Full Build Out ((FBO) 20-year horizon) of the Wastewater Treatment Plant (WWTP) project to assess potential impacts to Brook Trout.

Temperature Thresholds for Brook Trout in West Credit River

Brook Trout are ranked as the most sensitive fish species in Toronto-area streams (Wichert and Regier 1998), they are the indicator species for coldwater habitat in the Credit River watershed (MNR and CVC 2002) and were therefore selected as the sentinel species to assess potential impacts of the Erin WWTP effluent on water temperature in the West Credit River. Temperature thresholds for various life stages were reviewed and two temperature “thresholds” (optimum and upper tolerance) associated with spawning, egg development and adult behaviour (i.e. growth) were defined (Table 1). Optimum water temperatures for spawning, egg development and general adult behaviour were defined as 10.7°C, 6.1°C and 14.2°C, respectively, as reported in Key Ecological Temperature Metrics for Canadian Freshwater Fishes (Hasnain et al. 2010). Upper tolerance temperatures for spawning, egg production and adult behaviour were defined as 16°C (Hokanson et al. 2001), 11.7°C (Hokanson et al. 2001) and 19°C (various citations – Table 1), respectively.

Table 1. Water Temperature Considerations for Brook Trout at Various Life Stages. Note that bold values are carried forward into the assessment.

Life Stage	Water Temperature Considerations
Spawning	- Ovulation and spawning occur at **16°C** or lower (Hokanson et al. 2001) - Optimal spawning temperature = **10.7°C** (Hasnain et al. 2010)
Egg Development	- Optimum egg development temperature = **6.1°C** (Hasnain et al. 2010) - Egg viability decreases above **11.7°C** (Hokanson et al. 2001)

Adult	- Optimum growth temperature = **14.2°C** (Hasnain et al. 2010) - Optimum growth rate at 14 °C (Baldwin 1951) - Brook Trout do poorly in streams where water temperatures exceed 20°C for extended periods (McAfee 1966) - Brook Trout are sensitive to changes in water temperature because they do not tolerate water temperatures greater than **19°C** - 20°C for long (Creaser 1930; Burton and Odum 1945; Gibson 1966) - A general upper tolerance of **19°C** - 20°C is evident throughout the literature (Kerr 2000). - **19°C** is critical as temperatures above this are considered suboptimum (Hokanson et al. 1973) - When temperatures reach 20°C non-indigenous Brown Trout will outcompete Brook Trout (Taniguchi et al. 1998)

Brook Trout life stages and associated water temperature thresholds are presented for each month in Table 2. In the West Credit River, growth occurs throughout the year, with spawning in October/November (active spawning was observed on November 1, 2016 (HESL 2017a)), and egg development from November through to March of the following year. Egg development has the lowest temperature preference, so these values were applied as thresholds for November to March, spawning temperatures were applied to October, and growth temperatures were applied as thresholds for the rest of the year (April to September), when spawning and egg development are not occurring (Table 2).

Temperature thresholds were compared to continuous water temperature data collected by CVC at Winston Churchill Blvd. from 2009-2015 (station 501150002; Table 2, Figure 1). Existing 75th percentile and maximum water temperatures exceed the optimal temperature preference of 14.2°C for Brook Trout growth from May to September (Table 2, Figure 1) and the 10.7°C optimal temperature preference for spawning in October. Maximum recorded water temperatures also exceeded the upper tolerance thresholds of 19°C for growth from May to September, and the upper tolerance threshold for spawning of 16°C in October. The 75th percentile July temperature of 19.3°C also exceeds the upper tolerance threshold for growth.

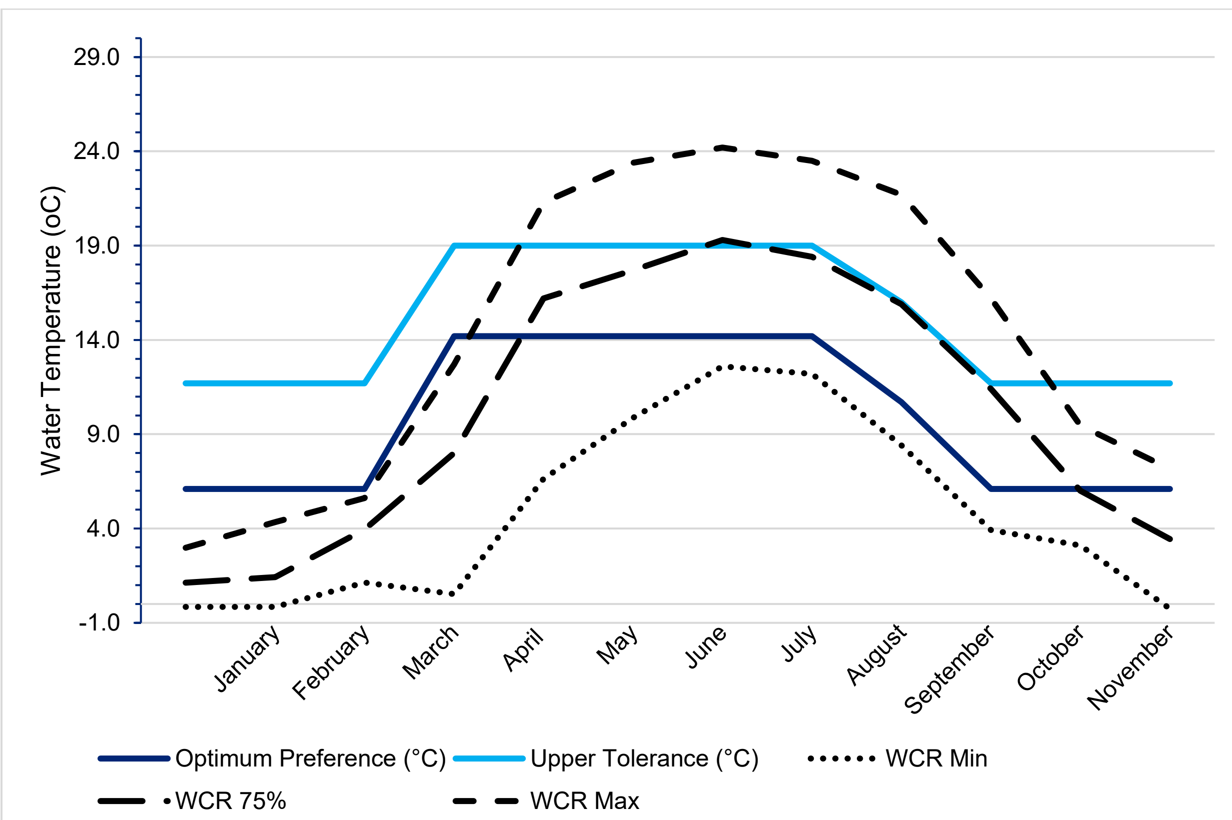
Table 2. Monthly Temperature Thresholds for Brook Trout in the West Credit River.

Month	Life Stage with Lowest Temperature Requirement	Optimal Temperature Preference (°C)	Upper Tolerance Temperature (°C)	Existing West Credit River Temperatures (°C)		
				Minimum	75th Percentile	Maximum
January	Egg Development	6.1	11.7	-0.2	1.1	3.0
February				-0.2	1.4	4.4
March				1.1	4.0	5.6

April	Growth	14.2	19	0.5	8.0	12.7
May				6.6	16.2	**21.3**
June				9.9	17.7	**23.4**
July				12.6	**19.3**	**24.2**
August				12.2	18.4	**23.5**
September				8.42	15.9	**21.7**
October	Spawning	10.7	16	3.9	11.4	**16.2**
November	Egg Development	6.1	11.7	3.1	6.0	9.5
December				-0.3	3.4	7.2

Notes: There was no temperature data for the months of January, February and December at station 501150002. Values for these months are based on continuous water temperatures collected at Belfountain at station 14526010 by CVC (Correlation between Belfountain and Winston Churchill data: r = 0.99; p<0.001). Shaded values exceeded optimal temperature preference values and bold values exceed upper tolerance temperatures.

Figure 1. Brook trout temperature requirements and water temperatures of West Credit River at Winston Churchill (2009-2015)



The Brook Trout population in the West Credit River near Winston Churchill Blvd. appeared to be thriving based on numbers of fish and spawning redds observed during surveys (HESL 2017a) even though existing 75th percentile water temperatures exceed optimal temperature preference for growth and spawning becase:

1. Water temperature is only one habitat component of many required to support robust populations;
2. Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001);
3. Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations; and
4. Groundwater upwellings are ubiquitous in the study area and they provide a consistent source of cold, oxygen-rich water for egg and sac-fry development.

Therefore, for the purposes of the temperature assessment, upper threshold water temperatures were used to assess any effects of the Erin WWTP on the Brook Trout life stages in the West Credit River.

Approach

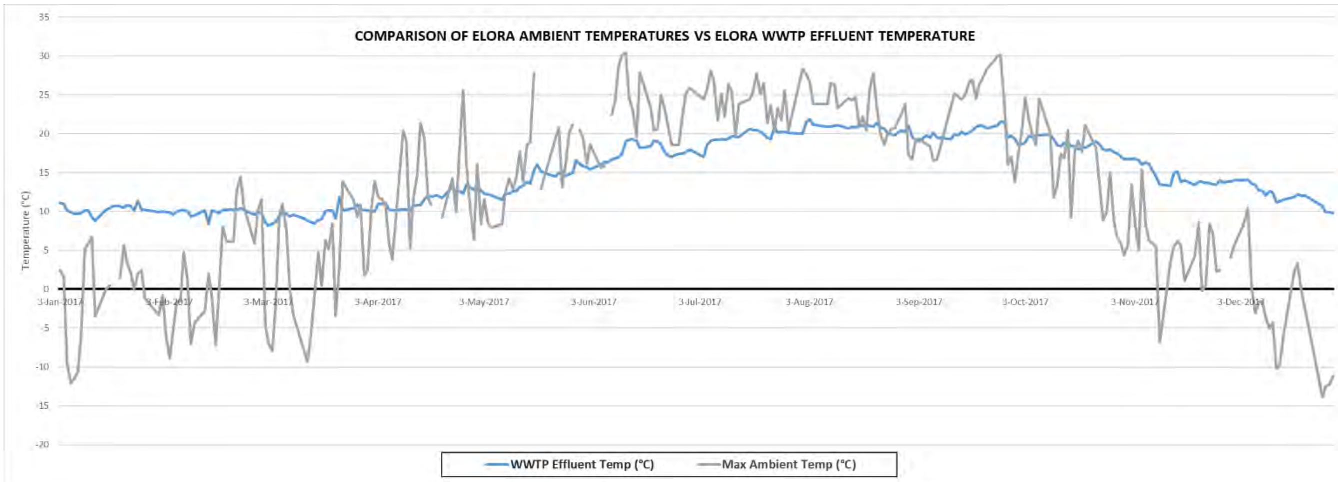
The effect of the Erin WWTP effluent on water temperatures in the West Credit River was calculated using:

1. A mass balance model (i.e., conservative approach) to estimate water temperatures after complete mixing of effluent within the creek; and
2. A CORMIX model to predict the size and shape of the thermal mixing zone.

Water temperature data for the West Credit River were obtained from CVC's station located at Winston Churchill Blvd (2009 through 2015 data; station 501150002), which was supplemented with water quality data collected by CVC at Belfountain (station 14526010). The 75th percentile, minimum and maximum water temperatures were calculated for each month (Table 2) as input into the models.

Monthly 75th percentile effluent temperatures were provided by Ainley Group (Preya Balgobin pers. communication, March 13, 2018) based on 2017 effluent temperatures for the Elora WWTP. The Elora WWTP effluent temperatures were used as it is close to Erin, and similar water sources and climate would result in similar effluent temperatures. It should be noted however that the Elora WWTP uses an extended air process which has higher retention time and longer exposure to ambient air temperatures compared to the treatment process that is proposed at Erin, which means that the use of Elora WWTP effluent temperatures represents a conservative approach of higher effluent temperatures than will likely be recorded at the Erin WWTP. These values were corrected for heat loss through the 1.7 km forcemain between the WWTP and the outfall to the West Credit River. Except for May, it is predicted that effluent will always be warmer than the creek (Table 3). Figure 2 presents ambient air temperatures in Elora compared to Elora WWTP effluent temperatures. The ambient temperatures show much greater fluctuations than the WWTP effluent temperature. The WWTP effluent temperatures gradually increase in warmer weather, and slowly decrease in cooler weather, and are not affected by swings in ambient air temperature.

Figure 2. Comparison of Elora Ambient Air Temperatures with Elora WWTP Effluent Temperatures.



Monthly 7Q20 flows for the West Credit River at 10th Line were the same as those used in the ACS (HESL 2017b). They were calculated by CVC (CVC 2016) and corrected for climate change (10% reduction as per the annual 7Q20 estimate by CVC) and used as input into the models. The lowest 7Q20 value occurs in September, followed by the other summer monthly flows (August, June and July). Highest 7Q20 values occur in the spring (April and March) and late fall/early winter (December/November; Table 3).

Models were run for both Phase 1 (39 L/s) and Full Build Out (83 L/s) effluent flows. It should be noted that Phase 1 is predicted to occur in the near term (next 3 to 5 years), and Full Build Out conditions will not occur for 20 or more years. Therefore, Full Build Out predictions may be validated and refined with future site-specific data (e.g. Erin WWTP effluent temperatures).

The CORMIX model inputs were those detailed in the *West Credit River Assimilative Capacity Study* (HESL 2017b) with addition of a surface heat exchange coefficient for modelling temperature. The CORMIX user manual (Doneker and Jirka 2014) suggests that, for conservative models, a value of 10 W/m^2,°C be used at low water temperatures and a value of 20 W/m^2,°C be used at high water temperatures. These values correspond to a wind speed of 0-2 m/sec - heat exchange would be greater at higher wind speeds. Following this, a surface heat exchange coefficient of 20 W/m^2,°C was used for the months of June through August, and a coefficient of 10 W/m^2,°C was used for all other months.

Mass Balance Model Results

The resulting water temperatures in the West Credit River downstream of the proposed WWTP discharge as calculated by the mass balance (at both Phase 1 and Full Build Out effluent flows of 39 L/s and 83 L/s) are presented in Table 3.

Table 3. Monthly Fully-Mixed Water Temperatures in West Credit River by Mass Balance Modelling

Month	75th Effluent Temp (°C)	75th % West Credit River Temp (°C)	Monthly 7Q20 (L/s)	Phase 1 Mixed Temp (°C)	Phase 1 Temp Increase (°C)	Full Build Out Mixed Temp (°C)	Full Build Out Temp Increase (°C)	Upper Tolerance Temperature (°C)
January	10.8	1.1	374	2.0	0.9	2.9	1.8	11.7
February	10.3	1.43	357	2.3	0.9	3.1	1.7	11.7
March	10.3	4.0	464	4.4	0.5	4.9	1.0	11.7
April	12.2	8.0	568	8.3	0.3	8.5	0.5	19.0
May	14.8	16.2	416	16.1	-0.1	16.0	-0.2	19.0
June	18.0	17.7	306	17.7	0.0	17.8	0.1	19.0
July	19.6	19.3	319	19.3	0.0	19.4	0.1	19.0
August	20.3	18.4	275	18.6	0.2	18.8	0.4	19.0
September	20.0	15.9	244	16.5	0.6	16.9	1.0	19.0
October	18.4	11.4	338	12.1	0.7	12.8	1.4	16.0
November	15.7	6.0	460	6.8	0.8	7.5	1.5	11.7
December	12.7	3.4	464	4.2	0.7	4.8	1.4	11.7

Note: Shaded values exceed both 75th percentile background and upper tolerance threshold for Brook Trout

During Phase 1, fully mixed 75th percentile water temperatures are predicted to decrease in May by 0.1ºC, not change in June and July, and increase between 0.2 to 0.9ºC in August to April. The largest increase in water temperatures will be in the late fall (November) and winter (December, January and February), with water temperature increases of 0.7 to 0.9ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The existing 75th percentile water temperature in July (19.3ºC) is above the upper tolerance threshold for growth (19ºC). Under Phase 1 effluent flows, July water temperature is predicted to stay the same (i.e. 19.3ºC), therefore, there is no predicted change from current conditions. Fully mixed water temperatures during the sensitive periods for Brook Trout spawning (October) and egg development (November through to March) will remain well below the upper tolerance temperatures (Table 3) although groundwater inflows will isolate eggs from the changes.

During Full Build Out, fully mixed 75th percentile water temperatures are predicted to decrease in May by 0.2ºC and increase between 0.1 to 1.8ºC between June and April. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. In July, the 75th percentile water temperature is predicted to be 19.4ºC, above the threshold of 19ºC, but only 0.1ºC above the existing 75th percentile water temperature of 19.3ºC.

CORMIX Model Results

During Phase 1, the upper tolerance threshold temperatures are met at the diffuser from January to June. In July, background 75th percentile West Credit River water temperatures exceed the upper tolerance threshold value of 19ºC (see mass-balance modeling results), therefore the threshold will not be met downstream. From August to December the distance to the point where effluent temperature declines to the upper tolerance threshold ranges from -2.5 m (backflow from diffuser) to 32 m. These distances are within the 152 m size of the mixing zone predicted for other water quality parameters in the effluent (HESL 2017b).

Table 3 Distance (m) to meet Upper Tolerance Thresholds in West Credit River.

Month	Effluent Temp (°C)	75th % WCR Temp (°C)	Monthly 7Q20 (L/s)	Upper Tolerance Temperature (°C)	Distance (m) downstream to Upper Tolerance - Phase 1	Distance (m) downstream to Upper Tolerance - Full Build-Out
January	10.8	1.13	374	11.7	0	0
February	10.3	1.43	357	11.7	0	0
March	10.3	3.95	464	11.7	0	3
April	12.2	8.00	568	19.0	0	0
May	14.8	16.20	416	19.0	a	
June	18.0	17.70	306	19.0	0	0
July	19.6	19.30	319	19.0	b	
August	20.3	18.40	275	19.0	32	84
September	20.0	15.90	244	19.0	3	3
October	18.4	11.40	338	16.0	3	715
November	15.7	6.00	460	11.7	7	12
December	12.7	3.44	464	11.7	-2.5	3

Notes: a – effluent is cooler than West Credit River, therefore the Upper Tolerance Threshold is never exceeded; b – existing 75th percentile West Credit River water temperatures exceed the Upper Tolerance Threshold

During Full Build Out, the upper tolerance threshold temperatures are met at the diffuser in January, February, April, and June. Again, in July, background 75th percentile West Credit River water temperatures exceed the upper tolerance threshold value of 19ºC, therefore the threshold will not be met downstream. In March, September, November, and December, the distance for temperature to decrease to the upper tolerance threshold ranges are less than 40 m. In August and October, the distance to upper tolerance threshold temperatures are 84 and 715 m respectively. We note that the large increase in October is an artifact that relates to the transition from a growth tolerance temperature of 19ºC to a spawning tolerance of 16ºC, which will not occur on October 1 but will depend on when fish actually spawn. The actual affected

distance in the river will be much less than the 715 m predicted. At 35 m downstream of the diffuser, water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development.

Thermal Impact on Fish and Other Aquatic Species

The proposed effluent outfall diffuser will be placed approximately 2 m upstream (i.e. south) of the large culvert that transmits flows beneath Winston Churchill Blvd. The culvert is approximately 45 m long and represents degraded habitat because it is permanently shaded, doesn't permit macrophyte growth and limits the form of the stream bed and width of the channel.

The predicted increases in temperature in the West Credit River downstream of the outfall as predicted through mass balance modeling are minimal. In the short-term (Phase 1), fully mixed water temperatures are predicted to stay the same (July) or increase by 0.9ºC. Fully mixed water temperatures during Brook Trout spawning (October) and egg development (November to March) will remain well below their upper tolerance temperatures.

In the longer-term (Full Build Out, > 20 years), fully mixed water temperatures are predicted to increase by a maximum of 1.7ºC. Except for July, water temperatures will remain below their upper tolerance thresholds for the various life stages. The nominal increase (0.2ºC) in July water temperature is not expected to affect the growth life stage of the local Brook Trout population for the following reasons:

1. Brook Trout in this reach have acclimatized to water temperatures up to 24.3ºC (maximum water temperature of Winston Churchill),
2. Brook Trout routinely experience water temperatures of 19.3ºC in the study area,
3. Temperature predictions are conservative since they are focused on 7Q20 flows (which are exceeded 99.5 to 99.9% of the time; Pyrce 2004) and 75th percentile water temperatures,
4. Brook Trout commonly seek out thermal refugia (Ebersole et al. 2001),
5. Seasonal temperature cycles provide an acclimatization period for Brook Trout (Raleigh 1982), and
6. Fully mixed water temperatures during sensitive spawning (October) and egg growth development (November to March) life stages will remain well below their upper tolerance temperatures.

The maximum predicted distance to upper threshold temperatures in the West Credit River downstream of the outfall during Phase 1 as predicted through CORMIX modeling is 32 m in August so increased temperatures will be constrained to degraded habitat located in the culvert. Predicted distances to upper threshold temperatures during Full Build Out are 84 m in August and 715 m in October but, the October distance of 715 m is considered artificially high. By 35 m downstream of the diffuser (within the culvert) water temperatures are predicted to be 19.2ºC and 16.2ºC for August and October, respectively. This is only 0.2ºC greater than the upper tolerance thresholds for spawning and egg development. Any effects on Brook Trout populations will be partially mitigated in August by their ability to seek out thermal refugia, and from November - March egg and sac-fry development will not be impacted because Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore

water temperatures near these spawning and development areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the change to water temperatures.

There are several qualifications mentioned throughout this assessment that made it conservative. Qualifications include:

1. These predictions were made for 7Q20 low flow conditions as a conservative estimate of change - flows will be higher and temperature changes smaller 99.5% of the time,
2. Seasonal temperature cycles from summer highs to winter lows provide an acclimatization period to temperature extremes for Brook Trout (Raleigh 1982),
3. Brook Trout commonly seek out thermal refugia within streams (Ebersole et al. 2001),
4. Different Brook Trout strains have acclimatized to the water temperatures of their environment (Stitt et al. 2014), so it is challenging applying reported thermal tolerances of assemblages in the West Credit River when the studies were not completed on these populations, and
5. Most importantly, Brook Trout commonly spawn overtop of rocky substrates and groundwater upwellings, and eggs develop within the interstitial spaces of the substrates. Groundwater inputs will not be impacted by the WWTP effluent and therefore water temperatures near these spawning areas and within the interstitial spaces between rocky substrates are not likely to change. Water temperature modelling is focused on the assimilation of effluent throughout the water column and not on water temperatures within or adjacent to sediments, so the prediction of impacts on spawning habitat represents a very conservative assessment of the effect of change to water temperatures.

Conclusions

The Provincial Water Quality Objective for water temperature is, “The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.” (MOE 1994). Based on the results of the thermal assessment on Brook Trout, including the various conservative qualifications, we predict that the temperature changes resulting from the WWTP discharge will not “significantly change the distribution and abundance of plant and animal life” per the Provincial Water Quality Objective.

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March 23, 2018 File: 115157

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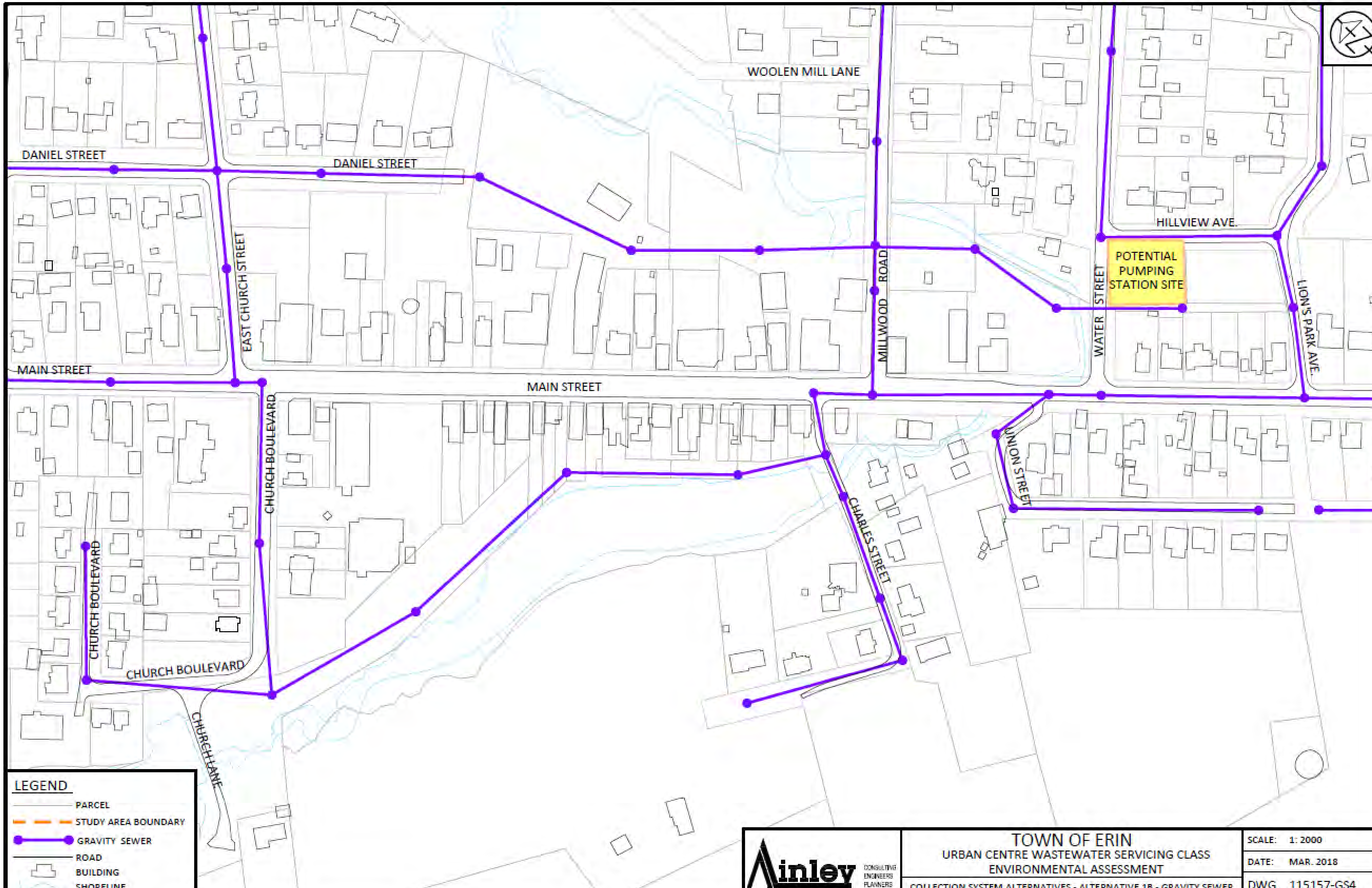

TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1B - GRAVITY SEWER

SCALE: 1: 2000
DATE: MAR. 2018
DWG. 115157-GS4

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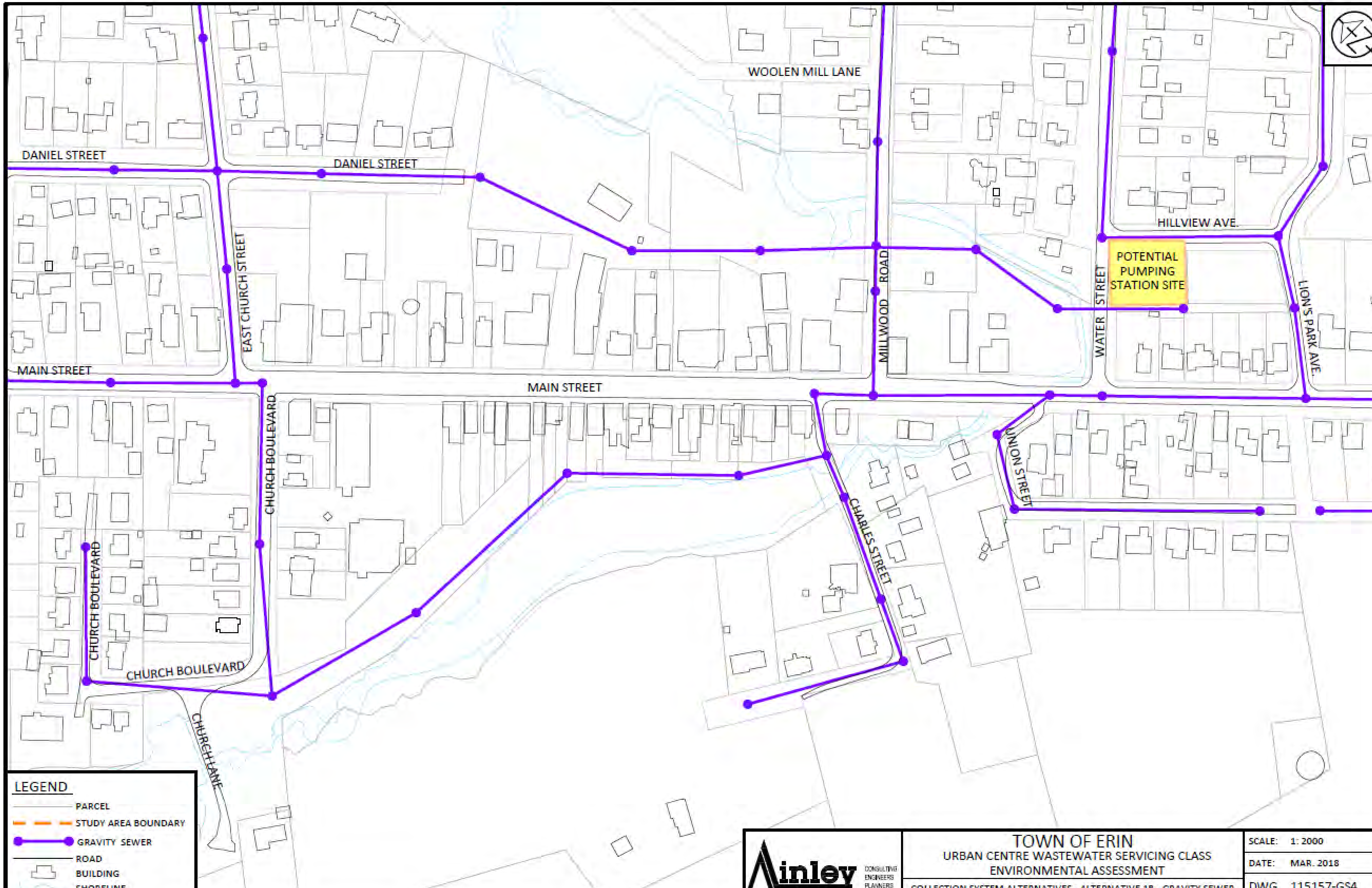

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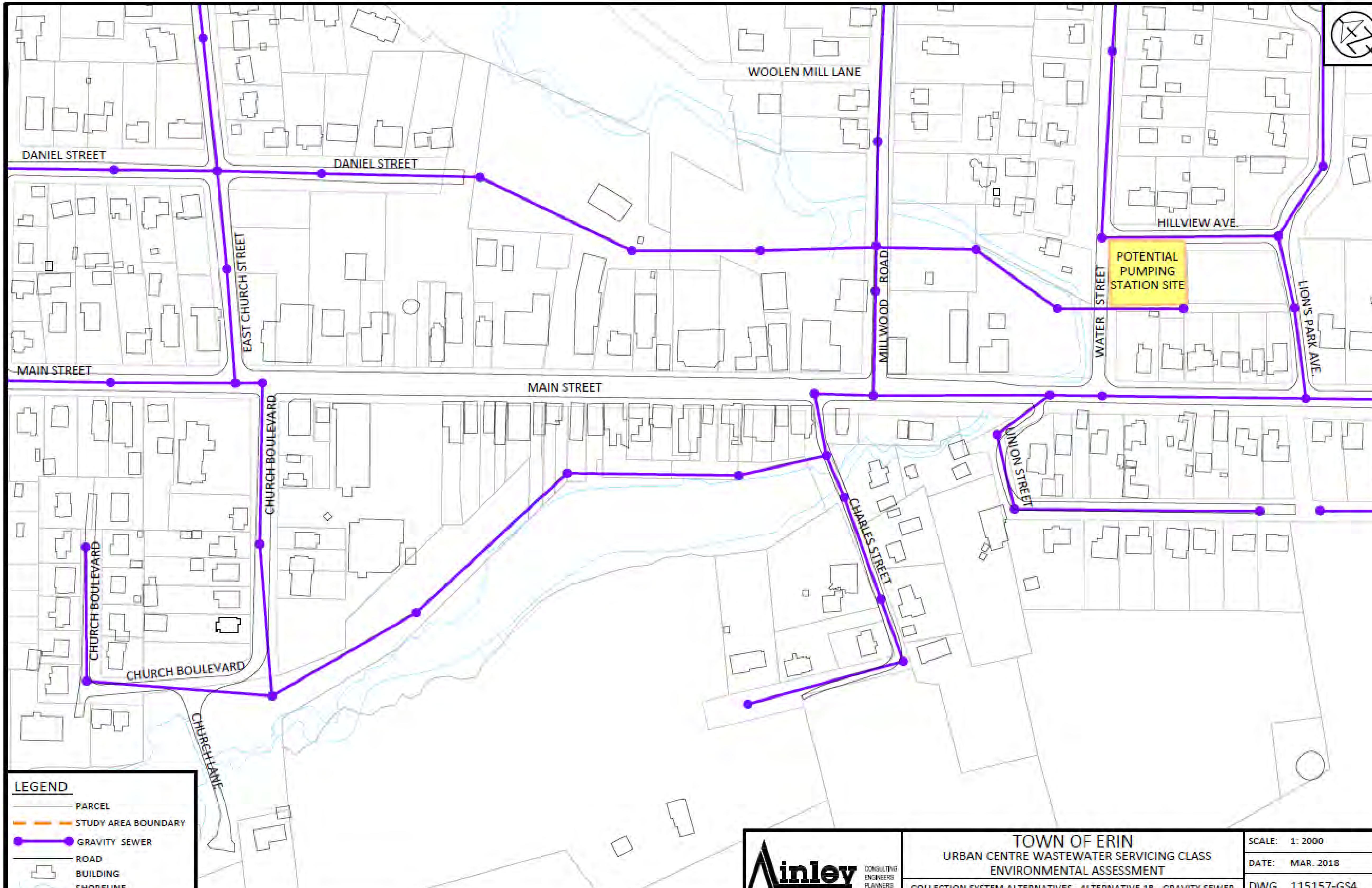

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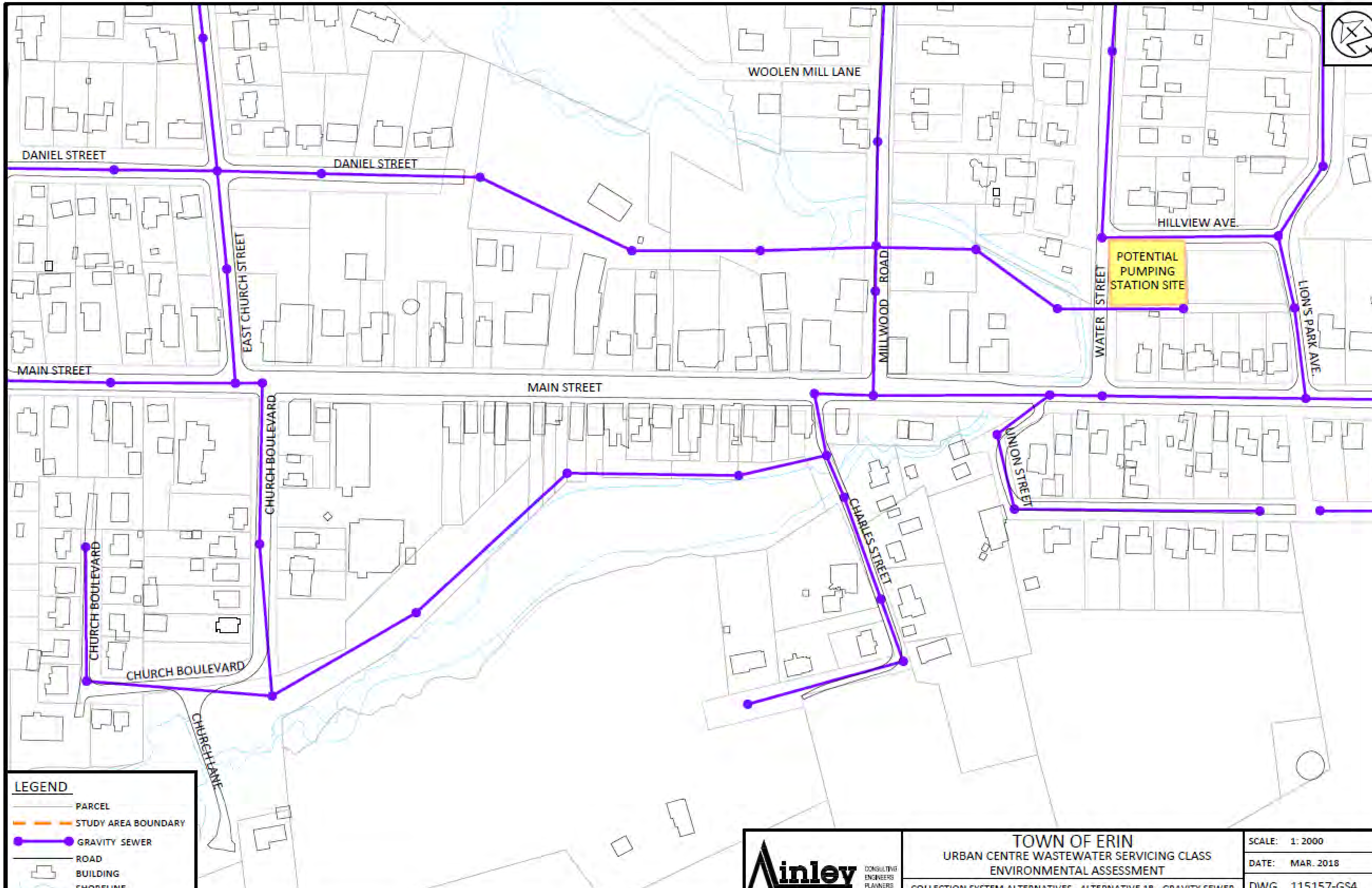

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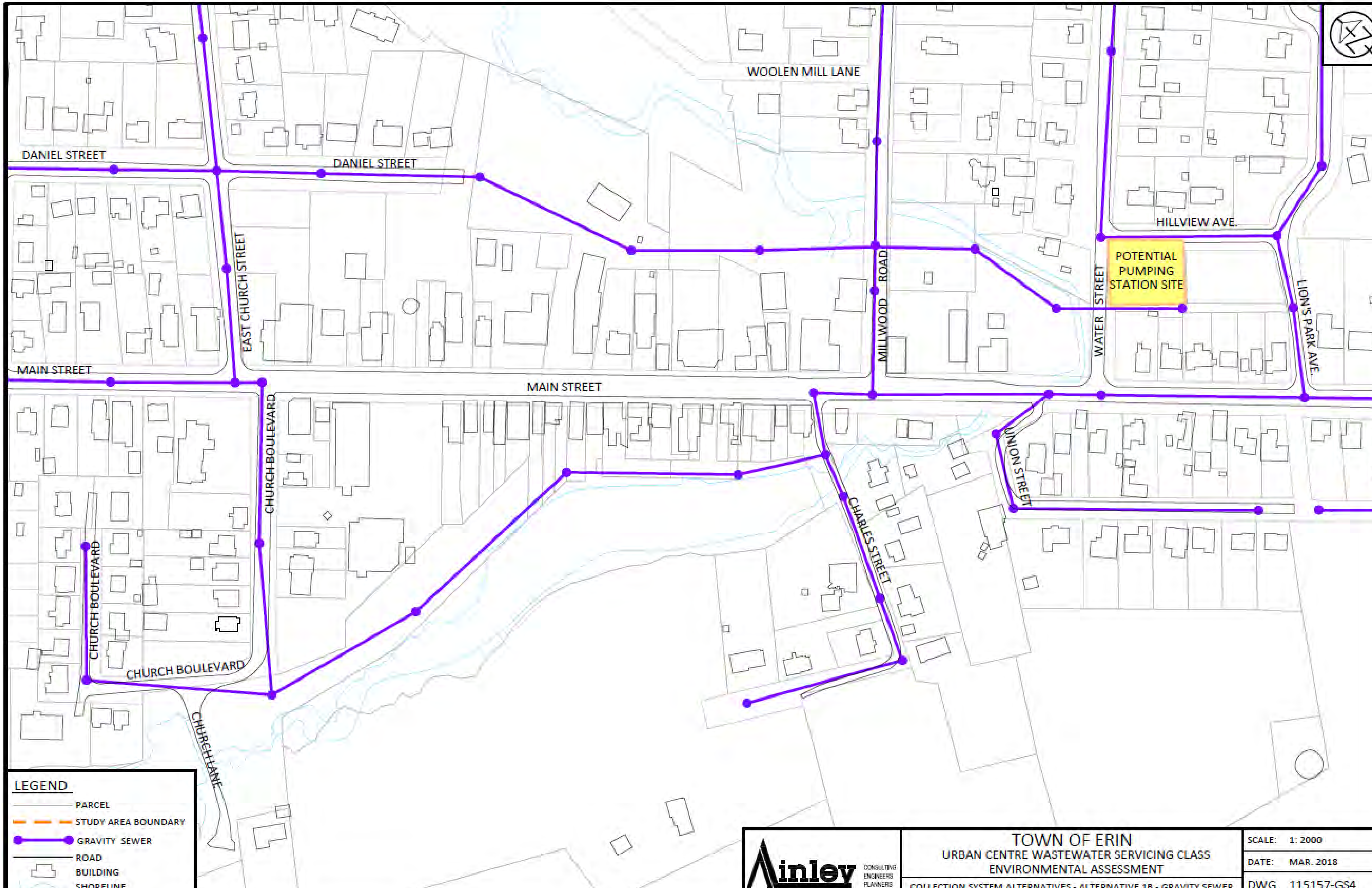

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To adopt this alternative, the sewer would need to pass through your property at [redacted]. We have attached a plan showing the potential location of the sewer for your reference. We have carried this as our recommended preferred alternative in our project documentation.

Subject to your agreement, this recommendation will be carried forward through to the conclusion of the environmental assessment process. We would appreciate your feedback to ensure your comments can be documented and included within the Environmental Study Report (ESR). While your property has been identified in the project reports, the Town is not seeking to purchase lands at this time. Until the Environmental Assessment Process is complete and the Town decides to proceed with implementation, the Town will not be in a position to complete purchase of the necessary easement for the sewer.

Ainley & Associates Limited
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Tel: (905) 595-6859 • Fax: (705) 445-0968

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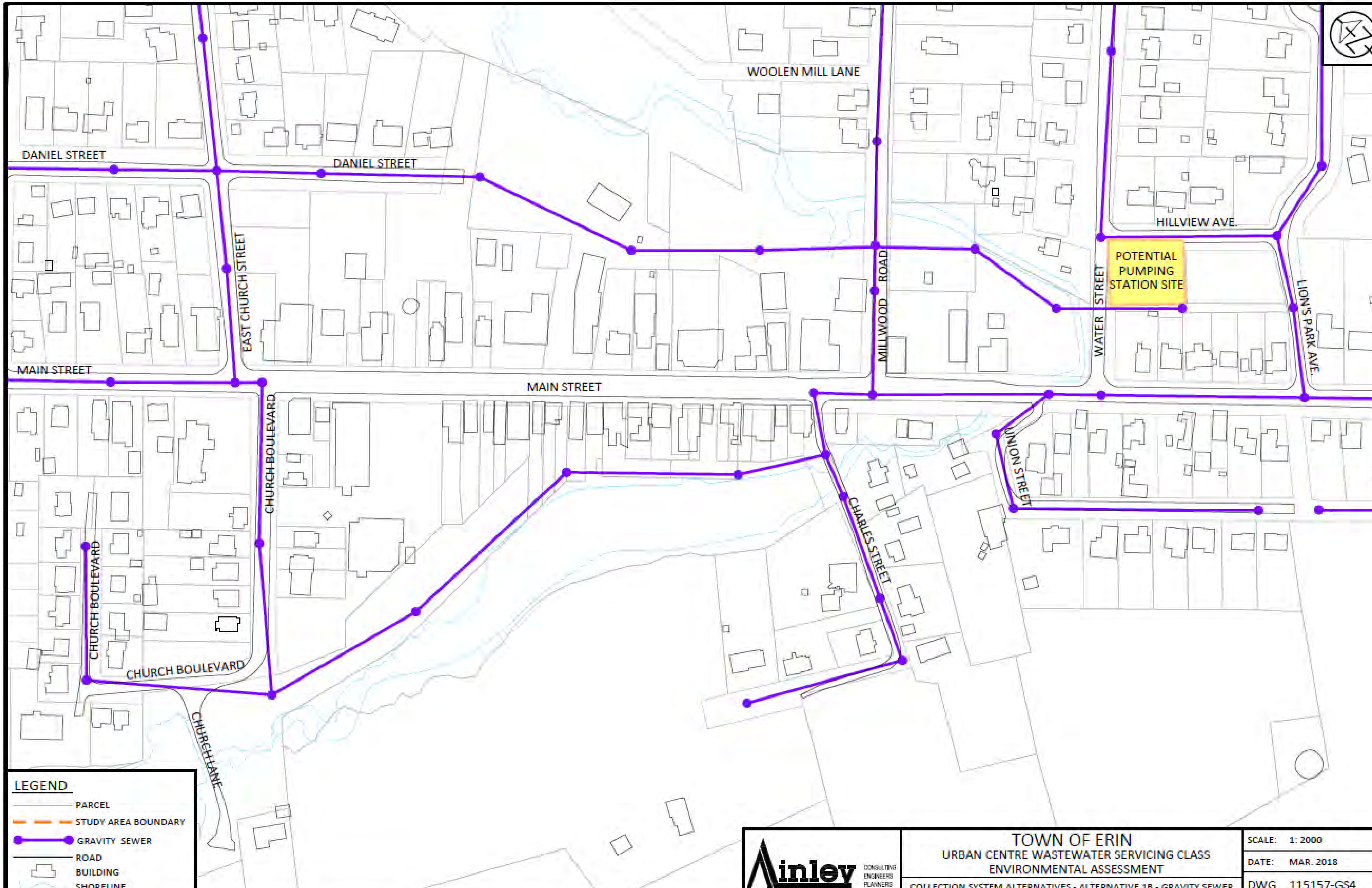

Ainley CONSULTING ENGINEERS PLANNERS

TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1B - GRAVITY SEWER

SCALE: 1: 2000
DATE: MAR. 2018
DWG. 115157-GS4

Ainley & Associates Limited
195 County Court Boulevard, Unit 300, Brampton, ON L6W 3X7
Tel: (905) 595-6859 • Fax: (705) 445-0968

March 23, 2018 File: 115157

Urban Centre Wastewater Servicing Class EA

Hello [redacted]

As you may be aware, we are presently conducting a Schedule ‘C’ Class Environmental Assessment for Wastewater Servicing for the Urban Areas of the Town of Erin including the Village of Erin and the Community of Hillsburgh (UCWS EA) on behalf of the Town of Erin. This project follows the recommendations of the Servicing and Settlement Master Plan (SSMP 2014) which partially addressed Phase 1 and 2 of the Class EA process for wastewater servicing. Since initiating this Wastewater Class EA project in May 2016, the project team has completed the Phase 1 and 2 activities and is currently working towards finalising Phase 3 and 4.

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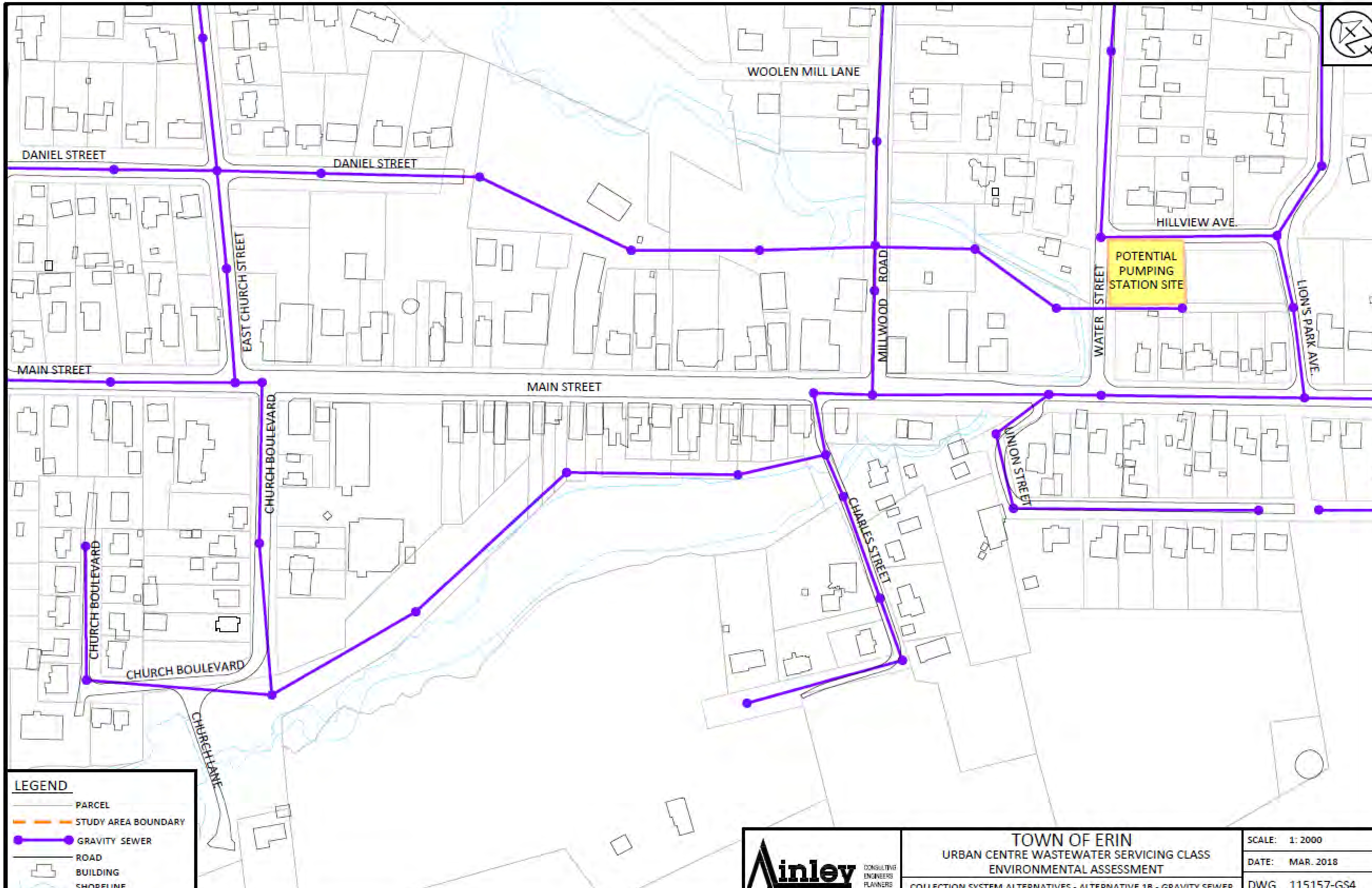

Ainley CONSULTING ENGINEERS PLANNERS	TOWN OF ERIN URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT	SCALE: 1: 2000
		DATE: MAR. 2018
	COLLECTION SYSTEM ALTERNATIVES - ALTERNATIVE 1B - GRAVITY SEWER	DWG. 115157-GS4

Ainley & Associates Limited
2 County Court Boulevard, Brampton, ON L6W 3X7
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March 23, 2018 File: 115157

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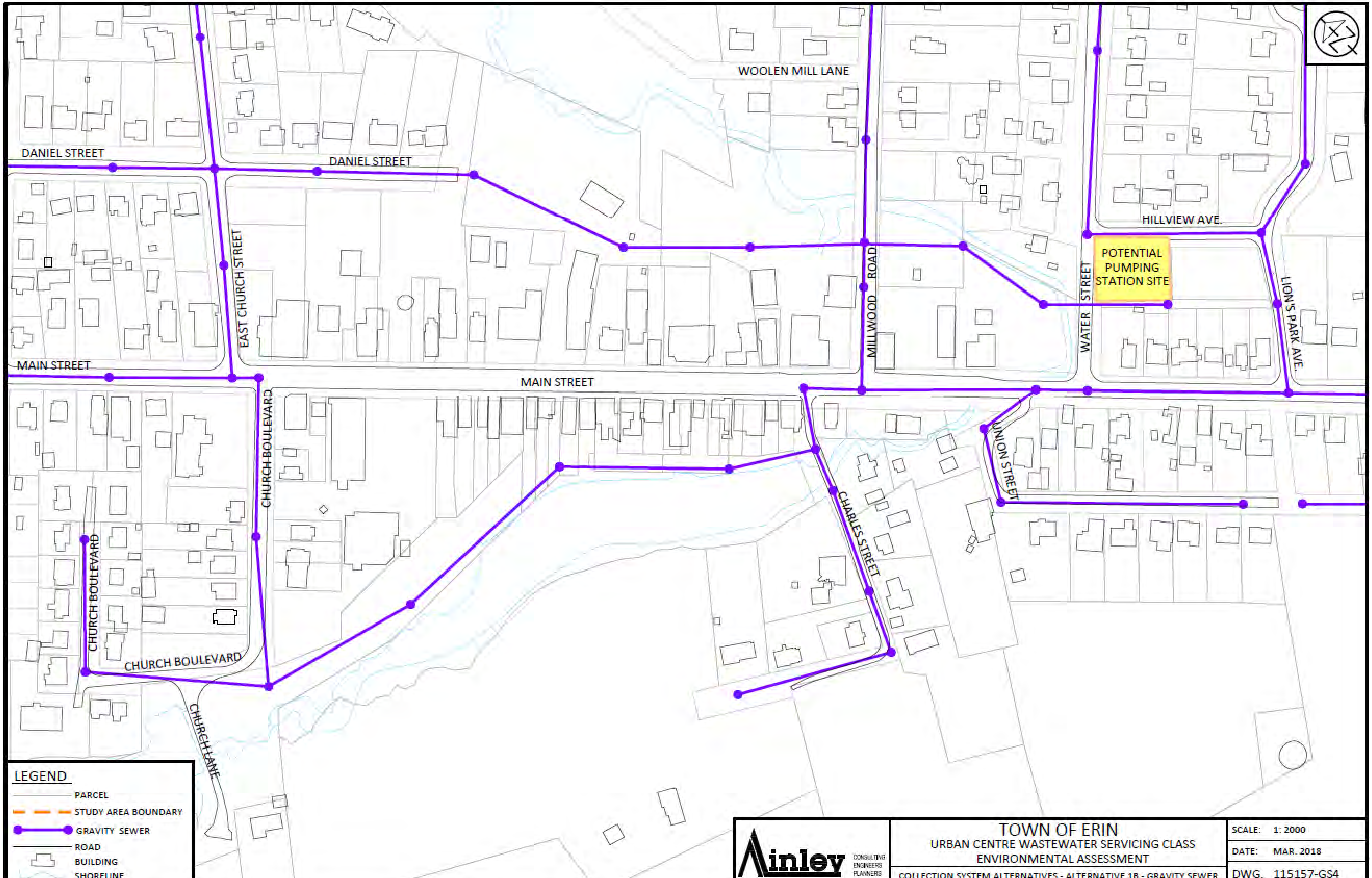

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A key aspect of Phase 3 has been identifying the recommended design solution along with identification of potential sites for the establishment of the collection network, pumping stations and wastewater treatment plant. This letter is to inform you that, through our study, we have identified your property at [redacted] as the recommended preferred site for the establishment of a sanitary pumping station. Specifically, the recommended site is at the south end of your property adjacent to the Elora Cataract Trail. Subject to your agreement, this recommendation will be carried forward through to the conclusion of the environmental assessment process. We would appreciate your feedback to ensure your comments can be documented and included within the Environmental Study Report (ESR). While your property has been identified in the project reports, the Town is not seeking to purchase lands at this time. Until the Environmental Assessment Process is complete and the Town decides to proceed with implementation, the Town will not be in a position to complete purchase of the necessary lands.

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TOWN OF ERIN
URBAN CENTRE WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT
ERIN SPS 2 CONCEPTUAL SITE PLAN

DATE: NOV. 2017

PROJECT: 115157

Ainley & Associates Limited
195 County Court Boulevard, Brampton, ON L6W 3X7
Tel: (905) 595-6859 • Fax: (705) 445-0968

March 23, 2018 File: 115157

Urban Centre Wastewater Servicing Class EA

[redacted]

As you are aware, we are presently conducting a Schedule 'C' Class Environmental Assessment for Wastewater Servicing for the Urban Areas of the Town of Erin including the Village of Erin and the Community of Hillsburgh (UCWS EA) on behalf of the Town of Erin. This project follows the recommendations of the Servicing and Settlement Master Plan (SSMP 2014) which partially addressed Phase 1 and 2 of the Class EA process for wastewater servicing. Since initiating this Wastewater Class EA project in May 2016, the project team has completed the Phase 1 and 2 activities and is currently working towards finalising Phase 3 and 4.

A key aspect of Phase 3 has been identifying the recommended design solution along with identification of potential sites for the establishment of the collection network, pumping stations and wastewater treatment plant. This letter is to inform you that, through our study, we have identified your property at [redacted] as the recommended preferred site for the establishment of a sanitary pumping station. Specifically, the recommended site is at the northwest end of your property adjacent to the existing driveway. The conceptual site plan provided in the project reports is provided herein. Subject to your agreement, this recommendation will be carried forward through to the conclusion of the environmental assessment process. We would appreciate your feedback to ensure your comments can be documented and included within the Environmental Study Report (ESR). While your property has been identified in the project reports, the Town is not seeking to purchase lands at this time. Until the Environmental Assessment Process is complete and the Town decides to proceed with implementation, the Town will not be in a position to complete purchase of the necessary lands.

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April 26, 2018 File: 115157

[redacted]

As you are aware, we are presently conducting a Schedule 'C' Class Environmental Assessment for Wastewater Servicing for the Urban Areas of the Town of Erin including the Village of Erin and the Community of Hillsburgh (UCWS EA) on behalf of the Town of Erin. This project follows the recommendations of the Servicing and Settlement Master Plan (SSMP 2014) which partially addressed Phase 1 and 2 of the Class EA process for wastewater servicing. Since initiating this Wastewater Class EA project in May 2016, the project team has completed the Phase 1 and 2 activities and is currently working towards finalising Phase 3 and 4.

A key aspect of Phase 3 has been identifying the recommended design solution along with identification of potential sites for the establishment of the collection network, pumping stations and wastewater treatment plant. This letter is to inform you that, through our study, we have identified your property [redacted] as a recommended preferred site for the establishment of a Wastewater Treatment Plant, conditional upon the timing of the project and subject to the aggregate resource being extracted by your company. Subject to your agreement, this recommendation will be carried forward through to the conclusion of the environmental assessment process. We would appreciate your feedback to ensure your comments can be documented and included within the Environmental Study Report (ESR). While your property has been identified in the project reports, the Town is not seeking to purchase lands at this time. Until the Environmental Assessment Process is complete and the Town decides to proceed with implementation, the Town will not be in a position to complete purchase of the necessary lands.

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Ainley CONSULTING ENGINEERS PLANNERS	**TOWN OF ERIN** URBAN WASTEWATER SERVICING CLASS ENVIRONMENTAL ASSESSMENT	DATE: NOVEMBER 2017
	WWTP SITE SELECTION FIGURE 3	PROJECT # 115157

Ainley & Associates Limited
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March 23, 2018 File: 115157

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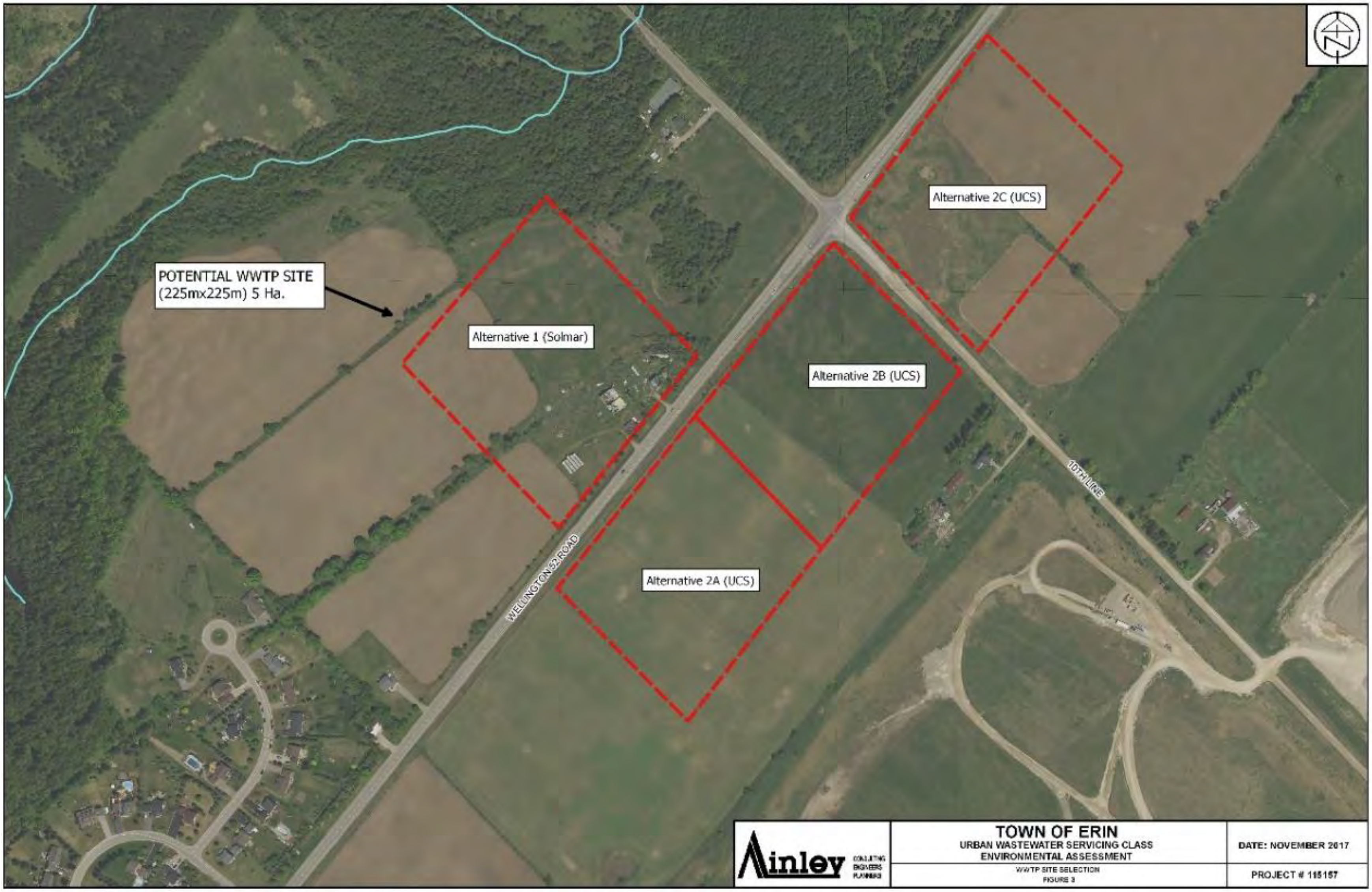

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March 23, 2018 File: 115157

Urban Centre Wastewater Servicing Class EA

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A key aspect of Phase 3 has been identifying the recommended design solution along with identification of potential sites for the establishment of the collection network, pumping stations and wastewater treatment plant. This letter is to inform you that, through our study, we have identified your property [redacted], as the recommended preferred site for the establishment of a sanitary pumping station. Specifically, the recommended site is directly east of the intersection of Trafalgar Road and the Elora Cataract Trail. The conceptual site plan for the proposed station is enclosed herein Subject to your agreement, this recommendation will be carried forward through to the conclusion of the environmental assessment process. We would appreciate your feedback to ensure your comments can be documented and included within the Environmental Study Report (ESR). While your property has been identified in the project reports, the Town is not seeking to purchase lands at this time. Until the Environmental Assessment Process is complete and the Town decides to proceed with implementation, the Town will not be in a position to complete purchase of the necessary lands.

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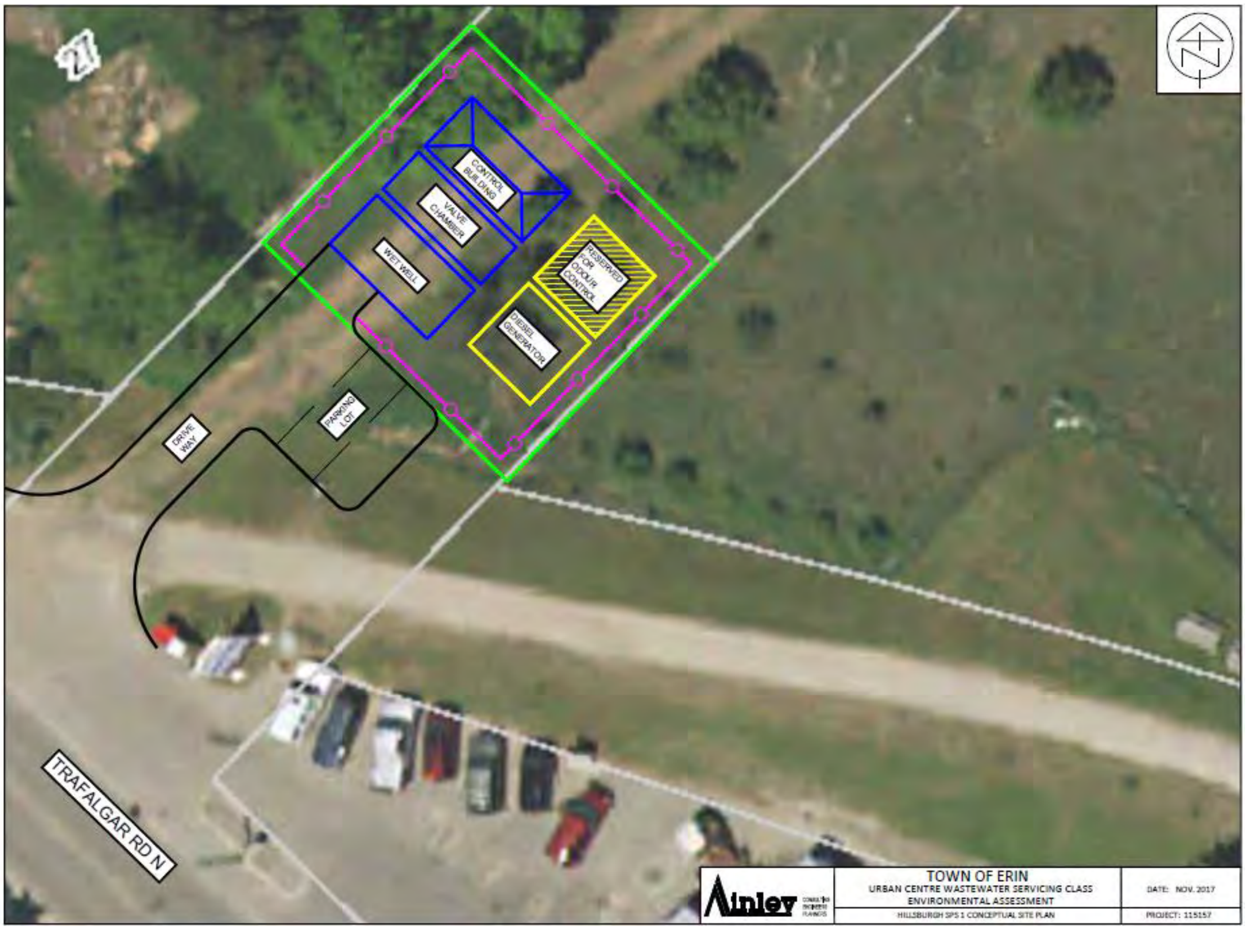


Appendix - O

Geotechnical Report

GeoPro Consulting Limited

Geotechnical-Hydrogeology-Environmental-Materials-Inspection

Preliminary Geotechnical Investigation

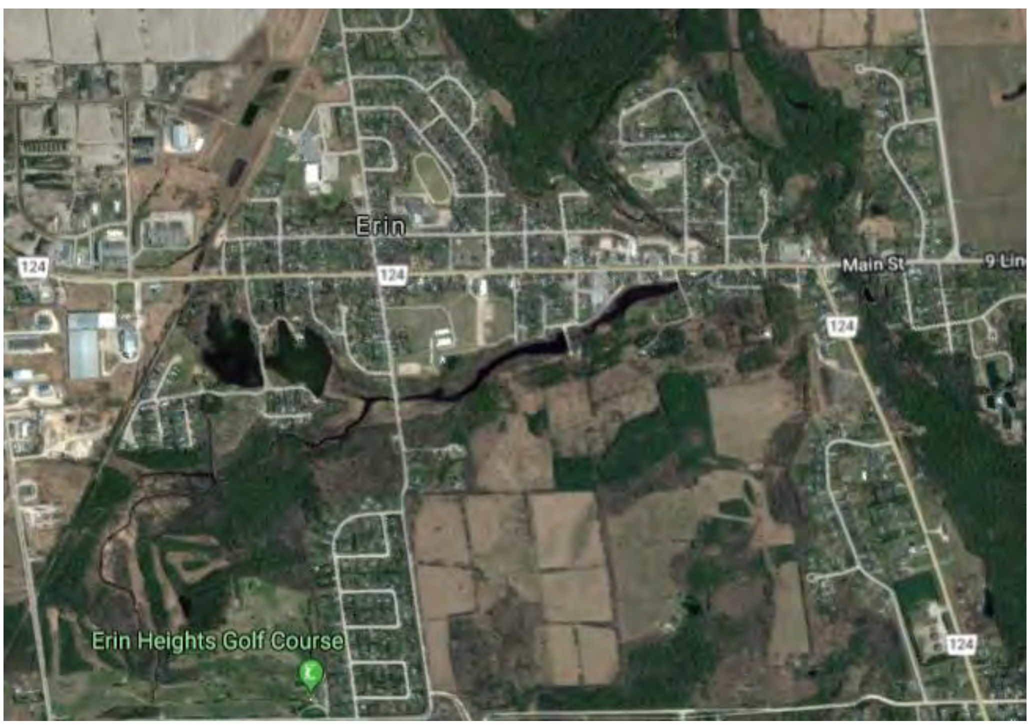
Urban Centre Wastewater Servicing

Class Environmental Assessment Study

Town of Erin, Ontario

Prepared For:

Ainley Group



GeoPro Project No.: 16-1255

Report Date: January 4, 2018

Professional, Proficient, Proactive

T: (905) 237-8336 E: office@geoproconsulting.ca

Unit 57, 40 Vogell Road, Richmond Hill, Ontario L4B 3N6

GeoPro CONSULTING LIMITED

Table of Contents

1 INTRODUCTION

GeoPro Consulting Limited (GeoPro) was retained by Ainley Group (the Client) to conduct a preliminary geotechnical investigation for the Urban Centre Wastewater Servicing Class Environmental Assessment (EA) Study - proposed wastewater treatment plant (WWTP), pumping stations and sanitary sewage collection system in Hillsburgh and Erin Village, Ontario.

The purpose of this geotechnical investigation was to obtain information on the existing subsurface conditions by means of a limited number of boreholes, in-situ tests and laboratory tests of soil samples to provide required geotechnical design information. Based on GeoPro's interpretation of the obtained data, geotechnical comments and recommendations related to the project designs are provided.

This report is prepared with the condition that the design will be in accordance with all applicable standards and codes, regulations of authorities having jurisdiction, and good engineering practice. Furthermore, the recommendations and opinions in this report are applicable only to the proposed project as described above. On-going liaison and communication with GeoPro during the design stage and construction phase of the project is strongly recommended to confirm that the recommendations in this report are applicable and/or correctly interpreted and implemented. Also, any queries concerning the geotechnical aspects of the proposed project shall be directed to GeoPro for further elaboration and/or clarification.

This report is provided on the basis of the terms of reference presented in our approved proposal prepared based on our understanding of the project. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this report can be relied upon.

This report deals with geotechnical issues only. The geo-environmental (chemical) aspects of the subsurface conditions, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources were not investigated and were beyond the scope of this assignment. However, limited chemical testing was carried out on selected soil samples for excess soil disposal purposes.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. Laboratory testing, for most part, follows ASTM or CSA Standards or modifications of these standards that have become standard practice in Ontario.

This report has been prepared for the Client only. Third party use of this report without GeoPro's consent is prohibited. The limitations to the report presented above form an integral part of the report and they must be considered in conjunction with this report.

2 SITE AND PROJECT DESCRIPTION

This preliminary geotechnical investigation is to support the preliminary designs for the urban centre wastewater servicing Class EA study in Hillsburgh and Erin Village, Ontario. It is understood that the proposed study consists of wastewater treatment plants (WWTPs), pumping stations and sanitary sewage collection systems.

3 INVESTIGATION PROCEDURE

Field work for the geotechnical investigation was carried out from October to December, 2017 during which time sixty (60) boreholes (Boreholes BH1 to BH37, BH37A, BH38, BH101 to BH104, BH107, T1 to T9, SPS01BE, SPS02E to SPS04E, SPS06E, SPS08E and SPS01H) were advanced to depths ranging from about 3.1 m to 8.1 m below the existing ground surface. The borehole locations are shown on Drawings 1 to 15.

A proposed borehole location plan prepared by GeoPro was provided to the Client for review prior to the filed investigation work. The approved borehole locations were staked in the field by GeoPro according to the drill rig accessibility and the underground utility conditions. The field work for this investigation was monitored by a member of our engineering staff who logged the boreholes and cared for the recovered samples.

The boreholes were advanced using truck and track mounted continuous flight auger equipment and continues split spoon supplied by drilling specialists subcontracted to GeoPro. Soil samples were recovered at regular intervals of depth using a 50 mm O.D. split-spoon sampler driven into the soil in accordance with the Standard Penetration Test (SPT) procedure described in ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. In some boreholes, the types and approximate depths of the subgrade soil were obtained using an auger sampling technique.

Groundwater condition observations were made in the boreholes during drilling and upon completion of drilling. The boreholes were backfilled and sealed upon completion of drilling. A monitoring well (51 mm in diameter) was installed in each of Boreholes BH10, BH11, BH15, BH17, BH20, BH23, BH24, BH33 to BH35, BH37, BH37A, BH38, BH101, BH103, BH104, BH107, T2, T3, T5, T9, SPS01BE, SPS02E to SPS04E, SPS06E, SPS08E and SPS01H to measure the long-term groundwater tables.

All soil samples obtained during this investigation were brought to our laboratory for further examination. These soil samples will be stored for a period of three (3) months after the day of issuing draft report, after which time they will be discarded unless we are advised otherwise in writing. Geotechnical classification testing (including water content, grain size distribution and Atterberg Limits, when applicable) was carried out on selected soil samples. The laboratory test results are attached in Figures 1 to 5.

It should be noted the elevations at the as-drilled borehole locations were not available at the time of preparing the report. The borehole locations plotted on the Borehole Location Plan, Drawings 1 to 15 were based on the measurement of the site features and should be considered to be approximate.

4 SUBSURFACE CONDITIONS

4.1 Subsurface Conditions

The borehole locations are shown on Drawings 1 to 15. Notes on sample descriptions are presented in Enclosure 1A. Explanations of terms used in the borehole logs are presented in Enclosure 1B. The subsurface conditions in the boreholes (Boreholes BH1 to BH37, BH37A, BH38, BH101 to BH104, BH107, T1 to T9, SPS01BE, SPS02E to SPS04E, SPS06E, SPS08E and SPS01H) are presented in the individual borehole logs (Enclosures 2 to 61 inclusive). Detailed descriptions of the major soil strata encountered in the boreholes drilled at the site are provided as follows.

4.1.1 Town of Erin (BH1 to BH30)

Pavement Structure

A flexible pavement structure was observed on various roadways in town of Erin. The range and average thicknesses of pavement structure are summarized in the following table:

Location	Pavement Structure (mm)	
	Asphalt Concrete Range (Average)	Granular Base/Subbase Range (Average)
Sideroad 17 (BH1 and BH2)	230 - 300 (265)	230 - 610 (420)
Main Street (BH3, BH8, BH23, BH24 and BH28)	25 - 290 (180)	365 - 465 (415)
May Street (BH4)	55	345
Daniel Street (BH5 and BH16)	60 - 70 (65)	360 - 440 (400)
Dundas Street East (BH7)	110	610
Dundas Street West (BH10 and BH11)	95 - 125 (110)	645 - 695 (670)
Scotch Street (BH9)	90	690
Carberry Street (BH6)	80	680
Erin Heights Drive (BH12 and BH14)	100	360
William Rex Crescent (BH13)	75	315

Church Boulevard (BH15)	95	665
Millwood Road (BH17 and BH19)	85 - 125 (210)	325 - 545 (435)
Waterford Drive (BH18)	120	400
Water Street (BH20)	95	625
Charles Street (BH21)	95	465
William Street (BH22)	45	205
Mountainview Crescent (BH29)	100	400
Leenders Lane (BH30)	115	665

Due to the generally sandy nature of the sand subgrade soils, the exact depth of granular subbase was difficult to distinguish.

Fill Materials

Fill materials consisting of sand, silty sand, sandy silt, sand and silt and gravelly sand to sand and gravel were encountered below the granular base/subbase materials in Boreholes BH1, BH3 to BH5, BH7, BH8, BH12 to BH14, and BH16 to BH29, and extended to depths ranging from about 0.8 m to 3.1 m below the existing ground surface. Borehole BH21 was terminated in these fill materials. SPT N values ranging from 2 to greater than 100 blows per 300 mm penetration indicated a very loose to very dense compactness. The in-situ moisture content measured in the soil samples ranged from approximately 2% to 27%.

Gravelly Sand to Sand and Gravel, and Sandy Gravel

Gravelly sand to sand and gravel, and sandy gravel deposits were encountered below the granular base/subbase materials, fill materials, sand and silt, sandy silt, sand, peat and organic silt deposits in Boreholes BH1 to BH12, BH15 to BH20 and BH22 to BH30, and extended to depths ranging from about 2.1 m to 5.0 m below the existing ground surface. Boreholes BH1 to BH9, BH11, BH12, BH15 to BH19 and BH22 to BH30 were terminated in these deposits. SPT values ranging from 5 to greater than 100 blows per 300mm penetration indicated a loose to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 2% to 19%.

Sand, Sand and Silt, Sandy Silt and Silty Sand

Sand, sand and silt, sandy silt and silty sand deposits were encountered below the granular base/subbase materials, fill materials, gravelly sand, sandy gravel and sand and gravel deposits in Boreholes BH1 to BH3, BH5 to BH7, BH10, BH11, BH23, BH26, BH27 and BH30, and extended to depths ranging from about 2.1 m to 5.0 m below the existing ground surface. Borehole BH10 was terminated in sand deposit. SPT N values ranging from 3 to 40 blows per 300 mm penetration indicated a very loose to dense compactness. The natural moisture content measured in the soil samples ranged from approximately 4% to 24%.

Organic Silt

Organic silt deposit was encountered below the fill materials in Borehole BH17, and extended to a depth of about 4.0 m below the existing ground surface. An SPT N value of 10 blows per 300 mm penetration indicated a loose to compact compactness. The natural moisture content measured in the soil sample was approximately 29%.

Peat

Peat deposit was encountered below the silty sand deposit in Borehole BH11, and extended to a depth of about 4.0 m below the existing ground surface. SPT N values ranging from 2 to 4 blows per 300 mm penetration indicated a very loose to loose compactness. The natural moisture content measured in the soil samples ranged from approximately 21% to 24%.

Sand and Silt Till and Sandy Silt Till

Sand and silt till and sandy silt till deposits were encountered below the fill materials and gravelly sand to sand and gravel deposits in Boreholes BH13, BH14 and BH20, and extended to depths ranging from about 4.8 m to 5.0 m below the existing ground surface. Boreholes BH13, BH14 and BH20 were terminated in these deposits. SPT N values ranging from 47 to greater than 100 blows per 300 mm penetration indicated a dense to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 6% to 9%.

Probable Bedrock

As best could be practically determined, dolostone presumed to coincide with the bedrock surface was encountered in Borehole BH21 below the fill materials at a depth of about 3.0 m below the existing ground surface. Exploration of the bedrock was not carried out as part of this preliminary assignment, however based on samples recovered from the penetration testing, the bedrock beneath the site appeared to consist of brown dolostone.

4.1.2 Town of Hillsburgh (Boreholes BH31 to BH37, BH37A and BH38)

Pavement Structure

A flexible pavement structure was observed on various roadways in town of Hillsburgh. The range and average thickness of pavement structure are summarized in the following table:

Location	Pavement Structure (mm)	
	Asphalt Concrete Range (Average)	Granular Base/Subbase Range (Average)
Hill Street (BH31)	85	565
Church Street (BH32)	45	525
George Street (BH33)	145	545
Covert Lane (BH34)	45	565
Spruce Street (BH35)	135	565
Douglas Crescent (BH36)	80	520
Trafalgar Road North (BH37 and BH37A and BH38)	115 - 130 (120)	380 - 475 (430)

Due to the generally sandy nature of the sand subgrade soils, the exact depth of granular subbase was difficult to distinguish.

Fill Materials

Fill materials consisting of silt, sand, gravelly sand, (organic) sandy silt, and sand and silt to silty (fine) sand were encountered below the granular base/subbase materials in Boreholes BH31 to BH35, BH37, BH37A and BH38, and extended to depths ranging from about 1.4 m to 2.9 m below the existing ground surface. SPT N values ranging from 3 to 34 blows per 300 mm penetration indicated a very loose to dense compactness. The in-situ moisture content measured in the soil samples ranged from approximately 4% to 25%.

Probable Fill Materials

Probable fill materials consisting of gravelly sand and sand and gravel were encountered below the fill materials in Boreholes BH37 and BH38, and extended to a depth of about 4.0 m below the existing ground surface. SPT N values ranging from 13 to 26 blows per 300 mm penetration indicated a compact compactness. The in-situ moisture content measured in the soil samples ranged from approximately 9% to 17%.

Sand, Sand and Silt and Silty Sand

Sand, sand and silt and silty sand deposits were encountered below the granular base/subbase materials, (probable) fill materials in Boreholes BH31 to BH33, BH36 and BH37, and extended to depths ranging from about 4.0 m to 8.1 m below the existing ground surface. Boreholes BH31, BH33 and BH37 were terminated in these deposits. SPT N values ranging from 4 to 93 blows per 300 mm penetration indicated a loose to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 1% to 24%.

Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel deposits were encountered below the fill materials, probable fill materials, sand, silty sand and organic sandy silt deposits in Boreholes BH32, BH34 to BH36, BH37A and BH38, and extended to a depth of about 5.0 m below the existing ground surface. Boreholes BH32, BH34 to BH36, BH37A and BH38 were terminated in these deposits. SPT values ranging from 17 to 81 blows per 300mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 4% to 15%.

Organic Sandy Silt

Organic sandy silt deposit was encountered below the fill materials in Borehole BH37A, and extended to a depth of about 1.7 m below the existing ground surface. An SPT N value of 17 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil sample was approximately 28%.

4.1.3 Existing Trail (T1 to T9)

Gravel Surface

Gravel surface with the thicknesses ringing from 20 mm to 170 mm was encountered surficially in Boreholes T1 to T9.

Fill Materials

Fill materials consisting of silty sand, sandy silt, sand and silt, and gravelly sand were encountered below the gravel surface in Boreholes T1 to T9, and extended to depths ranging from about 0.7 m to 3.4 m below the existing ground surface. SPT N values ranging from 2 to 46 blows per 300 mm penetration indicated a very loose to dense compactness. The in-situ moisture content measured in the soil samples ranged from approximately 4% to 23%.

Organic Silt

Organic silt deposit was encountered below the fill materials in Boreholes T6 and T9, and extended to depths ranging from about 2.9 m to 4.0 m below the existing ground surface. SPT N values ranging from 6 to 7 blows per 300 mm penetration indicated a loose compactness. The natural moisture content measured in the soil samples ranged from approximately 28% to 29%.

Peat

Peat deposit was encountered below the fill materials in Borehole T7, and extended to a depth of about 2.4 m below the existing ground surface. SPT N values ranging from 3 to 13 blows per 300 mm penetration indicated a very loose to compact compactness. The natural moisture content measured in the soil samples ranged from approximately 26% to 27%.

Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel deposits were encountered below the fill materials, sand, and silt deposits in Boreholes T1, T2 and T4 to T7, and extended to a depth of about 5.0 m below the existing ground surface. Boreholes T1, T2 and T4 to T7 were terminated in these deposits. SPT N values ranging from 24 to 59 blows per 300mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 2% to 15%.

Sand, Silt, Silty (Fine) Sand to (Fine) Sandy Silt and Fine Sand and Silt

Sand, silt, silty (fine) sand to (fine) sandy silt, and fine sand and silt deposits were encountered below the fill materials, peat and organic silt deposits in Boreholes T3 and T5 to T9, and extended to depths ranging from about 4.0 m to 5.6 m below the existing ground surface. Boreholes T3 and T9 were terminated in these deposits. SPT N values ranging from 2 to 27 blows per 300 mm penetration indicated a very loose to compact compactness. The natural moisture content measured in the soil samples ranged from approximately 16% to 29%.

Sandy Silt Till

Sandy silt till deposit was encountered below the silty sand deposit in Borehole T8, and extended to a depth of about 6.6 m below the existing ground surface. Borehole T8 was terminated in this deposit. An SPT N value of 26 blows per 300mm penetration indicated a compact compactness. The natural moisture content measured in the soil sample was approximately 11%.

4.1.4 Potential WWTP (BH101 to BH103)

Topsoil

Topsoil with thicknesses ranging from about 250 mm to 330 mm was encountered surficially in Boreholes BH101 to BH103.

Fill Materials

Fill materials consisting of sandy silt to sand and silt were encountered below the topsoil in Boreholes BH101 to BH103, and extended to depths ranging from about 0.8 m to 2.3 m below the existing ground surface. SPT N values ranging from 2 to 9 blows per 300 mm penetration indicated a very loose to loose compactness. The in-situ moisture content measured in the soil samples ranged from approximately 8% to 23%.

Probable Fill Materials

Probable fill materials consisting of gravelly sand were encountered below the fill materials in Borehole BH101, and extended to a depth of about 2.3 m below the existing ground surface. An

SPT N value of 4 blows per 300 mm penetration indicated a loose compactness. The in-situ moisture content measured in the soil sample was approximately 7%.

Sandy Gravel and Gravelly Sand to Sand and Gravel

Sandy gravel and gravelly sand to sand and gravel deposits were encountered below the fill materials and probable fill materials in Boreholes BH101 to BH103, and extended to depths ranging from about 4.7 m to 5.3 m below the existing ground surface. Boreholes BH101 to BH103 were terminated in these deposits. SPT values ranging from 11 to greater than 100 blows per 300mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 2% to 20%.

4.1.5 Proposed Outfall Area (BH104 and BH107)

Existing Pavement Structure

A flexible pavement structure was observed in Boreholes BH104 and BH107. The thicknesses of asphalt concrete ranged from about 60 mm to 110 mm with an average of 85 mm; and the thicknesses of underlying granular base/subbase materials ranged from about 490 mm to 520 mm with an average of 505 mm.

Fill Materials

Fill materials consisting of silty sand to sand and silt, gravelly sand, and sandy silt were encountered below the granular base/subbase materials in Boreholes BH104 and BH107, and extended to depths ranging from about 2.1 m to 2.9 m below the existing ground surface. SPT N values ranging from 5 to 16 blows per 300 mm penetration indicated a loose to compact compactness. The in-situ moisture content measured in the soil samples ranged from approximately 3% to 22%.

Organic Silt

Organic silt deposit was encountered below fill materials in Borehole BH104, and extended to a depth of about 4.0 m below the existing ground surface. An SPT N value of 7 blows per 300 mm penetration indicated a loose compactness. The natural moisture content measured in the soil sample was approximately 28%.

Sand and Silty Sand

Sand and silty sand deposits were encountered below fill materials and organic silt deposit in Boreholes BH104 and BH107, and extended to depths ranging from about 4.0 m to 5.0 m below the existing ground surface. Borehole BH104 was terminated in the sand deposit. SPT N values ranging from 26 to 31 blows per 300 mm penetration indicated a compact to dense compactness. The natural moisture content measured in these soil samples ranged from approximately 8% to 21%.

Sand and Gravel, and Gravelly Sand

Sand and gravel, and gravelly sand deposits were encountered below silty sand deposit in Borehole BH107, and extended to a depth of about 6.6 m below the existing ground surface. Borehole BH107 was terminated in the gravelly sand deposit. SPT N values ranging from 29 to 33 blows per 300 mm penetration indicated a compact to dense compactness. The natural moisture content measured in these soil samples ranged from approximately 8% to 14%.

4.1.6 Pumping Stations (SPS01BE, SPS02E to SPS04E, SPS06E and SPS08E)

4.1.6.1 Pumping Station SPS 01BE

Topsoil

Topsoil with a thickness of about 240 mm was encountered surficially in Borehole SPS01BE.

Fill Materials

Fill materials consisting of sandy silt was encountered below the topsoil in Borehole SPS01BE, and extended to a depth of about 1.4 m below the existing ground surface. SPT N value ranging from 7 to 34 blows per 300 mm penetration indicated a loose to dense compactness. The in-situ moisture content measured in the soil samples ranged from approximately 7% to 11%.

Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel deposits were encountered below the fill materials in Borehole SPS01BE, and extend to a depth of about 4.0 m below the existing ground surface. SPT N values ranging from 24 to 64 blows per 300 mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 9% to 11%.

Sandy Silt Till

Sandy silt till deposit was encountered below the gravelly sand to sand and gravel deposit in Borehole SPS01BE, and extend to a depth of about 7.8 m below the existing ground surface. Borehole SPS01BE was terminated in this deposit. SPT N values ranging from 38 to greater than 100 blows per 300 mm penetration indicated a dense to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 10% to 11%.

4.1.6.2 Pumping Station SPS 02E

Topsoil

Topsoil with a thickness of about 75 mm was encountered surficially in Borehole SPS02E.

Fill Materials

Fill materials consisting of sandy silt was encountered below the topsoil in Borehole SPS02E, and extended to a depth of about 2.1 m below the existing ground surface. SPT N values ranging from 2 to 6 blows per 300 mm penetration indicated a very loose to loose compactness. The in-situ moisture content measured in the soil samples ranged from approximately 8% to 15%.

Upper Gravelly Sand to Sand and Gravel

Upper gravelly sand to sand and gravel deposits were encountered below the fill materials in Borehole SPS02E, and extend to a depth of about 4.0 m below the existing ground surface. SPT N values ranging from 14 to 29 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil samples ranged from approximately 4% to 5%.

Sand

Sand deposit was encountered below the upper gravelly sand to sand and gravel deposits in Borehole SPS02E, and extend to a depth of about 6.4 m below the existing ground surface. SPT N values ranging from 14 to greater than 100 blows per 300 mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 13% to 15%.

Lower Gravelly Sand to Sand and Gravel

Lower gravelly sand to sand and gravel deposits were encountered below the sand deposit in Borehole SPS02E, and extend to a depth of about 7.7 m below the existing ground surface. Borehole SPS02E was terminated in these deposits. SPT N values of greater than 100 blows per 300 mm penetration indicated a very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 9% to 11%.

4.1.6.3 Pumping Station SPS 03E

Existing Pavement Structure

A flexible pavement structure was observed in Borehole SPS03E. The thickness of asphalt concrete encountered in the borehole was about 70 mm; and the thickness of underlying granular base/subbase was about 430 mm.

Fill Materials

Fill materials consisting of silty sand was encountered below the granular base/subbase in Borehole SPS03E, and extended to a depth of about 1.4 m below the existing ground surface. An SPT N value of 17 blows per 300 mm penetration indicated a compact compactness. The in-situ moisture content measured in the soil samples was approximately 5%.

Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel deposits were encountered below the fill materials in Borehole SPS03E, and extend to a depth of about 4.9 m below the existing ground surface. SPT N values ranging from 11 to 62 blows per 300 mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 3% to 10%.

Sand and Silt Till

Sand and silt till deposit was encountered below the gravelly sand to sand and gravel deposits in Borehole SPS03E, and extend to a depth of about 7.9 m below the existing ground surface. Borehole SPS03E was terminated in this deposit. SPT N values ranging from 11 to greater than 100 blows per 300 mm penetration indicated a compact to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 6% to 9%.

4.1.6.4 Pumping Station SPS 04E

Topsoil

Topsoil with a thickness of about 90 mm was encountered surficially in Borehole SPS04E.

Fill Materials

Fill materials consisting of sandy silt were encountered below the topsoil in Borehole SPS04E, and extended to a depth of 0.9 m below the existing ground surface. An SPT N value of 6 blows per 300 mm penetration indicated a loose compactness. The in-situ moisture content measured in the soil samples ranged from approximately 20% to 24%.

Organic Sandy Silt

Organic sandy silt deposit was encountered below the fill materials in Borehole SPS04E, and extended to a depth of about 1.1 m below the existing ground surface. An SPT N value of 6 blows per 300 mm penetration indicated a loose compactness. The natural moisture content measured in the soil sample was approximately 27%.

Sandy Silt, (Fine) Sand, and Silt

Sandy silt, (fine) sand, and silt deposits were encountered below the organic sandy silt and gravelly sand deposits in Borehole SPS04E, and extended to a depth of about 7.2 m below the existing ground surface. SPT N values ranging from 4 to 53 blows per 300 mm penetration indicated a loose to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 17% to 25%.

Upper Gravelly Sand

Upper gravelly sand deposit was encountered below the sandy silt deposit in Borehole SPS04E, and extended to a depth of about 2.1 m below the existing ground surface. An SPT N value of 11 blows per 300 mm penetration indicated a compact compactness. The natural moisture content measured in the soil sample was approximately 9%.

Lower Gravelly Sand to Sand and Gravel

Lower gravelly sand to sand and gravel deposits were encountered below the silt deposit in Borehole SPS04E, and extended to a depth of about 8.1 m below the existing ground surface. Borehole SPS04E was terminated in these deposits. An SPT N value of 71 blows per 300 mm penetration indicated a very dense compactness. The natural moisture content measured in the soil sample was approximately 8%.

4.1.6.5 Pumping Station SPS 06E

Topsoil

Topsoil with a thickness of about 150 mm was encountered surficially in Borehole SPS06E.

Fill Materials

Fill materials consisting of sandy silt was encountered below the topsoil in Borehole SPS06E, and extended to a depth of about 0.7 m below the existing ground surface. An SPT N value of 14 blows per 300 mm penetration indicated a compact compactness. The in-situ moisture content measured in the soil sample was approximately 13%.

Probable Fill Materials

Probable fill materials consisting of gravelly sand was encountered below the fill material in Borehole SPS06E, and extended to a depth of about 2.5 m below the existing ground surface. SPT N values ranging from 20 to 31 blows per 300 mm penetration indicated a compact to dense compactness. The in-situ moisture content measured in the soil samples ranged from approximately 8% to 18%.

Sand

Sand deposit was encountered below the probable fill materials in Borehole SPS06E, and extend to a depth of about 5.6 m below the existing ground surface. SPT N values ranging from 2 to 13 blows per 300 mm penetration indicated a very loose to compact compactness. The natural moisture content measured in the soil samples ranged from approximately 17% to 19%.

Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel deposits were encountered below the sand deposit in Borehole SPS06E, and extend to a depth of about 7.7 m below the existing ground surface. Borehole SPS06E was terminated in these deposits. SPT N values of greater than 100 blows per 300 mm penetration indicated a very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 7% to 8%.

4.1.6.6 Pumping Station SPS 08E

Existing Pavement Structure

A flexible pavement structure was observed in Borehole SPS08E. The thickness of asphalt concrete encountered in the borehole was about 110 mm; and the thickness of underlying granular base/subbase was about 510 mm.

Fill Materials

Fill materials consisting of silty sand to sand and silt were encountered below the granular base/subbase in Borehole SPS08E, and extended to a depth of about 4.0 m below the existing ground surface. SPT N values ranging from 5 to 10 blows per 300 mm penetration indicated a loose to compact compactness. The in-situ moisture content measured in the soil samples ranged from approximately 9% to 19%.

Gravelly Sand to Sand and Gravel

Gravelly sand to sand and gravel deposits were encountered below the fill materials in Borehole SPS08E, and extend to a depth of about 8.1 m below the existing ground surface. Borehole SPS08E was terminated in these deposits. SPT N values ranging from 25 to 48 blows per 300 mm penetration indicated a compact to dense compactness. The natural moisture content measured in the soil samples ranged from approximately 9% to 16%.

4.1.6.7 Pumping Station SPS 01H

Topsoil

Topsoil with a thickness of about 125 mm was encountered surficially in Borehole SPS01H.

Organic Sandy Silt

Organic sandy silt deposit was encountered below the topsoil in Borehole SPS01H, and extended to a depth of about 0.7 m below the existing ground surface. An SPT N value of 3 blows per 300 mm penetration indicated a very loose compactness. The natural moisture content measured in the soil sample was approximately 25%.

Gravelly Sand to Sandy Gravel

Gravelly sand to sandy gravel deposits were encountered below the organic sandy silt deposit in Borehole SPS01H, and extend to a depth of about 8.1 m below the existing ground surface. Borehole SPS01H was terminated in these deposits. SPT N values ranging from 6 to greater than 100 blows per 300 mm penetration indicated a loose to very dense compactness. The natural moisture content measured in the soil samples ranged from approximately 5% to 13%.

4.2 Groundwater Conditions

Groundwater condition observations made in the boreholes during and immediately upon completion of drilling are shown in the borehole logs and are also summarized in the following table. Boreholes BH2, BH4, BH7, BH13, BH14 and BH31 were open and dry upon completion of drilling.

BH No.	BH Depth (m)	Depth of Water Encountered during Drilling (mBGS)	Cave-in Depth upon Completion of Drilling (mBGS)	Water Level upon Completion of Drilling (mBGS)
BH1	5.0	-	4.3	-
BH3	5.0	4.6	4.1	-
BH5	5.0	-	2.7	-
BH6	5.0	3.0	2.1	2.1
BH8	5.0	-	2.1	-
BH9	5.0	-	3.2	-
BH10	5.0	0.8	3.4	3.4
BH11	5.0	0.8	3.0	1.8
BH12	5.0	-	3.7	-
BH15	5.0	3.0	4.4	4.4
BH16	5.0	-	2.9	-
BH17	5.0	2.3	-	-
BH18	4.7	-	3.8	-
BH19	5.0	-	4.0	-
BH20	5.0	1.5	3.7	3.7
BH21	3.1	1.5	1.5	1.5
BH22	4.6	1.5	2.1	1.5
BH23	5.0	2.3	-	-
BH24	5.0	1.5	4.3	4.3
BH25	5.0	4.6	4.0	-
BH26	5.0	-	4.4	-
BH27	5.0	-	2.7	-
BH28	5.0	3.0	2.0	-
BH29	5.0	3.0	3.7	2.9
BH30	5.0	2.3	2.3	2.3

BH32	5.0	-	2.4	-
BH33	8.1	1.5	-	-
BH34	5.0	1.5	4.4	-
BH35	5.0	4.6	3.0	2.7
BH36	5.0	-	2.4	-
BH37	5.0	3.0	-	-
BH37A	5.0	2.3	-	-
BH38	5.0	1.5	-	-
BH101	4.8	-	3.7	-
BH102	5.3	-	2.8	-
BH103	4.7	-	4.3	-
BH104	5.0	3.0	-	-
BH107	6.6	4.6	-	-
SPS01BE	7.8	1.5	6.7	-
SPS01H	8.1	3.0	2.7	2.7
SPS02E	7.7	4.6	3.4	3.4
SPS03E	7.9	2.7	-	-
SPS04E	8.1	1.5	4.9	4.9
SPS06E	7.7	0.8	-	-
SPS08E	8.1	3.5	-	-
T1	5.0	4.6	3.5	3.5
T2	5.0	2.3	-	-
T3	5.0	2.3	-	-
T4	5.0	2.3	1.4	-
T5	5.0	2.3	-	-
T6	5.0	2.3	3.4	2.7
T7	5.0	0.8	1.2	1.2
T8	6.6	2.3	5.2	4.6
T9	5.0	3.1	4.1	4.1

Note: mBGS = meters below ground surface

Twenty-eight (28) monitoring wells (51 mm in dia.) were installed to monitor groundwater levels. The monitoring well construction details and measured groundwater levels are shown in the following table.

Monitoring Well ID	Screen Interval (mBGS)	Water Level (mBGS) Date of Monitoring				
		December 5, 2017	December 11, 2017	December 15, 2017	December 17, 2017	December 21, 2017
BH10	2.3 – 3.8	1.22	-	-	-	-
BH11	1.5 – 3.0	1.08	-	-	-	-
BH15	3.1 – 4.6	-	-	dry	-	-
BH17	3.1 – 4.6	-	2.69	-	-	-
BH20	3.1 – 4.6	-	-	-	1.19	-

Monitoring Well ID	Screen Interval (mBGS)	Water Level (mBGS) Date of Monitoring				
		December 5, 2017	December 11, 2017	December 15, 2017	December 17, 2017	December 21, 2017
BH23	3.1 – 4.6	-	-	-	1.15	-
BH24	3.1 – 4.6	-	-	-	1.14	-
BH33	6.1 -7.6	-	-	-	1.93	-
BH34	3.1 -4.6	4.52	-	-	-	-
BH35	3.2 – 4.7	4.38	-	-	-	-
BH37	3.1 – 4.6	-	-	-	2.27	-
BH37A	3.1 – 4.6	-	-	-	3.11	-
BH38	3.1 – 4.6	-	-	-	2.75	-
BH101	2.1 – 3.6	dry	-	-	-	-
BH103	2.7 – 4.2	dry	-	-	-	-
BH104	3.5 – 5.0	-	-	-	-	2.73
BH107	4.6 – 6.1	-	-	-	-	5.07
SPS01BE	3.1 – 4.6	1.02	-	-	-	-
SPS01H	6.1 – 7.6	3.19	-	-	-	-
SPS02E	4.9 – 6.4	3.69	-	-	-	-
SPS03E	3.7 – 5.2	-	2.25	-	-	-
SPS04E	4.1 – 5.6	1.85	-	-	-	-
SPS06E	4.0 – 5.5	-	-	-	-	0.35
SPS08E	6.1 – 7.6	-	-	-	-	2.11
T2	3.1 – 4.6	1.18	-	-	-	-
T3	3.1 – 4.6	-	-	-	-	2.15
T5	3.1 – 4.6	-	-	-	-	2.64
T9	3.1 – 4.6	3.79	-	-	-	-

Note: mBGS = meters below ground surface

It should be noted that groundwater levels can vary and are subject to seasonal fluctuations in response to weather events.

4.3 Laboratory Testing Results

In the laboratory, each soil sample was examined as to its visual and textural characteristics by the Project Engineer. Moisture content determinations were carried out on all granular base/subbase and subgrade soil samples.

Grain size analyses of eleven (11) subgrade samples confirmed the visual descriptions of the subgrade soils. The summarized results are provided in the following table, and the grain size distribution curves of these samples are presented in Figures 1 to 5.

Soil Sample ID	Soil Depth (m)	Description
BH1 SS3	1.5 – 2.0	Sand and Silt
BH23 SS3	1.5 – 2.0	Sand to Silty Sand Fill
BH25 SS2	0.8 – 1.2	Gravelly Sand
BH28 SS5	3.1– 3.5	Gravelly Sand to Sandy Gravel
BH31 SS5	3.1 – 3.5	Silt Sand
BH36 SS2	0.8 – 1.2	Sand and Silt
BH101 SS4	2.3 – 3.1	Gravelly Sand to Sandy Gravel
BH104 SS3	1.5 – 2.0	Gravelly Sand Fill
SPS03E SS3	1.5 – 2.0	Sand and Gravel
T3 SS4	2.3 – 2.8	Silty Fine Sand to Fine Sand and Silt
T5 SS4	2.3 – 2.8	Silt

5 PRELIMINARY DISCUSSION AND RECOMMENDATIONS

This report contains the preliminary geotechnical engineering recommendations and comments. These preliminary recommendations and comments are based on factual information and are intended only for use by the design engineers. The number of boreholes may not be sufficient for detailed designs and to determine all the factors that may affect construction methods and costs. Subsurface conditions between and beyond the boreholes may differ from those encountered at the borehole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The anticipated construction conditions are also discussed, but only to the extent that they may influence design decisions. Construction methods discussed, however, express GeoPro's opinion only and are not intended to direct the contractors on how to carry out the construction. Contractors should also be aware that the data and their interpretation presented in this preliminary geotechnical report should not be sufficient to assess all the factors that may have an effect on the construction.

The preliminary design drawings of the project were not available when this report was prepared. Once the preliminary design drawings and site plan are available, this preliminary geotechnical report should be reviewed by GeoPro, and further recommendations may be provided as needed.

5.1 Conventional (Open Cut) Installation of the Proposed Sanitary Sewage

The invert depths of the proposed sanitary sewage are not available at the time of preparing the report. We have assumed that the majority of the sanitary sewage installations would require excavations between about 3 m and 4 m below the existing ground surface. According to the results of this investigation, the soils at the proposed founding depths are generally anticipated to be in the probable fill materials, peat, organic silt, silt, silty sand, gravelly sand to sandy gravel, sand and gravel, sand, sand and silt till, sandy silt till deposits and potentially probable bedrock. The native soils are considered to be suitable for supporting the pipes, provided the integrity of the base of the trench can be maintained during construction. The suitability of the existing fill materials to support the pipes, if encountered at the base of the trenches, should be further assessed during construction. This assessment will require inspection during construction by qualified geotechnical personnel from GeoPro to determine the suitability of the fill materials for supporting the pipes. Should any peat and organic silt deposits be encountered at the base of the trench, these peat and organic deposits should be completely removed and replaced with granular engineered fill.

It should be noted that some difficulties should be encountered in excavating the gravelly soils and glacial till at some locations. In addition, gravelly soils and glacial till are inferred to contain cobbles and boulders. Once the actual service invert depths are finalized, the following comments and recommendations should be reviewed and revised as necessary.

5.1.1 Trenching Excavation and Temporary Groundwater Control

Based on the results of this investigation, excavations (assumed up to 3 m to 4 m below the existing ground surface) for the site servicing are anticipated to be carried out through fills, peat, organic (sandy) silt, glacial till, silty/sandy/gravelly deposits and potentially probable bedrock. The site servicing pipes are anticipated to be generally above, at or below the groundwater tables measured at the borehole locations.

Groundwater control during excavations within the glacial tills can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. Perched groundwater may be expected in the fill materials, native peat, organic (sandy) silt and cohesionless silty/sandy/gravelly soils above the groundwater tables at various depths which can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. However, more significant groundwater seepage should be expected from fill materials and wet cohesionless silty/sandy/gravelly deposits below the prevailing groundwater tables and wet cohesionless silty/sandy/gravelly layers/zones within the glacial tills. Due to the predominant cohesionless silty/sandy/gravelly soils and the anticipated groundwater tables, some form of positive (pro-active) groundwater control or depressurization should be required to maintain the stability of the base and side slopes of the trench excavations, in addition to pumping from sumps. The groundwater level should be lowered to at least 1 m below the excavation base prior to excavating for the site services.

It should be noted that any construction dewatering or water taking in Ontario is governed by Ontario Regulation 387/04 - Water Taking and Transfer, made under the Ontario Water Resources Act (OWRA), and/or Ontario Regulation 63/16 – Registrations under Part II.2 of the Act – Water Taking, made under Environmental Protection Act. Based on these regulations, water taking of more than 400,000 L/day is subject to a Permit to Take Water (PTTW), while water taking of

50,000 L/day to 400,000 L/day is to be registered through the Environmental Activity and Sector Registry (EASR).

Where excavations are conducted by conventional temporary open cuts, side slopes should not be steeper than 1.5 horizontal to 1 vertical (1.5H:1V). However, depending upon the construction procedures adopted by the contractor, actual groundwater seepage conditions, the success of the contractor's groundwater control methods and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required, especially in looser/softer zones (i.e. in fills or wet sandy/silty deposits) or where localized seepage is encountered. Care should be taken to direct surface runoff away from the open excavations and all excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. According to OHSA, the compact to dense and stiff to hard glacial tills would be classified as Type 2 soils above groundwater table and Type 3 below groundwater table; the fill materials, native peat, organic (sandy) silt and silty/sandy/gravelly soils would be classified as Type 3 soils above groundwater table and Type 4 below groundwater table and unless supported by shoring or other approved retaining method, the excavations will require minimum side slopes of 3H:1V. In addition, care must be taken during excavation to ensure that adequate support is provided for any existing structures and underground services located adjacent to the excavations.

The excavated material should be placed well back from the edge of the excavation and stockpiling of materials adjacent to the excavation should be prohibited, to minimize surcharge loading near the excavation crest.

5.1.2 Temporary Shoring and Trench Boxes

It is understood that for the majority of the service installations, the extent of the excavations will have to be minimized to allow for traffic to continue using a reduced portion of the existing roadway. Where side slopes of excavations are steepened to limit the extent of the excavation, some form of trench support system such as a trench box system will be required. The trench support system shall be designed by a professional engineer. The earth pressure on the multiple braced shoring system may be evaluated by using the pressure distribution diagram shown on Drawing 16. It must be emphasized that a trench liner box provides protection for construction personnel but does not provide any lateral support for the adjacent excavation walls, underground services or existing structures. In the case of trench box excavation work, the tolerance for disturbance of any structure founded above a 1 horizontal to 1 vertical line projected up from the base of the excavation should be assessed prior to construction. If adjacent structures and/or utilities or existing pavement structure open for traffic are susceptible to damage from construction induced settlement, then excavation support using sheet piles or a strutted soldier pile and lagging wall must be considered. It is therefore, imperative that any underground services or existing structures adjacent to the excavations be accurately located prior to construction and adequate support provided where required. Steepened excavations should be left open for as short a duration as possible and completely backfilled at the end of each working day. Care must be taken during excavation near any underground structures located within or adjacent to the excavation. The owner of the structures/utilities should also be contacted prior to excavating near their easement to confirm that the proposed excavation meets their requirements.

While the use of trench boxes is an effective and economical trench-support method, its use can cause increased loss of ground relative to properly braced shoring, especially when working close to granular base courses below existing pavements or along existing utility trenches backfilled with granular materials. Trench boxes also reduce the contractor's ability to compact backfill materials placed between the trench wall and the outer trench box shell, thereby increasing the likelihood of post-construction settlements along the trench walls. When trench boxes are used along existing roadways, settlements frequently occur along the trench wall, which may manifest months after completion of backfilling. In such cases, following backfilling of the trench, road reconstruction should include a provision for saw-cutting the asphalt at least 1 m back from the trench walls, recompacting the upper trench backfill, and then repaving. Where permissible under the OHSA and where its use is considered to be a safe alternative for shoring and bracing, contractors may elect to utilize trench boxes for temporary trench wall support for trenches less than 6 m deep in Type 2 and 3 soils. Where trench depths exceed 6 m (or at any trench depth in Type 4 soil), engineered support systems designed by a qualified professional engineer are required under the OHSA.

Further to the above and in consideration of the cohesionless fill materials and native silty/sandy/gravelly soils, some loss of ground should be expected for the sections of nearly vertical excavation where a trench box will be used. It is anticipated that in the cohesionless soils, the unsupported soils on the trench sides will relax, filling the void between the trench walls and trench box. This may lead to loss of ground below the pavement and potentially undermine and reduce the stability of the pavement structure adjacent to the open traffic lanes. In order to minimize this effect, the gap between the trench walls and trench box should be minimized during the excavation and trench box installation.

5.1.3 Pipe Support and Bedding

The bedding for the service pipes should be compatible with the type and class of pipe, the surrounding subsoil and anticipated loading conditions and should be designed in accordance with the standards of the local municipality or Ontario Provincial Standard Specifications (OPSS). Where granular bedding is deemed to be acceptable, it should consist of at least 150 mm of TS 1010 Granular A or 19 mm crusher run limestone material. The thickness of the bedding may, however, have to be increased (i.e. 300 mm to 450 mm) depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered, especially when the soils at the trench base level consists of wet sandy/silty deposits. From springline to 300 mm above obvert of the pipe, sand cover could be used. All bedding and cover material should be placed in 150 mm loose lifts and uniformly compacted to at least 100 percent of the material's Standard Proctor Maximum Dry Density (SPMDD).

To avoid the loss of soil fines from the subgrade, clear stone bedding material should not be used in any case for pipe bedding or to stabilize the bases.

5.1.4 Trench Backfill

Based on visual and tactile examination and the measured natural water contents of the soil samples, the majority of the existing fill materials and silty/sandy/gravelly soils above groundwater tables and the glacial tills are anticipated to be generally at or near their estimated optimum water contents for compaction. However, the fill materials and native silty/sandy/gravelly soils below the prevailing groundwater tables are anticipated to be generally wet of their estimated optimum water contents for compaction, which should require some aeration prior to reuse as backfill materials.

A great amount of cobbles and boulders were encountered in some of the boreholes. The cobbles and boulders are not suitable for backfill and maybe wasted.

Portion of the existing fill materials containing organic matters, peat, and organic (sandy) silt should be wasted or disposed off-site.

The excavated materials at suitable water contents may be reused as trench backfill provided they are free of significant amounts of topsoil, organics or other deleterious material, and are placed and compacted as outlined below. It should also be noted that due to the predominantly fine-grained, silty nature of the majority of the existing fill materials and native soils at some locations, some difficulty would be expected in achieving adequate compaction, especially during wet weather.

The backfill should be placed in maximum 300 mm loose lifts at or near (±2%) their optimum moisture content and each lift should be compacted to at least 95% SPMDD. From 1 m below subgrade to subgrade elevation, the materials should be placed in maximum 300 mm loose lifts and uniformly compacted to at least 98 % SPMDD. Unsuitable materials such as organic soils, boulders, cobbles, frozen soils, etc. should not be used for backfilling. In pavement areas, the upper zone of the trench backfill within the depth of 1.4 m below the pavement surface should be non-frost susceptible materials without excessive fines and compacted to at least 98% SPMDD. The fine grained silty soils encountered at the site is potentially of high frost susceptibility, which should not be used in the upper zone of the trench backfill within the depth of 1.4 m below the pavement surface.

It should be noted that if the soils for trench backfilling were placed and compacted at wet of their optimum water content (>2%), pumping and rolling conditions may be encountered, which would require mitigative measures in order to construct roads and utilities. This might include significant extra thicknesses of granular base, base reinforcement using geogrids or importing of better quality common fill.

Alternatively, if placement water contents at the time of construction are too high, or if there is a shortage of suitable in-situ material, then an approved imported sandy material which meets the requirements for OPSS Select Subgrade Material ("SSM") could be used. It should be placed in loose lift thicknesses as indicated above and uniformly compacted to at least 95% SPMDD.

Normal post-construction settlement of the compacted trench backfill should be anticipated, with the majority of such settlement taking place within about 6 months following the completion of trench backfilling operations. This settlement may be compensated for, where necessary, by placing additional granular material prior to asphalt paving. Alternatively, if the asphalt binder course is placed shortly following the completion of trench backfilling operations in these areas, any settlement that may be reflected by subsidence of the surface of the binder asphalt should be compensated for by placing an additional thickness of binder asphalt or by padding.

5.1.5 Pavement Restoration Designs

This section of the report provides recommendations for the restoration of the pavement within the project limits. Disturbed/damaged pavement, resulting from the underground service construction operations, should be restored in kind to match the existing pavement structure. For Town of Erin, refer to Section 4.1.1 Pavement Structure. For Town of Hillsburgh, refer to Section 4.1.2 Pavement Structure.

The granular subbase and base materials should be uniformly compacted to at least 100 percent of their standard Proctor maximum dry densities (SPMDD). The asphalt material should be compacted between 92 to 96.5 percent of its maximum relative density, as measured in the field using a nuclear density gauge.

Since the reinstated pavement section will abut existing pavement, proper longitudinal lap joints should be constructed to key the new asphalt into the existing surface. The existing asphalt edges should be provided with a proper saw cut edge prior to keying in the new asphalt. Any pavement sections that are undermined due to construction activities should be removed by the saw cut and reconstructed. The subbase thickness should match the existing subbase depth of the adjacent pavement structure.

5.2 Proposed Wastewater Treatment Plant (WWTP) (Boreholes BH101 to BH103)

Based on the results of this preliminary geotechnical investigation, the native soils encountered at the potential WWTP location are generally considered to be suitable for supporting the proposed development.

The following preliminary geotechnical information is provided for the planning and preliminary design of the potential WWTP, underground services and paved roads at the site.

- The existing surficial topsoil/organics and other near surface very loose/soft soils including those containing significant amounts of organic matter, are not considered to be suitable for supporting building foundations, pavement structures and/or engineered fills.

- Fill materials were encountered below the topsoil in Boreholes BH101 to BH103 and extended to depths ranging from 0.8 to 2.3 m below the existing ground surface. The existing fill materials are considered to be unsuitable for supporting the proposed development and any other settlement sensitive structures. The existing fill materials are also considered to be unsuitable for supporting engineered fills.

- Depending upon the final site grading scheme and proposed final grade elevations, the areas may need to be brought up to the underside of the footings, if required, using engineered fill. The materials proposed for use as engineered fill should be approved by qualified geotechnical personnel from GeoPro at the source, prior to hauling to the site. Some of the native soils at the site would be unsuitable for reuse as engineered fill due to the anticipated difficulties in compaction. Imported materials approved by the geotechnical engineer may be considered for use as engineered fill. Details regarding placement and compaction requirements for engineered fill, if utilized at the site, can be provided once the actual development plans are available, as part of the detailed geotechnical recommendations for the project.

- A preliminary bearing resistance for conventional shallow spread and/or strip footings are provided in the following table.

BH No.	Bearing Resistance at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth Below Existing Ground (m)	Anticipated Bearing Soil
BH101	150	225	2.5	Gravelly Sand to Sandy Gravel
BH102	100	150	2.5	Gravelly Sand to Sandy Gravel
	150	225	3.5	Gravelly Sand to Sandy Gravel
BH103	150	225	1.0	Gravelly Sand to Sandy Gravel

*the bearing resistances are preliminary and not sufficient for detailed designs.

- All exterior footings and footings in unheated areas should be protected with a minimum of 1.4 m of earth cover for frost protection.

- Based on the results of this preliminary geotechnical investigation, groundwater control during excavations within the fill materials and native silty/sandy/gravelly soils above the prevailing groundwater tables can be handled, as required, by pumping from properly constructed filtered sumps located within the excavations. However, more significant groundwater seepage may be expected from the cohesionless silty/sandy/gravelly deposits below the prevailing groundwater tables; positive dewatering consisting of well points or eductors should be required to drawn down the groundwater table to at least 1 m below the excavation base elevation prior to excavation. Should groundwater be encountered during excavations. Due to the presence of the coarse-grained soils at the sites, groundwater table fluctuating may respond quickly to weather conditions. A long-term ground water monitoring program is to be carried out concurrently to evaluate the long-term groundwater table fluctuation.

- The cohesionless silty/sandy/ gravelly deposits at the site are extremely easy to be disturbed by construction activities and foot traffic. A 75 mm thick of concrete skim coat on the founding subgrade immediately after its approval may be required, to prevent its disturbance by construction activities.

- The majority of the subsoils above the local water table are generally near their estimated optimum water contents for compaction and should be suitable for reuse as trench backfill, provided they are free of significant amounts of topsoil, organics and other deleterious materials. Excavated silty/sandy/gravelly subsoils from below the local water table (i.e. for deeper excavations, if required) would likely require some drying prior to placement.

- A great amount of cobbles and boulders were encountered in some of the boreholes. The cobbles and boulders are not suitable for backfill and maybe wasted.

- It is anticipated that trench excavations for underground servicing would consist of conventional temporary open cuts with side slopes not steeper than 1.5 horizontal to 1 vertical. However, some local flattening of side slopes may be required in some area in loose soil zones or where significant water seepage is encountered. Conventional bedding thicknesses are anticipated for underground services founded within the native competent subsoils at the site. Additional bedding thickness may be required for services founded in wet sandy soils, depending upon the excavation depths and success of the contractor's groundwater control measures. It should be noted that cobbles and boulders should be encountered at the site. Excavation below the groundwater table in the sandy/silty/gravelly deposits, construction dewatering would be required. Active dewatering such as well points or eductors may be required prior to excavations in the cohesionless soils below the groundwater tables. Otherwise, it will result in an unstable base and flowing sides. The groundwater table must be lowered to at least 1.0 m below the lowest elevation of the excavation base.

- The lateral earth pressure acting at any depth on underground walls can be calculated as follows:

$$p = K_1 (\gamma_1 h_1 + q)$$

Where p = lateral earth pressure in kPa acting at depth h_1

K_1 = earth pressure coefficient K_1=0.5 for basement wall design

γ_1 = unit weight of overburden soil assuming 22 kN/m^3

h_1 = depth in overburden soil

q = value of surcharge in kPa

The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall.

The flood elevation may be considered in the design due to the predominant coarse grained cohessionless soils encountered at the site.

- Should the structure footprint be extending to the property lines, it is anticipated that the proposed excavations will be supported by a temporary shoring system consisting of timber lagging and soldier piles and tie back anchors. Unsupported open cut excavation may be utilized at the areas where the sufficient space is available. The shoring system must be designed in accordance with the 4th Edition of the Canadian Foundation Engineering Manual.

- The recommended pavement structures provided in the following table are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples. The values may need to be adjusted based on the city /regional standards. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

Recommended Pavement Structure Thickness

Material		Light Duty Parking (Cars)	Heavy Duty Parking (Delivery Trucks)
Hot-Mix Asphalt (OPSS 1150)	HL 3 Surface Course	40 mm	40 mm
	HL 8 Binder Course	50 mm	100 mm
Granular Material (OPSS.MUNI 1010)	Granular A Base	150 mm	150 mm
	Granular B Type I Subbase	300 mm	450 mm

Prepared and Approved Subgrade

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698
The subgrade must be compacted to 98% SPMDD for at least the upper 300 mm unless accepted by GeoPro.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped (preferably at a minimum grade of 2 %) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

5.3 Proposed Pumping Stations (Boreholes SPS01BE, SPS02E to SPS04E, SPS06E, SPS08E and SPS01H)

Based on the results of this preliminary geotechnical investigation, the native soils encountered at each of the proposed pumping station locations are generally considered to be suitable for supporting the proposed development.

The following preliminary geotechnical information is provided for the planning and preliminary design of the proposed pumping stations.

- The existing surficial topsoil/organics and other near surface very loose / soft soils including those containing significant amounts of organic matter, are not considered to be suitable for supporting building foundations, pavement structures and/or engineered fills.

- Fill materials were encountered below the topsoil and granular base/subbase materials in Boreholes SPS01BE, SPS02E, SPS03E, SPS04E, SPS06E and SPS08E and extended to depths ranging from 0.9 m to 4.0 m below the existing ground surface. The existing fill materials are considered to be unsuitable for supporting the proposed development and any other settlement sensitive structures. The existing fill materials are also considered to be unsuitable for supporting engineered fills.

- Depending upon the final site grading scheme and proposed final grade elevations, the areas may need to be brought up to the underside of the footings, if required, using engineered fill. The materials proposed for use as engineered fill should be approved by qualified geotechnical personnel from GeoPro at the source, prior to hauling to the site. Some of the native soils at the site would be unsuitable for reuse as engineered fill due to the anticipated difficulties in compaction. Imported materials approved by the geotechnical engineer may be considered for use as engineered fill. Details regarding placement and compaction requirements for engineered fill, if utilized at the site, can be provided once the actual development plans are available, as part of the detailed geotechnical recommendations for the project.

- A preliminary bearing resistance for conventional shallow spread and/or strip footings are provided in the following table.

BH No.	Bearing Resistance at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth Below Existing Ground (m)	Anticipated Bearing Soil
SPS01BE	400	600	6.0	Sandy Silt Till
SPS01H	300	450	6.0	Gravelly Sand to Sand and Gravel
SPS02E	200	300	6.5	Gravelly Sand to Sand and Gravel
SPS03E	400	600	6.0	Sand and Silt Till
SPS04E	300	450	6.5	Silt
SPS06E	300	450	6.0	Gravelly Sand to Sand and Gravel
SPS08E	300	450	5.0	Gravelly Sand to Sand and Gravel

*the bearing resistances are preliminary and not sufficient for detailed designs.

- All exterior footings and footings in unheated areas should be protected with a minimum of 1.4 m of earth cover for frost protection.

- Based on the results of this preliminary geotechnical investigation, groundwater control during excavations within the fill materials, organic (sandy) silt and silty/sandy/gravelly deposits above the prevailing groundwater tables can be handled, as required, by pumping from properly constructed filtered sumps located within the excavations. However, significant groundwater seepage will be expected from the water bearing cohesionless sandy/silty/gravelly deposits below the prevailing groundwater tables; positive dewatering consisting of well points or eductors should be required to drawn down the groundwater table to at least 1 m below the excavation base elevation prior to excavation. It should be noted that any construction dewatering or water taking in Ontario is governed by Ontario Regulation 387/04 - Water Taking and Transfer, made under the Ontario Water Resources Act (OWRA), and/or Ontario Regulation 63/16 – Registrations under Part II.2 of the Act – Water Taking, made under Environmental Protection Act. Based on these regulations, water taking of more than 400,000 L/day is subject to a Permit to Take Water (PTTW), while water taking of 50,000 L/day to 400,000 L/day is to be registered through the Environmental Activity and Sector Registry (EASR). The need for and the type of groundwater control measures can be reviewed by the engineer as part of the detailed geotechnical and hydrogeological investigations, which would be required to support the detailed designs of the proposed development.

- In consideration of the relatively high groundwater tables encountered at the sites, for any permanent underground structure, such as a basement, a permanent under-slab and perimeter drainage system will be required; subject to the volume of the water extracted from the drainage system, a permanent Permit To Take Water (PTTW) may be required, which should be consulted with local municipality and conservation authorities.

- Based on the groundwater level measured at each of the sites, the wet well and chamber structures of the proposed pump station are anticipated to extend below the measured groundwater tables and will, therefore, be subjected to hydrostatic uplifting pressures. In consideration of the coarse grained soils at the site, the groundwater table fluctuation may respond to the weather conditions quickly, as such, it is recommended that the groundwater tables for uplifting design may be considered as the existing ground surface or designed flood elevations, which ever is higher. Additional uplifting resistances such as enlarged base slabs and anchor systems may be considered for the sites.

- Water bearing cohesionless silty/sandy/ gravelly deposits at the site are extremely easy to be disturbed by construction activities and foot traffic. A 100 mm thick of concrete skim coat on the founding subgrade immediately after its approval may be required, to prevent its disturbance by construction activities.

- The majority of the subsoils above the local water table are generally near their estimated optimum water contents for compaction and should be suitable for reuse as trench backfill, provided they are free of significant amounts of topsoil, organics and other deleterious materials. Excavated silty/sandy/gravelly subsoils from below the local water table (i.e. for deeper excavations, if required) would likely require some drying prior to placement.

- It is anticipated that trench excavations for underground servicing would consist of conventional temporary open cuts with side slopes not steeper than 1.5 horizontal to 1 vertical. However, some local flattening of side slopes may be required in some area in loose soil zones or where significant water seepage is encountered. Conventional bedding thicknesses are anticipated for underground services founded within the native competent subsoils at the site. Additional bedding thickness may be required for services founded in wet sandy soils, depending upon the excavation depths and success of the contractor's groundwater control measures. It should be noted that cobbles and boulders should be encountered at the site. Excavation below the groundwater table in the silty/sandy/gravelly deposits, construction dewatering would be required. Active dewatering such as well points or eductors may be required prior to excavations in the cohesionless soils below the groundwater tables. Otherwise, it will result in an unstable base and flowing sides. The groundwater table must be lowered to at least 1.0 m below the lowest elevation of the excavation base.

- The lateral earth pressure acting at any depth on underground walls can be calculated as follows:

$$p = K_1 (\gamma_1 h_1 + q)$$

Where p = lateral earth pressure in kPa acting at depth h_1

K_1 = earth pressure coefficient K_1=0.5 for basement wall design

γ_1 = unit weight of overburden soil assuming 22 kN/m^3

h_1 = depth in overburden soil

q = value of surcharge in kPa

The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall.

The flood elevation may be considered in the design due to the predominant coarse grained cohessionless soils encountered at the site.

- Should the structure footprint be extending to the property lines, it is anticipated that the proposed excavations will be supported by a temporary shoring system consisting of timber lagging and soldier piles and tie back anchors. Unsupported open cut excavation may be utilized at the areas where the sufficient space is available. The shoring system must be designed in accordance with the 4th Edition of the Canadian Foundation Engineering Manual.

- The recommended pavement structures provided in the following table are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples. The values may need to be adjusted based on the city /regional standards. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

Recommended Pavement Structure Thickness

Material		Light Duty Parking (Cars)	Heavy Duty Parking (Delivery Trucks)
Hot-Mix Asphalt (OPSS 1150)	HL 3 Surface Course	40 mm	40 mm
	HL 8 Binder Course	50 mm	100 mm

Granular Material (OPSS.MUNI 1010)	Granular A Base	150 mm	150 mm
	Granular B Type I Subbase	300 mm	450 mm
Prepared and Approved Subgrade			

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698
The subgrade must be compacted to 98% SPMDD for at least the upper 300 mm unless accepted by GeoPro.

The long term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped (preferably at a minimum grade of 2 %) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

5.4 Sanitary Sewage Outfall (Boreholes BH104 and BH107)

The potential sanitary sewage outfall will be constructed in the vicinity of Boreholes BH104 and BH107. However, the preliminary founding elevations, size and types of the sanitary sewage outfall were not available at the time of preparing this report. Once the preliminary design is available, it should be further reviewed by the geotechnical engineer from GeoPro, following which additional recommendations can be provided, as required.

5.4.1 Foundation Design Considerations and Wingwalls

Based on the results of this investigation, the fill materials are considered unsuitable to support the proposed sanitary sewage outfall/wingwall structures and should be completely removed from the foundation footprint. The potential sanitary sewage outfall may be founded in the native, undisturbed, competent native deposits. The soil bearing resistance at the Serviceability Limit State (SLS) and a factored bearing resistance at the Ultimate Limit State (ULS), together with the corresponding founding depths at the borehole location and anticipated soil, are provided in the following table.

Borehole No.	Bearing Resistance at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth Below Existing Ground (m)	Anticipated Bearing Soil
BH104	200	300	4.5	Dense Sand
BH107	200	300	3.0	Compact Silty Sand

All foundation bases must be inspected by GeoPro to confirm the design bearing values prior to pouring concrete.

The anticipated founding soils are extremely easy to disturb, a mud slab consisting of at lest 100 mm lean concrete (i.e. 15 MPa) shall be placed immediately upon completion of inspection by a geotechnical engineering from GeoPro.

Foundations designed to the specified bearing resistance values at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

Where it is necessary to place foundations at different levels, the upper foundation must be founded below an imaginary 7 vertical to 10 horizontal (7V:10H) line drawn up from the base of the lower foundation. The lower footing must be installed first to minimize the risk of undermining the upper footing.

It should be noted that the recommended foundation type, founding depths, and bearing resistances were based on the borehole information only. The geotechnical recommendations and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to the subsurface conditions between and beyond the boreholes when foundation construction is underway. The interpretation between and beyond the boreholes and the recommendations of this report **must** therefore be checked through field inspections provided by a qualified geotechnical engineer from GeoPro to validate the information for use during the construction stage. Due to the anticipated variation of the subsurface conditions at this specific site, the geotechnical engineer who carried out the geotechnical investigation shall be retained during the construction stage to avoid the potential misinterpretation of the soil information presented in the report.

5.4.2 Subgrade Protection, Frost Protection and Scour Protection

It should be noted that the proposed founding level should be at least 1.4 m below the proposed final grade to provide sufficient earth cover for frost protection, unless the sanitary sewage outfall is designed to withstand the frost pressures. It should be noted that scour protection, such as rip rap and rock blocks, should not be considered as earth cover for frost protection purposes.

The requirements for design of erosion protection measures for the sanitary sewage outfall should be considered by design engineers. As a minimum requirement, rip rap protection for the sanitary sewage outfall should be considered in accordance with the applicable OPSS/OPSD standards.

5.4.3 Sliding Resistance

Resistance to lateral forces /sliding resistance between the sanitary sewage outfall footing base concrete and the subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. The coefficient of friction may be considered as follows:

- Coefficient of friction between pour-in-place concrete footings and native sand/silty sand soils = 0.4 (unfactored)

- Coefficient of friction between precast concrete footings and native sand/silty sand soils = 0.3 (unfactored)

It should be noted that these values are unfactored; in accordance with Section 6.7.5 of the CHBDC, a factor of 0.8 should be applied when calculating the horizontal resistance.

5.4.4 Temporary Excavations and Groundwater Control

It is anticipated that the foundation excavations at the site will consist of temporary open cuts with side slopes not steeper than 1.5 horizontal to 1 vertical (1.5H:1V). However, depending on the construction procedures adopted by the contractor and the weather conditions at the time of construction, some local flattening of the slopes will be required, especially in looser/softer zones (i.e. in fills) or where localized seepage is encountered. All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. According to the Act, the existing fills, organic silt and silty/ sandy/ gravelly deposits would be classified as Type 3 soils above groundwater table and Type 4 below the groundwater table.

The excavations for the sanitary sewage outfall may extend to a maximum depth of about 4 m to 5 m below the existing ground surface through the granular base/subbase, fill materials, native organic silt and silty/sandy/gravelly soils. If space permits, open-cut excavations to the proposed depths may be carried out in accordance with the guidelines outlined in the OHSA for Construction Activities. In addition, care must be taken during excavation to ensure that adequate support is provided for any existing structures and underground services located adjacent to the excavations.

Should adjacent structures and/or utilities be susceptible to damage from construction induced settlement, a more positive excavation support system, such as a shoring system designed by a professional engineer may be considered.

Groundwater control at the site should be required to allow for construction of foundation elements in a dry condition. Perched groundwater should be expected in the fill materials and native organic silt and cohesionless silty/sandy/gravelly soils above the groundwater tables at various depths which can be handled, as required, by pumping from properly constructed and filtered sumps located within the excavations. However, more significant groundwater seepage should be expected from wet organic silt and cohesionless silty/sandy/gravelly deposits below the prevailing groundwater tables at the time of construction. Due to the predominant cohesionless silty/sandy/gravelly soils and the anticipated groundwater tables, some form of positive (pro-active) groundwater control or depressurization should be required to maintain the stability of the base and side slopes of the excavations, in addition to pumping from sumps. The groundwater level should be lowered to at least 1 m below the excavation base prior to excavating for the site services.

It should be noted that any construction dewatering or water taking in Ontario is governed by Ontario Regulation 387/04 - Water Taking and Transfer, made under the Ontario Water Resources Act (OWRA), and/or Ontario Regulation 63/16 – Registrations under Part II.2 of the Act – Water Taking, made under Environmental Protection Act. Based on these regulations, water taking of more than 400,000 L/day is subject to a Permit to Take Water (PTTW), while water taking of 50,000 L/day to 400,000 L/day is to be registered through the Environmental Activity and Sector Registry (EASR).

Depending on the construction procedures and groundwater control measures adopted by the contractor and weather conditions at the time of construction, cut off measures, such as a sheet pile wall, may be required to improve the effectiveness of the groundwater control measures in addition to pumping from sumps.

Surface water should be directed away from the excavation area to prevent ponding of water that could result in disturbance and weakening of the foundation subgrade.

5.4.5 Lateral Earth Pressures for Design

The following recommendations are made concerning the design of the walls, assuming that the backfill to the sanitary sewage outfall structures, and wing walls consists of free-draining granular fill meeting the requirements of OPSS 1010 Granular A or Granular B. This fill should be compacted in loose lifts not greater than 200 mm in thickness to 98 percent of the material's Standard Proctor Maximum Dry Density (SPMDD) in accordance with OPSS 501. The fill materials should be benched into the existing roadway embankment side slopes if required. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to sub-drains and frost taper should be in accordance with applicable Ontario Provincial Standard Drawings.

Computation of earth pressures acting against any wing walls should be in accordance with applicable design codes. For design purposes, the following properties can be assumed for backfill.

Compacted Granular 'A' or Granular 'B' Type II

Angle of Internal Friction =35 (unfactored)

Unit Weight = 22 kN/m3

Coefficient of Lateral Earth Pressure:

Level Backfill	Backfill Sloping at 3H:1V	Backfill Sloping at 2H:1V
K_a=0.27	K_a=0.34	K_a=0.40
K_b=0.35	K_b=0.44	K_b=0.50

K_o=0.43	K_o=0.56	K_o=0.62
K*=0.45	K*=0.60	K*=0.66

Compacted Granular 'B' Type I

Angle of Internal Friction ϕ=32° (unfactored)

Unit Weight = 21 kN/m^3

Coefficient of Lateral Earth Pressure:

Level Backfill	Backfill Sloping at 3H:1V	Backfill Sloping at 2H:1V
K_a=0.31	K_a=0.39	K_a=0.47
K_b=0.39	K_b=0.49	K_b=0.57
K_o=0.47	K_o=0.62	K_o=0.69
K*=0.54	K*=0.68	K*=0.78

Note: K_a is the coefficient of active earth pressure

K_b is the backfill earth pressure coefficient for an unrestrained structure including compaction efforts

K_o is the coefficient of earth pressure at rest

K* is the earth pressure coefficient for a soil loading a fully restrained structure and includes compaction effects

These values are based on the assumption that the backfill behind the retaining structures is free-draining granular material and adequate drainage is provided.

The earth pressure coefficient to be adopted will depend on whether the retaining structure is restrained or some movement can occur such that the active state of earth pressure can develop. The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients. The use of vibratory compaction equipment behind the abutments and the walls should be restricted in size.

A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the walls, according to CHBDC Section 6.12.3 and Figure 6.6. Other surcharge loadings should be accounted for in the design as required.

The above calculation yields lateral pressures due to soil loading only. If the sanitary sewage outfall is intended to become partially submerged during the design flood event, then appropriate hydrostatic pressures below the water table should be added to the earth pressures calculated as above in order to obtain the total lateral pressure acting on the sanitary sewage outfall structure.

The fill depth during placement should be maintained equal on both sides of the outfall structure, with one side not exceeding the other by more than 500 mm.

The use of heavy vibratory equipment behind the sanitary sewage outfall structure and any other below-grade structures should be limited within a lateral distance equal to the height of the backfill (at the time of compaction) above the base of the structure. If required, GeoPro can provide additional assistance with the refinement of design earth pressure parameters based on the type of sanitary sewage outfall structure selected, dimensions, etc.

5.5 Seismic Site Class

The 2012 Ontario Building Code (OBC 2012) came into effect on January 1, 2014 and contains updated seismic analysis and design methodology. The seismic site classification methodology outlined in the code is based on subsurface conditions within the upper 30 m below grade. Two methods of defining the site class for the proposed development are presented in the following sections: a conservative approach based on shallow boreholes (i.e. boreholes less than 30 m in depth) using local geological/physiographical experience; and a method based on geophysical testing in accordance with Section 4.1.8.4A of the OBC 2012.

The conservative site classification is based on physical borehole information obtained at depths of less than 30 m and on general knowledge of the local geology and physiography. Based on this borehole information and our local experience, a Site Class D designation may be considered for the site.

6 ENVIRONMENTAL SOIL ANALYTICAL RESULTS

6.1 Soil Sample Submission

In order to provide information on the chemical quality of the subsurface soils, selected soil samples were submitted to AGAT Laboratories in Mississauga, Ontario ("AGAT") for chemical analyses. Descriptions of the selected soil samples and analytical parameters are presented in the following table:

Sample ID	Soil Depth (mBGS)	Primary Soil	Analytical Parameters
BH1 SS3	1.5 – 2.0	Sand and Silt	SAR
BH5 SS3	1.5 – 2.0	Sand	SAR
BH9 SS2	0.8 – 1.2	Gravelly Sand to Sand and Gravel	SAR
BH10 SS2	0.8 – 1.2	Gravelly Sand	SAR
BH14 SS2	0.8 – 1.2	Gravelly Sand Fill	SAR
BH15 SS2	0.8 – 1.2	Gravelly Sand to Sand and Gravel	SAR
BH19 SS2	0.8 – 1.2	Gravelly Sand Fill	SAR
BH21 SS2	0.8 – 1.2	Gravelly Sand to Sand and Gravel Fill	SAR
BH26 SS2	0.8 – 1.2	Silty Sand Fill	SAR
BH28 SS2	0.8 – 1.2	Sandy Silt to Silty Sand Fill	SAR
BH30 SS3	1.5 – 2.0	Gravelly Sand to Sand and Gravel	SAR
BH31 SS2	0.8 – 1.2	Gravelly Sand Fill	SAR
BH32 SS3	1.5 – 2.0	Sand	SAR

BH37 SS3	1.5 – 2.0	Silty Sand to Sand and Silt Fill	SAR
BH38 SS2	0.8 – 1.2	Silty Sand to Sand and Silt Fill	SAR
BH101 SS2	0.8 – 1.2	Silty Sand to Sand and Silt Fill	SAR
BH103 SS2	0.8 – 1.5	Gravelly Sand to Sand and Gravel	SAR
BH104 SS2&SS3	0.8 – 2.0	Silty Sand to Sand and Silt Fill; Gravelly Sand Fill	SAR
BH107 SS2&SS3	0.8 – 2.0	Silty Sand Fill	SAR
SPS01bE SS3	1.5 – 2.0	Gravelly Sand to Sand and Gravel	SAR
SPS01H SS2	0.8 – 1.2	Gravelly Sand to Sandy Gravel	SAR
SPS02E SS2	0.8 – 1.2	Sandy Silt Fill	SAR
SPS03E SS2	0.8 – 1.2	Silty Sand Fill	SAR
SPS04E SS3	1.5 – 2.0	Gravelly Sand	SAR
SPS06E SS2	0.8 – 1.2	Gravelly Sand Probable Fill	SAR
SPS08E SS2&SS3	0.8-2.0	Silty Sand to Sand and Silt Fill	SAR
T1 SS3A	1.5 – 2.0	Sand and Silt to Silty Sand Fill	SAR
T3 SS2	0.8 – 1.2	Sand and Silt to Silty Sand Fill	SAR
T6 SS2	0.8 – 1.2	Sandy Silt Fill	SAR
T8 SS2	0.8 – 1.2	Silty Sand to Sand and Silt Fill	SAR

Note: SAR = Sodium Adsorption Ratio

It should be noted that at the time of the sampling, no obvious visual or olfactory evidence of environmental impact (i.e. staining or odours) was observed at the sampling locations.

6.2 Soil Analysis Results

A total of twenty-nine (29) soil samples were analysed for parameter of SAR under Ontario Regulation 153/04 ("O. Reg. 153/04") as amended. A copy of the soil analytical results is provided in the Laboratory Certificates of Analysis, attached in Appendix A.

The soil analytical results were compared with the Ontario Ministry of the Environment and Climate Change (MOECC) "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act", April 2011, Table 1: Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/Industrial/Commercial/Community Property Uses (2011 MOECC Table 1 Standards); Table 2: Full Depth Generic Site Condition Standards in a Potable Ground Water Condition (2011 MOECC Table 2 Standards), and Table 3: Full Depth Generic Site Condition Standards in a non-potable Ground Water Condition (2011 MOECC Table 3 Standards).

Based on the comparison, exceedances of the MOECC Table 1, Table 2 or Table 3 standards were noted for SAR in the tested soil samples taken from Boreholes BH1, BH9, BH10, BH19, BH21, BH26, BH28, BH37, BH38, BH104 and BH107. The exceedance values detected in the soil samples are summarized in the following table:

Soil Sample ID	Parameter	Detected Value / Unit	MOECC Table 1 Standards Guideline Value	MOECC Table 2 and 3 Standards (R/P/I) Guideline Value	MOECC Table 2 and 3 Standards (I/C/C) Guideline Value
BH1 SS3	SAR	6.18	**2.4**	**5**	12
BH9 SS2	SAR	2.69	**2.4**	5	12
BH10 SS2	SAR	5.68	**2.4**	**5**	12
BH19 SS2	SAR	10.5	**2.4**	**5**	12
BH21 SS2	SAR	18.8	**2.4**	**5**	**12**
BH26 SS2	SAR	27.4	**2.4**	**5**	**12**
BH28 SS2	SAR	60.1	**2.4**	**5**	**12**
BH37 SS3	SAR	11.2	**2.4**	**5**	12
BH38 SS2	SAR	14.0	**2.4**	**5**	**12**
BH104 SS2&SS3	SAR	25.4	**2.4**	**5**	**12**
BH107 SS2&SS3	SAR	36.0	**2.4**	**5**	**12**
SPS08E SS2&SS3	SAR	3.41	**2.4**	5	12

Note: R/P/I = Residential, Parkland and Institutional Property Use
I/C/C = Industrial, Commercial and Community Property Use
2.4 = standard value exceeded by the analytical result

6.3 Discussion of Analytical Results

Based on the analytical results, exceedances of MOECC Table 1, Table 2 or Table 3 Standards were noted for SAR in the tested soil samples. It should be noted that the samples with exceedances of SAR values were taken from the boreholes located on the roadways. The elevated SAR values in the tested soil samples may likely be attributed to the application of de-icing salt on the road.

Based on the results of soil sample analysis, GeoPro would recommend the following disposal option:

1) The soils generated at the Site at the same tested sample depths from Boreholes BH5, BH14, BH15, BH30 to BH32, BH101, BH103, SPS01BE, SPS01H, SPS02E, SPS03E, SPS04E, SPS06E, T1, T3, T6 and T8 with no identified exceedances can be re-used on Site or re-used at a receiving site which is not used for agricultural purposes and would accept the soils as per the test results;
2) The soils generated at the Site at the same tested sample depth from Boreholes BH9 and SPS08E can be re-used for the on-site development, provided that the soils will not be in contact with groundwater, or re-used at a receiving site which is not considered as an environmentally sensitive site and would accept the soil as per the test results; and
3) The soils generated at the Site at the same tested sample depths from Boreholes BH1, BH10, BH19, BH21, BH26, BH28, BH37, BH38, BH104 and BH107, may be disposed at facilities, which are suitable to accept salt-impacted excess soil (i.e., certain former aggregate sites, mines, etc.) or at a licensed landfill site. However, additional chemical testing may be required by these facilities.

It should be noted that the results of the chemical analysis refer only to the soil samples analyzed, which were obtained from specific sampling locations and sampling depths, and that the soil chemistry may vary between and beyond the location and depth of the samples taken. Therefore, soil materials to be used on site or transported to other sites must be inspected during excavation for indication of variance in composition or any chemical/environmental constraints. If conditions indicate significant variations, further chemical analyses should be carried out.

Please note that the level of testing outlined herein is meant to provide a broad indication of soil quality based on the limited soil samples tested. The analytical results contained in this report should not be considered a warranty with respect to the soil quality or the use of the soil for any specific purpose. Furthermore, it must be noted that our scope of work was only limited to the review of the analytical results of the limited number of samples. The scope of work did not include any environmental evaluation or assessment of the subject site (such as a Phase One or Phase Two Environmental Site Assessment).

Sites accepting fill may have requirements relating to its aesthetic or engineering properties in addition to its chemical quality. Some receiving sites may have specific chemical testing protocols, which may require additional tests to meet the requirements. The requirements for accepting the fill at an off-site location must be confirmed in advance. GeoPro would be pleased to assist once the receiving sites are determined and the requirements of the receiving sites are available.

7 CORROSIVITY POTENTIAL

The sulphate (SO_4) resistance requirements for concrete in contact with the site soils were evaluated by performing water-soluble sulphate tests on four (4) soil samples taken from Boreholes BH1, BH5, BH9, BH10, BH14, BH15, BH19, BH26, BH28, BH30 to BH32, BH37, BH38, BH101, BH103, BH104, BH107, SPS01BE, SPS01H, SPS02E, SPS03E, SPS04E, SPS06E, SPS08E, T1, T3, T6 and T8, with depths shown in the following table. The analytical data are attached to Appendix B.

The test revealed that the sulphate concentrations in the tested soil samples from tested samples ranged from less than 2 to 59 ug/g (or <0.0002% to 0.0059%). The category of severity of attack is “negligible” based on CSA Standard A23.1, Concrete Materials and Methods of Concrete Construction. The final selection of the type of concrete should be made by the Engineer taking into account all aspects of design considerations.

The corrosivity of soils towards ferrous metal was evaluated by performing corrosivity tests on same soil samples. The corrosivity of soils was evaluated using the 10 points method which is based on five soil properties: sulphides, resistivity, pH, Redox potential and moisture content. The following table summarizes the ANSI/AWWA rating for the tested soil sample for the potential for corrosion towards buried grey or ductile cast iron pipe. A score of ten (10) points or more indicates potential for corrosion.

BH No./ Sample No.	Parameter (Score)							
	Depth (m)	**Soil Type**	**PH**	**Resistivity (ohm.cm)**	**Sulfide (%)**	**Redox potential (mV)**	**Moisture Content (%)**	**Total Points**
BH1 SS5	3.05 – 3.51	Gravelly Sand to Sand and Gravel	8.33 (0)	2090 (5)	< 0.05 (2)	161 (0)	7 (1)	8
BH5 SS5	3.05 – 3.51	Gravelly Sand to Sand and Gravel	8.83 (3)	4330 (0)	< 0.05 (2)	172 (0)	4 (1)	6
BH9 SS4	2.29 – 2.75	Gravelly Sand to Sand and Gravel	8.99 (3)	5150 (0)	< 0.05 (2)	153 (0)	3 (1)	6
BH10 SS5	3.05 – 3.51	Sand	8.64 (3)	4180 (0)	< 0.05 (2)	158 (0)	18 (2)	7
BH14 SS5	3.05 – 3.51	Sand and Silt Till	8.87 (3)	8850 (0)	< 0.05 (2)	172 (0)	8 (1)	6
BH15 SS5	3.05 – 3.51	Gravelly Sand to Sand and Gravel	9.07 (3)	4220 (0)	< 0.05 (2)	139 (0)	3 (1)	6
BH19 SS4	2.29 – 2.75	Gravelly Sand to Sand and Gravel	8.77 (3)	2410 (2)	< 0.05 (2)	145 (0)	4 (1)	8
BH26 SS5	3.05 – 3.51	Sand	9.30 (3)	2230 (2)	< 0.05 (2)	124 (0)	5 (1)	8
BH28 SS4	2.29 – 2.75	Gravelly Sand to Sandy Gravel	8.38 (0)	833 (10)	0.06 (3.5)	155 (0)	3 (1)	14.5
BH30 SS5	3.05 – 3.51	Gravelly Sand	8.87 (3)	8930 (0)	0.05 (3.5)	150 (0)	11 (2)	8.5
BH31 SS5	3.05 – 3.51	Silty Sand	8.89 (3)	8260 (0)	< 0.05 (2)	176 (0)	9 (1)	6
BH32 SS5	3.05 – 3.51	Sand	9.39 (3)	12000 (0)	< 0.05 (2)	157 (0)	5 (1)	6
BH37 SS4	2.29 – 2.75	Sand and Gravel Probable Fill	8.65 (3)	1080 (10)	0.05 (3.5)	181 (0)	9 (1)	17.5
BH38 SS4 &SS5	2.29 – 3.51	Sand and Silt Fill; Gravelly Sand Probable Fill	8.26 (0)	1160 (10)	0.06 (3.5)	188 (0)	19 (2)	15.5
BH101 SS5	3.05 – 3.81	Gravelly Sand to Sandy Gravel	8.27 (0)	11200 (0)	< 0.05 (2)	169 (0)	3 (1)	3
BH103 SS4	2.29 – 3.05	Gravelly Sand to Sand and Gravel	8.23 (0)	11900 (0)	< 0.05 (2)	163 (0)	6 (1)	3

BH No./ Sample No.	Parameter (Score)							
	Depth (m)	**Soil Type**	**PH**	**Resistivity (ohm.cm)**	**Sulfide (%)**	**Redox potential (mV)**	**Moisture Content (%)**	**Total Points**
BH104 SS4	2.29 – 2.75	Sandy Silt Fill	7.93 (0)	448 (10)	0.08 (3.5)	184 (0)	22 (2)	15.5
BH107 AS4	2.29 – 2.75	Silty Sand	9.05 (3)	526 (10)	0.08 (3.5)	153 (0)	6 (1)	17.5
SPS01BE SS4	2.29 – 2.75	Gravelly Sand to Sand and Gravel	8.75 (3)	7190 (0)	< 0.05 (2)	155 (0)	12 (2)	7
SPS01H SS5	3.05 – 3.51	Gravelly Sand to Sandy Gravel	8.44 (0)	5240 (0)	< 0.05 (2)	170 (0)	13 (2)	4
SPS02E SS5	3.05 – 3.51	Gravelly Sand to Sand and Gravel	8.70 (3)	9170 (0)	< 0.05 (2)	163 (0)	3 (1)	6
SPS03E SS5	3.05 – 3.51	Gravelly Sand to Sand and Gravel	8.89 (3)	8260 (0)	< 0.05 (2)	201 (0)	11 (2)	7
SPS04E SS5	3.05 – 3.51	Fine Sand	8.99 (3)	12500 (0)	< 0.05 (2)	156 (0)	22 (2)	7
SPS06E SS6	4.57 – 5.03	Sand	8.79 (3)	10000 (0)	0.07 (3.5)	169 (0)	18 (2)	8.5
SPS08E SS6	4.57 – 5.03	Gravelly sand to Sand and Gravel	8.4 (0)	6060 (0)	< 0.05 (2)	157 (0)	12 (2)	4
T1 SS5A&B	3.05 – 3.51	Silty Sand Fill; Gravelly Sand to Sand and Gravel	8.43 (0)	5680 (0)	< 0.05 (2)	171 (0)	11 (2)	4
T3 SS4	2.29 – 2.75	Silty Fine Sand to Fine Sand and Silt	8.61 (3)	12500 (0)	< 0.05 (2)	173 (0)	24 (2)	7
T6 SS5A	3.05 – 3.36	Sandy Silt Fill	7.99 (0)	7350 (0)	< 0.05 (2)	180 (0)	15 (2)	4
T8 SS5A&B	3.05 – 3.51	Silty Sand to Sand and Silt Fill; Silty Sand	8.21 (0)	5880 (0)	0.1 (3.5)	177 (0)	18 (2)	5.5

According to the ANSI/AWWA rating system, the tested results of samples BH1 SS5, BH5 SS5, BH9 SS4, BH10 SS5, BH14 SS5, BH15 SS5, BH19 SS4, BH26 SS5, BH30 SS5, BH31 SS5, BH32 SS5, BH101 SS5, BH103 SS4, SPS01bE SS4, SPS01H SS5, SPS02E SS5, SPS03E SS5, SPS04E SS5, SPS06E SS6, SPS08E SS6, T1 SS5A&B, T3 SS4, T6 SS5A, T8 SS5A&B indicate moderate potential for corrosion of grey ductile iron pipe. However, the tested results of samples BH28 SS4, BH37 SS4, BH38 SS4&SS5, BH104 SS4 and BH107 AS4 indicate that soils are corrosive to ductile-iron pipes, the anti-corrosion protection is needed. Further provision of recommendations for corrosion protection is outside of the scope of GeoPro's terms of reference.

Note that there may be other overriding factors in the assessment of corrosion potential, such as the application of de-icing salts on the roadway and subsequent leaching into the subsoils, stray currents, etc.

8 MONITORING AND TESTING

The geotechnical aspects of the final design drawings and specifications should be reviewed by GeoPro prior to tendering and construction, to confirm that the intent of this report has been met. During construction, full-time engineered fill monitoring and sufficient foundation inspections, subgrade inspections, in-situ density tests and materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes, and to monitor conformance to the pertinent project specifications.

9 CLOSURE

The preliminary geotechnical recommendations provided in this report are not sufficient for final design or construction purposes. Once the actual development plans are available, the information in this report should be reviewed by the geotechnical engineer and an additional detailed geotechnical and hydrogeological investigation carried out, compatible with the actual proposed development plans for the site. In this regard, GeoPro would be pleased to provide further geotechnical and hydrogeological services if site development plans proceed forward.

We appreciate the opportunity to be of service to you and trust that this report provides sufficient preliminary geotechnical engineering information to facilitate the planning and preliminary concept design of this project. We look forward to providing you with continuing service during the detailed design stage. Please do not hesitate to contact our office should you wish to discuss, in further detail, any aspects of this project.

Yours very truly,

GEOPRO CONSULTING LIMITED

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DRAWINGS

Legend:

Borehole Location

Borehole/Monitoring Well Location

Client: Ainley Group		Project No.: 16-1255	Drawing No.: 1
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	

Legend:

Borehole Location

Borehole/Monitoring Well Location

Client:	**Ainley Group**	Project No.: **16-1255**	Drawing No.: **2**
Drawn: **TY**	Approved: **DL**	Title:	**Borehole Location Plan**
Date: **November 2017**	Scale: **N.T.S.**	Project:	**Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario**
Original Size: **Letter**	Rev: **KS**	GeoPro Consulting Limited	

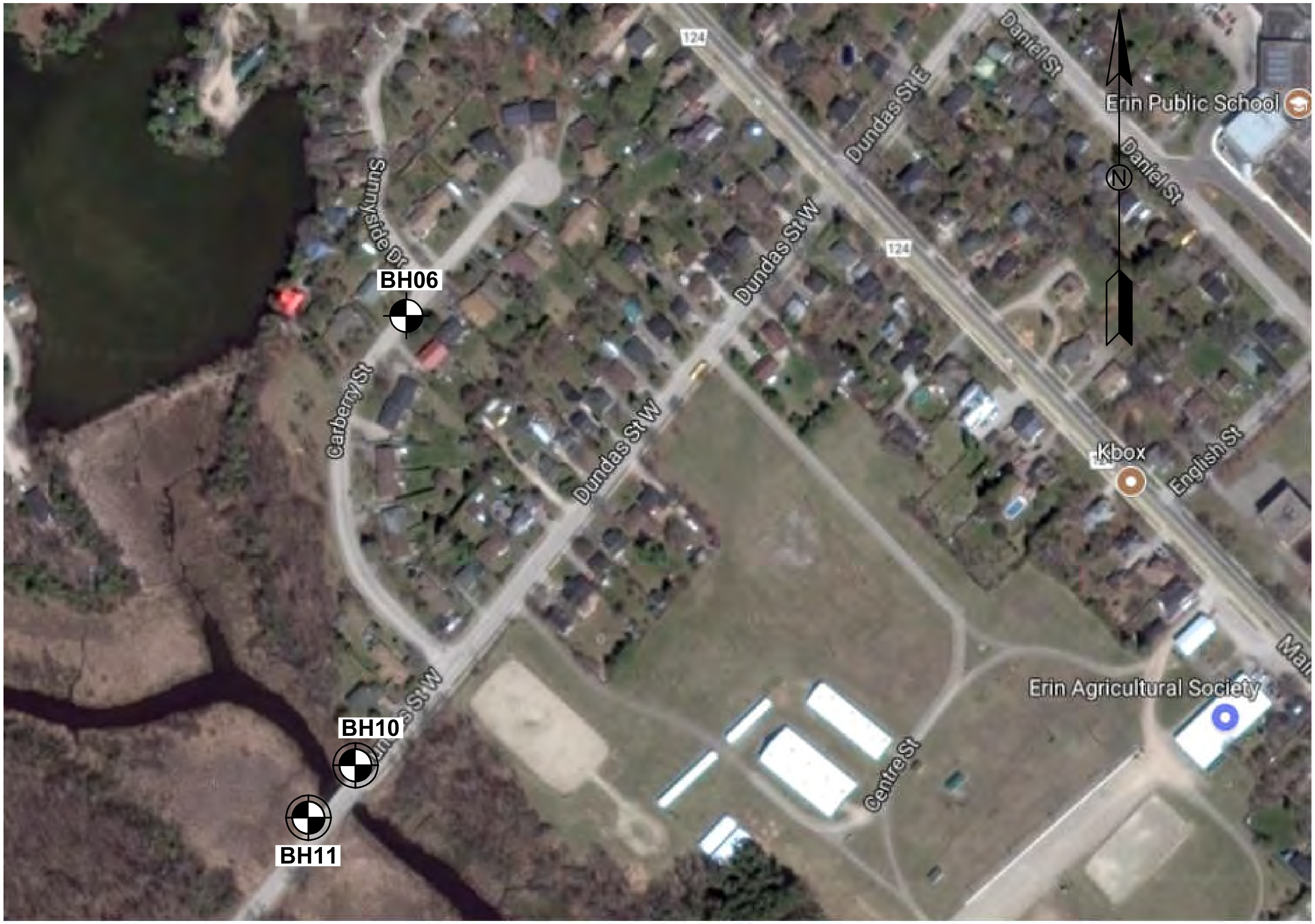
N

Legend:

Borehole Location

Borehole/Monitoring Well Location

Client: **Ainley Group**		Project No.: **16-1255**	Drawing No.: **3**
Drawn: **TY**	Approved: **DL**	Title: **Borehole Location Plan**	
Date: **November 2017**	Scale: **N.T.S.**	Project: **Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario**	
Original Size: **Letter**	Rev: **KS**	GeoPro Consulting Limited	

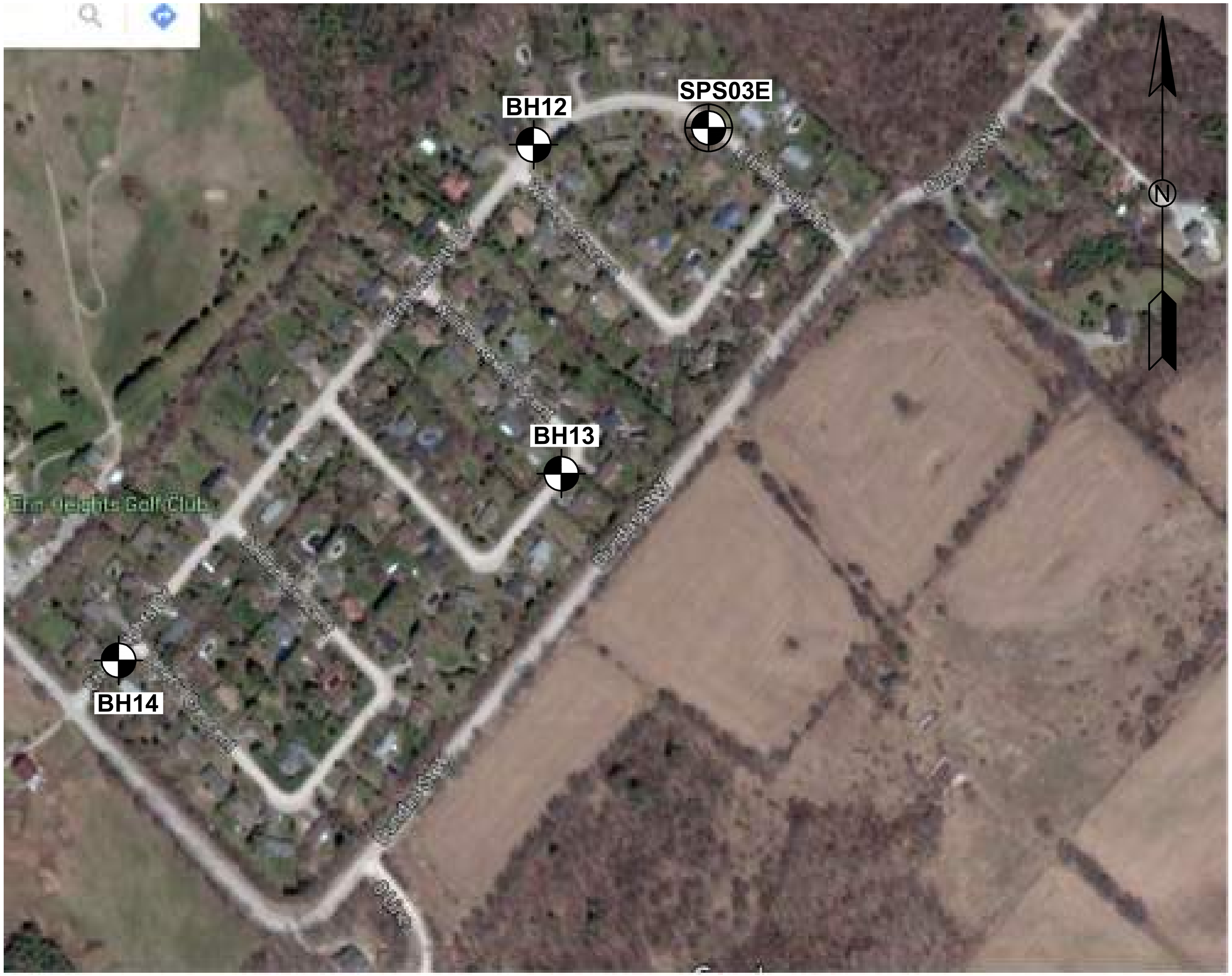


Legend:

Borehole Location

Borehole/Monitoring Well Location

Client: **Ainley Group**		Project No.: **16-1255**	Drawing No.: **4**
Drawn: **TY**	Approved: **DL**	Title: **Borehole Location Plan**	
Date: **November 2017**	Scale: **N.T.S.**	Project: **Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario**	
Original Size: **Letter**	Rev: **KS**	GeoPro Consulting Limited	



Legend:

Borehole Location

Borehole/Monitoring Well Location

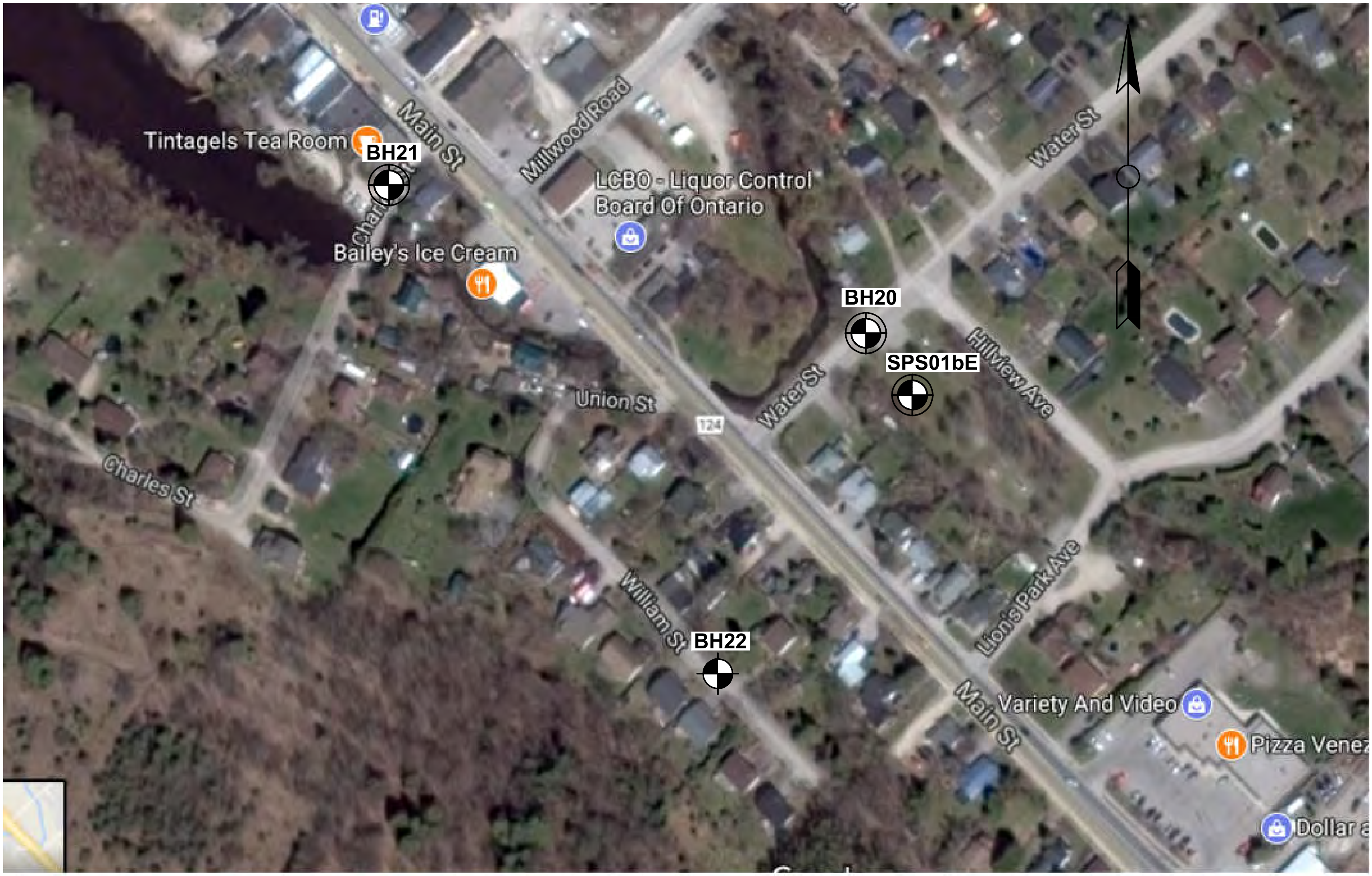
Client:	Ainley Group	Project No.: 16-1255	Drawing No.: 5
Drawn: TY	Approved: DL	Title:	Borehole Location Plan
Date: November 2017	Scale: N.T.S.	Project:	Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario
Original Size: Letter	Rev: KS		GeoPro Consulting Limited

Legend:

Borehole Location

Borehole/Monitoring Well Location

Client: Ainley Group		Project No.: 16-1255	Drawing No.: 6
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	



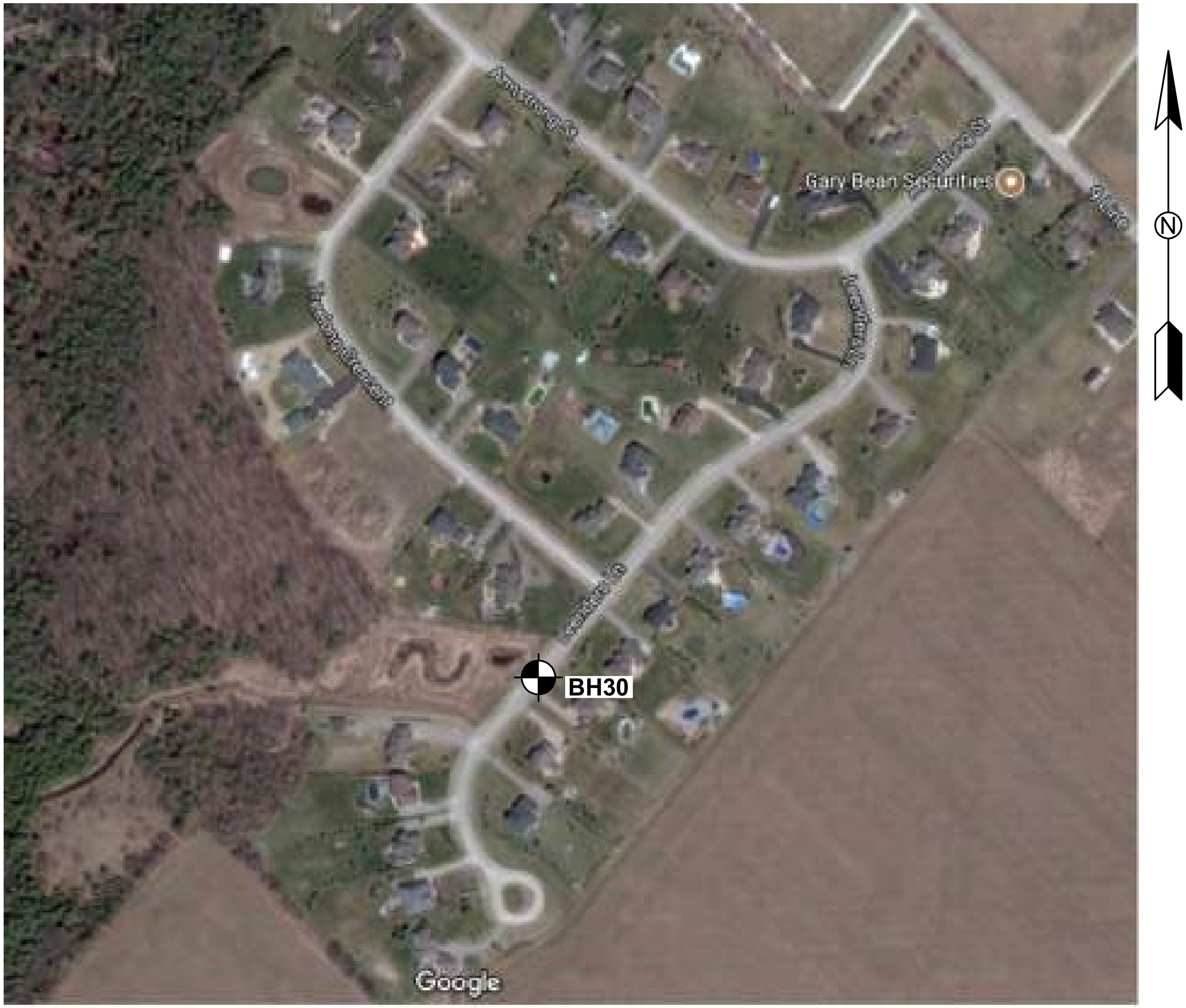
Legend:

Borehole Location

Borehole/Monitoring Well Location

Client: Ainley Group		Project No.: 16-1255	Drawing No.: 7
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	

Legend:				
Borehole Location	Client: Ainley Group		Project No.: 16-1255	Drawing No.: 8
Borehole/Monitoring Well Location	Drawn: TY	Approved: DL	Title: Borehole Location Plan	
	Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
	Original Size: Letter	Rev: KS	GeoPro Consulting Limited	



Legend:

Borehole Location

Borehole/Monitoring Well Location

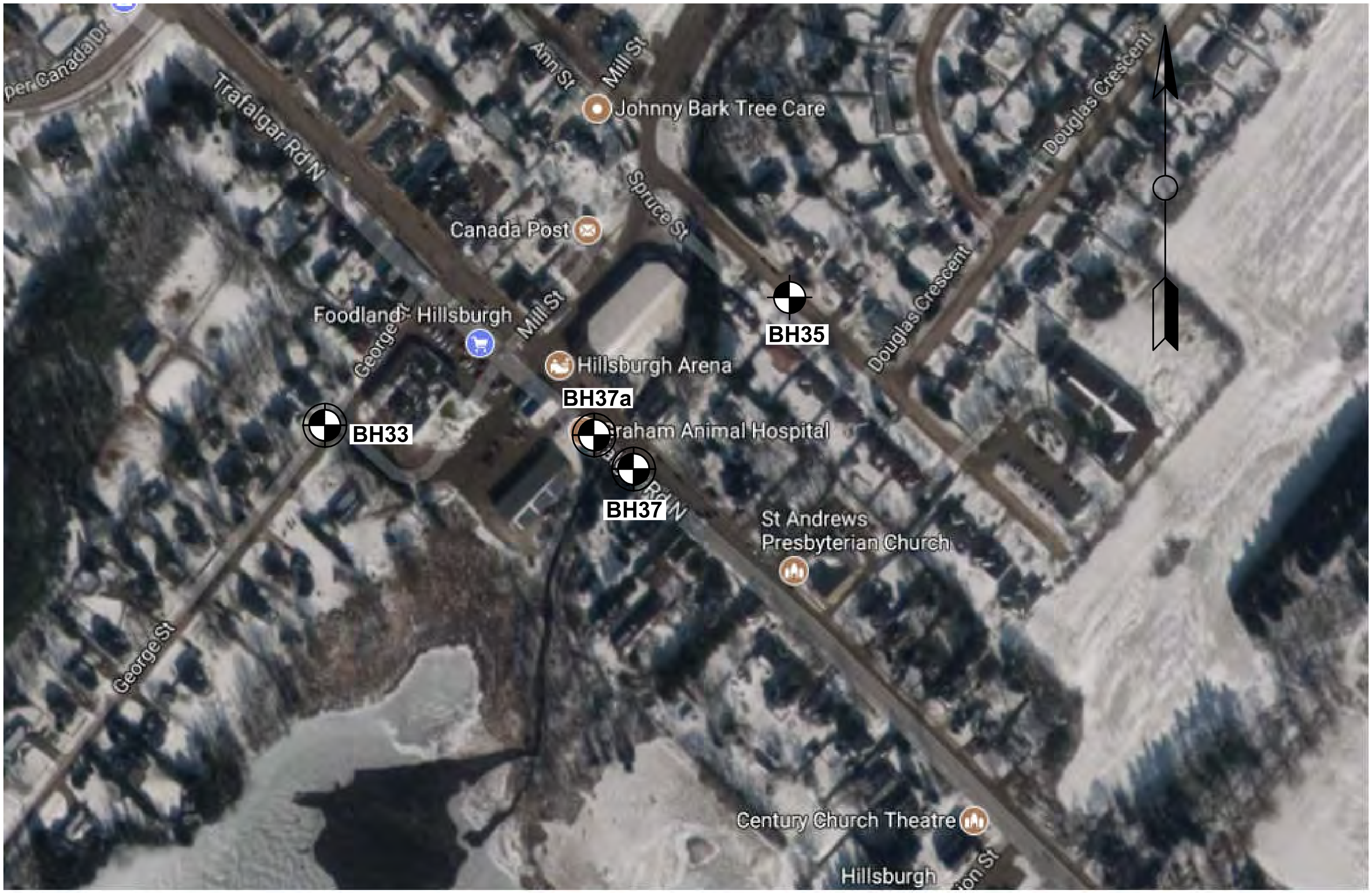
Client: Ainley Group		Project No.: 16-1255	Drawing No.: 9
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	

Legend:

Borehole Location

Borehole/Monitoring Well Location

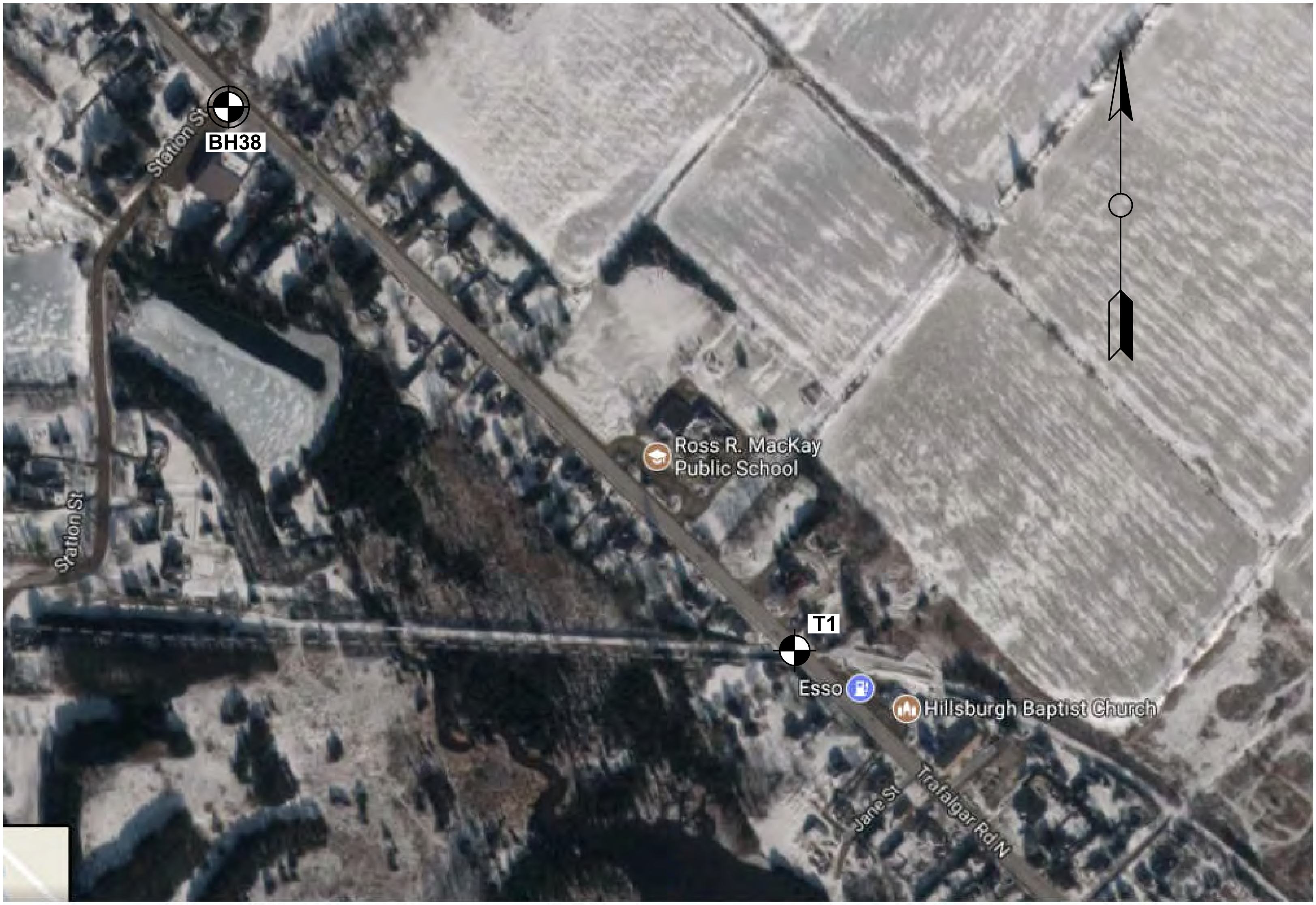
Client: Ainley Group		Project No.: 16-1255	Drawing No.: 10
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	



Legend:

- Borehole Location
- Borehole/Monitoring Well Location

Client:	Ainley Group	Project No.: 16-1255	Drawing No.: 11
Drawn: TY	Approved: DL	Title:	Borehole Location Plan
Date: November 2017	Scale: N.T.S.	Project:	Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario
Original Size: Letter	Rev: KS		GeoPro Consulting Limited



Legend:

- Borehole Location
- Borehole/Monitoring Well Location

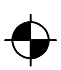
Client: Ainley Group		Project No.: 16-1255	Drawing No.: 12
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	

Legend:

- Borehole Location
- Borehole/Monitoring Well Location

Client: Ainley Group		Project No.: 16-1255	Drawing No.: 13
Drawn: TY	Approved: DL	Title: Borehole Location Plan	
Date: November 2017	Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
Original Size: Letter	Rev: KS	GeoPro Consulting Limited	

Legend:

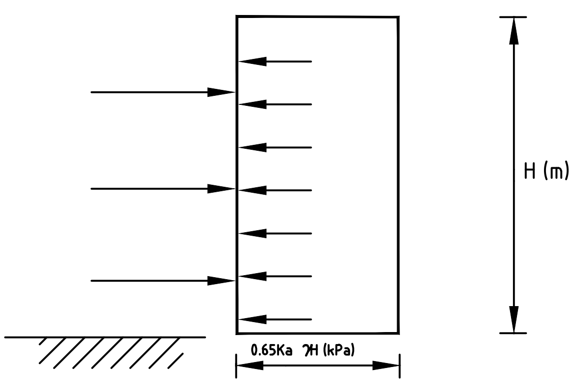


Borehole Location

Borehole/Monitoring Well Location

Client: **Ainley Group**		Project No.: **16-1255**	Drawing No.: **14**
Drawn: **TY**	Approved: **DL**	Title: **Borehole Location Plan**	
Date: **November 2017**	Scale: **N.T.S.**	Project: **Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario**	
Original Size: **Letter**	Rev: **KS**	GeoPro Consulting Limited	

Legend:			
Borehole Location	Client: Ainley Group	Project No.: 16-1255	Drawing No.: 15
Borehole/Monitoring Well Location	Drawn: TY / Approved: DL	Title: Borehole Location Plan	
	Date: November 2017 / Scale: N.T.S.	Project: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing Town of Erin, Ontario	
	Original Size: Letter / Rev: KS	GeoPro Consulting Limited	

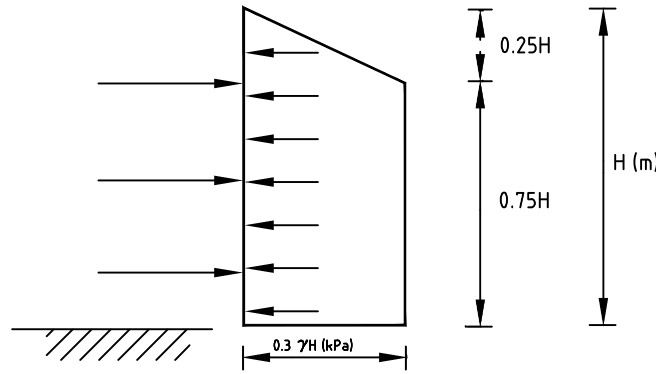


γ = unit weight of soil = 21.0 kN/m^3

γ' = submerged unit weight of soil (i.e. below ground water level)= 11.2 kN/m^3

Ka = 0.3

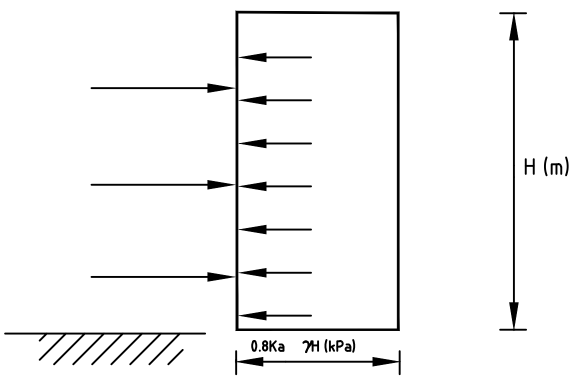
IN COMPACT TO VERY DENSE NON-COHESIVE SOILS (SANDS AND SILTS)



γ = unit weight of soil = 21.5 kN/m^3

γ' = submerged unit weight of soil (i.e. below ground water level)= 11.7 kN/m^3

IN COHESIVE CLAYS OR CLAYEY SOILS

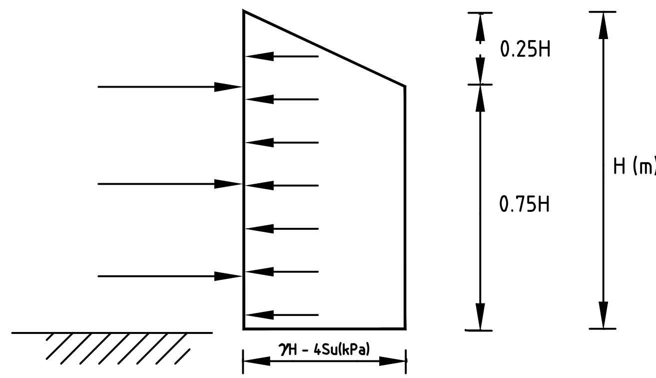


γ = unit weight of soil = 19.0 kN/m^3

γ' = submerged unit weight of soil (i.e. below ground water level)= 9.2 kN/m^3

Ka = 0.36

IN LOOSE OR DISTURBED NON-COHESIVE SOILS (SANDS AND SILTS)



γ = unit weight of soil = 19.0 kN/m^3

γ' = submerged unit weight of soil (i.e. below ground water level)= 9.2 kN/m^3

Su = 10 KPa

IN VERY SOFT TO FIRM COHESIVE CLAYS OR CLAYEY SOILS

Notes:

1. Check system for partial excavation condition.
2. If the free water level is above the base of the excavation, the hydrostatic pressure must be added to the above pressure distribution.
3. If surcharge loadings are present near the excavation, these must be included in the lateral pressure calculation.

Client:	The Municipal Infrastructure Group Ltd.			Project No.: 16-1255	Drawing No.: 16
Drawn:	GH	Approved:	JY	Title: Earth Pressure Distribution on Temporary Multiple Braced Excavations	
Date:	December, 2017	Scale:	N.T.S	Project: Preliminary Geotechnical Investigation Urban Centre Wastewater Servicing, Town of Erin, Ontario	
Original Size:	Letter	Rev:	JY	GeoPro Consulting Limited	

S:\Projects_Standard Report Drawings\EARTH PRESSURE DISTRIBUTION ON BRACED EXCAVATIONS-Aug-2012.dwg

ENCLOSURES

Enclosure 1A: Notes on Sample Descriptions

1. Each soil stratum is described according to the *Modified Unified Soil Classification System*. The compactness condition of cohesionless soils (SPT) and the consistency of cohesive soils (undrained shear strength) are defined according to Canadian Foundation Engineering Manual, 4th Edition. Different soil classification systems may be used by others. Please note that a description of the soil stratums is based on visual and tactile examination of the samples augmented with field and laboratory test results, such as a grain size analysis and/or Atterberg Limits testing. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

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Geotechnical-Hydrogeology-Environmental-Materials-Inspection

Enclosure 1B: Explanation of Terms Used in the Record of Boreholes

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
NR	No recovery
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube Sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

PM – Samples advanced by manual pressure
WR – Samples advanced by weight of sampler and rod
WH – Samples advanced by static weight of hammer

Dynamic Cone Penetration Resistance, N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in).

Piezo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60 degree conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurement of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

Textural Classification of Soils (ASTM D2487)

Classification	Particle Size
Boulders	> 300 mm
Cobbles	75 mm - 300 mm
Gravel	4.75 mm - 75 mm
Sand	0.075 mm – 4.75 mm
Silt	0.002 mm-0.075 mm
Clay	<0.002 mm(*)

(*) Canadian Foundation Engineering Manual (4th Edition)

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	Proportion
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

Soil Description

a) Cohesive Soils(*)

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) Hierarchy of Shear Strength prediction

1. Lab triaxial test
2. Field vane shear test
3. Lab. vane shear test
4. SPT "N" value
5. Pocket penetrometer

b) Cohesionless Soils

Compactness Condition (Formerly Relative Density)	SPT "N" Value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (specific gravity, Gs)
DS	Direct shear test
ENV	Environmental/ chemical analysis
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified proctor compaction test
SPC	Standard proctor compaction test
OC	Organic content test
U	Unconsolidated Undrained Triaxial Test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

LOG OF BOREHOLE BH1

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-14
REF. NO.: 16-1255
ENCL. NO.: 2

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (300 mm)				
0.3	**GRANULAR BASE/SUBBASE:** (230 mm)	1A	AS		
0.5	**FILL:** sandy silt to silty sand, trace clay, trace gravel, brown, moist, compact	1B	AS		
		2A	SS	24	
1.1	**SANDY GRAVEL:** trace silt, containing cobbles and boulders, brown, moist, compact	2B	SS		
1.4	**SAND AND SILT:** some gravel, trace clay, containing cobbles and boulders, brown, moist, loose	3	SS	7	13 43 37 7
		4	SS	9	
2.9	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt till, layers/zones of sandy silt till, containing cobbles and boulders, brown, moist, dense	5	SS	46	
		6	SS	41	
5.0	**END OF BOREHOLE:** Note: 1) Borehole caved at a depth of 4.3 m below ground surface (mBGS) upon completion of drilling.				

Column headings also include: STRATA PLOT; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m, 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane; 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3).

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ✕3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH2

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: CS
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-08
REF. NO.: 16-1255
ENCL. NO.: 3

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (230 mm)			
0.2	**GRANULAR BASE/SUBBASE:** (610 mm)	1	AS	
		2A	SS	
0.8	**SANDY SILT:** some sand, trace to some clay, trace gravel, dark brown to brown, moist to wet, loose to compact	2B	SS	23
		3	SS	8
		4	SS	8
2.9	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace to some clay, brown, moist, compact to dense	5	SS	19
		6	SS	50
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.			

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH3

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**	
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL	DATE: 2017-11-23
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 4

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m, approx.)	WATER CONTENT (%, approx.)
0.0	**ASPHALT CONCRETE:** (25 mm)					
	GRANULAR BASE/SUBBASE: (465 mm)	1A	AS			~5
0.5	**NO RECOVERY:** likely sandy silt, trace organics	1B	AS			~5
		2	AS	7	7	~21
1.4	**FILL:** sandy silt to sand and silt, trace clay, trace gravel, brown, moist, loose	3	SS	7	7	~12
2.1	**FILL:** sand, some silt, trace gravel, brown, moist, loose	4	SS	4	4	~8
2.9	**SAND:** some silt, brown, moist, loose	5	SS	5	5	~8
4.0	**GRAVELLY SAND:** some silt, trace clay, containing rock fragments, containging cobbles and boulders, brown, saturated, compact	6	SS	18	18	~13
5.0	**END OF BOREHOLE:**					

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 4.1 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m, 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane, 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL; STRATA PLOT.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH4

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: GH
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-01
REF. NO.: 16-1255
ENCL. NO.: 5

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)	WATER CONTENT (%)
0.0 / 0.1	**ASPHALT CONCRETE:** (55 mm) **GRANULAR BASE/SUBBASE:** (345 mm)	1A	AS			~7
0.4	**FILL:** sand, some gravel, trace to some silt, trace clay, brown, moist	1B	AS			~6
0.8	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist, loose to dense	2	SS	27	27	~3
		3	SS	18	18	~3
		4	AS			~3
		5	SS	5	5	~3
		6	SS	49	49	~3
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.					

Other columns: STRATA PLOT, GROUND WATER, ELEVATION, DYNAMIC PENETRATION TEST (SPT / Cone, blows/0.3m: 20 40 60 80), SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80), Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L, WATER CONTENT (%) 10 20 30 40, UNIT WT (kN/m^3), REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE BH5

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: GH

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-01

REF. NO.: 16-1255

ENCL. NO.: 6

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (70 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (360 mm)	1A	AS	
0.4	**FILL:** gravelly sand, trace silt, brown, moist, loose	1B	AS	
		2	SS	7
1.4	**SAND:** some gravel, trace silt, brown, moist, compact	3	SS	13
		4	AS	
2.9	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, containing cobbles and boulders, brown, moist, dense to very dense	5	SS	31
		6	SS	68
5.0	**END OF BOREHOLE**			

Note:
1) Borehole caved at a depth of 2.7 m below ground surface (mBGS) upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ✕3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH6

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-09
REF. NO.: 16-1255
ENCL. NO.: 7

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT blows/0.3m (approx.)	WATER CONTENT (%) (approx.)
0.0	**ASPHALT CONCRETE:** (80 mm)					
0.1	**GRANULAR BASE/SUBBASE:** (680 mm)	1	AS			○
0.8	**GRAVELLY SAND:** some silt, trace clay, containing cobbles and boudlers, brown, moist, dense	2	SS	44	○	○
1.4	**SAND:** some gravel to gravelly, some silt, trace clay, brown, moist, compact	3	SS	26	○	○
2.1	**SAND AND GRAVEL TO GRAVELLY SAND:** some silt, trace clay, containing cobbles and boulders, brown to grey, moist to wet, compact to dense	4	SS	42	○	○
	--- wet	5	SS	35	○	○
	--- grey, layers/zones of sand	6	SS	14	○	○
5.0	**END OF BOREHOLE**					

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.1 mBGS upon completion of drilling.
3) Borehole caved at a depth of 2.1 below ground surface upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE BH7

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**	
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: CS	DATE: 2017-11-08
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 8

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (110 mm)			
0.1	**GRANULAR SUBBASE/BASE:** (610 mm)	1A	AS	
0.7	**FILL:** sandy silt, trace clay, trace gravel, layers of silty sand, brown, moist, compact	1B	AS	
		2	SS	16
1.4	**SANDY SILT:** trace to some clay, trace gravel, some organics, dark brown, moist, loose	3	SS	6
2.1	**SAND AND GRAVEL:** trace to some silt, containing cobbles and boulders, brown, moist, dense	4	SS	32
2.9	**SAND:** trace to some silt, trace to some gravel, brown, moist, compact	5	SS	13
4.0	**SAND AND GRAVEL:** trace to some silt, containing cobbles and boulders, brown, moist, dense	6	SS	50
5.0	**END OF BOREHOLE**			

Note:
1) Borehole was open and dry upon completion of drilling.

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10 20 30 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH8

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-21
REF. NO.: 16-1255
ENCL. NO.: 9

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (150 mm)			
0.2	**GRANULAR BASE/SUBBASE:** (430mm)	1A	AS	
0.6	**FILL:** silty sand, some gravel, containing cobbles, brown, moist, compact	1B	AS	
		2	SS	19
		3	SS	13
2.1	**GRAVELLY SAND TO SAND AND GRAVEL:** trace silt, containing rock fragments, containing cobbles and boulders, brown, moist, compact to very dense	4	SS	41
		5	SS	54
		6	SS	17
5.0	**END OF BOREHOLE:** Note: 1) Borehole caved at a depth of 2.1 m below ground surface (mBGS) upon completion of drilling.			

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10, 20, 30, 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH9

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer; DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL; DATE: 2017-11-09
DATUM: N/A	SAMPLE REVIEW: TY; REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL; ENCL. NO.: 10

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	DYNAMIC PENETRATION TEST (SPT)	WATER CONTENT
0.0	**ASPHALT CONCRETE:** (90 mm)					
0.1	**GRANULAR BASE/SUBBASE:** (690 mm)	1	AS			o
0.8	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace clay, containing cobbles and boulders, brown, moist, compact to very dense	2A	SS			
		2B	SS	18	o	o
		3	SS	50 / 130 mm	>100	o
		4	SS	36	o	o
		5	SS	49	o	o
	--- auger grinding	6	SS	96 / 255 mm	>100	o
5.0	**END OF BOREHOLE**					

Note:
1) Borehole caved at a depth of 3.2 m below ground surface (mBGS) upon completion of drilling.

Legend: DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80). SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80). Plastic Limit W_P, Natural Moisture Content W, Liquid Limit W_L. WATER CONTENT (%) (10, 20, 30, 40). UNIT WT (kN/m^3). REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH10

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-08

REF. NO.: 16-1255

ENCL. NO.: 11

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (95 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (695 mm)	1	AS	
0.8	**GRAVELLY SAND:** some silt, trace clay, containging cobbles and boulders, brown, moist to wet, loose to compact	2	SS	13
		3	SS	6
2.1	**SAND:** some silt, trace gravel, brown, saturated, very loose to compact	4	SS	3
		5	SS	12
		6	SS	9
5.0	**END OF BOREHOLE**			

GROUND WATER: Concrete; Bentonite; 1.2mBGS Dec 05; Sand; Screen; Natural pack

DYNAMIC PENETRATION TEST: O SPT; Cone; blows/0.3m — 20, 40, 60, 80

SHEAR STRENGTH (kPa): ● Unconfined; ✕ Field Vane & Sensitivity; ▲ Quick Triaxial; ⊠ Penetrometer; + Lab Vane — 20, 40, 60, 80

Plastic Limit w_P — Natural Moisture Content w — Liquid Limit w_L

WATER CONTENT (%): 10, 20, 30, 40

UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

Notes:
1) Water encountered at a depth of 0.8 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.4 mBGS upon completion of driling.
3) Borehole caved at a depth of 3.4 mBGS upon completion of driling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	1.22

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH11

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-08
REF. NO.: 16-1255
ENCL. NO.: 12

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (125 mm)				Concrete
0.1	**GRANULAR BASE/SUBBASE:** (645 mm)	1	AS		Bentonite
0.8	**SANDY SILT:** some sand, some organics, dark brown, moist, compact	2A	SS	11	1.1mBGS Dec 05
1.1	**SILTY SAND:** trace clay, some organics, some rootlets, brown, moist, loose to compact	2B	SS		Sand
		3	SS	7	
2.1	**PEAT:** black, moist, very loose to loose	4	SS	2	Screen
		5	SS	4	
4.0	**SAND AND GRAVEL:** trace to some silt, trace clay, grey, wet, compact	6	SS	11	Natural pack
5.0	**END OF BOREHOLE**				

Chart columns: DYNAMIC PENETRATION TEST (SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL); STRATA PLOT; ELEVATION.

Notes:
1) Water encountered at a depth of 0.8 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.8 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.0 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	1.08

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH12

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**	
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: GH	DATE: 2017-10-31
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 13

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (100 mm)						
0.1	**GRANULAR BASE/SUBBASE:** (360 mm)	1A	AS				
0.5	**FILL:** gravelly sand, some silt to silty, trace clay, brown, moist, loose	1B	AS				
		2	SS	9			
1.4	**GRAVELLY SAND:** trace silt, containing cobbles and boulders, brown, moist, compact	3	SS	15			
		4	AS				
		5	SS	24			
		6	SS	15			
5.0	**END OF BOREHOLE** Note: 1) Borehole caved at a depth of 3.7 m below ground surface (mBGS) upon completion of drilling.						

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)

SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)

Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40)

UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

01 - GEOPRO SOIL LOG GEOPRO 16-1255 BH LOG PROJECT DATA 20180101- RL -8.GPJ 2018-01-04 11:02

LOG OF BOREHOLE BH13

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: GH

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-10-31

REF. NO.: 16-1255

ENCL. NO.: 14

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (75 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (315 mm)	1A	AS	
0.4	**FILL:** sandy silt, trace to some clay, trace gravel, containing rock fragments, containing cobbles, compact	1B	AS	
		2	SS	14
1.4	**FILL:** silty sand, trace to some gravel, trace clay, pockets of clayey silt, brown, moist, loose	3	SS	8
		4	AS	
2.9	**SAND AND SILT TILL:** trace clay, trace gravel, containing cobbles and boulders, brown, moist, dense to very dense	5	SS	48
		6	SS	74
5.0	**END OF BOREHOLE**			

Note:
1) Borehole was open and dry upon completion of drilling.

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)

SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)

Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L

WATER CONTENT (%) (10, 20, 30, 40)

GROUND WATER | ELEVATION | UNIT WT (kN/m^3) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE BH14

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: GH

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-10-31

REF. NO.: 16-1255

ENCL. NO.: 15

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (100 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (360 mm)	1A	AS	
0.5	**FILL:** silty sand, some gravel, trace clay, brown, moist	1B	AS	
0.8	**FILL:** gravelly sand, some silt to silty, containing rock fragments, brown, moist, dense	2	SS	42
1.4	**FILL:** silty sand, trace clay, trace gravel, brown, moist, very loose	3	SS	2
		4	AS	
2.9	**SAND AND SILT TILL:** trace clay, trace gravel, containing cobbles and boulders, brown, moist, very dense	5	SS	65
		6	SS	50 / 75 mm
4.8	**END OF BOREHOLE**			

Note:
1) Borehole was open and dry upon completion of drilling.

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80). SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80). Sample 6: > >100

Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L. WATER CONTENT (%) 10 20 30 40

GROUND WATER | ELEVATION | UNIT WT (kN/m^3) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH15

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-17
REF. NO.: 16-1255
ENCL. NO.: 16

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	Natural Moisture Content	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (95 mm)				Concrete			
0.1	**GRANULAR BASE/SUBBASE:** (665 mm)	1	AS				○	
0.8	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, containing cobbles and boulders, moist to wet, compact to very dense	2	SS	19	Bentonite	○	○	
	--- auger grinding	3	SS	63		○	○	
		4	SS	36	Sand	○	○	
	--- wet --- auger grinding	5	SS	39	Screen	○	○	
		6	SS	61	Natural pack	○	○	
5.0	**END OF BOREHOLE**							

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.4 mBGS upon completion of driling.
3) Borehole caved at a depth of 4.4 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 15, 2017	dry

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE BH16

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-23
REF. NO.: 16-1255
ENCL. NO.: 17

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)	Water Content (%)
0.0	**ASPHALT CONCRETE:** (60 mm)					
0.1	**GRANULAR BASE/SUBBASE:** (440 mm)	1A	AS			~3
0.5	**FILL:** gravelly sand, trace clay, trace silt, brown, moist, loose to compact	1B	AS			~5
		2	SS	10	10	~5
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, containing rock fragments, containing cobbles and boulders, brown, moist, dense	3	SS	31	31	~4
	---auger grinding					
		4	SS	47	47	~5
		5	SS	42	42	~3
5.0	**END OF BOREHOLE**					

Note:
1) Borehole caved at a depth of 2.9 m below ground surface (mBGS) upon completion of drilling.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH17

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer; DIAMETER: 205 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL; DATE: 2017-11-23
DATUM: N/A	SAMPLE REVIEW: TY; REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL; ENCL. NO.: 18

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (125 mm)				
0.1	**GRANULAR BASE/SUBBASE:** (325 mm)	1A	AS		Concrete
0.5	**FILL:** sand and silt to silty sand, trace to some clay, trace gravel, brown, moist to wet, loose to compact	1B	AS		
		2	SS	29	Bentonite
		3	SS	13	
	--- wet	4	SS	6	2.7mBGS Dec 11; Sand
2.9	**ORGANIC SILT:** some sand, trace clay, containing cobbles and boulders, black, moist, loose to compact	5	SS	10	Screen
4.0	**GRAVELLY SAND:** trace clay, trace silt, containing rock fragments, brown, saturated, compact	6	SS	27	Natural pack
5.0	**END OF BOREHOLE**				

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m 20 40 60 80
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane; 20 40 60 80
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) 10 20 30 40
UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 11, 2017	2.69

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH18

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER:
SAMPLE REVIEW:
CHECKED:
DIAMETER: 205 mm
DATE: 2017-11-23
REF. NO.: 16-1255
ENCL. NO.: 19

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	DYNAMIC PENETRATION (SPT)	WATER CONTENT (%)
0.0	**ASPHALT CONCRETE:** (120 mm)					
0.1	**GRANULAR BASE/SUBBASE:** (400 mm)	1A	AS			o
0.5	**FILL:** gravelly sand, some silt, trace clay, brown, moist, compact	1B	AS			o
		2	SS	21	o	o
1.4	**FILL:** sandy silt to sand and silt, trace clay, trace gravel, containing cobbles, brown, moist to wet, loose to very dense	3	SS	6	o	o
		4	SS	50 / 145 mm	> >100	o
2.9	**NO RECOVERY:** likely sand and gravel, very dense --- auger grinding	5	SS	50 / 75 mm	> >100	o
4.0	**GRAVELLY SAND:** some silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, moist, very dense	6	SS	50 / 100 mm	> >100	o
4.7	**END OF BOREHOLE**					

Note:
1) Borehole caved at a depth of 3.8 m below ground surface (mBGS) upon completion of drilling.

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES (NUMBER, TYPE, "N" BLOWS/0.3m); GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m; 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane; 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH19

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-13
REF. NO.: 16-1255
ENCL. NO.: 20

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)	Water Content (%)
0.0	**ASPHALT CONCRETE:** (85 mm)					
0.1	**GRANULAR BASE/SUBBASE:** (545 mm)	1A	AS			~5
0.6	**FILL:** gravelly sand, trace to some silt, brown, moist, compact	1B	AS			~5
		2	SS	24	24	~8
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, containing rock fragments, containing cobbles and boulders, dense to very dense	3	SS	46	46	~6
		4	SS	53	53	~6
2.9	**NO RECOVERY DUE TO COBBLES:** likely sand and gravel, very dense --- auger grinding	5	SS	50 / 100 mm	> >100	~6
3.9	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, containing rock fragments, containing cobbles and boulders, dense	6	SS	32	32	~5
5.0	**END OF BOREHOLE:** Note: 1) Borehole caved at a depth of 4.0 m below ground surface (mBGS) upon completion of drilling.					

Column headings: SOIL PROFILE (ELEV DEPTH (m), DESCRIPTION, STRATA PLOT); SAMPLES (NUMBER, TYPE, "N" BLOWS/0.3m); GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m, 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane, 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH20

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-13
REF. NO.: 16-1255
ENCL. NO.: 21

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (95 mm)				
0.1	**GRANULAR BASE/SUBBASE:** (625 mm)	1A	AS		Concrete
0.7	**FILL:** silty sand, some gravel, trace clay, trace organics, dark brown, moist, compact	1B	AS		
		2	SS	20	1.2mBGS Dec 17; Bentonite
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, layers/zones of sand, containing rock fragments, containing cobbles and boulders, brown, wet, dense to very dense	3	SS	41	
		4	SS	46	
	--- layers of sand	5	SS	61	Sand; Screen
4.0	**SANDY SILT TILL:** trace to some clay, trace gravel, containing cobbles and boulders, grey, moist, dense	6	SS	47	Natural Pack
5.0	**END OF BOREHOLE**				

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m: 20 40 60 80
SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane: 20 40 60 80
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%): 10 20 30 40
UNIT WT (kN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL
ELEVATION

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.7 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.7 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 17, 2017	1.19

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ✕3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH21

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-14
REF. NO.: 16-1255
ENCL. NO.: 22

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (95 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (465 mm)	1A	AS	
0.6	**FILL:** gravelly sand to sand and gravel, some silt, trace clay, dark brown, moist to wet, compact to very dense	1B	AS	
		2	SS	19
	--- wet	3	SS	13
	--- auger grinding	4	SS	50 / 130 mm
3.0	~~**PROBABLE BEDROCK:**~~			
3.1	dolostone, brown	5	SS	50 / 25 mm

END OF BOREHOLE DUE TO AUGER REFUSAL ON PROBABLE BEDROCK

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.5 mBGS upon completion of drilling.
3) Borehole caved at a depth of 1.5 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; STRATA PLOT; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit W_P, Natural Moisture Content W, Liquid Limit W_L; WATER CONTENT (%) 10, 20, 30, 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH22

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: GH

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-01

REF. NO.: 16-1255

ENCL. NO.: 23

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	Remarks
0.0 / 0.1	**ASPHALT CONCRETE:** (45 mm)				
0.3	**GRANULAR BASE/SUBBASE:** (205 mm)	1A	AS		
	FILL: gravelly sand, trace to some silt, trace clay, brown, moist, compact	1B	AS		
		2	SS	17	
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, containing cobbles and boulders, brown, wet, compact to very dense	3	SS	22	
		4	AS		
		5	SS	93 / 230 mm	
	--- auger grinding				
		6	SS	50 / 25 mm	
4.6	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.5 mBGS upon completion of drilling.
3) Borehole caved at a depth of 2.1 mBGS upon completion of drilling.

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80); SPT plotted > >100 for samples 5 and 6.

SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)

Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L — WATER CONTENT (%) (10, 20, 30, 40)

UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH23

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155m
DATE: 2017-11-23
REF. NO.: 16-1255
ENCL. NO.: 24

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT N	Water Content (%)	GR	SA	SI	CL
0.0	**ASPHALT CONCRETE:** (170 mm)				Concrete						
0.2	**GRANULAR BASE/SUBBASE:** (400 mm)	1A	AS				o				
0.6	**FILL:** sand to silty sand, trace gravel, trace organics, trace roolets, pockets of sandy silt, brown to grey, moist, loose to compact	1B	AS				o				
		2	SS	7	1.2mBGS Dec 17; Bentonite	o	o				
	--- grey	3	SS	8		o	o	7	79	14	
		4	SS	14		o	o				
2.9	**SAND:** trace to some silt, trace to some gravel, containing rock fragments, grey, wet, dense	5	SS	40	Sand; Screen	o	o				
		6A	SS				o				
4.7	**SANDY GRAVEL:** some silt, containing cobbles and boulders, brown, saturated, dense	6B	SS	38	Natural Pack	o	o				
5.0	**END OF BOREHOLE**										

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 17, 2017	1.15

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH24

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**	
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL	DATE: 2017-11-15
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 25

ELEV DEPTH (m)	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (290 mm)				Concrete
0.3	**GRANULAR BASE/SUBBASE:** (400 mm)	1A	AS		
0.7	**FILL:** sandy silt to silty sand, trace clay, trace gravel, trace organics, dark brown, moist, very dense	1B	AS		
		2	SS	54	1.1mBGS Dec 17
					Bentonite
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace clay, grey, wet, very dense	3	SS	54	
		5	SS	62	Sand
					Screen
		6	SS	51	Natural Pack
5.0	**END OF BOREHOLE**				

Column headings: DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); ELEVATION; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

Note:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.3 mBGS upon completion of drilling.
3) Borehole caved at a depth of 4.3 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 17, 2017	1.14

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE BH25

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: GH
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-01
REF. NO.: 16-1255
ENCL. NO.: 26

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)	WATER CONTENT (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (80 mm)						
0.1	**GRANULAR BASE/SUBBASE:** (340 mm)	1A	AS			o	
0.4	**FILL:** silty sand, some gravel, trace clay, brown, moist	1B	AS			o	
0.8	**GRAVELLY SAND:** trace to some silt, trace clay, containing cobbles and boulders, brown, moist, compact to dense	2	SS	25	o	o	38 48 12 2
		3	SS	21	o	o	
		4	AS			o	
		5	SS	39	o	o	
4.0	**SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, wet, compact	6	SS	26	o	o	
5.0	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 4.0 mBGS upon completion of drilling.

Legend: DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80). SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80). Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L. WATER CONTENT (%) 10 20 30 40. UNIT WT (kN/m^3). STRATA PLOT. GROUND WATER. ELEVATION.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH26

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-15
REF. NO.: 16-1255
ENCL. NO.: 27

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (160 mm)			
0.2	**GRANULAR BASE/SUBBASE:** (500 mm)	1A	AS	
0.7	**FILL:** silty sand, trace to some gravel, brown, moist, dense	1B	AS	
		2	SS	35
1.4	**SAND:** trace silt, trace gravel, brown, moist, compact	3	SS	16
		4	SS	12
		5	SS	12
4.0	**GRAVELLY SAND:** trace silt, containing cobbles and boulders, brown, moist, dense	6	SS	38
5.0	**END OF BOREHOLE**			

Note:
1) Borehole caved at a depth of 4.4 m below ground surface (mBGS) upon completion of drilling.

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) 10 20 30 40
UNIT WT (kN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH27

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer; DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL; DATE: 2017-11-15
DATUM: N/A	SAMPLE REVIEW: TY; REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL; ENCL. NO.: 28

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (195 mm)			
0.2	**GRANULAR BASE/SUBBASE:** (485 mm)	1A	AS	
0.7	**FILL:** gravelly sand, some silt, containing cobbles and boulders, brown, moist, compact to dense	1B	AS	
		2	SS	30
		3	SS	19
2.1	**SAND:** trace to some gravel, trace silt, containing cobbles and boulders, brown, moist, compact	4	SS	14
		5	SS	12
4.0	**GRAVELLY SAND:** trace silt, containing rock fragments, containing cobbles and boulders, brown, moist, compact to dense	6	SS	30
5.0	**END OF BOREHOLE**			

Column headings: SOIL PROFILE (ELEV DEPTH (m), DESCRIPTION, STRATA PLOT); SAMPLES (NUMBER, TYPE, "N" BLOWS/0.3m); GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, X Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

Note:
1) Borehole caved at a depth of 2.7 m below ground surface (mBGS) upon completion of drilling.

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH28

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-15
REF. NO.: 16-1255
ENCL. NO.: 29

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (255 mm)						
0.3	**GRANULAR BASE/SUBBASE:** (365 mm)	1A	AS				
0.6	**FILL:** sandy silt to silty sand, trace clay, trace gravel, trace organics, dark brown to brown, moist, very loose to loose	1B	AS				
		2	SS	5			
	---brown	3	SS	3			
2.1	**GRAVELLY SAND TO SANDY GRAVEL:** trace silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to dense	4	SS	47			
	--- auger grinding, wet	5	SS	15			57 34 9
		6	SS	41			
5.0	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 2.0 mBGS upon completion of drilling.

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH29

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: GH
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-10-31
REF. NO.: 16-1255
ENCL. NO.: 30

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (100 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (400 mm)	1A	AS	
0.5	**FILL:** sandy silt, some clay, trace gravel, brown, moist	1B	AS	
0.8	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some clay, trace to some silt, containing cobbles and boulders, brown, moist to wet, compact to dense	2	SS	24
		3	SS	38
		4	SS	19
	--- wet	5	SS	35
		6	SS	23
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.9 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.7 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; STRATA PLOT; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH30

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-13
REF. NO.: 16-1255
ENCL. NO.: 31

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**ASPHALT CONCRETE:** (115 mm)			
0.1	**GRANULAR BASE/SUBBASE:** (665 mm)	1	AS	
0.8	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, containing cobbles and boulders, brown, moist, dense to very dense	2A	SS	
		2B	SS	48
		3	SS	65
2.1	**SAND:** trace silt, trace gravel, brown, wet, compact	4A	SS	26
2.6	**GRAVELLY SAND:** trace to some silt, containing rock fragments, containing cobbles and boulders, brown, wet, compact	4B	SS	
		5	SS	19
4.0	**SAND:** trace silt, trace gravel, brown, wet, compact	6A	SS	28
4.9	**SAND AND GRAVEL:** trace silt, containing cobbles and boulders, brown, wet, compact	6B	SS	
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.3 mBGS upon completion of drilling.
3) Borehole caved at a depth of 2.3 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

01 - GEOPRO SOIL LOG GEOPRO 16-1255 BH LOG PROJECT DATA 20180101- RL -8.GPJ 2018-01-04 11:03

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH31

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**	
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL	DATE: 2017-11-02
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 32

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (85 mm)				
0.1	**GRANULAR BASE/SUBBASE:** (565 mm)	1A	AS		
0.7	**FILL:** gravelly sand, trace clay, trace silt, brown, moist, compact	1B	AS		
		2	SS	24	
1.4	**FILL:** silty sand, trace to some gravel, trace clay, containing cobbles, brown, moist, dense	3A	SS	34	
1.8	**FILL:** sandy silt, trace to some clay, trace gravel, trace organics, dark brown, moist to wet, dense	3B	SS		
2.7	**SILTY SAND:** trace clay, trace gravel, layers of silty sand, pockets of sand, brown, moist, compact	5	SS	22	4 61 30 5
4.0	**SAND:** trace silt, trace gravel, brown, moist, very dense	6	SS	71	
5.0	**END OF BOREHOLE** Note: 1) Borehole was open and dry upon completion of drilling.				

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH32

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-02
REF. NO.: 16-1255
ENCL. NO.: 33

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0 / 0.1	**ASPHALT CONCRETE:** (45 mm) **GRANULAR BASE/SUBBASE:** (525 mm)	1A	AS	
0.6	**FILL:** gravelly sand, trace clay, trace silt, brown, moist, dense	1B	AS	
		2	SS	32
1.4	**SAND:** trace to some gravel, trace silt, brown, moist, compact to very dense	3	SS	20
		4	SS	23
		5	SS	93
		6A	SS	52
4.7	**SAND AND GRAVEL:** trace silt, brown, moist, very dense	6B	SS	
5.0	**END OF BOREHOLE**			

Note:
1) Borehole caved at a depth of 2.4 m below ground surface (mBGS) upon completion of drilling.

Column headings: SOIL PROFILE; STRATA PLOT; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH33

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**	
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL	DATE: 2017-11-22
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 34

Dynamic Penetration Test: O SPT, Cone, blows/0.3m (20, 40, 60, 80). Shear Strength (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80). Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; Water Content (%) (10, 20, 30, 40). Unit WT (kN/m³). Remarks and Grain Size Distribution (%): GR SA SI CL.

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (145 mm)				Concrete
0.1	**GRANULAR BASE/SUBBASE:** (545 mm)	1A	AS		
0.7	**FILL:** sand and silt to silty sand, trace clay, trace gravel, trace organics, brown, moist to wet, very loose to loose	1B	AS		
		2	SS	6	
	--- wet	3	SS	3	1.9mBGS Dec 17
2.1	**SAND:** trace to some silt, trace gravel, brown, wet, loose	4	SS	6	Bentonite
		5	SS	7	
		6	SS	7	
		7	SS	4	Sand, Screen
		8	SS	7	Natural Pack
8.1	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 17, 2017	1.93

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

01 - GEOPRO SOIL LOG GEOPRO 16-1255 BH LOG PROJECT DATA 20180101- RL -8.GPJ 2018-01-04 11:03

LOG OF BOREHOLE BH34

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**		
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm	
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL	DATE: 2017-11-02	
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255	
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 35	

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	Natural Moisture Content
0.0 / 0.1	**ASPHALT CONCRETE:** (45 mm) **GRANULAR BASE/SUBBASE:** (565 mm)	1A	AS		Concrete		○
0.6	**FILL:** silty fine sand to sand and silt, trace clay, trace gravel, layers of organic silt, brown, moist to wet, loose	1B	AS				○
		2	SS	7	Bentonite	○	○
	--- wet	3	SS	7		○	○
2.1	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist to wet, compact to very dense	4	SS	23		○	○
		5	SS	60	Sand; Screen	○	○
	--- wet	6	SS	64	4.5mBGS Dec 05; Natural Pack	○	○
5.0	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 4.4 mBGS upon completion of drilling.
3) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	4.52

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m 20 40 60 80. SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane 20 40 60 80. Plastic Limit W_P, Natural Moisture Content W, Liquid Limit W_L. WATER CONTENT (%) 10 20 30 40. UNIT WT (kN/m³). REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH35

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-02

REF. NO.: 16-1255

ENCL. NO.: 36

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
0.0	**ASPHALT CONCRETE:** (135 mm)
0.1	**GRANULAR BASE/SUBBASE:** (565 mm)
0.7	**FILL:** silty sand, trace to some clay, trace gravel, containing cobbles, brown, moist, loose to compact
2.5	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist to wet, very dense --- wet
5.0	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3m
1A	AS	
1B	AS	
2	SS	6
3	SS	22
5	SS	60
6	SS	81

GROUND WATER: Concrete; Benonite; Sand; Screen; 4.4mBGS Dec 05; Natural Pack

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80)

SHEAR STRENGTH (kPa): ● Unconfined; ✕ Field Vane & Sensitivity; ▲ Quick Triaxial; ⊠ Penetrometer; + Lab Vane (20, 40, 60, 80)

Plastic Limit W_P — Natural Moisture Content W — Liquid Limit W_L

WATER CONTENT (%) (10, 20, 30, 40)

UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.7 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.0 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	4.38

GROUNDWATER ELEVATIONS

Measurement: 1st, 2nd, 3rd, 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH36

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-02
REF. NO.: 16-1255
ENCL. NO.: 37

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)	Water Content (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (80 mm)						
0.1	**GRANULAR BASE/SUBBASE:** (520 mm)	1A	AS			o	
0.6	**SAND AND SILT:** some gravel, trace clay, brown, moist, compact	1B	AS			o	
		2	SS	18	o	o	15 40 38 7
		3A	SS	24	o	o	
1.8	**SILTY SAND:** some gravel, trace clay, containing cobbles and boulder, brown, moist, compact to very dense	3B	SS			o	
		4	SS	29	o	o	
		5	SS	65	o	o	
4.0	**GRAVELLY SAND:** trace silt, containing cobbles and boulders, brown, moist, dense	6	SS	33	o	o	
5.0	**END OF BOREHOLE**						

Note:
1) Borehole caved at a depth of 2.4 m below ground surface (mBGS) upon completion of drilling.

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH37

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-22
REF. NO.: 16-1255
ENCL. NO.: 38

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (130 mm)				Concrete
0.1	**GRANULAR BASE/SUBBASE:** (440 mm)	1A	AS		
0.6	**FILL:** silty sand to sand and silt, trace clay, trace gravel, pockets of organic silt, brown, moist, loose to compact	1B	AS		
		2	SS	22	Bentonite
		3	SS	7	
2.1	**PROBABLE FILL:** sand and gravel, trace to some silt, brown, moist, compact				2.3mBGS Dec 17
		4	SS	13	
		5	SS	26	Sand, Screen
4.0	**SAND:** trace to some silt, trace gravel, brown, saturated, loose to compact				
		6	SS	10	Natural Pack
5.0	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)
Date W.L. Depth
Dec. 17, 2017 2.27

DYNAMIC PENETRATION TEST: SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): Unconfined, Field Vane & Sensitivity, Quick Triaxial, Penetrometer, Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) 10 20 30 40
UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH37A

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-22
REF. NO.: 16-1255
ENCL. NO.: 39

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (115 mm)				Concrete
0.1	**GRANULAR BASE/SUBBASE:** (475 mm)	1A	AS		
0.6	**FILL:** silt, trace clay, trace sand, trace gravel, layers of silty sand, brown, wet, compact	1B	AS		
		2A	SS		
0.9	**FILL:** sand, trace to some silt, trace gravel, brown, moist, compact	2B	SS	14	Bentonite
1.4	**ORGANIC SANDY SILT:** trace gravel, dark grey, moist, compact	3A	SS		
1.7	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to dense --- wet	3B	SS	17	
		4	SS	19	3.1mBGS Dec 17
		5	SS	18	Sand; Screen
		6	SS	32	Natural Pack
5.0	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 17, 2017	3.11

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m 20 40 60 80
SHEAR STRENGTH (kPa): ● Unconfined ✕ Field Vane & Sensitivity ▲ Quick Triaxial ⊠ Penetrometer + Lab Vane 20 40 60 80
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) 10 20 30 40
UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH38

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-22
REF. NO.: 16-1255
ENCL. NO.: 40

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (120 mm)				Concrete
0.1	**GRANULAR BASE/SUBBASE:** (380 mm)	1A	AS		
0.5	**FILL:** silty sand to sand and silt, trace clay, trace gravel, trace organics, trace rootlets, layers of sandy silt, brown, moist, compact	1B	AS		
		2	SS	11	Bentonite
		3A	SS	11	
1.8	**FILL:** organic sandy silt, dark grey, moist, compact	3B	SS		
2.1	**FILL:** sand and silt, some gravel, trace to some clay, brown, wet, loose	4	SS	8	2.8mBGS Dec 17
2.9	**PROBABLE FILL:** gravelly sand, some silt, trace clay, brown, wet, compact	5	SS	20	Sand; Screen
4.0	**SAND AND GRAVEL:** some silt, trace clay, containing cobbles and boulders, brown, wet, dense	6	SS	33	Natural Pack
5.0	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 17, 2017	2.75

Chart columns: DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m³); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL; ELEVATION; STRATA PLOT

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH101

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Split Spoon
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-28
REF. NO.: 16-1255
ENCL. NO.: 41

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	WATER CONTENT	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (330 mm)				Concrete			
0.3	**FILL:** sandy silt to sand and silt, trace clay, trace gravel, trace organics, trace rootlets, brown, moist to wet, loose	1	SS	5	Benonite	5		
		2	SS	4		4		
1.5	**PROBABLE FILL:** gravelly sand, trace to some silt, pockets of clayey silt, brown, moist, loose	3	SS	4		4		
2.3	**GRAVELLY SAND TO SANDY GRAVEL:** trace to some silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, moist, compact to very dense	4	SS	22	Sand, Screen	22		77 17 6
		5	SS	25		25		
		6	SS	30	Natural Pack	30		
		7	SS	50 / 75 mm		>>100		
4.8	**END OF BOREHOLE**							

Notes:
1) Borehole caved at a depth of 3.7 m below ground surface (mBGS) upon completion of drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	dry

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m^3)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH102

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Split Spoon

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-04-12

REF. NO.: 16-1255

ENCL. NO.: 42

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	ELEVATION	UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL:** (250 mm)							
0.3	**FILL:** sandy silt, trace clay, trace gravel, zones of sand and silt, brown, moist to wet, very loose to loose	1	SS	3				
		2	SS	2				
		3	SS	4				
2.3	**GRAVELLY SAND TO SAND AND GRAVEL:** trace silt, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to dense	4	SS	11				
		5	SS	21				
		6	SS	29				
		7	SS	38				
5.3	**END OF BOREHOLE** Note: 1) Borehole caved at a depth of 2.8 m below ground surface (mBGS) upon completion of drilling.							

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)

SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)

Plastic Limit W_P — Natural Moisture Content W — Liquid Limit W_L

WATER CONTENT (%) (10, 20, 30, 40)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH103

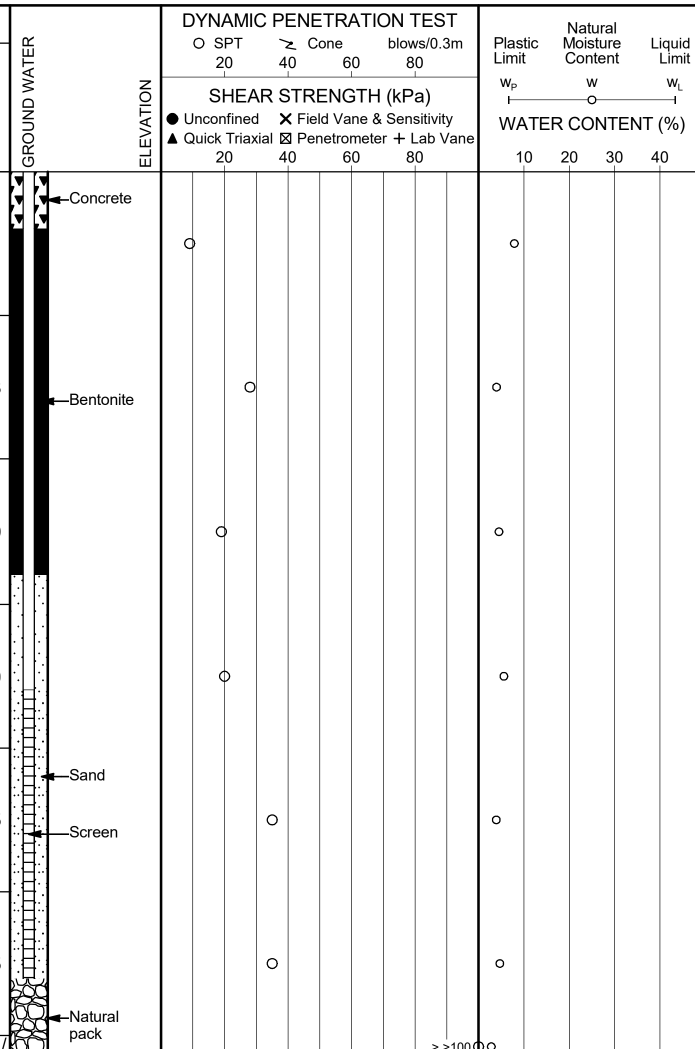
PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Split Spoon
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL

DIAMETER: 155 mm
DATE: 2017-11-28
REF. NO.: 16-1255
ENCL. NO.: 43

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**TOPSOIL:** (300 mm)			
0.3	**FILL:** sandy silt, trace gravel, trace organics, trace rootlets, dark brown, moist, loose	1	SS	9
0.8	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, layers of sand, containing rock fragments, containing cobbles and boulders, brown, moist, compact to very dense	2	SS	28
		3	SS	19
		4	SS	20
		5	SS	35
		6	SS	35
		7	SS	50 / 115 mm
4.7	**END OF BOREHOLE**			



Notes:
1) Borehole caved at a depth of 4.3 m below ground surface (mBGS) upon completion of drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	dry

Other columns on the log form: ELEVATION; UNIT WT (kN/m³); REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +³, ×³: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH104

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-20
REF. NO.: 16-1255
ENCL. NO.: 44

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	WATER CONTENT	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**ASPHALT CONCRETE:** (60 mm)							
0.1	**GRANULAR BASE/SUBBASE:** (490 mm)	1A	AS		Concrete		○	
0.6	**FILL:** silty sand to sand and silt, trace clay, trace gravel, brown, moist, compact	1B	AS				○	
		2	SS	16		○	○	
1.4	**FILL:** gravelly sand, some silt, trace clay, brown, moist, loose	3	SS	7	Bentonite	○	○	31 42 22 5
2.1	**FILL:** sandy silt, trace to some clay, trace gravel, trace organics, layers of organic silt, brown, wet, loose	4	SS	5	2.7mBGS Dec 21	○	○	
2.9	**ORGANIC SILT:** some sand, trace clay, trace gravel, seams of silty sand, black, moist, loose	5	SS	7	Sand	○	○	
4.0	**SAND:** trace silt, trace gravel, brown, wet, dense	6	SS	31	Screen	○	○	
5.0	**END OF BOREHOLE**				Natural Pack			

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 21, 2017	2.73

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m 20 40 60 80
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane 20 40 60 80
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) 10 20 30 40
UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE BH107

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-11-20
REF. NO.: 16-1255
ENCL. NO.: 45

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	Water Content (%)
0.0	**ASPHALT CONCRETE:** (110 mm)				Concrete		
0.1	**GRANULAR BASE/SUBBASE:** (520 mm)	1A	AS				o
0.6	**FILL:** silty sand, trace clay, trace gravel, layers/zones of sand, containing cobbles, brown, moist, loose	1B	AS				o
		2	SS	9		o	o
		3	SS	7		o	o
2.1	**NO RECOVERY:** likely silty sand	4	AS		Bentonite		o
2.9	**SILTY SAND:** some gravel, trace clay, containing cobbles and boulders, brown, moist, compact	5	SS	26		o	o
4.0	**SAND AND GRAVEL:** containing rock fragments, containing cobbles and boulders, brown, moist, compact --- auger grinding	6	SS	29	5.1mBGS Dec 21; Screen	o	o
5.6	**GRAVELLY SAND:** trace silt, containing cobbles and boulders, grey, saturated, dense	7	SS	33	Natural Pack	o	o
6.6	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 21, 2017	5.07

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE SPS01BE

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-08

REF. NO.: 16-1255

ENCL. NO.: 46

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	DYNAMIC PENETRATION TEST (SPT, blows/0.3m)	WATER CONTENT (%)
0.0	**TOPSOIL:** (240 mm)				Concrete		
0.2	**FILL:** sandy silt, some gravel, trace to some clay, trace organics, trace rootlets, containing cobbles, brown, moist, loose to dense	1	SS	7			
		2	SS	34	1.0mBGS Dec 05		
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace clay, containing cobbles and boulders, brown, wet, compact to very dense				Bentonite		
		3	SS	43			
		4	SS	64	Sand		
		5	SS	24	Screen		
4.0	**SANDY SILT TILL:** trace to some clay, trace gravel, containing cobbles and boulders, grey, moist, dense to very dense	6	SS	38			
		7	SS	50 / 100 mm	Natural pack	> >100	
		8	SS	50 / 125 mm		> >100	
7.8	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 6.7 mBGS upon completion of drilling.
3) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	1.02

Other column headings: STRATA PLOT; ELEVATION; SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane; Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity. ▲ ε=3% Strain at Failure

LOG OF BOREHOLE SPS01H

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer; DIAMETER: 155 mm
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL; DATE: 2017-11-03
DATUM: N/A	SAMPLE REVIEW: TY; REF. NO.: 16-1255
BH LOCATION: See Borehole Location Plan	CHECKED: DL; ENCL. NO.: 47

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	WATER CONTENT (%)
0.0	**TOPSOIL:** (125 mm)				Concrete		
0.1	**ORGANIC SANDY SILT:** trace clay, trace garvel, trace rootlets, dark brown, moist, very loose	1	SS	3		3	~25
0.7	**GRAVELLY SAND TO SANDY GRAVEL:** trace to some clay, trace to some silt, containing cobbles and boulders, brown, moist to wet, loose to very dense	2	SS	17		17	~5
		3	SS	12	Bentonite	12	~9
		4	SS	6		6	~13
	--- wet	5	SS	23	3.2mBGS Dec 05	23	~14
	--- auger grinding						
		6	SS	51	Sand	51	~7
	--- auger grinding	7	SS	50 / 125 mm	Screen		~10
	--- auger grinding	8	SS	76	Natural Pack	76	~7
8.1	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 3.0 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.7 mBGS upon completion of drilling.
3) Borehole caved at a depth of 2.7 below ground surface upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	3.19

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20, 40, 60, 80). SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80). Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L. WATER CONTENT (%) (10, 20, 30, 40). UNIT WT (kN/m^3). REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE SPS02E

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-03

REF. NO.: 16-1255

ENCL. NO.: 48

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT	WATER CONTENT
0.0	**TOPSOIL:** (75 mm)				Concrete		
0.1	**FILL:** sandy silt, trace clay, trace gravel, trace organics, trace rootlets, dark brown, moist, loose	1	SS	6			
0.7	**FILL:** sandy silt, trace clay, trace gravel, containing red bricks, brown, moist, very loose	2	SS	2			
		3	SS	3			
2.1	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, containing cobbles and boulders, brown, moist, compact	4	SS	14	Bentonite		
		5	SS	29	3.7mBGS Dec 05		
4.0	**SAND:** trace to some gravel, trace silt, containing cobbles and boulders, dark brown, wet, compact to very dense	6	SS	14	Sand; Screen		
		7A	SS	72 / 205 mm		> >100	
6.4	**GRAVELLY SAND TO SAND AND GRAVEL:** trace silt, brown, wet, very dense	7B	SS		Natural pack		
		8	SS	50 / 50 mm		> >100	
7.7	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.4 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.4 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	3.69

DYNAMIC PENETRATION TEST: O SPT, Cone, blows/0.3m (20 40 60 80). SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20 40 60 80). Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10 20 30 40). UNIT WT (kN/m^3). REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity. ▲ ε=3% Strain at Failure

LOG OF BOREHOLE SPS03E

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: GH
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-10-30
REF. NO.: 16-1255
ENCL. NO.: 49

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0 / 0.1	**ASPHALT CONCRETE:** (70 mm)				Concrete	
	GRANULAR BASE/SUBBASE: (430 mm)	1A	AS			
0.5	**FILL:** silty sand, some gravel, trace clay, containing cobbles, brown, moist, compact --- auger grinding	1B	AS			
		2	SS	17		
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist to wet, compact to very dense	3	SS	62	Bentonite	46 46 8
					2.3mBGS Dec 11	
		4	SS	50		
	--- wet	5	SS	44		
					Sand; Screen	
		6A	SS	11		
4.9	**SAND AND SILT TILL:** some gravel, trace clay, containing cobbles and boulders, brown, moist, compact to very dense	6B	SS			
		7	SS	50 / 75 mm	Natural pack	
		8	SS	50 / 75 mm		
7.9	**END OF BOREHOLE**					

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80). SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80). Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40. UNIT WT (kN/m^3). SPT values for samples 7 and 8 plotted as > >100.

Notes:
1) Water encountered at a depth of 2.7 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 11, 2017	2.25

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity. ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE SPS04E

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-03
REF. NO.: 16-1255
ENCL. NO.: 50

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	Water Content (%)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
0.0 / 0.1	**TOPSOIL:** (90 mm) / **FILL:** sandy silt, trace to some clay, trace gravel, some organics, brown, moist, loose	1	SS	6	Concrete			
		2A	SS					
0.9	**ORGANIC SANDY SILT:** trace clay, dark brown, moist, loose	2B	SS	6				
1.1	**SANDY SILT:** trace to some clay, some organics, brown, moist, loose	2C	SS					
1.4	**GRAVELLY SAND:** some silt, brown, wet, compact	3	SS	11	1.9mBGS Dec 05; Bentonite			
2.1	**FINE SAND:** trace silt, trace gravel, brown, saturated, loose	4	SS	4				
		5	SS	5				
4.0	**SAND:** trace to some silt, trace gravel, brown, saturated, compact	6	SS	21	Sand; Screen			
5.6	**SILT:** trace clay, layers of clay silt, containing cobbles and boulders, brown, moist, very dense	7	SS	53	Natural Pack			
7.2	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist, very dense	8	SS	71				
8.1	**END OF BOREHOLE:**							

Notes:
1) Water encountered at a depth of 1.5 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.9 mBGS upon completion of drilling.
3) Borehole caved at a depth of 4.9 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	1.85

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m³)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE SPS06E

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-11-21
REF. NO.: 16-1255
ENCL. NO.: 51

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	SPT (blows/0.3m)	Water Content (%)
0.0	**TOPSOIL:** (150 mm)				Concrete		
0.2	**FILL:** sandy silt, trace clay, trace gravel, trace organics, trace rootlets, containing rock fragments, brown, moist, compact	1	SS	14	0.4mBGS Dec 21		
0.7	**PROBABLE FILL:** gravelly sand, some silt, trace gravel, brown, wet to saturated, compact to dense	2	SS	20			
	--- saturated	3	SS	31	Bentonite		
2.5	**SAND:** trace to some gravel, trace silt, brown, wet, very loose to compact	5	SS	13			
		6	SS	2	Sand; Screen		
5.6	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, wet, very dense	7	SS	50 / 90 mm	Natural Pack	>100	
		8	SS	50 / 100 mm		>100	
7.7	**END OF BOREHOLE**						

Notes:
1) Water encountered at a depth of 0.8 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 21, 2017	0.35

Column headings: SOIL PROFILE; SAMPLES; STRATA PLOT; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE SPS08E

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-12-15
REF. NO.: 16-1255
ENCL. NO.: 52

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**ASPHALT CONCRETE:** (110 mm)				Concrete
0.1	**GRANULAR BASE/SUBBASE:** (510 mm)	1A	AS		
0.5	**FILL:** silty sand to sand and silt, some gravel, trace clay, trace rootlets, pockets of silt, containing cobbles, brown, moist to wet, loose to compact	1B	AS		
		2	SS	10	
		3	SS	6	2.1mBGS Dec 21
		4	SS	7	Bentonite
	--- wet	5	SS	5	
4.0	**GRAVELLY SAND TO SAND AND GRAVEL:** trace to some silt, containing rock fragments, containing cobbles and boulders, brown, wet, compact to dense	6	SS	25	
	--- auger grinding	7	SS	48	Sand; Screen
		8	SS	43	Natural pack
8.1	**END OF BOREHOLE**				

Notes:
1) Water encountered at a depth of 3.5 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 21, 2017	2.10

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20 40 60 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20 40 60 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10 20 30 40)
UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE T1

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing	**DRILLING DATA**		
CLIENT: Ainley Group	METHOD: Continuous Flight Auger - Auto Hammer	DIAMETER: 155 mm	
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario	FIELD ENGINEER: KL	DATE: 2017-11-07	
DATUM: N/A	SAMPLE REVIEW: TY	REF. NO.: 16-1255	
BH LOCATION: See Borehole Location Plan	CHECKED: DL	ENCL. NO.: 53	

ELEV / DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	REMARKS
0.0	**GRAVEL SURFACE:** (90 mm)				
0.1	**FILL:** sandy silt, trace to some clay, trace gravel, trace organics, layers of clayey silt, brown, moist to wet, very loose to compact	1	SS	10	
		2	SS	4	
1.4	**FILL:** sand and silt to silty sand, trace clay, trace gravel, pockets of clayey silt, brown, moist, very loose to compact	3	SS	5	
		4	SS	3	
		5A	SS	26	
3.2	**GRAVELLY SAND TO SAND AND GRAVEL:** trace clay, trace silt, containing cobbles and boulders, brown, moist to wet, compact to dense	5B	SS		
	--- wet	6	SS	46	
5.0	**END OF THE BOREHOLE**				

Notes:
1) Water encountered at a depth of 4.6 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 3.5 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.5 mBGS upon completion of drilling.

DYNAMIC PENETRATION TEST: SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): Unconfined, Quick Triaxial, Field Vane & Sensitivity, Penetrometer, Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L — WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m^3)
REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE T2

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-11-17
REF. NO.: 16-1255
ENCL. NO.: 54

SOIL PROFILE

ELEV DEPTH (m)	DESCRIPTION
0.0	**GRAVEL SURFACE:** (170 mm)
0.2	**FILL:** silty sand, some gravel, trace to some clay, containing rock fragments, containing cobbles, brown, moist to wet, loose to compact
1.4	**GRAVELLY SAND TO SAND AND GRAVEL:** some silt, trace clay, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to dense --- wet
5.0	**END OF BOREHOLE**

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3m
1	SS	11
2	SS	9
3	SS	24
4	SS	27
5	SS	34
6	SS	31

GROUND WATER: Concrete; 1.2mBGS Dec 05; Bentonite; Sand; Screen; Natural Pack

Column headings: ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 5, 2017	1.18

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE T3

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-17
REF. NO.: 16-1255
ENCL. NO.: 55

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**GRAVEL SURFACE:** (20 mm)				Concrete	
	FILL: sand and silt to silty sand, trace clay, trace gravel, trace organics, trace rootlets, brown, moist to wet, very loose to loose --- cobbles	1	SS	5		
		2	SS	2	Bentonite	
	--- wet	3	SS	5		
2.1	**SILTY FINE SAND TO FINE SAND AND SILT:** trace clay, trace gravel, brown, saturated, loose to compact				2.2mBGS Dec 21	
		4	SS	9		0 29 68 3
		5	SS	8	Sand, Screen	
		6	SS	11	Natural Pack	
5.0	**END OF BOREHOLE:**					

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 21, 2017	2.15

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m^3)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE T4

GeoPro

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-16
REF. NO.: 16-1255
ENCL. NO.: 56

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**GRAVEL SURFACE:** (65 mm)			
0.1	**FILL:** silty sand, trace gravel, brown, moist, loose	1A	SS	7
0.3	**FILL:** gravelly sand, some silt, trace organics, dark brown, moist, loose	1B	SS	
0.7	**GRAVELLY SAND TO SAND AND GRAVEL:** trace silt, layers/zones of sand, containing rock fragments, containing cobbles and boulders, brown, moist to wet, compact to very dense	2	SS	39
		3	SS	27
		4	SS	27
		5	SS	24
		6	SS	59
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) Borehole caved at a depth of 1.4 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; STRATA PLOT; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (SPT, Cone, blows/0.3m, 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane; 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

01 - GEOPRO SOIL LOG GEOPRO 16-1255 BH LOG PROJECT DATA 20180101- RL -8.GPJ 2018-01-04 11:04

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

GeoPro

LOG OF BOREHOLE T5

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-11-16
REF. NO.: 16-1255
ENCL. NO.: 57

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**GRAVEL SURFACE:** (70 mm)				Concrete	
0.1	**FILL:** silty sand, some gravel, trace clay, brown, moist, loose	1	SS	8		
0.7	**FILL:** sandy silt, trace to some clay, trace gravel, trace organics, trace rootlets, pockets of clayey silt, dark brown to brown, moist, very loose to loose	2	SS	3	Bentonite	
	--- brown	3	SS	7		
2.1	**SILT:** trace clay, layers/zones of sand and silt, brown, wet, compact	4	SS	16	2.6mBGS Dec 21	0 9 88 3
		5	SS	19	Sand; Screen	
4.0	**GRAVELLY SAND:** some silt, trace clay, containing cobbles and boulders, brown, wet, dense	6	SS	31	Natural Pack	
5.0	**END OF BOREHOLE**					

DYNAMIC PENETRATION TEST: ○ SPT, Cone, blows/0.3m (20, 40, 60, 80)
SHEAR STRENGTH (kPa): ● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane (20, 40, 60, 80)
Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L
WATER CONTENT (%) (10, 20, 30, 40)
UNIT WT (kN/m³)

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

Date	W.L. Depth
Dec. 21, 2017	2.64

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE T6

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 155 mm
DATE: 2017-11-07
REF. NO.: 16-1255
ENCL. NO.: 58

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m, plotted)	Natural Moisture Content (%, plotted)
0.0	**GRAVEL SURFACE:** (75 mm)					
0.1	**FILL:** silty sand, trace to some gravel, trace clay, grey to brown, moist, loose --- brown	1	SS	6	~6	~7
0.7	**FILL:** sandy silt, trace clay, trace gravel, brown, moist, loose	2	SS	7	~7	~13
1.4	**FILL:** silty sand, trace to some gravel, trace clay, brown, moist, loose	3	SS	9	~9	~7
2.1	**FILL:** sandy silt, trace to some clay, trace to some gravel, some organics, dark brown, moist to wet, very loose to loose --- wet	4	SS	2	~2	~18
		5A	SS	7	~7	~15
3.4	**ORGANIC SILT:** trace clay, trace rootlets, black, moist, loose	5B	SS			~29
4.0	**SAND:** trace silt, brown, wet, compact	6A	SS	27		~17
4.7	**GRAVELLY SAND:** trace clay, trace silt, containing cobbles and boulders, brown, wet, compact	6B	SS		~27	~10
5.0	**END OF BOREHOLE**					

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 2.7 mBGS upon completion of drilling.
3) Borehole caved at a depth of 3.4 mBGS upon completion of drilling.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE T7

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-08

REF. NO.: 16-1255

ENCL. NO.: 59

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m
0.0	**GRAVEL SURFACE:** (150 mm)			
0.2	**FILL:** silty sand, trace to some gravel, trace clay, brown, moist, loose to dense	1	SS	9
		2A	SS	46
1.1	**FILL:** sandy silt, trace to some gravel, trace clay, trace organics, trace rootlets, containing cobbles, brown, moist, very loose to dense	2B	SS	
		3A	SS	3
1.7	**PEAT:** black, moist, very loose to compact	3B	SS	
		4A	SS	13
2.4	**SAND:** trace silt, trace gravel, brown, wet, loose to compact	4B	SS	
		5	SS	10
4.0	**GRAVELLY SAND:** some clay, some silt, layers/zones of clayey silt, grey, wet, dense	6	SS	34
5.0	**END OF BOREHOLE**			

Notes:
1) Water encountered at a depth of 0.8 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 1.2 mBGS upon completion of drilling.
3) Borehole caved at a depth of 1.2 mBGS upon completion of drilling.

Chart columns: STRATA PLOT; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

LOG OF BOREHOLE T8

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing
CLIENT: Ainley Group
PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario
DATUM: N/A
BH LOCATION: See Borehole Location Plan

DRILLING DATA
METHOD: Continuous Flight Auger - Auto Hammer
FIELD ENGINEER: KL
SAMPLE REVIEW: TY
CHECKED: DL
DIAMETER: 205 mm
DATE: 2017-11-17
REF. NO.: 16-1255
ENCL. NO.: 60

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" BLOWS/0.3m	SPT (blows/0.3m)	Natural Moisture Content (%)
0.0 / 0.1	**GRAVEL SURFACE:** (50 mm)					
	FILL: silty sand to sand and silt, trace clay, trace gravel, layers/zones of sand, brown, moist to wet, loose	1	SS	6	○	○
		2	SS	2	○	○
		3	SS	3	○	○
		4	SS	3	○	○
		5A	SS	5	○	○
3.2	**SILTY SAND:** trace to some clay, trace gravel, containing cobbles and boulders, brown, wet to saturated, very loose to loose	5B	SS			○
	--- saturated	6	SS	2	○	○
5.6	**SANDY SILT TILL:** some clay, trace gravel, layer s of clayey silt, containing cobbles and boulders, brown, moist, compact	7	SS	26	○	○
6.6	**END OF BOREHOLE:**					

Notes:
1) Water encountered at a depth of 2.3 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.6 mBGS upon completion of drilling.
3) Borehole caved at a depth of 5.2 mBGS upon completion of drilling.

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER; ELEVATION; DYNAMIC PENETRATION TEST (○ SPT, Cone, blows/0.3m: 20 40 60 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20 40 60 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) 10 20 30 40; UNIT WT (kN/m³); REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

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LOG OF BOREHOLE T9

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

CLIENT: Ainley Group

PROJECT LOCATION: Town of Erin and Hillsburgh, Ontario

DATUM: N/A

BH LOCATION: See Borehole Location Plan

DRILLING DATA

METHOD: Continuous Flight Auger - Auto Hammer

FIELD ENGINEER: KL

SAMPLE REVIEW: TY

CHECKED: DL

DIAMETER: 155 mm

DATE: 2017-11-07

REF. NO.: 16-1255

ENCL. NO.: 61

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3m	GROUND WATER
0.0	**GRAVEL SURFACE:** (100 mm)				Concrete
0.1	**FILL:** silty sand, trace to some clay, trace to some gravel, trace organics, dark brown, moist to wet, very loose to compact	1	SS	11	
		2	SS	7	
		3	SS	3	Bentonite
2.1	**ORGANIC SILT:** trace clay, trace gravel, trace rootlets, black, moist, loose	4	SS	6	
2.9	**FINE SAND AND SILT:** trace clay, brown, moist to wet, loose	5	SS	7	Sand; Screen; 3.8mBGS Dec 05
4.0	**SAND:** trace silt, brown, wet, compact	6	SS	19	Natural Pack
5.0	**END OF BOREHOLE**				

Column headings also printed: STRATA PLOT; ELEVATION; DYNAMIC PENETRATION TEST (O SPT, Cone, blows/0.3m: 20, 40, 60, 80); SHEAR STRENGTH (kPa) (● Unconfined, ✕ Field Vane & Sensitivity, ▲ Quick Triaxial, ⊠ Penetrometer, + Lab Vane: 20, 40, 60, 80); Plastic Limit w_P, Natural Moisture Content w, Liquid Limit w_L; WATER CONTENT (%) (10, 20, 30, 40); UNIT WT (kN/m^3); REMARKS AND GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL).

Notes:
1) Water encountered at a depth of 3.1 m below ground surface (mBGS) during drilling.
2) Water was at a depth of 4.1 mBGS upon completion of drilling.
3) Borehole caved at a depth of 4.1 mBGS upon completion of drilling.
4) 51 mm dia. monitoring well was installed in borehole upon completion of drilling.

Water Level Reading (mBGS)

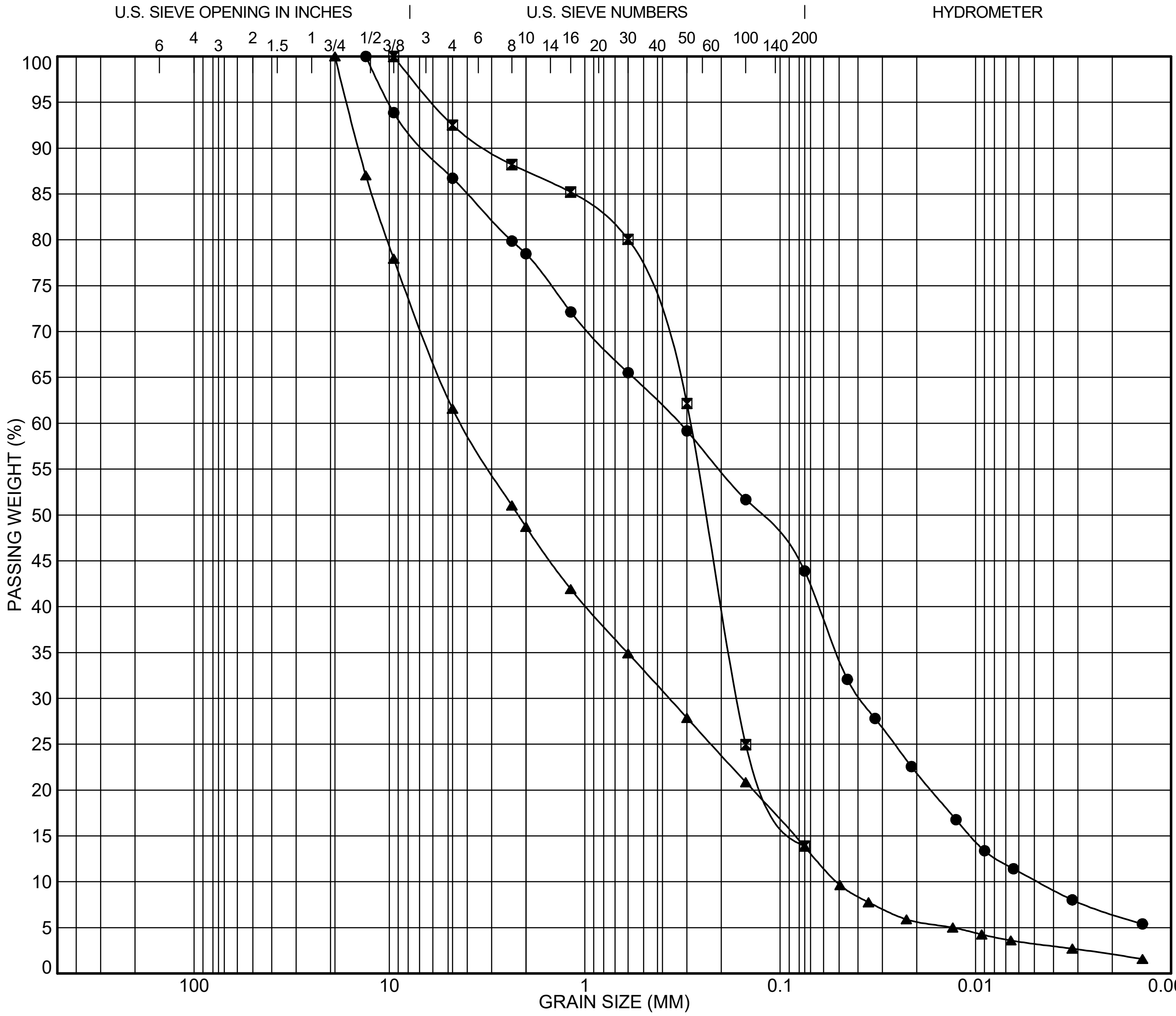
Date	W.L. Depth
Dec. 5, 2017	3.79

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ▲ ε=3% Strain at Failure

FIGURES



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
● BH1	SS3	1.52					0.95	68.48
⊠ BH23	SS3	1.52						
▲ BH25	SS2	0.76					0.62	83.40

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BH1	SS3	1.52	13.2	0.329	0.039	0.005	13.3	42.8	37.4	6.5
⊠ BH23	SS3	1.52	9.5	0.288	0.165		7.5	78.6	13.9	
▲ BH25	SS2	0.76	19	4.277	0.37	0.051	38.4	47.8	11.8	2.1

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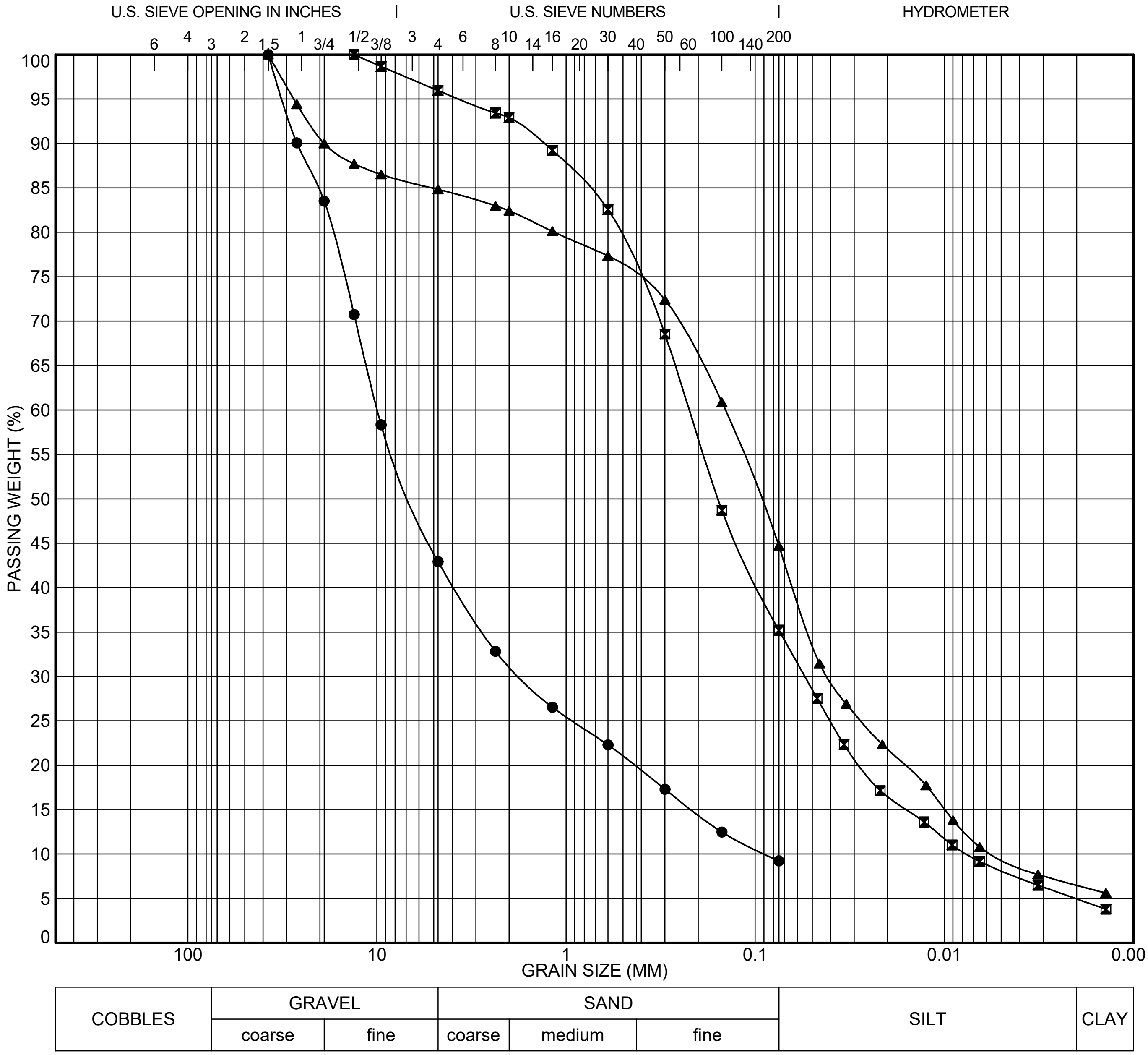
GRAIN SIZE DISTRIBUTION

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

LOCATION: Town of Erin, Ontario

PROJECT NO.: 16-1255	SAMPLED ON: 2017-11-01
FIGURE NO.: 1	TESTED ON: 2017-11-30



Specimen Identification				Classification	LL	PL	PI	Cc	Cu
●	BH28	SS5	3.05					3.41	112.30
⌛	BH31	SS5	3.05					1.77	29.43
▲	BH36	SS2	0.76					2.16	26.62

Specimen Identification				D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH28	SS5	3.05	37.5	9.93	1.73	0.088	57.1	33.7	9.2	
⌛	BH31	SS5	3.05	13.2	0.223	0.055	0.008	4.0	60.8	30.2	5.0
▲	BH36	SS2	0.76	37.5	0.145	0.041	0.005	15.2	40.1	38.2	6.5

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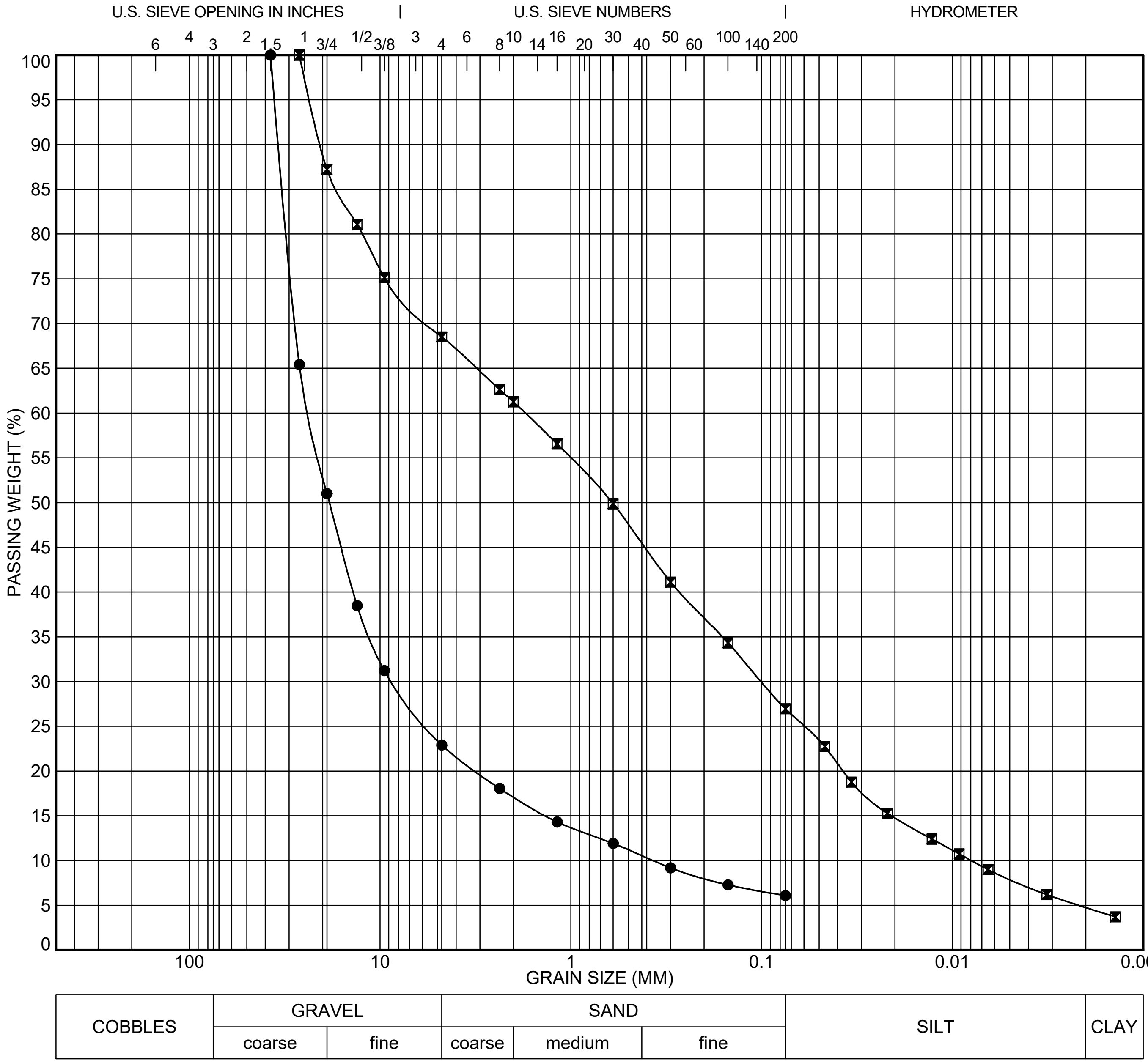
GRAIN SIZE DISTRIBUTION

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

LOCATION: Town of Erin, Ontario

PROJECT NO.: 16-1255	SAMPLED ON: 2017-11-02
FIGURE NO.: 2	TESTED ON: 2017-11-30



Specimen Identification				Classification	LL	PL	PI	Cc	Cu
●	BH101	SS4	2.29					8.52	63.31
⊠	BH104	SS3	1.52					0.72	218.55

Specimen Identification				D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH101	SS4	2.29	37.5	23.383	8.578	0.369	77.1	16.8	6.1	
⊠	BH104	SS3	1.52	26.5	1.737	0.1	0.008	31.5	41.5	22.2	4.8

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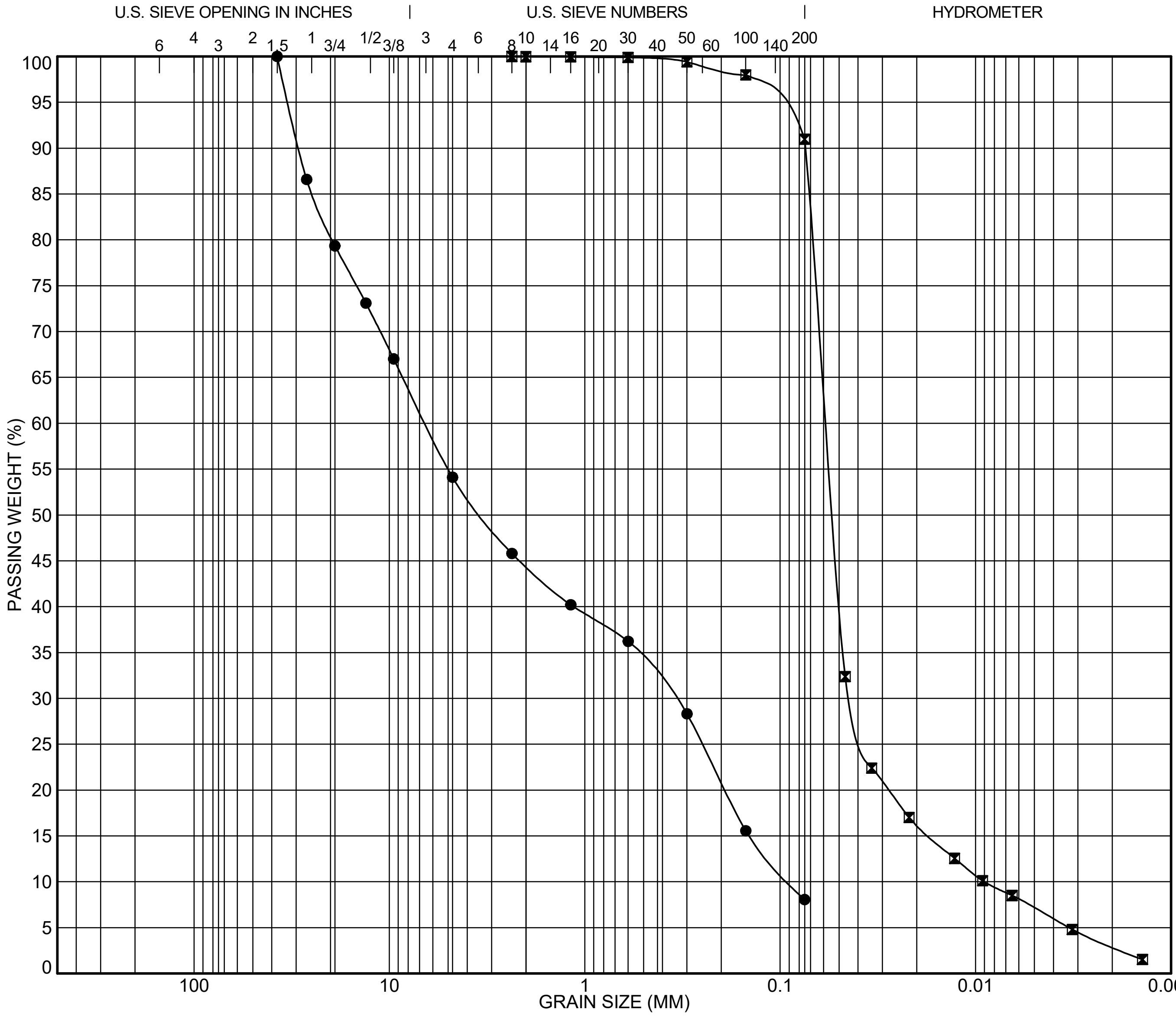
GRAIN SIZE DISTRIBUTION

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

LOCATION: Town of Erin, Ontario

PROJECT NO.: 16-1255	SAMPLED ON: 2017-11-20
FIGURE NO.: 3	TESTED ON: 2017-11-30



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**SPS03E**	**SS3**	**1.52**					**0.21**	**72.65**
⊠	**T5**	**SS4**	**2.29**					**3.56**	**6.48**

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**SPS03E**	**SS3**	**1.52**	**37.5**	**6.518**	**0.348**	**0.09**	**45.9**	**46.0**	**8.1**	
⊠	**T5**	**SS4**	**2.29**	**2.36**	**0.058**	**0.043**	**0.009**	**0.0**	**9.0**	**88.0**	**2.9**

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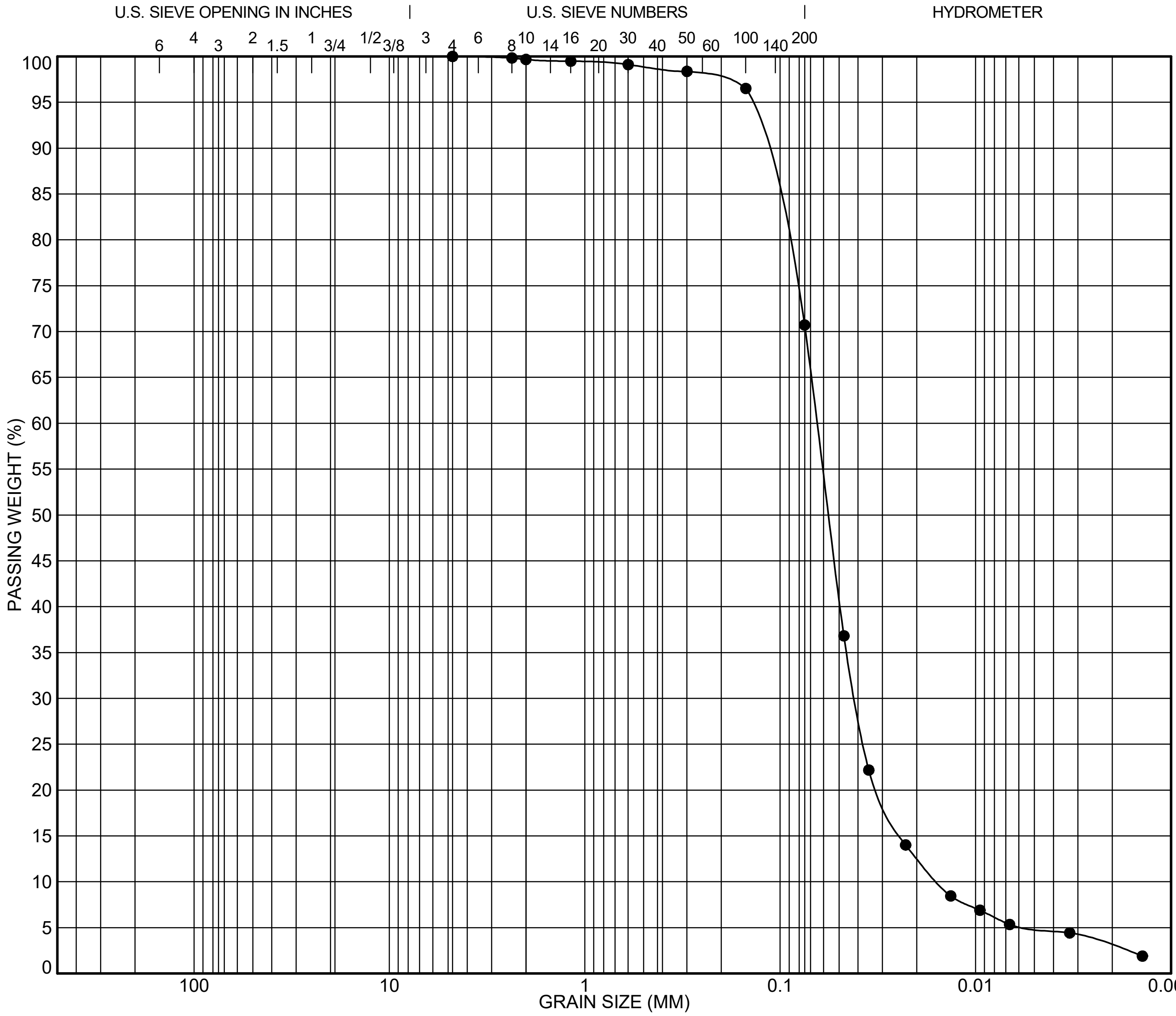
Unit 57, 40 Vogell Road, Richmond Hill, Ontario L4B 3N6
Tel: 905-237-8336 Fax: 905-248-3699
office@geoproconsulting.ca www.geoproconsulting.ca

GRAIN SIZE DISTRIBUTION

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

LOCATION: Town of Erin, Ontario

PROJECT NO.: 16-1255	SAMPLED ON: 2017-11-16
FIGURE NO.: 4	TESTED ON: 2017-11-30



COBBLES	GRAVEL		SAND			SILT	CLAY
	coarse	fine	coarse	medium	fine		

	Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**T3**	**SS4**	**2.29**					**1.68**	**4.17**

	Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T3**	**SS4**	**2.29**	**4.75**	**0.065**	**0.041**	**0.016**	**0.0**	**29.3**	**67.8**	**2.9**

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GRAIN SIZE DISTRIBUTION

PROJECT: Preliminary Geotechnical Investigation for Urban Centre Wastewater Servicing

LOCATION: Town of Erin, Ontario

PROJECT NO.: 16-1255	SAMPLED ON: 2017-11-17
FIGURE NO.: 5	TESTED ON: 2017-12-15

APPENDIX A

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T282046

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 15, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
ATTENTION TO: Bujing Guan
SAMPLING SITE:Erin
SAMPLED BY:Kirby

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-11-07
DATE REPORTED: 2017-11-15

		SAMPLE DESCRIPTION:		SPS03E SS2	BH 5 SS3	BH 14 SS2	BH 31 SS2	BH 32 SS3
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2017-10-31	2017-10-31	2017-10-31	2017-11-02	2017-11-02
Parameter	Unit	G / S	RDL	8892198	8892214	8892216	8892218	8892220
Sodium Adsorption Ratio	NA	2.4	NA	1.01	0.764	1.66	1.27	1.42

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8892198-8892220 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:Erin

AGAT WORK ORDER: 17T282046
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Soil Analysis

RPT Date: Nov 15, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8892198	8892198	1.01	1.04	2.9%	NA	NA			NA			NA		

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T282046
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:Erin
SAMPLED BY:Kirby

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

SR6

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905 712 5100 Fax: 905 712 5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 17T282046

Cooler Quantity:
Arrival Temperatures: 3.0 2.9 1.9 / 2.9 2.6 2.7
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Report Information:

Company: GeoPro Consulting
Contact: Bojing Guan, Tim Yu
Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements:

☐ No Regulatory Requirement

(Please check all applicable boxes)

☑ Regulation 153/04
Table: (Indicate One)
☐ Ind/Com
☑ Res/Park
☐ Agriculture
Soil Texture (Check One)
☑ Coarse
☐ Fine

☐ Sewer Use
☐ Sanitary
☐ Storm
Region:
☐ MISA

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis ☑ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255
Site Location: Etla
Sampled By: Kirby
AGAT Quote #: PO:

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company: As above
Contact:
Address:
Email:

Sample Matrix Legend

- B Biota
- GW Ground Water
- O Oil
- P Paint
- S Soil
- SD Sediment
- SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153 analysis
SPS05E SS2	Oct 3, 2017	P.m.	1	Soil	—		✓
BH 4 SS3	Oct 11, 2017	P.m.	1	↑	—		✓
BH 14 SS2	Oct 31, 2017	P.m.	1		—		✓
BH 31 SS2	Nov 2, 2017	P.m.	1	↓	—		✓
BH 32 SS3	Nov 2, 2017	P.m.	1	Soil	—		✓

Analysis columns: Metals and Inorganics; ☐ Hydride Forming Metals; ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr6+ ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR; Full Metals Scan; Regulation/Custom Metals; Nutrients: ☐ TP ☐ NH3 ☐ TKN ☐ NO3 ☐ NO2 ☐ NO3+NO2; Volatiles: ☐ VOC ☐ BTEX ☐ THM; PHCs F1 - F4; ABNs; PAHs; PCBs: ☐ Total ☐ Aroclors; Organochlorine Pesticides; TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs; Sewer Use

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Nov. 6, 2017 — Time:

Samples Received By (Print Name and Sign): Craig [signature] — Date: 11/06/17 — Time: 1145

Samples Relinquished By (Print Name and Sign): Craig [signature] — Date: 11/07/17 — Time: 340

Samples Received By (Print Name and Sign): — Date: — Time:

Page 1 of 1

No: T 059109

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME:	GEOPRO CONSULTING LTD UNIT 57, 40 VOGELL ROAD RICHMOND HILL, ON L4B3N6 (905) 237-8336
ATTENTION TO:	Bujing Guan
PROJECT:	16-1255
AGAT WORK ORDER:	17T283347
SOIL ANALYSIS REVIEWED BY:	Amanjot Bhela, Inorganic Coordinator
DATE REPORTED:	Nov 20, 2017
PAGES (INCLUDING COVER):	5
VERSION*:	1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 17T283347
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-11-10
DATE REPORTED: 2017-11-20

			SAMPLE DESCRIPTION:	SPS01H SS2	SPS02E SS2	SPS04E SS3	T1 SS3A	T6 SS2
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-11-03	2017-11-03	2017-11-03	2017-11-07	2017-11-07
Parameter	Unit	G / S	RDL	8903812	8903819	8903820	8903821	8903822
Sodium Adsorption Ratio	NA	2.4	NA	0.213	0.939	0.354	1.60	0.094

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8903812-8903822 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T283347
ATTENTION TO: Bujing Guan
SAMPLED BY:

Soil Analysis

RPT Date: Nov 20, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8902126		0.078	0.094	18.6%	NA	NA			NA			NA		

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD

AGAT WORK ORDER: 17T283347

PROJECT: 16-1255

ATTENTION TO: Bujing Guan

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

SRZ 1 Bag

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905 712 5100 Fax: 905 712 5122
webearth.agatlabs.com

Laboratory Use Only

Work Order #: 17T283347

Cooler Quantity:

Arrival Temperatures: 3.2 | 3.0 | 2.9 / 3.0 | 3.4 | 2.6

Custody Seal Intact: ☐Yes ☐No ☐N/A

Notes:

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: GeoPro Consulting

Contact: Baijing Guan Tim Yu

Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON

Phone: 905-237-8336 Fax:

Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☑ Regulation 153/04 — Table 1 — ☐Ind/Com ☑Res/Park ☐Agriculture; Soil Texture (Check One) ☑Coarse ☐Fine

☐ Sewer Use — ☐Sanitary ☐Storm; Region

☐ Regulation 558; ☐ CCME; ☐ Prov. Water Quality Objectives (PWQO); ☐ Other

☐ MISA

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis ☑ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255

Site Location: Erin

Sampled By: Koby

AGAT Quote #: PO:

Invoice Information: Bill To Same: Yes ☑ No ☐

Company: As above

Contact:

Address:

Email:

Sample Matrix Legend

- B Biota
- GW Ground Water
- O Oil
- P Paint
- S Soil
- SD Sediment
- SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	Metals - 153 Metals (excl. Hydrides) / Hydride Metals	ORPs	PHCs F1-F4 / BTEX	Full Metals Scan	Regulation/Custom Metals	Nutrients	Volatiles	PHCs F1-F4	ABNs	PAHs	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use
SPJ01E SS2	Nov 3, 2017	pm	1	Soil	—					✓											
SPJ02E SS2	Nov 3, 2017	pm	1	Soil	—					✓											
SPJ04E SS3	Nov 3, 2017	pm	1	Soil	—					✓											
T1 SS2A	Nov 7, 2017	Am	1	Soil	—					✓											
T6 SS2	Nov 7, 2017	pm	1	Soil	—					✓											

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Nov 10, 2017

Samples Received By (Print Name and Sign): [signature] — Date: 11/10/17 Time: 1:10

Samples Relinquished By (Print Name and Sign): [signature] — Date: 11/10/17 Time: 4:55

Page 1 of 1

Nº: T 059121

Pink Copy - Client Yellow Copy - AGAT White Copy - AGAT

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T284728

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 27, 2017

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 17T284728
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-11-15
DATE REPORTED: 2017-11-27

			SAMPLE DESCRIPTION:	BH9 SS2	BH10 SS2	BH15 SS2	SPS01bE SS3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-11-09	2017-11-08	2017-11-09	2017-11-08
Parameter	Unit	G / S	RDL	8911566	8911567	8911568	8911569
Sodium Adsorption Ratio	NA	2.4	NA	2.69	5.68	2.20	0.827

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8911566-8911569 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract obtained from 2:1 leaching procedure (2 parts extraction fluid:1 part wet soil).

Certified By: Amanjot Bhela

Guideline Violation

AGAT WORK ORDER: 17T284728

PROJECT: 16-1255

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD

ATTENTION TO: Bujing Guan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8911566	BH9 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	2.69
8911567	BH10 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	5.68

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T284728
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

Soil Analysis

RPT Date: Nov 27, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8911559		6.72	6.65	1.0%	NA	NA			NA			NA		

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD | AGAT WORK ORDER: 17T284728

PROJECT: 16-1255 | ATTENTION TO: Bujing Guan

SAMPLING SITE: | SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

1/2

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 17T 284718
Cooler Quantity:
Arrival Temperatures: 3.1 | 3.0 | 2.7 / 3.0 | 2.5 | 2.6
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Report Information:
Company: GeoPro Consulting
Contact: Beijing Guan, Tim Yu
Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement
(Please check all applicable boxes)
☑ Regulation 153/04 — Table 1 — ☐ Ind/Com ☑ Res/Park ☐ Agriculture — Soil Texture (Check One): ☑ Coarse ☐ Fine
☐ Sewer Use — ☐ Sanitary ☐ Storm — Region
☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other
☐ MISA

Is this submission for a Record of Site Condition? ☐ Yes ☑ No
Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Turnaround Time (TAT) Required:
Regular TAT: ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply): ☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: 16-1255
Site Location: Erin
Sampled By: Kirby
AGAT Quote #: PO:

Invoice Information: Bill To Same: Yes ☑ No ☐
Company: As above
Contact:
Address:
Email:

Sample Matrix Legend
B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	ORPs / Reg 153	Full Metals Scan	Regulation/Custom Metals	Nutrients	Volatiles	PHCs F1-F4	ABNs	PAHs	PCBs	Organochlorine Pesticides	TCLP	Sewer Use
BH 9 SS2	Nov 9, 2017	Am	1	Soil	—			✓											
BH 10 SS2	Nov 8, 2017	Am	1	Soil	—			✓											
BH 15 SS2	Nov 9, 2017	Am	1	Soil	—			✓											
Sp. Side SS3	Nov 8, 2017	Am	1	Soil	—			✓											

Samples Relinquished By (Print Name and Sign): Tim Yu [signature] Date: Nov 15, 2017 Time:
Samples Received By (Print Name and Sign): Craig [signature] Date: 11/15/17 Time: 11:05
Samples Relinquished By (Print Name and Sign): Craig [signature] Date: 11/15/17 Time: 4:35
Samples Received By (Print Name and Sign):

Page 1 of 1

Nº: T 059396

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT:

AGAT WORK ORDER: 17T286765

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 30, 2017

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 17T286765
PROJECT:

CLIENT NAME: GEOPRO CONSULTING LTD
SAMPLING SITE:

ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-11-21

DATE REPORTED: 2017-11-30

			SAMPLE DESCRIPTION:	BH 1 SS3	BH 19 SS2	BH 21 SS2	BH 26 SS2	BH 28 SS2	BH 30 SS3
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-11-14	2017-11-13	2017-11-14	2017-11-15	2017-11-15	2017-11-13
Parameter	Unit	G / S	RDL	8925311	8925312	8925313	8925314	8925315	8925317
Sodium Adsorption Ratio	NA	2.4	NA	6.18	10.5	18.8	27.4	60.1	1.09

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8925311-8925317 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Amanjot Bhela

Guideline Violation

AGAT WORK ORDER: 17T286765

PROJECT:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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CLIENT NAME: GEOPRO CONSULTING LTD

ATTENTION TO: Bujing Guan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8925311	BH 1 SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	6.18
8925312	BH 19 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	10.5
8925313	BH 21 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	18.8
8925314	BH 26 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	27.4
8925315	BH 28 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	60.1

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CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT:
SAMPLING SITE:

AGAT WORK ORDER: 17T286765
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Soil Analysis

RPT Date: Nov 30, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8925311	8925311	6.18	6.23	0.8%	NA	NA			NA			NA		

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT:
SAMPLING SITE:

AGAT WORK ORDER: 17T286765
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

5R-12

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 17T286765

Cooler Quantity: BAG

Arrival Temperatures: 4.6 4.3 4.1 / 3.6 3.3 3.1

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Report Information:

Company: GeoPro Consulting

Contact: Bujing Guan, Tim Yu

Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON

Phone: 905-237-8336 Fax:

Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☑ Regulation 153/04 — Table: 1 (Indicate One); ☐ Ind/Com; ☑ Res/Park; ☐ Agriculture

Soil Texture (Check One): ☑ Coarse; ☐ Fine

☐ Sewer Use: ☐ Sanitary; ☐ Storm; Region: ____ (Indicate One)

☐ MISA

☐ Regulation 558

☐ CCME

☐ Prov. Water Quality Objectives (PWQO)

☐ Other: ____ (Indicate One)

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT: ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply): ☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255

Site Location: Erin, ON

Sampled By: Kirby

AGAT Quote #: PO:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company: as above

Contact:

Address:

Email:

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	All Metals / 153 Metals (excl. Hydrides) / Hydride Metals	ORPs: B-HWS, Cl, CN, EC, FOC, Hg, pH, SAR (O. Reg 153)	Full Metals Scan	Regulatory/Custom Metals	Nutrients: TP, NH4, TKN, NO3, NO2, NO3+NO2	Volatiles: VOC, BTEX, THM	PHCs F1 - F4	ABNs	PAHs	PCBs: Total, Aroclors	Organochlorine Pesticides	TCLP: Metals, VOCs, ABNs, B(a)P, PCBs	Sewer Use
BH 1 SS3	Nov 14, 2017	Pm	1	Soil	—				✓											
BH 14 SS2	Nov 13, 2017	Pm	1	Soil	—				✓											
BH 21 SS2	Nov 14, 2017	Pm	1	Soil	—				✓											
BH 26 SS1	Nov 15, 2017	Pm	1	Soil	—				✓											
BH 28 SS2	Nov 15, 2017	Pm	1	Soil	—				✓											
BH 30 SS6	Nov 14, 2017	Pm	1	Soil	—				✓											

Samples Relinquished By (Print Name and Sign): Tim Yu [signature] — Date: Nov 20, 2017 — Time:

Samples Received By (Print Name and Sign): [signature] — Date: 2017/11/21 — Time: 12:22

Samples Relinquished By (Print Name and Sign): — Date: 2017/11/21 — Time: 4:16

Samples Received By (Print Name and Sign):

Samples Relinquished By (Print Name and Sign): — Date — Time

Samples Received By (Print Name and Sign): — Date — Time

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Nº: T 059383

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T289318

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Dec 05, 2017

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 17T289318

PROJECT: 16-1255

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD

ATTENTION TO: Bujing Guan

SAMPLING SITE:

SAMPLED BY:

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-11-28

DATE REPORTED: 2017-12-05

			SAMPLE DESCRIPTION:	BH37 SS3	BH 38 SS2	BH104 SS2&SS3	BH107 SS2&SS3	T3 SS2	T8 SS2	SPSO6E SS2
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-11-22	2017-11-22	2017-11-22	2017-11-22	2017-11-22	2017-11-22	2017-11-22
Parameter	Unit	G / S	RDL	8941978	8941981	8941982	8941983	8941984	8941985	8941986
Sodium Adsorption Ratio	NA	2.4	NA	11.2	14.0	25.4	36.0	0.198	0.167	0.913

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8941978-8941986 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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Guideline Violation

AGAT WORK ORDER: 17T289318

PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD

ATTENTION TO: Bujing Guan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8941978	BH37 SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	11.2
8941981	BH 38 SS2	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	14.0
8941982	BH104 SS2&SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	25.4
8941983	BH107 SS2&SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	36.0

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Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T289318
ATTENTION TO: Bujing Guan
SAMPLED BY:

Soil Analysis

RPT Date: Dec 05, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8941978	8941978	11.2	11.4	1.8%	NA	NA			NA			NA		

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
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FAX (905)712-5122
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Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T289318
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 17T280848
Cooler Quantity: Bag, Ice, 1 cooler
Arrival Temperatures: 4.3 | 4.5 | 4.3 / 4 | 3.7 | 2.9
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: 17T289318

Report Information:
Company: GeoPro Consulting
Contact: Bujing Guan, Tim Yu
Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement
(Please check all applicable boxes)
☑ Regulation 153/04 — Table: ☐ Ind/Com ☑ Res/Park ☐ Agriculture; Soil Texture: ☑ Coarse ☐ Fine
☐ Sewer Use: ☐ Sanitary ☐ Storm; Region
☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
☐ MISA

Turnaround Time (TAT) Required:
Regular TAT ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: 16-1255
Site Location: Erin, ON
Sampled By: Kirby
AGAT Quote #: PO:

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Invoice Information: Bill To Same: Yes ☐ No ☐
Company: As above
Contact:
Address:
Email:

Sample Matrix Legend
B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification		Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	O. Reg 153 – Metals & Inorganics / PHCs / PAHs (checked)
BH37	SS3	Nov 21, 2017	AM	1	Soil	—	✓
BH38	SS2	Nov 21, 2017	AM	1	Soil	—	✓
BH104	SS2 & SS3	Nov 21, 2017	AM	1	Soil	—	✓
BH107	SS2 & SS3	Nov 21, 2017	AM	1	Soil	—	✓
T3	SS2	Nov 17, 2017	AM	1	Soil	—	✓
T8	SS2	Nov 17, 2017	AM	1	Soil	—	✓
SPLOGE	SS2	Nov 21, 2017	AM	1	Soil	—	✓

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Nov 27, 2017 — Time: 4:17
Samples Received By (Print Name and Sign): — Date: 2017/11/28 — Time: 11:03

Page 1 of 1

Nº: T 059316

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T291834

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Dec 11, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 17T291834
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
SAMPLING SITE:

ATTENTION TO: Bujing Guan
SAMPLED BY:

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-12-05

DATE REPORTED: 2017-12-11

			SAMPLE DESCRIPTION:	BH103 SS2	BH101 SS2
			SAMPLE TYPE:	Soil	Soil
			DATE SAMPLED:	2017-11-28	2017-11-28
Parameter	Unit	G / S	RDL	8956173	8956176
Sodium Adsorption Ratio	NA	2.4	NA	0.183	0.066

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8956173-8956176 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T291834
ATTENTION TO: Bujing Guan
SAMPLED BY:

Soil Analysis

RPT Date: Dec 11, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8956173	8956173	0.183	0.173	5.6%	NA	NA			NA			NA		

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD | AGAT WORK ORDER: 17T291834

PROJECT: 16-1255 | ATTENTION TO: Bujing Guan

SAMPLING SITE: | SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Laboratory Use Only

Work Order #: 17T291834

Cooler Quantity: 1 cooler

Arrival Temperatures: 4.7 4.5 4.5 / 2.6 3.3 3.1

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: GeoPro Consulting
Contact: Buying Guan, Tim Yu
Address: Unit 57, 45 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☑ Regulation 153/04 — Table 1 (Indicate One): ☐ Ind/Com ☑ Res/Park ☐ Agriculture
Soil Texture (Check One): ☑ Coarse ☐ Fine
☐ Sewer Use: ☐ Sanitary ☐ Storm — Region — Indicate One
☐ MISA
☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other — Indicate One

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255
Site Location: Erin, ON
Sampled By: Kirby
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company: As above
Contact:
Address:
Email:

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Analysis columns: Field Filtered - Metals, Hg, CrVI (Y/N); Metals and Inorganics; Metals - ☐ CrVI ☐ Hg ☐ HWS-B; Hydride Forming Metals; O. Reg 153: BTEX ☐ F1 ☐ F2 ☐ F3 ☐ F4 / PHCs F1 - F4; Full Metals Scan; Regulation/Custom Metals; Nutrients: ☐ TP ☐ NH₃ ☐ TKN ☐ NO₃ ☐ NO₂ ☐ NO₃+NO₂; Volatiles: ☐ VOC ☐ BTEX ☐ THM; PHCs F1 - F4; ABNs; PAHs; PCBs: ☐ Total ☐ Aroclors; Organochlorine Pesticides; TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs; Sewer Use

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	O. Reg 153 PHCs F1 - F4
BH103 SS2	Nov 28, 2017	pm	1	Soil	—	✓
BH101 SS2	Nov 28, 2017	pm	1	Soil	—	✓

Samples Relinquished By (Print Name and Sign): Tim Yu	Date: Dec 4, 2017	Time:	Samples Received By (Print Name and Sign):	Date: Dec/2/5	Time: 1:57
Samples Relinquished By (Print Name and Sign):	Date: 2017/12/5	Time: 4:21	Samples Received By (Print Name and Sign):	Date:	Time:
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign):	Date:	Time:

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Nº: T 059390

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MISSISSAUGA, ONTARIO
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TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T297671

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Dec 29, 2017

PAGES (INCLUDING COVER): 6

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
SAMPLING SITE:

ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

O. Reg. 153(511) - ORPs (Soil)

DATE RECEIVED: 2017-12-21

DATE REPORTED: 2017-12-29

			SAMPLE DESCRIPTION:	SP 508E SS2 + SS3
			SAMPLE TYPE:	Soil
			DATE SAMPLED:	2017-12-15
Parameter	Unit	G / S	RDL	8992116
Sodium Adsorption Ratio	NA	2.4	NA	3.41

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8992116 SAR was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil).

Certified By: Nivine Basily

5835 COOPERS AVENUE
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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Guideline Violation

AGAT WORK ORDER: 17T297671

PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD

ATTENTION TO: Bujing Guan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
8992116	SP 508E SS2 + SS3	ON T1 S RPI/ICC	O. Reg. 153(511) - ORPs (Soil)	Sodium Adsorption Ratio	NA	2.4	3.41

5835 COOPERS AVENUE
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CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD

PROJECT: 16-1255

SAMPLING SITE:

AGAT WORK ORDER: 17T297671

ATTENTION TO: Bujing Guan

SAMPLED BY:Kirby

Soil Analysis

RPT Date: Dec 29, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - ORPs (Soil)															
Sodium Adsorption Ratio	8994392		0.673	0.688	2.2%	NA									

Comments: NA signifies Not Applicable.

Certified By: Nivine Basily

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T297671
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:Kirby

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905 712 5100 Fax: 905 712 5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 17T297671
Cooler Quantity: Med
Arrival Temperatures: 4.8 | 4.2 | 4 ; 3.8 | 3.7 | 3.5
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Report Information:
Company: GeoPro Consulting
Contact: Bujing Guan, Tim Yu
Address: Unit 57, 40 Vogell Rd. Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements:
☐ No Regulatory Requirement
(Please check all applicable boxes)

- ☑ Regulation 153/04 — Table 1; ☐ Ind/Com; ☑ Res/Park; ☐ Agriculture; Soil Texture (Check One): ☑ Coarse; ☐ Fine
- ☐ Sewer Use: ☐ Sanitary; ☐ Storm; Region; ☐ MISA
- ☐ Regulation 558; ☐ CCME; ☐ Prov. Water Quality Objectives (PWQO); ☐ Other

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Turnaround Time (TAT) Required:
Regular TAT ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: 16-1255
Site Location: Erin, ON
Sampled By: Kirby
AGAT Quote #: PO:

Invoice Information:
Bill To Same: Yes ☑ No ☐
Company: As above
Contact:
Address:
Email:

Sample Matrix Legend
- B — Biota
- GW — Ground Water
- O — Oil
- P — Paint
- S — Soil
- SD — Sediment
- SW — Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	Metals / Hydride Metals / ORPs	ORPs	PHCs F1-F4 (O. Reg 153)	Full Metals Scan	Regulation/Custom Metals	Nutrients	Volatiles	PHCs F1-F4	ABNs	PAHs	PCBs	Organochlorine Pesticides	TCLP	Sewer Use
SPS 08E 552+553	Dec 15, 2017	PM	1	Soil	—					✓											

Samples Relinquished By (Print Name and Sign): Tim Yu [signature] Date: Dec 20, 2017 Time:
Samples Relinquished By (Print Name and Sign): Ray [signature] Date: 2017/12/21 Time: 4:12
Samples Received By (Print Name and Sign): Ray [signature] Date: 2017/12/21 Time: 9:33
Samples Received By (Print Name and Sign): Date: Time:
Samples Relinquished By (Print Name and Sign): Date: Time:

Page 1 of 1

Nº: T 059252

Pink Copy - Client | Yellow Copy - AGAT | White Copy - AGAT

APPENDIX B

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T282050

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 15, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 17T282050
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2017-11-07
DATE REPORTED: 2017-11-15

			SAMPLE DESCRIPTION:	SPS 03E SS5	BH 5 SS5	BH 14 SS5	BH 31 SS5	BH 32 SS5
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-10-30	2017-10-31	2017-10-31	2017-11-02	2017-11-02
Parameter	Unit	G / S	RDL	8891318	8891398	8891399	8891400	8891401
Sulfide (S2-)	%		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chloride (2:1)	µg/g		2	31	98	19	32	12
Sulphate (2:1)	µg/g		2	8	7	4	<2	2
pH (2:1)	pH Units		NA	8.89	8.83	8.87	8.89	9.39
Electrical Conductivity (2:1)	mS/cm		0.005	0.121	0.231	0.113	0.121	0.083
Resistivity (2:1)	ohm.cm		1	8260	4330	8850	8260	12000
Redox Potential (2:1)	mV		5	201	172	172	176	157

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8891318-8891401 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

AGAT Laboratories
5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T282050
ATTENTION TO: Bujing Guan
SAMPLED BY:

Soil Analysis

RPT Date: Nov 15, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8891318	8891318	< 0.05	< 0.05	NA	< 0.05	98%	80%	120%						
Chloride (2:1)	8891401	8891401	12	12	0.0%	< 2	104%	80%	120%	101%	80%	120%	99%	70%	130%
Sulphate (2:1)	8891401	8891401	2	2	NA	< 2	96%	80%	120%	101%	80%	120%	102%	70%	130%
pH (2:1)	8891401	8891401	9.39	9.40	0.1%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8891401	8891401	0.083	0.083	0.0%	< 0.005	97%	90%	110%	NA			NA		
Redox Potential (2:1)	8891401	8891401	157	158	0.6%	< 5	103%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD | AGAT WORK ORDER: 17T282050
PROJECT: 16-1255 | ATTENTION TO: Bujing Guan
SAMPLING SITE: | SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

5RG

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 17T282050

Cooler Quantity:
Arrival Temperatures: 3.3 2.2 2.6 / 3.9 2.6 2.9
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Report Information:

Company: GeoPro Consulting
Contact: Bujing Guan / Tim Yu
Address: Unit 57, 40 Vogell Rd
Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements:

☐ No Regulatory Requirement

(Please check all applicable boxes)

☐ Regulation 153/04 — Table ___ (Indicate One) ☐ Ind/Com ☐ Res/Park ☐ Agriculture — Soil Texture (Check One) ☐ Coarse ☐ Fine
☐ Sewer Use ☐ Sanitary ☐ Storm — Region ___ (Indicate One) ☐ MISA
☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other ___ (Indicate One)

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis ☐ Yes ☑ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255
Site Location: Erin
Sampled By: Kirby
AGAT Quote #: PO:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☑ No ☐

Company: As above
Contact:
Address:
Email:

Sample Matrix Legend

B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	Hydride Forming Metals / ICP Metals	ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr6 ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH3 ☐ TKN ☐ NO3 ☐ NO2 ☐ NO3+NO2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use	Corrosivity
SPS 03 E SS5	Oct 31, 2017	PM	1	Soil	—																✓
BH 5 SS5	Oct 31, 2017	PM	1	↓	—																✓
BH 14 SS5	Oct 31, 2017	PM	1	↓	—																✓
BH 31 SS5	Nov 2, 2017	PM	1	↓	—																✓
BH 34 SS5	Nov 2, 2017	PM	1	Soil	—																✓

Samples Relinquished By (Print Name and Sign): Tim Yu, Tim Yu — Date: Nov 6, 2017 — Time:
Samples Received By (Print Name and Sign): [signature] — Date: 11/06/17 — Time: 11:45
Samples Relinquished By (Print Name and Sign): — Date: — Time:
Samples Received By (Print Name and Sign): — Date: — Time:
Samples Relinquished By (Print Name and Sign): [signature] — Date: 11/07/17 — Time: 2:10
Samples Received By (Print Name and Sign): — Date: — Time:

Page 1 of 1

№: T 059122

Pink Copy - Client | Yellow Copy - AGAT | White Copy - AGAT

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T283345

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 20, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 17T283345

PROJECT: 16-1255

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD

ATTENTION TO: Bujing Guan

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2017-11-10

DATE REPORTED: 2017-11-20

			SAMPLE DESCRIPTION:	SPS01H SS5	SPS02E SS5	SPS04E SS5	T1 SS5A & B	T6 SS5A
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-11-03	2017-11-03	2017-11-03	2017-11-07	2017-11-07
Parameter	Unit	G / S	RDL	8903887	8903891	8903892	8903893	8903894
Sulfide (S2-)	%		0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chloride (2:1)	µg/g		2	66	19	20	62	9
Sulphate (2:1)	µg/g		2	12	5	4	6	3
pH (2:1)	pH Units		NA	8.44	8.70	8.99	8.43	7.99
Electrical Conductivity (2:1)	mS/cm		0.005	0.191	0.109	0.080	0.176	0.136
Resistivity (2:1)	ohm.cm		1	5240	9170	12500	5680	7350
Redox Potential (2:1)	mV		5	170	163	156	171	180

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8903887-8903894 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD

PROJECT: 16-1255

SAMPLING SITE:

AGAT WORK ORDER: 17T283345

ATTENTION TO: Bujing Guan

SAMPLED BY:

Soil Analysis

RPT Date: Nov 20, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8903894	8903894	< 0.05	< 0.05	NA	< 0.05	98%	80%	120%						
Chloride (2:1)	8902966		67	62	7.8%	< 2	101%	80%	120%	101%	80%	120%	98%	70%	130%
Sulphate (2:1)	8902966		103	99	4.0%	< 2	96%	80%	120%	104%	80%	120%	100%	70%	130%
pH (2:1)	8902966		7.97	7.99	0.3%	NA	100%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8898808		0.206	0.209	1.4%	< 0.005	96%	90%	110%	NA			NA		
Redox Potential (2:1)	8902966		182	181	0.6%	< 5	101%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD | AGAT WORK ORDER: 17T283345
PROJECT: 16-1255 | ATTENTION TO: Bujing Guan
SAMPLING SITE: | SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories SR7 / Bag

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: LTT 283345

Cooler Quantity:

Arrival Temperatures: 3.2 | 3.0 | 2.9 / 3.0 | 3.4 | 3.0

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Report Information:

Company: GeoPro Consulting

Contact: Beijing Guan, Tim Yu

Address: Unit 57, 40 Vogell Rd, Richmond Hill ON

Phone: 905-237-8336 Fax:

Reports to be sent to:
1. Email: bguan@geproconsulting.ca
2. Email: timy@geproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☐ Regulation 153/04 — Table: ☐ Ind/Com ☐ Res/Park ☐ Agriculture — Soil Texture (Check One): ☐ Coarse ☐ Fine

☐ Sewer Use ☐ Sanitary ☐ Storm — Region: ☐ MISA

☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☐ Yes ☑ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply): ☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1235

Site Location: Erin

Sampled By: Kirby

AGAT Quote #: PO:

Invoice Information: Bill To Same: Yes ☑ No ☐

Company: As above

Contact:

Address:

Email:

Sample Matrix Legend

B — Biota
GW — Ground Water
O — Oil
P — Paint
S — Soil
SD — Sediment
SW — Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	...	Sewer Use	Corrosivity
SP 5 01 W SS5	Nov 1 2017	PM	1	Soil	—					✓
SP 5 01 E SS5	Nov 1, 2017	PM	1	Soil	—					✓
SP 5 04 E SS5	Nov 1, 2017	PM	1	Soil	—					✓
T1 SS5A&B	Nov 7 2017	AM	1	Soil	—					✓
T6 SS5A	Nov 7 2017	PM	1	Soil	—					✓

Samples Relinquished By (Print Name and Sign): Tim Yu [signature] — Date: Nov 1?, 2017

Samples Received By (Print Name and Sign): [signature] — 11/10/17 — Time: 1:10

Samples Relinquished By (Print Name and Sign): [signature] — 11/10/17 — Time: 4:50

Samples Received By (Print Name and Sign):

Page ___ of ___

No: T 059120

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T284718

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 27, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 17T284718
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
SAMPLING SITE:

ATTENTION TO: Bujing Guan
SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2017-11-15

DATE REPORTED: 2017-11-27

Parameter	Unit	G / S	RDL	BH9 SS4	BH10 SS5	BH15 SS5	SPS 01bE SS4
			SAMPLE TYPE:	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2017-11-09	2017-11-08	2017-11-09	2017-11-08
				8911561	8911562	8911563	8911564
Sulfide (S2-)	%		0.05	<0.05	<0.05	<0.05	<0.05
Chloride (2:1)	µg/g		2	73	91	73	43
Sulphate (2:1)	µg/g		2	13	15	8	8
pH (2:1)	pH Units		NA	8.99	8.64	9.07	8.75
Electrical Conductivity (2:1)	mS/cm		0.005	0.194	0.239	0.237	0.139
Resistivity (2:1)	ohm.cm		1	5150	4180	4220	7190
Redox Potential (2:1)	mV		5	153	158	139	155

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8911561-8911564 EC, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

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Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T284718
ATTENTION TO: Bujing Guan
SAMPLED BY:

Soil Analysis

RPT Date: Nov 27, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8911561	8911561	< 0.05	< 0.05	NA	< 0.05	98%	80%	120%						
Chloride (2:1)	8905875		2	2	NA	< 2	101%	80%	120%	99%	80%	120%	100%	70%	130%
Sulphate (2:1)	8905875		3	3	NA	< 2	94%	80%	120%	99%	80%	120%	99%	70%	130%
pH (2:1)	8905875		8.16	8.13	0.4%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8911559		0.495	0.514	3.8%	< 0.005	97%	90%	110%	NA			NA		
Redox Potential (2:1)	8905875		155	155	0.0%	< 5	101%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

Certified By: Amanjot Bhela

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Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T284718
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

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Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
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Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form

Laboratory Use Only

Work Order #: 17T284718

Cooler Quantity:

Arrival Temperatures: 5.0 | 5.0 | 2.2 / 3.0 | 2.5 | 2.6

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Report Information:

Company: GeoPro Consulting

Contact: Bujing Guan, Tim Yu

Address: Unit 57, 40 Vogell Rd. Richmond Hill, ON

Phone: 905-237-8336 Fax:

Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: tim.yu@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

☐ Regulation 153/04 — Table: ☐ Ind/Com ☐ Res/Park ☐ Agriculture; Soil Texture: ☐ Coarse ☐ Fine

☐ Sewer Use — ☐ Sanitary ☐ Storm; Region:

☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other

Is this submission for a Record of Site Condition? ☐ Yes ☐ No

Report Guideline on Certificate of Analysis: ☐ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT: ☐ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply): ☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT

*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1233

Site Location: Erin

Sampled By: Kirby

AGAT Quote #: PO:

Invoice Information: Bill To Same: Yes ☑ No ☐

Company: As above

Contact:

Address:

Email:

Sample Matrix Legend

- B — Biota
- GW — Ground Water
- O — Oil
- P — Paint
- S — Soil
- SD — Sediment
- SW — Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	O. Reg 153 ...	...	...	Regulation/Custom Metals	Nutrients	Volatiles	PHCs F1-F4	ABNs	PAHs	PCBs	Organochlorine Pesticides	TCLP	Sewer Use	Corrosivity
BH 4 SS4	Nov 7, 2017	AM	1	Soil	—																✓
BH 10 SS5	Nov 8, 2017	AM	1	Soil	—																✓
BH 15 SS5	Nov 9, 2017	AM	1	Soil	—																✓
SPS 01BE SS4	Nov 8, 2017	AM	1	Soil	—																✓

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Nov 1?, 2017

Samples Received By (Print Name and Sign): Gary [signature] — Date: 11/16/17 Time: 1105

Samples Relinquished By (Print Name and Sign): Gary [signature] — Date: MISF 43

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No: T 059397

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T286763

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 30, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 17T286763
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
SAMPLING SITE:

ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Corrosivity Package

DATE RECEIVED: 2017-11-21 DATE REPORTED: 2017-11-30

			SAMPLE DESCRIPTION:	BH 1 SS5	BH 19 SS4	BH 26 SS5		BH 28 SS4		BH 30 SS5
			SAMPLE TYPE:	Soil	Soil	Soil		Soil		Soil
			DATE SAMPLED:	2017-11-14	2017-11-13	2017-11-15		2017-11-15		2017-11-13
Parameter	Unit	G / S	RDL	8925357	8925361	8925370	RDL	8925373	RDL	8925378
Sulfide (S2-)	%		0.05	<0.05	<0.05	<0.05	0.05	0.06	0.05	0.05
Chloride (2:1)	µg/g		2	252	193	227	4	818	2	25
Sulphate (2:1)	µg/g		2	17	15	7	4	31	2	6
pH (2:1)	pH Units		NA	8.33	8.77	9.30	NA	8.38	NA	8.87
Electrical Conductivity (2:1)	mS/cm		0.005	0.478	0.415	0.448	0.005	1.20	0.005	0.112
Resistivity (2:1)	ohm.cm		1	2090	2410	2230	1	833	1	8930
Redox Potential (2:1)	mV		5	161	145	124	5	155	5	150

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8925357-8925370 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

8925373 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Elevated RDL indicates the degree of sample dilution prior to the analysis for Anions in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

8925378 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

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Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T286763
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Soil Analysis

RPT Date: Nov 30, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8925357	8925357	< 0.05	< 0.05	NA	< 0.05	99%	80%	120%						
Chloride (2:1)	8925370	8925370	227	236	3.9%	< 2	108%	80%	120%	106%	80%	120%	104%	70%	130%
Sulphate (2:1)	8925370	8925370	7	7	NA	< 2	95%	80%	120%	99%	80%	120%	103%	70%	130%
pH (2:1)	8925370	8925370	9.30	9.23	0.8%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8925370	8925370	0.448	0.477	6.3%	< 0.005	98%	90%	110%	NA			NA		
Redox Potential (2:1)	8925370	8925370	124	124	0.0%	< 5	104%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T286763
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

SR 12

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Laboratory Use Only

Work Order #: 17T296763

Cooler Quantity: Bag

Arrival Temperatures: 4.6 4.3 4.1 / 3.6 3.3 3.1

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form

Report Information:

Company: Geo Pro Consulting

Contact: Bujing Guan, Tim Yu

Address: Unit 57, 40 Vogell Rd. Richmond Hill, ON

Phone: 905-237-8336 Fax:

Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

☐ Regulation 153/04 — Table; ☐ Ind/Com; ☐ Res/Park; ☐ Agriculture; Soil Texture: ☐ Coarse ☐ Fine

☐ Sewer Use — ☐ Sanitary ☐ Storm; Region; ☐ MISA

☐ Regulation 558; ☐ CCME; ☐ Prov. Water Quality Objectives (PWQO); ☐ Other

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255

Site Location: Erin, ON

Sampled By: Kirby

AGAT Quote #: PO:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information: Bill To Same: Yes ☑ No ☐

Company: As above

Contact:

Address:

Email:

Sample Matrix Legend

- B — Biota
- GW — Ground Water
- O — Oil
- P — Paint
- S — Soil
- SD — Sediment
- SW — Surface Water

Analyses columns: Field Filtered - Metals, Hg, CrVI; Metals and Inorganics; ☐ All Metals ☐ Hydride Metals ☐ Hydride Forming Metals; ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR; Full Metals Scan; Regulation/Custom Metals; Nutrients: ☐ TP ☐ NH3 ☐ TKN ☐ NO3 ☐ NO2 ☐ NO3+NO2; Volatiles: ☐ VOC ☐ BTEX ☐ THM; PHCs F1 - F4; ABNs; PAHs; PCBs: ☐ Total ☐ Aroclors; Organochlorine Pesticides; TCLP Metals ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs; Sewer Use; Corrosivity

Sample Identification		Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Corrosivity
BH 1	SS 5	Nov 14, 2017	P.M.	1	Soil	—	✓
BH 19	SS 4	Nov 15, 2017	P.M.	1	Soil	—	✓
BH 26	SS 5	Nov 15, 2017	P.M.	1	Soil	—	✓
BH 28	SS 4	Nov 15, 2017	P.M.	1	Soil	—	✓
BH 30	SS 5	Nov 17, 2017	P.M.	1	Soil	—	✓

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Nov 21, 2017 — Time:

Samples Received By (Print Name and Sign): [signature] — Date: 2017/11/21 — Time: 12:21

Samples Relinquished By (Print Name and Sign): [signature] — Date: 2017/11/21 — Time: 4:16

Samples Received By (Print Name and Sign): — Date: — Time:

Samples Relinquished By (Print Name and Sign): — Date: — Time:

Samples Received By (Print Name and Sign): — Date: — Time:

Page 1 of 1

Nº: T 059399

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MISSISSAUGA, ONTARIO
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http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T289231

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Dec 05, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

5835 COOPERS AVENUE
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Certificate of Analysis

AGAT WORK ORDER: 17T289231
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:Kirby

Corrosivity Package

DATE RECEIVED: 2017-11-28
DATE REPORTED: 2017-12-05

Parameter	Unit	G / S	RDL	BH37 SS4	BH38 SS4 & SS5	RDL	BH104 SS4	RDL	BH107 SS4	RDL	T3 SS4
SAMPLE TYPE:				Soil	Soil		Soil		Soil		Soil
DATE SAMPLED:				2017-11-22	2017-11-22		2017-11-20		2017-11-20		2017-11-17
				8942020	8942027		8942028		8942029		8942030
Sulfide (S2-)	%		0.05	0.05	0.06	0.05	0.08	0.05	0.08	0.05	<0.05
Chloride (2:1)	µg/g		2	513	515	8	1490	4	1260	2	8
Sulphate (2:1)	µg/g		2	22	21	8	59	4	22	2	3
pH (2:1)	pH Units		NA	8.65	8.26	NA	7.93	NA	9.05	NA	8.61
Electrical Conductivity (2:1)	mS/cm		0.005	0.929	0.865	0.005	2.23	0.005	1.90	0.005	0.080
Resistivity (2:1)	ohm.cm		1	1080	1160	1	448	1	526	1	12500
Redox Potential (2:1)	mV		5	181	188	5	184	5	153	5	173

Parameter	Unit	G / S	RDL	T8 SS5A&B	SPS06E SS6
SAMPLE TYPE:				Soil	Soil
DATE SAMPLED:				2017-11-17	2017-11-21
				8942031	8942042
Sulfide (S2-)	%		0.05	0.10	0.07
Chloride (2:1)	µg/g		2	48	18
Sulphate (2:1)	µg/g		2	4	11
pH (2:1)	pH Units		NA	8.21	8.79
Electrical Conductivity (2:1)	mS/cm		0.005	0.170	0.100
Resistivity (2:1)	ohm.cm		1	5880	10000
Redox Potential (2:1)	mV		5	177	169

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8942020-8942027 EC, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

8942028-8942029 EC, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).
Elevated RDL indicates the degree of sample dilution prior to the analysis for Anions in order to keep analytes within the calibration range of the instrument and to reduce matrix interference.

*Sulphide analyzed at AGAT 5623 McAdam

8942030-8942042 EC, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T289231
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Soil Analysis

RPT Date: Dec 05, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8942020	8942020	0.05	0.05	NA	< 0.05	98%	80%	120%						
Chloride (2:1)	8941914		22	21	4.7%	< 2	100%	80%	120%	105%	80%	120%	104%	70%	130%
Sulphate (2:1)	8941914		198	195	1.5%	< 2	92%	80%	120%	103%	80%	120%	106%	70%	130%
pH (2:1)	8941914		8.27	8.25	0.2%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8941978		0.985	0.977	0.8%	< 0.005	97%	90%	110%	NA			NA		
Redox Potential (2:1)	8941914		193	194	0.5%	< 5	101%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD

AGAT WORK ORDER: 17T289231

PROJECT: 16-1255

ATTENTION TO: Bujing Guan

SAMPLING SITE:

SAMPLED BY:Kirby

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905 712 5100 Fax: 905 712 5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 17T289231
Cooler Quantity:
Arrival Temperatures: 4.8 | 4.5 | 4.3 / 4 | 5.4 | 5.4
Custody Seal Intact: Yes / No / N/A
Notes:

Report Information:
Company: GeoPro Consulting
Contact: Bujing Guan, Tim Yu
Address: Unit 57 40 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement
(Please check all applicable boxes)
Regulation 153/04 — Table; Ind/Com; Res/Park; Agriculture
Soil Texture: Coarse; Fine
Sewer Use — Sanitary; Storm; Region; MISA
Regulation 558; CCME; Prov. Water Quality Objectives (PWQO); Other

Is this submission for a Record of Site Condition? ☐ Yes ☑ No
Report Guideline on Certificate of Analysis ☑ Yes ☐ No

Turnaround Time (TAT) Required:
Regular TAT ☑ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: 16-1255
Site Location: Erin, ON
Sampled By: Kirby
AGAT Quote #: PO:

Invoice Information: Bill To Same: Yes ☑ No ☐
Company: As above
Contact:
Address:
Email:

Sample Matrix Legend
B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Corrosivity
BH 37 SS4	Nov 21, 2017	PM	1	Soil	—	✓
BH 38 SS4 & SS5	Nov 21, 2017	PM	1	↑	—	✓
BH 104 SS4	Nov 20, 2017	↑	1		—	✓
BH 107 SS4	Nov 20, 2017		1		—	✓
T3 SS4	Nov 17, 2017		1		—	✓
T8 SS5 & SS8	Nov 17, 2017	↓	1	↓	—	✓
CP3-6E SS6	Nov 21, 2017	PM	1	Soil	—	✓

Samples Relinquished By (Print Name and Sign): Bujing Guan | Date: 2017/11/28 | Time: 4:17
Samples Received By (Print Name and Sign): | Date: 2017/11/28 | Time: 1:03

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Nº: T 059317

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5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T291830

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Dec 13, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

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FAX (905)712-5122
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Certificate of Analysis

AGAT WORK ORDER: 17T291830
PROJECT: 16-1255

CLIENT NAME: GEOPRO CONSULTING LTD
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2017-12-05
DATE REPORTED: 2017-12-13

Parameter	Unit	G / S	RDL	BH103 SS4	BH101 SS5
SAMPLE TYPE:				Soil	Soil
DATE SAMPLED:				2017-11-28	2017-11-28
				8956047	8956048
Sulfide (S2-)	%		0.05	<0.05	<0.05
Chloride (2:1)	µg/g		2	5	6
Sulphate (2:1)	µg/g		2	3	3
pH (2:1)	pH Units		NA	8.23	8.27
Electrical Conductivity (2:1)	mS/cm		0.005	0.084	0.089
Resistivity (2:1)	ohm.cm		1	11900	11200
Redox Potential (2:1)	mV		5	163	169

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

8956047-8956048 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

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CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD | AGAT WORK ORDER: 17T291830
PROJECT: 16-1255 | ATTENTION TO: Bujing Guan
SAMPLING SITE: | SAMPLED BY:

Soil Analysis

RPT Date: Dec 13, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8956048	8956048	< 0.05	< 0.05	NA	< 0.05	101%	80%	120%						
Chloride (2:1)	8954296		39	38	2.6%	< 2	106%	80%	120%	107%	80%	120%	107%	70%	130%
Sulphate (2:1)	8954296		24	24	0.0%	< 2	95%	80%	120%	97%	80%	120%	106%	70%	130%
pH (2:1)	8956060		9.20	9.27	0.8%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8956173		0.127	0.125	1.6%	< 0.005	92%	90%	110%	NA			NA		
Redox Potential (2:1)	8955613		188	189	0.5%	< 5	104%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

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Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T291830
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

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Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 17T291830

Cooler Quantity: large

Arrival Temperatures: 4.7 4.5 4.3 / 3.6 3.3 3.2

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Report Information:

Company: GeoPro Consulting
Contact: Bujing Guan, Tim Yu
Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timy@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☐ Regulation 153/04 — Table: Ind/Com, Res/Park, Agriculture; Soil Texture (Check One): Coarse, Fine
☐ Sewer Use — Sanitary, Storm; Region; ☐ MISA
☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255
Site Location: Erin, ON
Sampled By: Kirby
AGAT Quote #: PO:

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis ☑ Yes ☐ No

Invoice Information: Bill To Same: Yes ☑ No ☐

Company: as above
Contact:
Address:
Email:

Sample Matrix Legend

Code	Matrix
B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI	Metals and Inorganics	...	Corrosivity
BH 103 SS4	Nov 28, 2017	PM	1	Soil	—				✓
BH 101 SS5	Nov 28, 2017	PM	1	Soil	—				✓

Analysis columns: Field Filtered - Metals, Hg, CrVI; Metals and Inorganics; All Metals / 153 Metals (excl. Hydrides); ORPs; Full Metals Scan; Regulation/Custom Metals; Nutrients; Volatiles; PHCs F1-F4; ABNs; PAHs; PCBs; Organochlorine Pesticides; TCLP; Sewer Use; Corrosivity

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Dec 4, 2017
Samples Relinquished By (Print Name and Sign): [signature] — Date: 2017/12/[illegible] Time: 4:21
Samples Received By (Print Name and Sign): [signature] — Date: 2017/12/5 Time: 15:57
Samples Received By (Print Name and Sign):

Page 1 of 1

Nº: T 059318

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
UNIT 57, 40 VOGELL ROAD
RICHMOND HILL, ON L4B3N6
(905) 237-8336

ATTENTION TO: Bujing Guan

PROJECT: 16-1255

AGAT WORK ORDER: 17T297643

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Dec 29, 2017

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 17T297643
PROJECT: 16-1255

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GEOPRO CONSULTING LTD
SAMPLING SITE:

ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Corrosivity Package

DATE RECEIVED: 2017-12-21

DATE REPORTED: 2017-12-29

			SAMPLE DESCRIPTION:	SPS08E SS6
			SAMPLE TYPE:	Soil
			DATE SAMPLED:	2017-12-15
Parameter	Unit	G / S	RDL	8991976
Sulfide (S2-)	%		0.05	<0.05
Chloride (2:1)	µg/g	NA	2	32
Sulphate (2:1)	µg/g		2	12
pH (2:1)	pH Units		NA	8.40
Electrical Conductivity (2:1)	mS/cm	0.57	0.005	0.165
Resistivity (2:1)	ohm.cm		1	6060
Redox Potential (2:1)	mV		5	157

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

8991976 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

*Sulphide analyzed at AGAT 5623 McAdam

Certified By: Amanjot Bhela

5835 COOPERS AVENUE
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GEOPRO CONSULTING LTD
PROJECT: 16-1255
SAMPLING SITE:

AGAT WORK ORDER: 17T297643
ATTENTION TO: Bujing Guan
SAMPLED BY:Kirby

Soil Analysis

RPT Date: Dec 29, 2017			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper	Recovery	Acceptable Limits Lower	Acceptable Limits Upper
Corrosivity Package															
Sulfide (S2-)	8991976	8991976	< 0.05	< 0.05	NA	< 0.05	99%	80%	120%						
Chloride (2:1)	8993018		35	38	8.2%	< 2	98%	80%	120%	100%	80%	120%	122%	70%	130%
Sulphate (2:1)	8993018		66	70	5.9%	< 2	101%	80%	120%	102%	80%	120%	105%	70%	130%
pH (2:1)	8990650		8.14	8.15	0.1%	NA	100%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	8992997		1.32	1.42	7.3%	< 0.005	98%	90%	110%	NA			NA		
Redox Potential (2:1)	8993018		142	139	2.1%	< 5	104%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

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FAX (905)712-5122
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Method Summary

CLIENT NAME: GEOPRO CONSULTING LTD
AGAT WORK ORDER: 17T297643
PROJECT: 16-1255
ATTENTION TO: Bujing Guan
SAMPLING SITE:
SAMPLED BY:Kirby

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide (S2-)	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

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Ph: 905 712 5100 Fax: 905 712 5122
webearth.agatlabs.com

Laboratory Use Only

Work Order #: 17T297643

Cooler Quantity:

Arrival Temperatures:

Custody Seal Intact: Yes No N/A

Notes:

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: Geo Pro Consulting
Contact: Bujing Guan, Tim Yu
Address: Unit 57, 40 Vogell Rd, Richmond Hill, ON
Phone: 905-237-8336 Fax:
Reports to be sent to:
1. Email: bguan@geoproconsulting.ca
2. Email: timyu@geoproconsulting.ca

Regulatory Requirements: ☐ No Regulatory Requirement

☑ Regulation 153/04 — Table: ☐ Ind/Com ☑ Res/Park ☐ Agriculture; Soil Texture: ☑ Coarse ☐ Fine
☐ Sewer Use: ☐ Sanitary ☐ Storm; Region; ☐ MISA
☐ Regulation 558 ☐ CCME ☐ Prov. Water Quality Objectives (PWQO) ☐ Other

Is this submission for a Record of Site Condition? ☐ Yes ☑ No

Report Guideline on Certificate of Analysis: ☑ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT: ☑ 5 to 7 Business Days

Rush TAT: ☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: 16-1255
Site Location: Erin, ON
Sampled By: Kirby
AGAT Quote #: PO:

Invoice Information: Bill To Same: Yes ☑ No ☐

Company: as above
Contact:
Address:
Email:

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	Metals and Inorganics	Hydride Forming Metals	ORPs	Full Metals Scan	Regulation/Custom Metals	Nutrients	Volatiles	PHCs F1-F4	ABNs	PAHs	PCBs	Organochlorine Pesticides	TCLP	Sewer Use	Corrosivity
SP3-08E SS6	Dec 15, 2017	Pm	1	Soil	—																✓

Samples Relinquished By (Print Name and Sign): Tim Yu — Date: Dec 20, 2017 — Time: 4:12
Samples Received By (Print Name and Sign): — Date: 2017/12/21 — Time: 9:33

Page 1 of 1

Nº: T 059253

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LIMITATIONS TO THE REPORT

This report is intended solely for the Client named. The report is prepared based on the work has been undertaken in accordance with normally accepted geotechnical engineering practices in Ontario.

The comments and recommendations given in this report are based on information determined at the limited number of the test hole and test pit locations. The boundaries between the various strata as shown on the borehole logs are based on non-continuous sampling and represent an inferred transition between the various strata and their lateral continuation rather than a precise plane of geological change. Subsurface and groundwater conditions between and beyond the test holes and test pits may differ significantly from those encountered at the test hole and test pit locations. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole and test pit locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The report reflects our best judgment based on the information available to GeoPro Consulting Limited at the time of preparation. Unless otherwise agreed in writing by GeoPro Consulting Limited, it shall not be used to express or imply warranty as to any other purposes. No portion of this report shall be used as a separate entity, it is written to be read in its entirety. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated.

The design recommendations given in this report are applicable only to the project designed and constructed completely in accordance with the details stated in this report. Otherwise, our responsibility is limited to interpreting the subsurface information at the borehole or test pit locations.

Should any comments and recommendations provided in this report be made on any construction related issues, they are intended only for the guidance of the designers. The number of test holes and test pits may not be sufficient to determine all the factors that may affect construction activities, methods and costs. Such as, the thickness of surficial topsoil or fill layers may vary significantly and unpredictably; the amount of the cobbles and boulders may vary significantly than what described in the report; unexpected water bearing zones/layers with various thickness and extent may be encountered in the fill and native soils. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and make their own conclusions as to how the subsurface conditions may affect their work and determine the proper construction methods.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GeoPro Consulting Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.