Mount Albert Water Supply Upgrades Class Environmental Assessment

Technical Memorandum No. 2 - Identification and Assessment of Alternative Solutions

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Regional Municipality of York

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1. Introduction

The Mount Albert community, located within the Town of East Gwillimbury, receives drinking water from groundwater wells owned, operated and maintained by the Regional Municipality of York (York Region). York Region is also responsible for providing, maintaining and operating treatment and water storage facilities within this drinking water system. Components of York Region owned Mount Albert Water Supply infrastructure currently include three groundwater wells (Wells 1, 2 and 3), two treatment facilities (Wells 1 & 2 Facility and Well 3 Facility), 3.2 km of transmission watermains and two elevated water storage tanks, the Mount Albert Sewage Pumping Station (SPS) and Mount Albert Water Resource Recovery Facility (WRRF). The Town of East Gwillimbury owns and operates the local distribution system consisting of the distribution network of watermains, hydrants, and service connections, as well as the sanitary sewer collection system.

The Mount Albert groundwater supply contains elevated levels of naturally occurring iron and manganese, which are currently controlled by sequestration through sodium silicate addition. The distribution system has reported experiencing water quality-related issues such as deposition of solids and the occurrence of discoloured water. Furthermore, Health Canada recently established two new guideline values for total manganese in drinking water, including a maximum acceptable concentration (MAC) of 0.12 mg/L and a reduction of the aesthetic objective (AO) from 0.05 mg/L to 0.02 mg/L. For the purposes of this study, it is assumed that the Ontario Ministry of Environment, Conservation and Parks (MECP) will eventually harmonize with these Health Canada Guidelines; however, at this time, MECP has not yet provided a timeline for consideration of potential changes to manganese regulations.

With the goals to mitigate aesthetic water quality issues and to meet or exceed potential changes in drinking water regulations and standards, York Region has initiated a Schedule B Class Environmental Assessment (EA) study to determine the preferred solution to upgrade the Mount Albert Water Supply System that is socially, environmentally and financially sustainable, with consideration also given to the improvement of system redundancy and reliability. Jacobs was retained by York Region to complete this Class EA study.

1.1 Purpose of Memorandum

Consistent with the requirements of Phase 2 of the Class EA process, the purpose of this technical memorandum (TM-2) is to identify reasonable and feasible solutions to address the problem statement for the Mount Albert Water Supply System and establish the preliminary preferred solution. The memo documents the long list of alternatives developed to address the Problem/Opportunity Statement and details the process used to screen these alternatives to develop a short-list to be carried forward for further detailed evaluation. The screening and evaluation frameworks, along with the considerations of Natural, Social, Cultural and Economic Environments related to each short-listed alternative, are documented in this memo. This memo then identifies the preliminary preferred alternative solution that will be presented to the public, review agencies, and other stakeholders to gather their input.

1.2 Mount Albert Water Supply System Upgrades Schedule B Class EA Process

The Mount Albert Water Supply Upgrades project is proceeding as a Schedule B activity, which requires the completion of a screening process involving mandatory contact with directly affected public and relevant review agencies to make them aware of the project and to provide an opportunity to address their concerns. Schedule B projects require that Phases 1 and 2 of the Class EA be followed and that a Project File report be prepared and filed for review by the public and the MECP.

The completion of Phase 1 – Problem or Opportunity is documented in “Technical Memorandum No. 1 - Problem / Opportunity Statement” (May 8, 2020) and summarized below.

Phase 2 of the Class EA process addresses the development of Alternative Solutions to address the problem or opportunity, taking into consideration the existing environment and public and review agency input to establish the preferred solution.

Project decisions are then documented in a Project File, which will be made available for review by public, review agencies, and other interest groups for a 30-day period. At the completion of the comment period, if there are no outstanding concerns raised by the public, stakeholders, or review agencies, the proponent may proceed to Phase 5- Project Implementation of the preferred solution.

1.2.1 Phase 1 - Problem / Opportunity Statement

Phase 1 of the Municipal Class EA planning process requires the proponent to first document factors leading to the conclusion that the improvement is needed and develop a clear statement of the problem/opportunity to be investigated.

An analysis of background information and supplementary field investigation and studies were completed to document existing conditions in the Mount Albert Water Supply System and provide the rationale for the development of a Problem / Opportunity Statement as summarized below.

The Mount Albert Water Supply System has sufficient supply capacity and storage to service current and future water demands beyond 2041, with Well 1 in service. In general, the facilities are designed with duty and standby equipment to avoid service interruptions in the event of component failure.

The wells, Wells 1 & 2 Facility, Well 3 Facility, and Mount Albert North Elevated Tank (North ET) are considered in good physical condition needing only routine maintenance and minor upgrades to achieve an extended lifespan of service in addition to the ongoing works. The Mount Albert South Elevated Tank (South ET) is reported to be in "Very Poor" condition and not currently fit for use. The well treatment facilities are each designed with duty/standby equipment and standby power facilities to avoid service interruptions in the event of component failure.

Iron and manganese in the raw water from the existing wells regularly exceeds the current provincial Aesthetic Objectives, and current treatment does not provide consistent control, resulting in particulate deposition in the distribution system and customer complaints associated with discoloured water. Hardness levels are greater than two to three times the provincial upper Operational Guideline, but within the threshold, as defined in the York Region's Design Guidelines and provincial guidelines.

The distribution system maintained and operated by the Town of East Gwillimbury has a relatively younger stock of watermains, with no watermain breaks in the system between 2012 and 2017. However, distribution sampling of the total and dissolved iron in the distribution system showed that iron and manganese deposition was occurring across the system, independent of correlation to water age, pipe material, pipe age or pipe diameter. More importantly, iron and manganese deposition occurred regardless of the amount of iron and manganese in the dissolved form, suggesting that changes to the silicate dosing would not substantially improve sequestration in the drinking water system.

Assessment of free chlorine residuals through both sampling and modelling shows stable free chlorine residuals in the distribution system and consistently above the minimum operating target of 0.4 mg/L. Further, there was little variation between the free chlorine residual and total chlorine residual measurements and no obvious trends, indicating consistent biostability in the distribution system.

The North Elevated Tank is considered to be in fair condition, requiring only cleaning and minor repairs in the near future. As the South ET is not currently operational, there would be no storage available during the relatively short duration outage required for these activities. More extensive repairs requiring a longer outage, including interior and exterior tank coating replacement, are identified to be required within 11-25 years.

A number of opportunities have been identified to address identified system constraints and improve the operation and maintenance of the existing system that would not require major capital investment. These opportunities included improvements of silicate dosing systems, inspection and cleaning of the contact chambers and the North ET, as well as the collaboration with the Town of East Gwillimbury on monitoring, cleaning and flushing programs for the distribution system.

While silicate dosage improvements at the wells may allow for more effective sequestration, it is noted that the raw water quality exceeds the recommended targets for effective sequestration at Wells 1 and 2. As the raw water quality at Well 3 is comparatively better, dosage improvements may provide more satisfactory results. For all wells, the interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process cannot be easily avoided, and the potential of water quality issues remains.

Even if sequestration in Well 3 could be improved, the supply is insufficient on its own to meet the long-term needs of the community, and more extensive capital investments to Wells 1 & 2 Facility beyond the scope of system optimization would be required to provide redundancy.

While there are opportunities to improve existing operation, it is noted that raw water chemistry may still preclude satisfactory operation. It is therefore recommended that investigation of alternatives, such as iron and manganese removal of Wells 1 and 2 or development of alternate sources, be undertaken to identify a preferred alternative to resolve distribution system issues and associated discoloured water complaints from residents.

The analysis of the Mount Albert Water Supply System has generated the following Problem / Opportunity Statement to guide the identification and investigation of alternative solutions in accordance with Phase 2 of the Class EA process.

Mount Albert is currently supplied solely by groundwater that contains elevated levels of naturally occurring iron and manganese above the aesthetic objectives. The current practice of sequestration does not provide effective control of these constituents, as evidenced by significant particulate deposition throughout the distribution system and frequent customer complaints associated with discoloured water. Additionally, the Mount Albert North Elevated Tank cannot be taken out of service for any prolonged period without creating significant constraints for the operation of the system. Optimization of existing water infrastructure can improve these issues but may not provide a complete resolution. To mitigate aesthetic water quality issues and comply with future manganese regulation, a preferred solution to upgrade the Mount Albert Water Supply System that is socially, environmentally and financially sustainable will be identified, with consideration given to treatment methodologies and improvement of overall system redundancy and reliability.

2. Alternative Solutions

The identification and evaluation of alternative solutions have been undertaken to systematically assess the different water servicing alternatives, with respect to social, environmental, technical, and economic criteria, following the process as outlined in Figure 2-1 and described below.

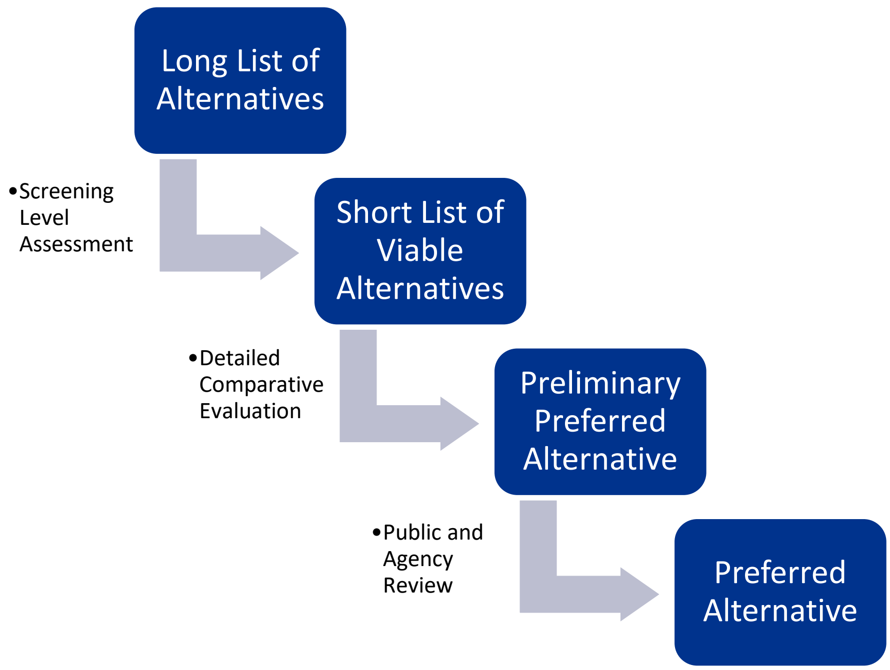


Figure 2-1. Phase 2 – Alternative Solutions Planning Process

2.1 Development of Long List of Alternatives

The following long list of alternatives was identified in consultation with York Region to address the problem statement for the Mount Albert Water Supply System. Each of the alternatives was evaluated based on the ability to address the Problem/Opportunity Statement using the screening criteria presented in Table 2-1.

Details of each of the alternatives are provided in the sections that follow along with an assessment based on their ability to meet the screening criteria. Those that meet all of the screening criteria are considered viable and are carried forward for more detailed evaluation and comparison in subsequent sections

A) **Improve water quality** – which will focus on the iron and manganese particulate deposition across the distribution system and frequent customer complaints associated with discoloured water.

- Alternative A1: Do Nothing
- Alternative A2: Limit Community Growth
- Alternative A3: Implement Water Conservation and Efficiency Measures
- Alternative A4: Continue Sequestration at Wells 1&2 Facility and Well 3 Facility, and Upgrade Systems to Optimize Operations and Maintenance
- Alternative A5: Provide Iron and Manganese Removal Technology for All Wells
- Alternative A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility

– Alternative A7: Connect New Well (MW18) to Mount Albert Water Supply System and Remove Wells 1 and/or 2

– Alternative A8: Connect to Existing Alternate Water Supply Source

– Alternative A9: Develop New Water Supply Sources

B) **Improve feasibility of storage maintenance –** which will focus on improvements to facilitate removing the North ET from service for maintenance.

– Alternative B1: Do Nothing
– Alternative B2: Rehabilitation of Mount Albert South Elevated Tank and Return it to Service
– Alternative B3: Operate the Distribution System in Pressure Mode
– Alternative B4: Provide New Storage

Table 2-1. Screening Criteria for the Long-List of Alternatives

Alternatives	Criteria	Description
Improve Water Quality	Does the alternative provide sufficient system capacity to meet projected water demands?	The Mount Albert Water Supply System has sufficient supply capacity and storage to service current and future water demands beyond 2041 with appropriate redundancy. Maximum Day Demand of 3.4 ML/d in 2021 and 3.1 ML/d in 2041 and Storage Volume of (2,558 m^3) in 2021.
Improve Water Quality	Can the alternative provide consistently reliable water quality that meets current and pending regulations?	The Mount Albert Water Supply System can meet current regulations, including the aesthetic objective (AO) of 0.3 mg/L for total iron in drinking water and the potential implementation of the new manganese guidelines, which are the MAC of 0.12 mg/L and the aesthetic objective (AO) of 0.02 mg/L for total manganese in drinking water. Deposition in Mount Albert's distribution system and associated cleaning/flushing are minimized. Negative aesthetic events associated with iron and manganese are controlled in Mount Albert Water Supply System, indicated by reaching ≤2.5 total annual complaints per 1000 customer accounts (AWWA Partnership for Safe Water, 2014) and apparent colour in the distribution system ≤25 units from sampling stations samples and ≤40 units from hydrant samples (AWWA M58).
Improve Water Quality	Does the alternative work with alternatives to improve the North ET maintenance?	Alternative does not preclude implementation of alternatives considered to improve the feasibility of storage maintenance of the Mount Albert Water Supply System
Improve Feasibility of Storage Maintenance	Does the alternative allow the maintenance of the North ET	The North ET can be taken out of service for inspection, cleaning, and proper maintenance, allowing the infrastructure to reach an extended life span and minimizing the potential impact of sediments present in the bottom of the tank on water quality.
Improve Feasibility of Storage Maintenance	Does the alternative work with alternatives to improve water quality?	Alternative does not preclude implementation of alternatives considered to improve the water quality of the Mount Albert Water Supply System

2.2 Alternative Solutions to Improve Water Quality

2.2.1 Alternative A1: Do Nothing

Do Nothing is the baseline non-infrastructure solution considered as part of the Class EA process. In this scenario, the Mount Albert Water Supply System would continue to operate as it currently does, with no changes to existing water supply, treatment or distribution management practices. Iron and manganese would continue to be controlled by sequestration through sodium silicate addition without further optimization.

Although the Mount Albert Water Supply System has sufficient supply capacity and storage to service current and future water demands beyond 2041, this alternative would not address deposition and associated water aesthetic issues. In addition, in the event MECP harmonizes with Health Canada Guidelines for MAC of 0.12 mg/L of manganese, Well 1 would likely remain out of service and projected water demands in 2021 would not be met with adequate redundancy. As this alternative does not provide a solution to the problem, it is not considered further.

2.2.2 Alternative A2: Limit Community Growth

Another non-infrastructure solution to be considered is to Limit Community Growth. This alternative involves restricting population growth within the Mount Albert Community to minimize the impacts on existing infrastructure and resources. Mount Albert Water Supply System continues to operate as it currently does in this scenario, without any changes to existing water supply, treatment or distribution management practices. Iron and manganese continue to be controlled by sequestration through the addition of sodium silicate without further optimization.

As the existing system has sufficient capacity at present for identified long term needs, limiting future growth would provide no benefit to existing conditions. While limiting growth may reduce stress on system redundancy if Well 1 remains out of service to comply with anticipated manganese regulations, this alternative does not address deposition and associated water aesthetic issues. Further, it is inconsistent with York Region and the Town of East-Gwillimbury Official Plans and provincial policy statements. Therefore, this alternative does not provide a viable solution and was not considered further.

2.2.3 Alternative A3: Implement Water Conservation and Efficiency Measures

The Water Conservation and Efficiency Measures alternative involves implementing further water conservation strategies to decrease water demand. An effective water conservation and efficiency program could defer infrastructure expansions of the water supply system required to accommodate future growth. York Region has adopted the One Water Approach, which promotes the reduction of water use and water reuse while providing a positive effect on the long-term water demands. In March 2016, York Region updated the Long-Term Water Conservation Strategy, focusing on the following areas: expansion and enhancement of market-based water conservation programs; development of water reuse projects; development and enhancement of water conservation programs to target high water users; and continued implementation of an education and outreach program.

The ultimate goal of the 2016 Long-Term Water Conservation Strategy is to reduce residential water consumption. Per capita water demand, for example, has been steadily declining over the last decade, resulting in significant water savings that translate into more efficient use of infrastructure, lower energy consumption and fewer greenhouse gas emissions.

York Region and the Mount Albert Community has seen significant success with the water conservation measures that have been put in place. The success of the One Water Approach and Long-Term Water Conservation Strategy were taken into consideration in the forecast of future water demands, making water conservation an integral part of this study and embedded in all alternatives. It is projected the residential water consumption will reduce from the current 233 litres per capita per day to 189 litres per day by 2041.

As the Mount Albert Water Supply System would continue to operate as it currently does in this scenario, without any changes to existing water supply, treatment or distribution management practices, this alternative does not provide a complete solution on its own. There would be no additional measures to improve the deposition of iron and manganese in the distribution system and associated water aesthetic issues.

Therefore, this alternative was not carried forward for further evaluation but is considered intrinsic to all alternatives to ensure sustainability.

2.2.4 Alternative A4: Continue Sequestration at Wells 1&2 Facility and Well 3 Facility, and Upgrade Systems to Optimize Operations and Maintenance

Alternative A4 involves the continuation of sequestration as the control method of iron and manganese, but with the implementation of the optimization strategies recommended in the System Capacity Optimization Study.

While silica dosing system improvements at the wells may allow for more effective sequestration, it is noted that the raw water quality exceeds the recommended targets for effective sequestration at Wells 1 and 2. Although Well 3 presents comparatively better water quality and the improvements may provide more satisfactory results, Well 3 capacity is insufficient on its own to meet the long-term needs of the community.

The interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process cannot be easily avoided for the wells, and the potential for water quality issues remains. Therefore, focused operation and maintenance efforts are required to monitor the sequestration effectiveness across the distribution system and to keep the chlorine contact chambers, North ET and the distribution system free of deposition.

In addition, in the event MECP harmonizes with Health Canada Guidelines for MAC of 0.12 mg/L of manganese, Well 1 would remain out of service and projected water demands in 2021 would not be met with adequate redundancy.

From a technical perspective, while this alternative has some potential to provide a solution to the problem statement, there remains significant uncertainty that successful implementation can be achieved without significant operator intervention and cost. The alternative will, however, be carried forward for further evaluation for more detailed assessment.

2.2.5 Alternative A5: Provide Iron and Manganese Removal Technology for All Wells

Alternative A5 involves providing iron and manganese removal technology for all wells. A review of available treatment technologies undertaken through the recently completed *York Region Groundwater Treatment Strategy* (April 2020) identified the use of the adsorptive filtration using a continuously regenerated adsorptive media for removal. The well supply is pre-oxidated with chlorine to oxidize iron, which then precipitates and is removed through a series of pressure filters. Manganese is removed via adsorption onto the filter media surface. Solids collected through filtration are removed through periodic backwashing for disposal either to the sanitary sewer collection system or on-site residual management, which provides solids concentration on-site, supernatant discharge to a local receiver and sludge disposal off-site or to the sanitary sewer collection system.

Individual treatment facilities can be located at each of the well sites or centralized at one of the facilities with the well supply pumped from the other for treatment. Sufficient space is available at both sites; however, as there are no sanitary sewer collection facilities in the vicinity of Well 3, consideration was given to two sub-options as follows:

- Sub-option A5a: Centralized removal technology at Wells 1 & 2 Facility
- Sub-option A5b: Decentralized removal technology at both facilities

For Alternative A5a, the existing transmission main from Well 3 would be repurposed and extended to convey raw water to a new treatment facility at the Well 1 and 2 site.

For Alternative A5b, treatment facilities would be constructed at each well site, sized for the on-site well capacity. As the sanitary sewer collection system does not extend to Well 3, provisions would be required for residual management suitable for the location.

Reviewing the viability of these alternatives notes that as removal technology would reduce manganese levels below the Health Canada Guideline MAC of 0.12 mg/L of manganese and AO of 0.02 mg/L, Well 1 can be returned to service to provide sufficient supply capacity to meet current and future water demands beyond 2041.

This strategy will provide consistent and reliable removal of iron and manganese and therefore reduce deposition in the chlorine contact chambers, North ET and the distribution system, and associated customer complaints related to discoloured water. The frequency of storage and distribution cleaning would be reduced following the implementation of a focused program to clear the system of existing accumulated deposits.

The treatment facilities are anticipated to consist of a series of pressure filters provided with integrated backwashing provisions and, therefore, it is anticipated that pressure mode operation during elevated tank maintenance could be maintained.

The Alternative A5 sub-options are considered viable for implementation and capable of meeting the screening, and both were carried forward for further evaluation.

2.2.6 Alternative A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility

Alternative A6 combines the solutions of Alternatives A4 and A5. Given the improved raw water quality of Well 3, sequestration would continue for iron and manganese control method at Well 3, following the implementation of the optimization strategies recommended in the System Capacity Optimization Study. Wells 1 & 2 Facility would be upgraded with iron and manganese removal technology as detailed in Alternative A5.

As Well 1 would be returned to service, sufficient supply capacity would be available to meet current and future water demands beyond 2041. The addition of removal technology is anticipated to meet the aesthetic objectives and treatment goals at Wells 1 & 2 Facility and, as the raw water quality at Well 3 is comparatively better than Wells 1 and 2, system optimization may provide for more consistent results. The interference of the identified factors of hardness, alkalinity and potentially phosphate on the sequestration effectiveness process cannot be easily avoided, and the potential for water quality issues remains. Focused operation and maintenance efforts will continue to be required to monitor the sequestration effectiveness across the distribution system. As iron and manganese will still be present in the treated water, frequent inspection and cleaning of the chlorine contact chamber at Well 3 Facility, North ET and the distribution system will be required to minimize deposition.

As the quality of treated water from each facility will be considerably different, there is potential that issues may arise from blending the supplies. The stability of sequestered iron from Well 3 supply could be disturbed by the presence of oxidized iron and manganese in the system contributing to deposition across the distribution system.

While there remains significant uncertainty of the effectiveness of sequestration at Well 3, this option is considered viable due to the lower levels of iron and manganese present in the raw water at Well 3; therefore, it was carried forward for further evaluation.

2.2.7 Alternative A7: Connect New Well (MW18) to Mount Albert Water Supply System and Remove Wells 1 and/or 2

This alternative considers the connection of a new well to the Mount Albert Water Supply System to replace one or more of the existing wells. A preliminary hydrogeological investigation was undertaken by York Region in 2019 to investigate the feasibility of a new groundwater supply well with improved water quality and new test well (Well MW18) was located in the vicinity of Well 3, given its comparatively better water quality.

Results showed that Well MW18 is non-GUDI and capable of producing 38 L/s on a long-term basis while pumping tests were performed up to 47.2 L/s (4.07 ML/d). Table 2-2 presents the MW18 water quality 72-hours pumping sampling results. These results were compared to the Ontario Drinking Water Standards (ODWS) and provincial guidelines and found that all parameters met the corresponding criteria limit/range, with the notable exception of hardness and manganese. Table 2-2 also presents the average water quality of Well 3 for comparison purposes.

Table 2-2. Raw Water Quality for Well MW18 and Well 3

Parameter	Drinking Water Standards or Guidelines [1]	Well MW18[2]	Well 3
Dissolved Organic Carbon, mg/L	5 (AO)	0.73	0.5 - 1.0
pH	6.5-8.5 (OG)	8.04	7.7 - 8.1
Alkalinity, mg/L as $CaCO_3$	30-500 (OG)	211	231 - 248
Hardness, mg/L as $CaCO_3$	80-100 (OG)	287	330 - 349
Ammonium and Ammonia, mg/L as N	0.1[3]	0.13	0.09 - 0.09
Nitrate, mg/L as N	10 (MAC)	<0.5	4.31 - 5.96
Nitrite, mg/L as N	1 (MAC)	<0.05	0.049 - <0.25[7]
Methane, L/m^3	3 (AO)	0.17	0.050 - 0.071
Sulfide, mg/L as H_2S	0.05 (AO)	<0.005	<0.005
Iron, total, mg/L	0.3 (AO)	0.222	0.067 - 0.522
Manganese, total, mg/L	0.05 (AO), HC: 0.12 (MAC)[4], 0.02 (AO)[5]	0.0515	0.040 - 0.056
Sodium, mg/L	200[6] (AO)	6.87	9.1 - 11.3
Calcium, mg/L		80.2	94.9 - 99.8
Magnesium, mg/L		21.1	22.7 - 24.3
Chloride, mg/L	250 (AO)	20.8	26.0 - 31.4
Sulfate, mg/L	500 (AO)	44.2	37.3 - 62.1
Phosphate, mg/L		<0.05	<0.005 - <0.02[7,8]

Notes:

1. Ontario Drinking Water Standards (ODWS) O.Reg. 169/03 – Maximum Acceptable Concentration (MAC); Aesthetic Objectives (AO) and Operational Guidelines (OG) as presented in the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (MOE, 2006).
2. 72-hours sampling per Mount Albert Groundwater Exploration Study
3. Health Canada's Drinking Water Guidelines recommend limiting excess free ammonia to below 0.1 mg/L-N to help prevent nitrification; however, there is no aesthetic objective or maximum acceptable concentration noted.
4. Maximum Acceptable Concentration (MAC) under Health Canada's Drinking Water Guidelines
5. Aesthetic Objective (AO) under Health Canada's Drinking Water Guidelines
6. MOE (2006) notes that "The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L, so that this information may be passed on to local physicians".
7. Where some of the measured values were reported as less than the Method Detection Limit (MDL), the average was calculated by assigning half the MDL to those values. If all measured values were less than MDL or if the average was less than the MDL, the average is indicated as being less than the MDL.
8. The data reported for phosphate for 2016 to 2018 for Well 3 from the MDL of <0.01 to RDL of <2.5 mg/L. The unusually high RDL of 2.5 mg/L would skew the results if used as described in Note 7, and therefore, the historical values for 2010 to 2015 are presented for this parameter using the method described in Note 7 for values reported as less than the MDL for this time period.

Under this alternative, Well 3 Facility would be expanded to connect Well MW18 and Wells 1 and/or 2 would be decommissioned. The provision of better raw water quality allows for the potential that sequestration effectiveness can be improved, and therefore, this alternative considers sub-options that include sequestration continuing at some or all of the facilities after implementation of the optimization strategies, as noted in the three sub-options below:

- Sub-option A7a: Replace Well 1 with Well MW18 and continue sequestration for all wells;
- Sub-option A7b: Replace Wells 1 and 2 with Well MW18, re-rate Wells 3 and MW18 for a maximum taking per minute of 39.4 L/s (3.40 ML/d) to match the forecasted MDD, and continue sequestration;
- Sub-option A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and provide iron and manganese removal technology for Well 2 at the Wells 1&2 Facility.

As Well MW18 testing indicates sufficient quantity of supply, it is considered that the sub-options that replace Well 1 with MW18 would meet the criteria of sufficient supply for the long-term needs. If both Wells 1 and 2 are replaced, it is considered that additional hydrogeological study would confirm the viability of increasing the maximum taking per minute required, as there would be no net increase in daily water taking from the aquifer. Reconstruction of Well 3 would be required for the increased rate. For alternative A7b, as it was noted that the higher elevation areas in the vicinity of Wells 1 & 2 Facility are modelled to experience low pressures when Wells 1 and 2 are off if all supply is delivered from the Well 3 site, then hydraulic modelling would be required to assess whether this arrangement would provide consistent and acceptable system pressures.

While it is noted that preliminary testing showed higher iron concentrations in MW18 than in Well 3, it is considered that the raw water quality would be comparatively better than Wells 1 and 2, and system optimization may provide for more consistent results if sequestration is continued. As noted with previous options, the potential for water quality issues remains, and focused operation and maintenance efforts will continue to be required to monitor the sequestration effectiveness across the distribution system. As iron and manganese will still be present in the treated water, frequent inspection and cleaning of the chlorine contact chamber at Well 3 Facility, North ET, and the distribution system will be required to minimize deposition.

For Alternative A7c, with the blending of treated water from the two facilities, there is potential that issues may arise from blending the supplies. The stability of sequestered iron from Well 3 supply could be disturbed by the presence of oxidized iron and manganese in the system contributing to deposition across the distribution system.

While there remains uncertainty of the effectiveness of sequestration at Well 3 Facility, this option is considered viable due to the improved raw water quality and therefore, all sub-options were carried forward for further evaluation.

2.2.8 Alternative A8: Connect to Existing Alternate Water Supply Source

Alternative A8 involves connecting the Mount Albert Water Supply System to existing water supply sources in the proximity and decommissioning Wells 1 & 2 Facility and Well 3 Facility. Given the rural setting of the community, there are no local options in the near vicinity. The closest connections are as follows:

- Sub-option A8a: Connect to York Water System via a 12 km feedermain to Sharon-Queensville-Newmarket water system.
- Sub-option A8b: Connect to another groundwater supply via a 10 km feedermain to Ballantrae Water Supply System.
- Sub-option A8c: Connect to Georgina Water System via a 22 km feedermain to Keswick.

The York Water System water is sourced from Lake Ontario through the City of Toronto and Region of Peel water systems blended with groundwater supplies from the Yonge Street Aquifer and connection to this system would result in a transfer of water from Lake Ontario watershed to Lake Huron watershed (through discharge of treated wastewater effluent to Lake Simcoe). Policy 3.2.6.3.a of the Provincial Growth Plan (2019) does not permit communities to extend the water services from a Great Lake source unless required for public health and safety. In addition, the Greenbelt Plan allows the extension of water services outside of the settlement area boundary only in case of health issues, which is not the challenge for Mount Albert Water Supply System.

Ballantrae-Musselman Community is supplied by a groundwater water system drawing water from the Thorncliffe Aquifer Complex (TAC), also accessed by the Mount Albert water supply system and presenting similar iron and manganese concentrations. The Ballantrae Water Supply System faces challenges to meet the long-term water needs of the community. A recent Schedule 'B' Municipal Class Environmental Assessment Study was completed to evaluate possible solutions that recommended expansion of the existing well facilities to meet Community demands; therefore, the Ballantrae Water Supply System does not have excess capacity to accommodate Mount Albert water demands.

The Georgina Water System is sourced from Lake Simcoe and connection to this system would require extensive pumping to overcome the 45 m elevation difference. Although this alternative would provide improved water quality to the Mount Albert Community, it is not considered a practical solution due to its technical complexity and construction impacts, combined with significant investment required for construction of the connection and long-term power costs.

Each of the sub-options would require significant investment for connections, and there are additional issues with policy compliance and/or capacity availability. Therefore, this alternative is not technically feasible, and it was not considered further.

2.2.9 Alternative A9: Develop New Water Supply Sources

Alternative A9 involves the exploration of a new groundwater supply source in a new well site, with improved water quality with respect to iron and manganese to replace Wells 1, 2 and 3, which would be decommissioned. Across York Region, there are generally three laterally extensive aquifer units that have historically been considered sufficiently productive for municipal water supply: the shallow Oak Ridges Moraine Aquifer Complex (ORAC) and the deep Thorncliffe Aquifer Complex (TAC) and Scarborough Aquifer Complex (SAC).

The Study Area setting is dominated by the ORAC, which is a shallow aquifer only utilized for private water wells in Mount Albert. The moraine is a major source of groundwater recharge, and a large number of creeks and rivers are derived from groundwater discharge from the moraine. Where the Oak Ridges Moraine deposits are unconfined, typically at the crest of the moraine, the aquifer may be susceptible to contamination from surface water.

The majority of the production wells in York Region are screened in the TAC, including all three (3) municipal production wells in Mount Albert. With some exceptions, these aquifers unit are generally well confined and extensive and has historically demonstrated good yield. These deep aquifers are generally well protected from anthropogenic contaminant sources, and while their groundwater meets ODWS, elevated levels of iron and manganese are typical of the deeper aquifers.

While the shallower aquifer offers lower iron and manganese levels, there is a higher likelihood of capacity issues, groundwater contamination and interference with private wells. As most of York Region wells drawing from the deeper aquifer experience high iron and manganese levels, it is unlikely that a measurably improved water supply could be identified even with an extensive groundwater exploration program. Therefore, this alternative is not considered to offer a practical solution, and it was not considered further.

2.3 Alternative Solutions to Improve Feasibility of Storage Maintenance

2.3.1 Alternative B1: Do Nothing

Do Nothing is the baseline non-infrastructure solution considered as part of the Class EA process. In this alternative, maintenance activities of the North ET are undertaken while it remains in service. As it is reported that in-situ efforts using remote-operated equipment have not been effective for cleaning the tank, this alternative does not facilitate long-term inspection, cleaning and proper maintenance of the tank, and it was not considered further.

2.3.2 Alternative B2: Rehabilitation of Mount Albert South Elevated Tank and Return it to Service

Alternative B2 involves returning the South ET back to service temporarily during the North ET maintenance. It is expected the North ET will be taken off-line for up to 15 days on a 1 to 5-year frequency for routine maintenance and cleaning, depending on the treatment process and for up to 6 months every 20 to 30 years for extensive maintenance.

The South ET is currently offline due to its poor asset condition, and a major rehabilitation is required to bring this tank back into service. The recent condition assessment estimated that a cost of $550,000 would be required in order to restore the tank to provide even temporary service (Landmark, 2020). To return the South ET to full service would require far more extensive structural repairs, including removal and replacement of the coatings inside and outside and all of the piping, electrical, instrumentation, etc. and the estimated cost would be in the order of $2-3M, based on similar ET upgrades.

As the North ET can provide all of the required storage of 2,558 m^3 beyond 2041, the storage volume from South ET is not required for normal operation. The well pumps can also satisfy the maximum day demand to 2041. The South ET has a design storage capacity of 910 m^3, which is sufficient to provide equalization storage for the Mount Albert Water Supply System but does not provide sufficient fire flow storage (1,200 m^3 or 10,000 L/min for 2 hours). As a result, when the North ET is out-of-service, fire supply of 10,000 L/min could not be adequately maintained for 2 hours, and alternative sources of water for fire supply would be required as a contingency. If the maximum permitted taking from the wells could be increased from the current rate of 3,465 L/min (4.99 ML/d) to up to 6,800 L/min (all three wells in service) for this emergency scenario, then the volume of additional storage to provide as contingency could be correspondingly reduced.

Returning South ET to service could provide a benefit to the areas in the distribution network that are modelled to have low pressure near the Wells 1 & 2 Facility due to hydraulic limitations in the distribution system; however, improvements to the coordination of well operations to tank levels could also resolve this issue.

This alternative allows for the adequate maintenance of the North ET with potential improvement to modelled areas of low system pressure; however, it is considered that the extensive capital investment required for the infrequent and isolated occurrences may not be justified. It is therefore carried forward for further evaluation of these issues.

2.3.3 Alternative B3: Operate the Distribution System in Pressure Mode

Alternative B3 involves operating the distribution system in pressure mode when the North ET is by-passed during inspection and maintenance activities. The well pumps are all equipped with VFDs, which can be controlled for pressure mode operation. However, the minimum pumping capacity is approximately 12 L/s based on the minimum pump speed. Since the demand during nighttime can be as low as 3 L/s, the main challenge of this alternative is to avoid overpressurization of the distribution system. Solutions to avoid overpressurization include increasing nighttime demand, typically through irrigation and other outdoor water uses or wasting significant amounts of water, through autoflushers and pressure relief valves. While the North ET is out-of-service, there would be no fire storage available, and the wells' maximum output (6,800 L/min) does not meet the fire flow requirement of 10,000 L/min. Although waiving the maximum permitted taking flow for this emergency scenario may increase fire flow availability, additional alternative sources of water for fire protection would be required as a contingency when North ET is out-of-service.

Hydraulic modelling and field validation is required to assess the operational protocols necessary to avoid overpressurization of the system and the availability of fire flow protection during this scenario, as well as potential testing of all three well pumps in operation to assess the ability to increase the permitted taking requirement. Consideration can also be given in future to replacing one of the well pumps with a smaller pump during longer duration outages, to more closely match low demand; however, this would impact fire flow protection.

Provided that appropriate measures can be implemented to address these issues, this alternative does allow the adequate maintenance of the North ET. Therefore, it was carried forward for further evaluation.

2.3.4 Alternative B4: Provide New Storage

Alternative B4 involves the construction of a new storage facility to allow for North ET by-pass during inspection and maintenance activities. As the North ET capacity is sufficient to meet the projected water storage requirement in Mount Albert Drinking Water System beyond 2041 and there are no requirements for on-site storage for treatment, provision of additional storage would represent a significant investment for effectively redundant supply. Furthermore, additional storage increases the water age in the distribution system, which may contribute to water quality issues related to chlorine residual decay. Therefore, Alternative B4 was not carried forward for further evaluation.

2.4 Summary of the Short-Listed Alternative Solutions

The screening factors provided a high-level assessment of the long list of alternatives. Table 2-3 and Table 2-4 summarizes the screening process carried for each category to identify the viable alternative solutions.

Table 2-3. Screening Assessment to Improve Water Quality

Alternatives	Sufficient Capacity to Meet Demands	Reliable Water Quality	North ET Maintenance Alternatives	Recommendation
A1: Do Nothing	Yes[1]	No	Yes	Not Viable
A2: Limit Community Growth	Yes[1]	No	Yes	Not Viable
A3: Water Conservation and Efficiency Measures	Yes	No	Yes	Recommended as part of any solution
A4: Continue Sequestration at Wells 1&2 Facility and Well 3 Facility, and Upgrade Systems to Optimize Operations and Maintenance	Yes	Yes[2]	Yes	Viable Option for Evaluation
A5: Provide Iron and Manganese Removal Technology for All Wells	N/A	N/A	N/A	N/A
Sub-option A5a: Centralized Removal Technology at Wells 1 & 2 Facility	Yes	Yes	Yes	Viable Option for Evaluation
Sub-option A5b: Decentralized Removal Technology at both Facilities	Yes	Yes	Yes	Viable Option for Evaluation
A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility	Yes	Yes[2]	Yes	Viable Option for Evaluation

Alternatives	Sufficient Capacity to Meet Demands	Reliable Water Quality	North ET Maintenance Alternatives	Recommendation
A7: Connect New Well (MW18) to Mount Albert Water Supply System and Remove Wells 1 and/or 2	N/A	N/A	N/A	N/A
Sub-option A7a: Replace Well 1 with Well MW18 and Continue Sequestration for all Wells	Yes	Yes [2]	Yes	Viable Option for Evaluation
Sub-option A7b: Replace Wells 1 and 2 with Well MW18, Re-rate Wells 3 and MW18, and Continue Sequestration	Yes	Yes [2]	Yes	Viable Option for Evaluation
Sub-option A7c: Replace Well 1 with Well MW18, Continue Sequestration at Well 3 Facility, and provide iron and manganese removal technology at Wells 1&2 Facility	Yes	Yes [2]	Yes	Viable Option for Evaluation
8A: Connect to Existing Alternate Water Supply Source	No	No	Yes	Not Viable
9A: Develop New Water Supply Sources	Yes	No	Yes	Not Viable

Note:

1. Provided Well 1 remains in service.
2. Provided optimization strategies and infrastructure improvements address issues, potential interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process are not limiting, and potential blending issues can be mitigated, when applicable.

Table 2-4. Screening Assessment to Improve Feasibility of Storage Maintenance

Alternatives	Maintenance of the Mount Albert North Elevated Tank	Improve Water Quality Alternatives	Recommendation
B1: Do Nothing	No	Yes	Not Viable
B2: Rehabilitation of Mount Albert South Elevated Tank and Return it to Service	Yes	Yes	Viable Option for Evaluation
B3: Operate the Distribution System in Pressure Mode By-passing the North Elevated Tank	Yes	Yes	Viable Option for Evaluation
B4: Provide New Storage	Yes	No	Not Viable

Based on the screening evaluation presented, the following alternatives were considered viable options for further evaluation:

A) Improve water quality

- **Alternative A4:** Continue Sequestration at Wells 1&2 Facility and Well 3 Facility, and Upgrade Systems to Optimize Operations and Maintenance
- **Alternative A5:** Provide Iron and Manganese Removal Technology for All Wells
  - Sub-option A5a: Centralized removal technology at Wells 1 & 2 Facility
  - Sub-option A5b: Decentralized removal technology at both facilities

- **Alternative A6:** Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility
- **Alternative A7:** Connect New Well (MW18) to Mount Albert Water Supply System and Remove Wells 1 and/or 2
  - Sub-option A7a: Replace Well 1 with Well MW18 and continue sequestration at both facilities
  - Sub-option A7b: Replace Wells 1 and 2 with Well MW18, re-rate Wells 3 and MW18, and continue sequestration
  - Sub-option A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and provide iron and manganese removal technology at Wells 1&2 Facility

B) Improve feasibility of storage maintenance

- **Alternative B2:** Rehabilitation of Mount Albert South Elevated Tank and Return it to Service
- **Alternative B3:** Operate the Distribution System in Pressure Mode

In addition, the following enhancements were identified to be included in all alternatives to improve the overall system redundancy, reliability and performance:

- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the North ET
- Collaborate with Town of East Gwillimbury to develop and implement a tailored monitoring program for the distribution system to assess and track water quality and maintenance needs of the distribution system
- Collaborate with Town of East Gwillimbury to refine a unidirectional flushing program to identify optimal flushing conditions and frequency and implement a swabbing program to address accumulated deposits. The goal would be to achieve ≤2.5 total annual complaints per 1000 customer accounts (AWWA Partnership for Safe Water, 2014) and apparent colour in distribution system ≤25 units from sampling stations samples and ≤40 units from hydrant samples (AWWA M58).
- Validate low pressure detected by the hydraulic model is occurring in the distribution system, then determine operational adjustments required to address the low-pressure issues in the distribution system without compromising water quality.

3. Supplemental Studies to Support Development of Short-Listed Alternatives

To support the evaluation of the short-listed alternatives, a series of desk-top analysis and field studies were undertaken to allow for the assessment of potential impact and the required mitigating measures.

3.1 Land-use

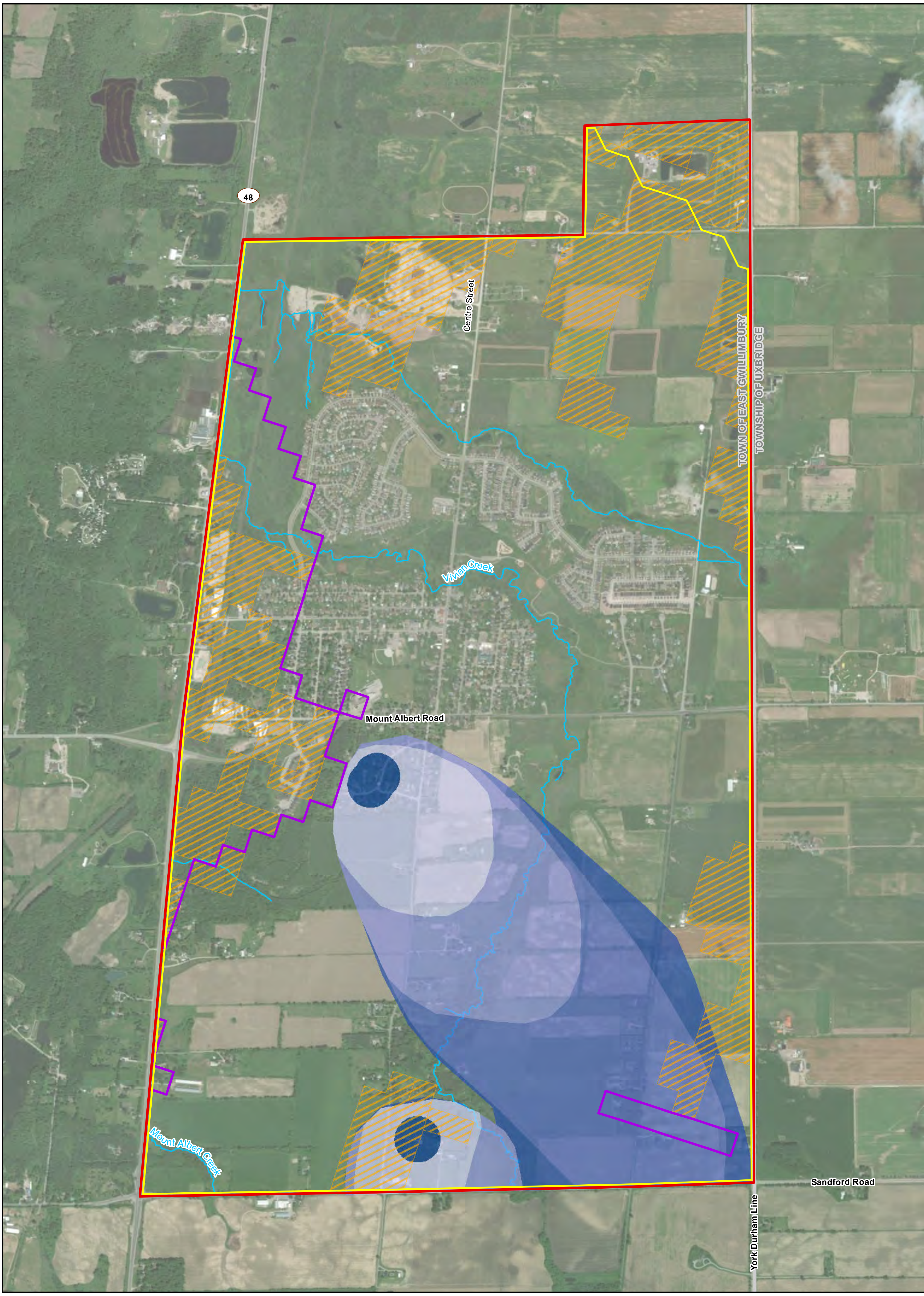
Located on the eastern border of East Gwillimbury, the Community of Mount Albert is primarily a residential community with a commercial, institutional and retail support area, surrounded by farms, regional forests and conservation areas. The urban area occupies the northern portion of the Study Area, while agricultural/rural land is located in the southern portion. Most of the Study Area is within the Greenbelt Plan and is designated "Protected Countryside" (92% of the study area), and a small portion of the land to the west is within the Oak Ridges Moraine Conservation Plan (ORMCP) area (8% of the study area).

Most of the Study Area is within Recharge Management Area (WHPA-Q). The south-central area of the Study Area, which includes a portion of Well 3 Facility, contains significant groundwater recharge areas per the Lake Simcoe Region Conservation Authority (LSRCA). The west-central area includes areas of highly vulnerable aquifers per ORMCP and LSRCA. The southeastern portion of the Study Area also includes Wellhead Protection Areas (WHPA) for Wells 1 and 2 and Well 3. The land-use activities in these areas may impact the groundwater quality and quantity, and proposed developments or change in activity must comply with the local source water protection plan according to the *Clean Water Act* (2006). A map indicating the land designations relative to source water protection is shown in Figure 3-1.

A number of underground utilities are located within the Study Area.

- Local watermains, sanitary sewers and storm sewers owned and operated by the Town of East Gwillimbury
- Hydro One Networks Inc.
- Enbridge Gas Distribution
- Bell Canada
- Rogers Cable Communications Inc

A Subsurface Utility Engineering investigation was completed within Wells 1& 2, Wells 3 and North ET facilities and confirmed the presence of these utilities in the anticipated impacted area. The actual location of the above outside the Wells 1& 2 Facility, Wells 3 Facility and North ET will be confirmed during the preliminary and detailed design phase of the project. For additional details, the Subsurface Utility Engineering Study can be found in **Appendix A**.



Recharge Management Area (WHPA-Q)
LSRCA Highly Vulnerable Aquifers
LSRCA Significant Groundwater Recharge

Wellhead Protection Area
2 Year Zone
5 Year Zone
10 Year Zone
25 Year Zone
100 m Radius

Watercourse
Study Area

N
0 100 200
Metres

Note:
1. Aerial Source: Vivid-Canada, 2013.

Figure 3-1
Source Water Protection
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3.2 Natural Features Assessment

3.2.1 Geotechnical and Hydrogeology

Ground surface topography in the Study Area ranges from a high of approximately 309 m above sea level (mASL) at the southern extent of the Study Area to a low of 228 mASL in the northwestern portion of the Study Area. The Well 1 & 2 Facility is located south of the main community of Mount Albert between residential properties on all sides, and the topography is undulating and slopes down to the south and west. The Well No. 3 Facility is located south of the main community of Mount Albert situated between agricultural fields immediately to the north, south, east and west of the property, and the topography is slightly undulating and slopes down to the north and east. The North ET property is located within the northeast corner of the community of Mount Albert between residential properties to the east, west and south and agricultural fields to the north, with relatively steep gradients.

The geology in the Study Area typically consists of post-glacial deposits (recent deposits) over the Oak Ridges Moraine Aquifer Complex (ORAC). In the direct vicinity of the Wells 1 & 2 Facility, Well 3 Facility, and the North ET, the regional geology is characterized by post-glacial deposits over Newmarket Till. The post-glacial deposits are typically comprised of sand, silt and/or clay sediments that form relatively thin and locally discontinuous layers, which may also include organic deposits, man-made deposits, as well as modern alluvial deposits along present day rivers and streams. The ORAC is comprised of interlobate glacial deposits whose texture ranges from silt to gravelly sand, but that typically consists of sand and gravel sediments. The ORAC is discontinuous and absent at each of the facilities but is present as a shallow discontinuous layer nearby each of the three sites. The Newmarket Till is comprised of dense sand to silty sand diamicton sediments.

The physiographic landforms characterizing the Study Area are predominantly drumlins, till plains, sand plains, and peat and muck. The surficial soils vary across the Study Area. Wells 1& 2, Wells 3 and North ET facilities are all located in regions characterized by till material consisting of stone-poor, sandy silt to silty sand on Paleozoic Terrain. Fine and coarse-textured glaciolacustrine deposits, alluvial deposits and organic deposits can also be expected at the surface across the Study Area.

The Study Area has several unique physiological features which may require significant construction efforts (earthworks or extending foundations), especially in the vicinity of a water body or similar. The modern alluvial deposits that are encountered near creeks, rivers and other similar bodies of water will typically contain organics and loose soils that would require removal or foundations that extend below these incompetent soils. The topography of the local terrain typically slopes towards these surficial alluvial deposits, which was observed at the existing facilities.

The Study Area hydrogeological setting is dominated by the ORAC, a shallow aquifer only utilized for private water wells in Mount Albert. It was identified approximately 400 well records in the Study Area associated with domestic use, livestock and commercial use. ORAC aquifer is discontinuous and absent at the wells production sites but present nearby of these locations.

The Mount Albert production wells are interpreted to draw water from the TAC. TAC aquifer unit is deep and well protected from anthropogenic contaminant sources due to confinement by overlying till units. There is no apparent hydraulic connection with the TAC or Inter-Newmarket Sediments (INS) aquifer units with the ORAC aquifer unit within the vicinity of the production wells. However, there is some degree of hydraulic connection between the INS and TAC within the vicinity of Well 3.

In general, the raw groundwater quality observed in production wells meets the Ontario Drinking Water Quality Standards (ODWQS), except for iron and manganese, which routinely exceed the provincial aesthetic objectives for these parameters. The elevated levels of iron and manganese are typical of the deeper aquifers in York Region and are attributed to naturogenic sources. The iron and manganese concentration trends are generally stable, indicating that the water quality is at equilibrium with the aquifer material. Recent exploration and water quality analysis have indicated no faecal contamination or indication of the presence of enteric protozoa and other microorganisms, confirming that the Mount Albert production wells are not Under Direct Influence of surface water (non-GUDI).

Monitoring of stream stage height in Vivian Creek during pumping tests at Well MW18 and Well 3 and chemical comparison of Vivian Creek surface water and groundwater sampled from ORAC and TAC monitoring wells indicate no direct hydraulic connection between surface water and groundwater within the vicinity of Well 3 and MW18.

Within the vicinity of Wells 1 & 2 Facility and Well 3 Facility, the depth to the water table is estimated to be between 12 m and 14 m Below Ground Surface (bgs), and 7 m and 10 m bgs, respectively. Construction dewatering requirements are not anticipated to be significant at these facilities. Within the vicinity of the North ET, the depth to the water table is estimated to be between <1 m and 22 m bgs, and substantial construction dewatering volumes are anticipated at the North ET facility.

For additional details, the Geotechnical Study and the Hydrogeological Study can be found in **Appendix B** and **Appendix C**, respectively.

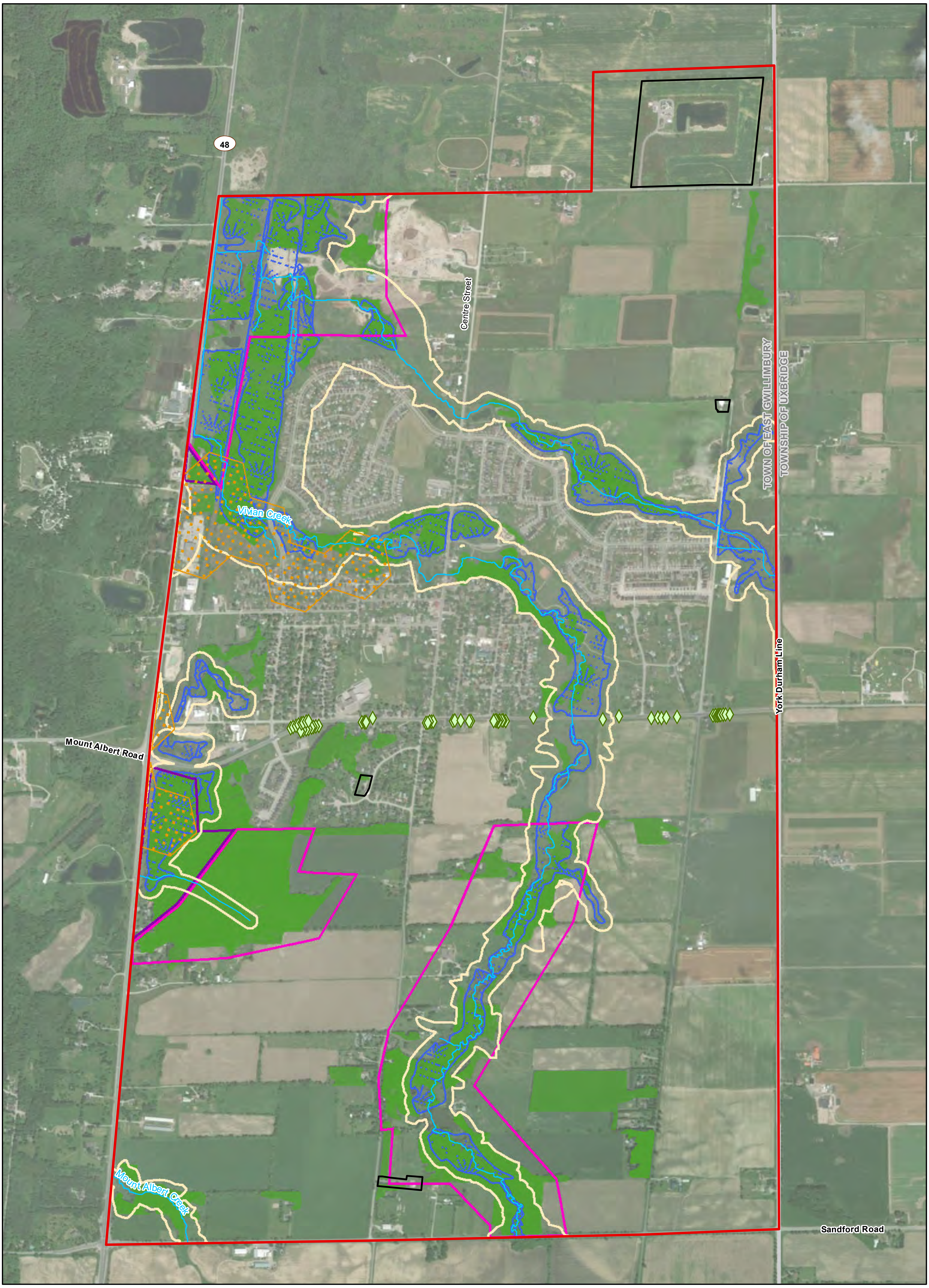
3.2.2 Aquatic and Terrestrial Environment

The Study Area is located in the Lake Simcoe Watershed within the Black River Subwatershed and is within the LSRCA jurisdiction. Mount Albert Wells 1&2 Facility and Well 3 Facility are near Vivian Creek, which is a tributary to Mount Albert Creek and the Black River. Vivian Creek flows in a generally north and westerly direction from south of the Study Area, until it discharges into Mount Albert Creek near the intersection of Highway 4848 and Queensville Sideroad. Vivian Creek is considered to be a cool water habitat based on thermal regime and the fish community (LSRCA, 2010). Fish species found in waterbody include Brook Trout, Largemouth Bass, Pumpkinseed, Rock Bass, White Sucker, Northern Redbelly Dace, Fathead Minnow, Eastern Blacknose Dace, Longnose Dace, Creek Chub, Central Mudminnow, Mottled Sculpin, Brook Stickleback, and Johnny Darter. None of these species are endangered, threatened, or special concern per O. Reg. 230/08: Species at Risk in Ontario List.

According to Ministry of Natural Resources and Forestry (MNRF) mapping and GIS layers received from York Region, the Study Area supports a number of significant natural environmental features: forest and woodlands, creeks, LSRCA regulated areas including wetlands, Greenbelt natural heritage system, ORM natural core areas including wetlands, and wellhead protection areas. On the other hand, no Areas of Natural and Scientific Interest (ANSI), Environmental Sensitive Area (ESA), Provincially Significant Wetlands (PSW), habitat of endangered, rare or threatened species per ORMCP or other significant ecological area are found in Study Area. It should be noted that the wetlands adjacent to the Wells 1 & 2 Facility and Well 3 Facility have not yet been evaluated under the Ontario Wetland Evaluation System (OWES) and construction in their vicinity would need to consider their current designation. These significant aquatic and terrestrial features are documented in Figure 3-2. These features need to be avoided to the extent possible.

Mature trees and dense vegetation border the western and northern perimeter of the Well 1 & 2 Facility with a relatively steep slope that tapers into the adjacent residential properties. The immediate area around Well No. 3 Facility is relatively clear of mature trees or dense vegetation; however, a forested area with treed swamps and marsh is located near the northeast corner of the property. The North ET property area includes a few mature trees and vegetation along the northern perimeter.

A map indicating the aquatic and terrestrial features is shown in Figure 3-2.



Street Tree
LSRCA Regulated Area
ORM Conservation Priority Area
LSRCA Wetland
Forest/Woodland
ORM Natural Core Area
Greenbelt Natural Heritage System
Watercourse
Property Boundary
Study Area

Note:
1. Aerial Source: Vivid-Canada, 2013.

Figure 3-2
Aquatic and Terrestrial Environment
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3.3 Surface Water Study

A surface water study was undertaken to document baseline information related to nearby natural receiving waters and to provide an initial assessment of potential surface water impacts from the management and disposal of residuals from the iron and manganese removal technology.

The backwash wastewater containing the solids collected through filtration can be disposed either direct to the sanitary sewer collection system or receive on-site treatment. The on-site treatment system would be required to treat the backwash wastewater to a quality that would allow it to be discharged to the environment, either directly or via the stormwater system. The alternatives considered the use of the gravity settling process as on-site treatment which can typically achieve 90% removal of suspended solids, along with iron and manganese. The sludge generated in the on-site treatment can be pumped to the sanitary sewer collection system or hauled to Duffin Creek Water Pollution Control Plant (WPCP) for further treatment and disposal. Backwash wastewater or generated sludge, directed to the sanitary sewer collection system, are treated at the Mount Albert Water WRRF.

The Mount Albert WRRF, located at 5866 Doane Road, Mount Albert, has a design capacity of 2.04 ML/d to service a population of 6,000 based on a per capital flow of 340 L/cap/d. From 2015 to 2017, the maximum raw wastewater flowrate was 74.47 L/s, while the total influent flow ranged from 0.8 ML/d to 1.8 ML/d, with and average daily flow of 1.15 ML/d. The Mount Albert WRRF generally meets its effluent compliance limits, except for some historical monthly exceedances of TSS, Total Phosphorous and TAN.

The capacity assessment of Mount Albert WRRF completed in 2018 (Blue Sky) reported the liquid train estimated equivalent capacity as 1.90 ML/d limited by the oxygenation system and the solid train estimated equivalent capacity as 1.18 ML/d (or 295 kg/d of dry solids) limited by the sludge holding tank. The sludge holding tank capacity assessment considered a minimum of 4-day storage to allow for the storage over a long weekend. Iron and manganese concentrations are recommended to be less than 0.1 mg/L at the inlet of the UV disinfection units to avoid fouling. Considering the iron and manganese loads and the performance of existing secondary clarifier and tertiary treatment processes, there are no concerns with regards to achieving the required iron and manganese levels prior to the UV reactors.

The Duffin Creek WPCP, located at 901 McKay Rd, Pickering, has a design capacity of 630 ML/d and it is operated by the Regional Municipality of Durham. From 2017 to 2019, the maximum raw wastewater flow was 787 ML/d, while the average daily flow was 339 ML/d. The Duffin Creek WPCP generally meets its effluent compliance limits. The Duffin Creek WPCP includes a septage receiving station and also imports sludges from facilities within the Regional of Municipality of York and the Regional Municipality of Durham.

Discharge of the supernatant from the on-site treatment to Vivian Creek would need to consider the impact on stream flow and quality. There is limited data available to estimate a low flow value (e.g., the 7Q20 flows noted in MOEE, 1994) for assessment of impact; however, based on information collected by York during the groundwater exploration study, the lowest reported Creek stream flow 6,400 m^3/d (74 L/s) was used for the preliminary assessment.

There is also limited water quality data available. Using data collected from a provincial water quality monitoring station on Mount Albert Creek, downstream of the confluence of Vivian Creek and Mount Albert Creek near the intersection of Highway 48 and Queensville Sideroad E (Station 03007702102) and Vivian Creek samples collected by York Region, a comparison to the PWQOs indicated that the median and 75^{th} percentile of the data collected from are within the PWQOs, with the exception of aluminium, cadmium, iron, one field pH measurement, total phosphorus, and zinc.

The preliminary assessment identified ten water parameters as potential concerns with discharging the supernatant to Vivian Creek.

- Chlorine
- Dissolved Oxygen
- Iron
- Manganese
- Nitrate
- Total Ammonia Nitrogen
- Total Suspended Solids
- Temperature
- Total Phosphorus
- Turbidity

Analysis of available data indicates that levels of chlorine, iron, manganese, and total suspended solids would need to be reduced to prevent impacts to Vivian Creek. Effluent limits for chlorine and total suspended solids were proposed for consideration based on the available data for the purpose of the Class EA study. However, limited Vivian Creek stream flow and water quality data are available near the proposed discharge points for the supernatant to assess the impact of iron and manganese discharge. It was recommended to further assess the treatment requirements for the backwash wastewater and effluent discharge limits.

3.4 Cultural Environment

A Stage 1 Archeological Assessment (AA) was conducted to establish the archaeological potential of the areas to be potentially impacted by alternative solutions. The following heritage and archeological features were identified in the community:

- Two designated heritage resources: the Mount Albert Wesleyan Methodist Pioneer Cemetery at 19015 Center Street and the George Haigh House at 5716 Mt. Albert Road
- Four early cemeteries: Franklin Pioneer Cemetery at 5548 Herald Road; Mount Albert Cemetery at 19675 Centre Street; the Mount Albert Wesleyan Methodist Pioneer Cemetery; and Birchard Family Burying Ground at 5590 Mount Albert Road
- Five registered archeological sites

No heritage conservation districts, commemorative plaques or monuments are located in the Study Area or within 300 m of the Study Area.

The only heritage feature located in proximity to the area potentially impacted by the works is the Mount Albert Wesleyan Methodist Pioneer Cemetery. The swaths of land adjacent to the Mount Albert Wesleyan Methodist Pioneer Cemetery were identified as having moderate or high potential for the recovery of unmarked burials, and additional archaeological/cemetery investigations are required in case construction activities occur in this area. Lands beyond the 20-metres of the cemetery were identified as having low potential for unmarked burials, and are considered free of further investigations.

A portion of the Study Area was determined to have been subjected to deep and extensive disturbances such as existing roadways and rights-of-ways, buried utilities, structural footprints, previous grading and construction activities, etc. that have removed archaeological potential. Several areas within the Study Area have been subject to previous archaeological assessment and cleared of further archaeological concern, and Vivian Creek has been identified as a feature of no or low archaeological potential. The remaining area was identified as retaining archaeological potential.

Most of Wells 1 & 2 Facility property has been considerably disturbed; however, the northwest and south of the property retain archaeological potential. The forested area at Well 3 Facility and a portion of the property near the northeast corner of the property, as well as the immediate area around Well No. 3 Facility, retain archaeological potential. These areas identified as retaining archaeological potential requires further archaeological investigation and must be subjected to a Stage 2 AA in case construction activities or other soil disturbing activities occur within these areas, including construction laydown areas.

For additional details, the Stage 1 Archeological Assessment can be found in **Appendix E**.

4. Development of Short-Listed Alternative Solutions

The following section established the conceptual designs and the technical considerations, as well as preliminary costs for each short-listed alternative. The concept designs were developed to establish the level of effort related to each alternative to allow the comparative evaluation for the purpose of the Class EA study. The design concept for the preferred alternative will be confirmed, refined and detailed in Phase 5 of the Class EA Study.

To calculate the Whole Life Cost (WLC) of each alternative, a 20-year planning period from 2021 to 2040 was used, and the following assumptions were applied:

- On capital projects, an allowance of 20% for design/engineering and contract administration/site inspection, and a 30% construction contingency based on the construction costs were included in calculating the total capital investments;
- An allowance of 5% of capital projects or studies was used for York Region's Project Management;
- A HST rate of 1.76% was used;
- An interest rate of 5% and an inflation rate of 3% were used;
- The capital costs were distributed along the 20 years, according to the planning horizon for the required infrastructure investments;
- Costs associated with the renewal of new or existing infrastructure were not considered;
- Revenue from the Town of East Gwillimbury is considered equal for all alternatives (related to the demand), therefore, not included in the analysis;
- Operation and maintenance expenditures included chemical consumption, power consumption related to additional building footprint, sludge haulage, additional operation and maintenance labour effort required, water and sewer fees, cleaning of storage and contact tanks, distribution system cleaning program and monitoring, where applicable.
- Any costs related to cleaning of the local distribution system will be assumed by the Town of East Gwillimbury and were not considered;
- Costs related to the risks of each alternative are not being considered.

It is important to note that in the WLC analysis, the common works between the alternatives are not included in this analysis, including the works related to current operation & maintenance of the wells, the North ET, and water distribution system.

4.1 Alternative Solutions to Improve Water Quality

4.1.1 Alternative A4: Continue Sequestration at Wells 1&2 Facility and Well 3 Facility, and Upgrade Systems to Optimize Operations and Maintenance

Conceptual Design

Alternative A4 involves the continuation of sequestration as the control method of iron and manganese with the implementation of the optimization strategies. The System Capacity Optimization Study has identified the following opportunities to address identified system constraints and improve the operation of the existing system.

- Silicate dosing systems:
  - Implement improvements undertaken at Wells 1 & 2 Facility at Well 3 Facility to allow for tempered flushing and cleaning of the calibration columns and injection points

- Supply a pressure or flow switch to provide a more positive indication of silicate application at both facilities
- Increase regular mixing and changeover in sodium silicate tanks to maintain silicate product quality at both facilities
- Continued monitoring and validation of dosage accuracy for continuous process improvements
- Review of the impact of raw water chemistry on sequestration effectiveness, as infrastructure issues are addressed.

- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank
- Collaborate with the Town of East Gwillimbury to develop and implement a tailored monitoring program for the distribution system to assess and track iron and manganese sequestration effectiveness and distribution system maintenance needs.
- Collaborate with the Town of East Gwillimbury to refine a unidirectional flushing program to identify optimal flushing conditions and frequency and implement a swabbing program to address accumulated deposits
- Validate the low pressure detected by the hydraulic model is occurring in the distribution system, then investigate operational adjustments to address the low-pressure issues in the distribution system without compromising the water quality.

Figure 4-1 presents the schematic diagram for this alternative.

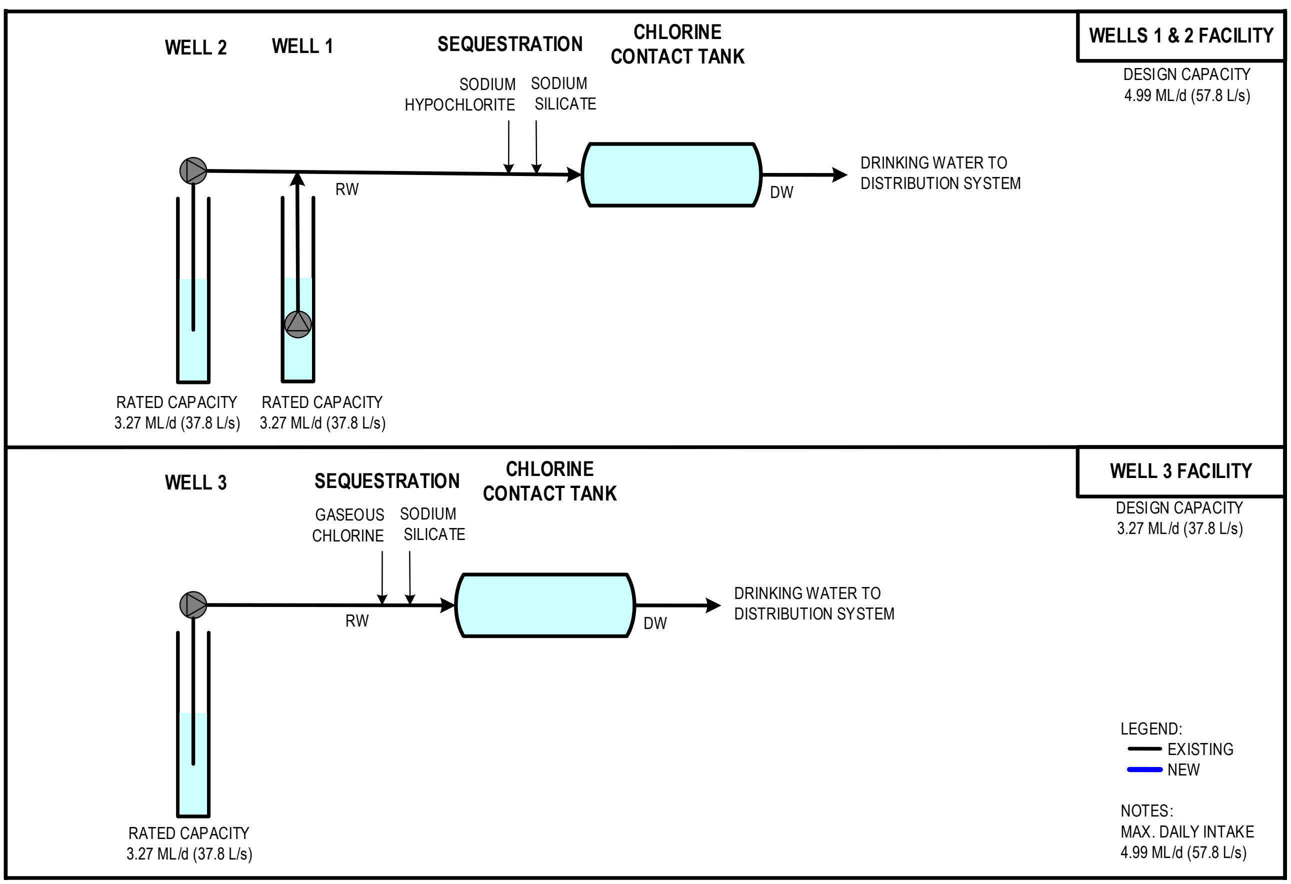

Figure 4-1. Alternative A4 Schematic Diagram

Technical Considerations

The current practice of sequestration with sodium silicate to complex iron and manganese and prevent deposition in the distribution system and subsequent water quality problems is not providing complete control. It is noted that the raw water quality exceeds the recommended targets for effective sequestration at Wells 1 and 2. Although raw water quality in Well 3 is comparatively better, the interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process cannot be easily avoided for all wells, and the potential for water quality issues remains. It is also recognized that there are likely many compounding influences on the effectiveness of sequestration, in addition to raw water characteristics, including sodium silicate dosage control, and the condition of the contact chambers, water distribution system and North ET.

While the proposed capital improvements may improve existing operation, significant focused operation and maintenance efforts would be required to monitor the sequestration effectiveness across the distribution system and to minimize deposition at the chlorine contact chambers, North ET and the distribution system. The iron and manganese deposition in the distribution system is considered potentially heavy (>10 g/m/year), requiring frequent cleaning and flushing of the system to address the deposition of solids and associated negative aesthetic events in order to reduce customer complaints.

Also, the alternative presents challenges in accommodating the new Health Canada manganese guidelines, if it is implemented by MECP, as maintaining Well 1 in operation is required to provide adequate redundancy throughout the planning horizon.

No modification of the PTTW is required, but an amendment of the DWWP and the MDWL will be required to include the modification of sodium silicate dosing system.

The timeline for implementation of Alternative A4 is at least 2.25 years, considering 3 months for detailed design procurement, 9 months for design, 3 months for construction procurement, and 12 months for construction.

Whole Life Cost

To implement Alternative A4, the key infrastructure upgrades and Operation & Maintenance (O&M) initiatives are proposed below. The WLC analysis was estimated on Net Present Value (NPV). Table 4-1 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A4. Detailed calculations are presented in **Appendix G**.

- Silicate dosing system improvement at Wells 1 & 2 Facility (flow switch and sodium silicate storage)
- Silicate dosing system improvement at Well 3 Facility
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank
- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-1. Alternative A4: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Sub-Component	Preliminary Cost[1]
Capital Investment[2]	Silicate dosing system improvement at Wells 1 & 2 Facility	$80,000
Capital Investment[2]	Silicate dosing system improvement at Well 3 Facility	$200,000
Capital Investment[2]	Design & Construction Administration (20%)	$56,000
Capital Investment[2]	Contingency (30%)	$102,000
Capital Investment[2]	York Region Project Management (5%)	$24,000
Capital Investment[2]	HST (1.76%)	$11,000
Capital Investment[2]	**Total Capital Costs**	**$473,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$115,200
Operation & Maintenance Expenditures[3]	Clean and inspection of 2 chlorine contact chambers (every year)[4]	$1,200,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every year)[4]	$400,000
Operation & Maintenance Expenditures[3]	Unidirectional flushing program (every year)[4]	$768,000
Operation & Maintenance Expenditures[3]	Swabbing program (every 5 years)[4]	$352,000
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$1,000,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$3,835,200**
Net Present Value	Capital Investment (Discounted)	$453,938
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$3,214,485
Net Present Value	**Total Whole Life Cost**	**$3,668,423**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2024.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering heavy accumulation of deposits in the distribution system.

4.1.2 Alternative A5: Provide Iron and Manganese Removal Technology for All Wells

Conceptual Design

Alternative A5 involves providing iron and manganese removal through adsorptive filtration and chlorine as oxidant. A multi-filter design approach has been applied in order to minimize equipment, footprint and backwash volume requirements. Viable residual management strategies are discussed in Section 4.1.5. This alternative is divided into two sub-options: A5a: Centralized removal technology at Wells 1 & 2 Facility, and A5b: Decentralized removal technology at both facilities. Table 4-2 presents the key features for the concept design. Figure 4-2 and Figure 4-3 present the schematic diagrams for each sub-option of this alternative.

Table 4-2. Alternative A5: Key Concept Design Features

Facility	Alternative	A5a: Centralized Removal Technology at Wells 1 & 2 Facility	A5b: Decentralized Removal Technology at both Facilities
Wells 1 & 2	Design Capacity (ML/d)[1]	4.99[2]	4.99[3]
Wells 1 & 2	Filtration System[4]	10 filters of 1.2 m dia. (4 ft)	10 filters of 1.2 m dia. (4 ft)
Wells 1 & 2	Residual Volume (m^3/d)[5]	60-100	60-100
Wells 1 & 2	Footprint required[6]	9 m X 5.5 m (50 m^2)	9 m X 5.5 m (50 m^2)
Well 3 Facility	Design Capacity (ML/d)[1]	N/A	3.27[7]
Well 3 Facility	Filtration System[4]	N/A	8 filters of 1.2 m dia. (4 ft)
Well 3 Facility	Residual Volume (m^3/d)[5]	N/A	50-80
Well 3 Facility	Footprint required[6]	N/A	7.5 m X 5.5 m (40 m^2)
	Total Firm Capacity (ML/d)[8]	**4.91**	**4.89**

Notes:

1. Maximum water taking of 4.99 ML/d (57.8 L/s) with a maximum taking per minute per well of 3.27 ML/d (37.88 L/s) per current PTTW.
2. Any combination of Wells 1 to 3.
3. Any combination of Wells 1 and 2.
4. Maximum design filtration flowrate of 18 m/h will all filters in service and 20 m/h with one filter out of service.
5. Each filter in operation is backwashed once daily.
6. Building housing the removal technology and the associated equipment, including oxidant dosing systems. Residual management requirements identified separately.
7. Well 3 only.
8. Considering the loss of backwash volume without air scour.

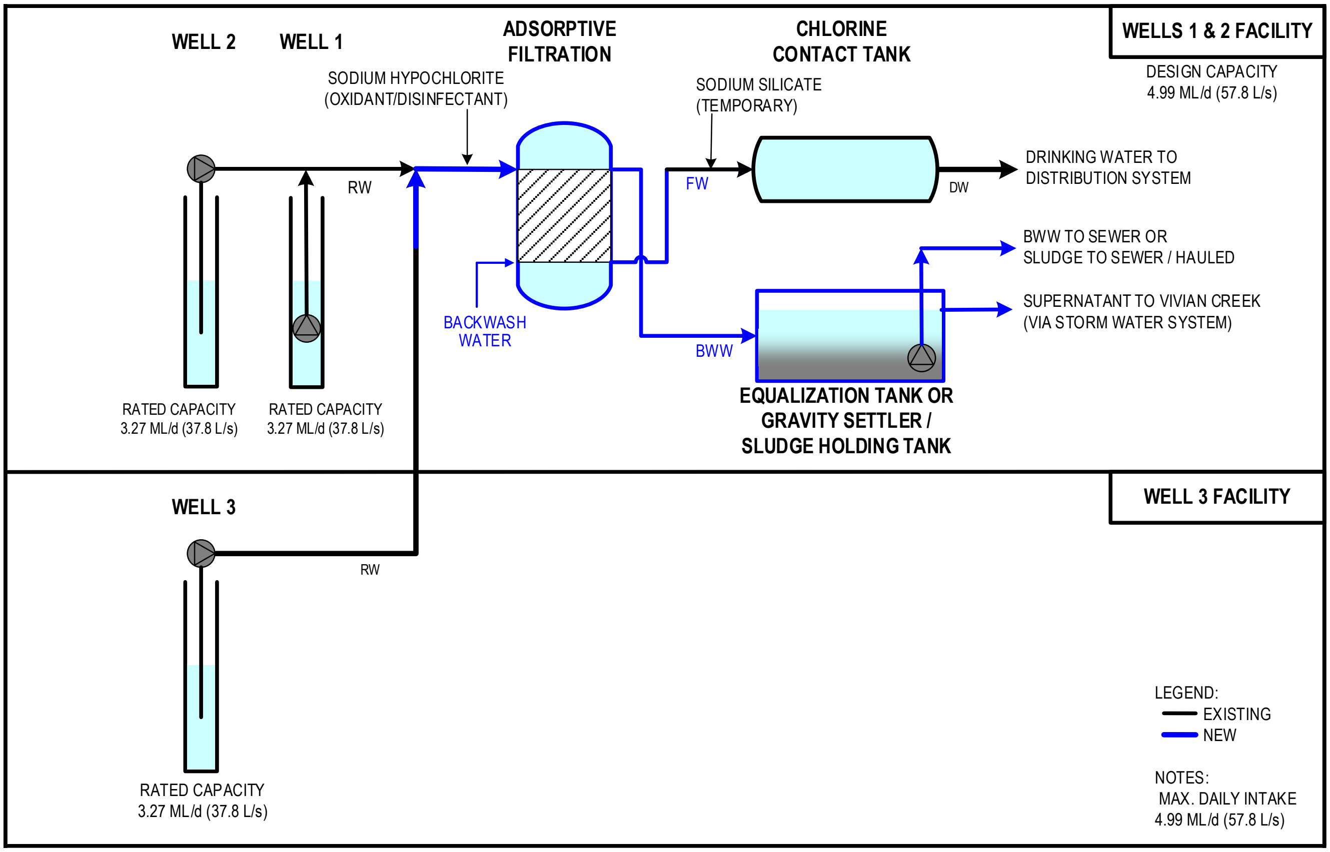

Figure 4-2. Alternative A5a Schematic Diagram

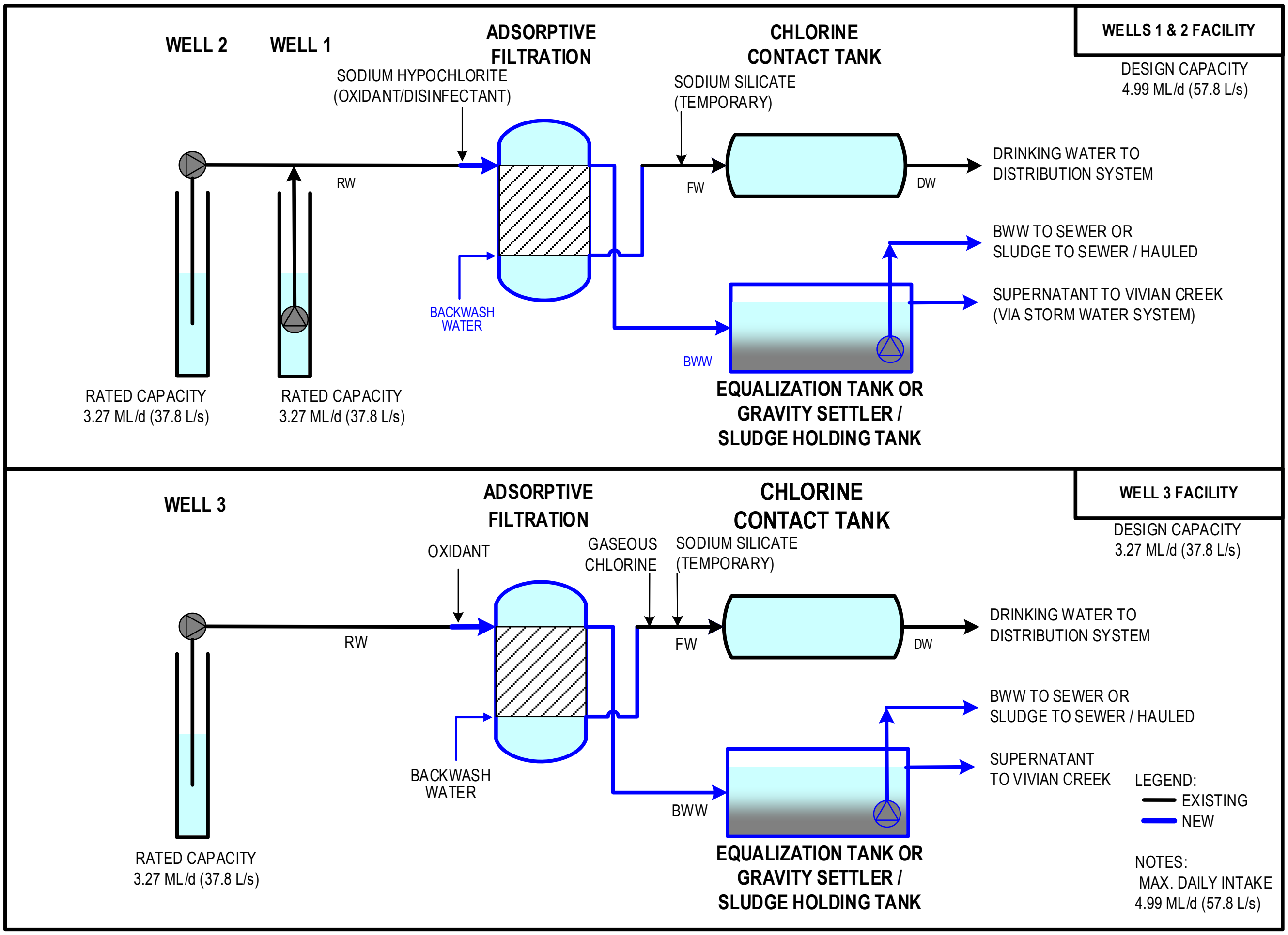

Figure 4-3. Alternative A5b Schematic Diagram

For Alternative A5a, the existing 400 mm CPP transmission main would be repurposed as a raw watermain between Well 3 Facility and the corner of Centre Street and Cupples Farm Lane as there are no customers serviced from this length. A new raw watermain would be extended 350 m along Cleverdon Boulevard to reach Wells 1 & 2 Facility. For Alternative A5b, no linear infrastructure is required.

Both treatment facilities sites have the potential to accommodate the identified building footprint to house the removal technology. For Wells 1 & 2 Facility, a new building housing the removal technology and the associated equipment could be located north or south of the existing building. For Well 3 Facility, a building extension northeast of the existing building would house treatment equipment. The final location of the new buildings will be defined during design. York Region is planning to replace the sodium hypochlorite system with a chlorine gas system at Wells 1 & 2 Facility. It is being considered the existing sodium hypochlorite room can be modified to accommodate the new chlorine system. The conceptual site layout for each sub-option is presented in **Appendix F**.

Technical Considerations

The addition of removal technology would allow for aesthetic objectives and treatment goals to be achieved consistently. This strategy considerably reduces the levels of iron and manganese in the treated water and the deposition in the chlorine contact chambers, North ET and the distribution system which diminishes, customer complaints related to discoloured water, the need for monitoring, and the frequency of cleaning and flushing infrastructure. It is estimated that iron levels in the treated water will be ≤ 0.01 mg/L, and the manganese levels will be ≤ 0.005 mg/L, which would be in compliance with potential manganese guidelines. The iron and manganese deposition in the distribution system is considered low (<1 g/m/year), minimizing resulting customer complaints. However, it is noted that continued sodium silicate dosing, along with distribution system cleaning practices, would be required after commissioning to mitigate the remobilization of legacy deposits in the distribution system. The sequestrant dose would be decreased over time (typically within the first two years of operation) as the distribution system stabilizes with new water quality.

For Alternative A5a, there is little potential concern that the particulate iron and manganese will accumulate along the raw water transmission main, requiring frequent cleaning and flushing of the system to address the deposition of solids. Although the wells have elevated hardness, the hardness concentrations are typical to groundwater sources and do not approach levels that would impact the selected removal technology, but it remains an important role in the maintenance of the system. Provision can be made in the design to include the media cleaning measures (soaking in phosphoric acid) to facilitate the maintenance activities. The wells present low phosphate levels, and it is anticipated that phosphate complexation is not an expected concern. Bench tests performed as part of the Groundwater Treatment Strategy (GWTS) studies suggested that organic complexation and colloidal formation are not expected concerns. It is recommended to conduct pilot testing of the selected iron and manganese removal technology to confirm preferred media, efficiency, and design guidelines. It is estimated that the removal technology will increase the headloss of each well facility by 69 kPa (10 psi); however, this would not impact the well pumps' ability to pump the Top Water Level (TWL) of the North ET, nor distribution system pressures.

For Alternative A5a, the existing transmission main has sufficient capacity to deliver water from Well 3 and Well MW18, if Well MW18 is required as part of the system in the future to replace Well 1 or 2 due to their age or condition.

Alternative A5b provides a higher level of redundancy and operational flexibility than Alternative A5a since it includes multiple wells being treated at different locations. Consideration can be given to maintain the sequestration and chlorination systems at Well 3 Facility, allowing the Well 3 Facility to direct feed into the distribution system in case of emergency to increase the security of supply. Appropriate valving would also be required in the valve chamber at the transition from the existing transmission main and the new raw watermain.

No modification of the PTTW is required, but an amendment of the DWWP and the MDWL will be required to include the removal technology and the residual management system. Additional permits and approvals related to the residual management system are discussed in Section 4.1.5. It is anticipated that the current system classification will change from Class II to Class III.

The timeline for implementation of Alternative A5a is approximately 4 years, considering 3 months for detailed design procurement, 18 months for design, 3 months for construction procurement, and 2 years for construction. The timeline for implementation of Alternative A5b is estimated to be 5 years, considering 3 months for detailed design procurement, 18 months for design, 3 months for construction procurement, and a marginally longer period of 3 years for construction, given the need to maintain wells in service during construction at multiple sites. There are opportunities to accelerate implementation through construction scheduling.

Whole Life Cost for Alternative A5a

To implement Alternative A5a, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-3 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A5a, except the costs associated with the residual management system. Detailed calculations are presented in **Appendix G**.

- 350 m of 400 mm watermain from the corner of Centre Street and Cupples Farm Lane to Wells 1 & 2 Facility and associated valve chambers
- New building housing removal technology at Wells 1 & 2 Facility for all wells
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility

- Clean and inspect the Mount Albert North Elevated Tank
- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-3. Alternative A5a: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Subcomponent	Preliminary Cost[1]
Capital Investment[2]	Raw Watermain	$455,000
Capital Investment[2]	New Treatment Building at Wells 1 & 2 Facility	$2,250,000
Capital Investment[2]	Design & Construction Administration (20%)	$542,000
Capital Investment[2]	Contingency (30%)	$977,000
Capital Investment[2]	York Region Project Management (5%)	$212,000
Capital Investment[2]	HST (1.76%)	$81,000
Capital Investment[2]	**Total Capital Costs**	**$4,517,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$32,800
Operation & Maintenance Expenditures[3]	Chlorine Gas for Oxidation	$30,300
Operation & Maintenance Expenditures[3]	O&M Labour	$624,000
Operation & Maintenance Expenditures[3]	Power Consumption	$49,500
Operation & Maintenance Expenditures[3]	Clean and inspection of chlorine contact chamber (every 5 years)[4]	$480,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every 5 years)[4]	$160,000
Operation & Maintenance Expenditures[3]	Unidirectional flushing program of raw water transmission main (every year)[5]	$36,000
Operation & Maintenance Expenditures[3]	Swabbing program of raw water transmission main (every 5 years)[5]	$16,500
Operation & Maintenance Expenditures[3]	Unidirectional flushing program of distribution system (every 5 years)[4]	$307,200
Operation & Maintenance Expenditures[3]	Swabbing program of distribution system (every 20 years)[4]	$154,000
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$325,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$2,215,300**
Net Present Value	Capital Investment (Discounted)	$4,246,953
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$1,924,358
Net Present Value	**Total Whole Life Cost**	**$6,171,311**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2025. Costs associated with the residual management system are not included.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering low accumulation of deposits in the distribution system.
5. Considering heavy accumulation of deposits in the raw water transmission main.

Whole Life Cost for Alternative A5b

To implement Alternative A5b, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table4-4 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A5b, except the costs associated with the residual management system. Detailed calculations are presented in **Appendix G**.

- New building to house removal technology at Wells 1 & 2 Facility
- Building extension housing removal technology at Well 3 Facility
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank
- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-4. Alternative A5b: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Subcomponent	Preliminary Cost[1]
Capital Investment[2]	New Treatment Building at Wells 1 & 2 Facility	$2,250,000
Capital Investment[2]	New Treatment Building at Well 3 Facility	$1,950,000
Capital Investment[2]	Design & Construction Administration (20%)	$841,000
Capital Investment[2]	Contingency (30%)	$1,513,000
Capital Investment[2]	York Region Project Management (5%)	$331,000
Capital Investment[2]	HST (1.76%)	$123,000
Capital Investment[2]	**Total Capital Costs**	**$7,008,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$32,800
Operation & Maintenance Expenditures[3]	Chlorine Gas for Oxidation	$30,300
Operation & Maintenance Expenditures[3]	O&M Labour	$936,000
Operation & Maintenance Expenditures[3]	Power Consumption	$58,500
Operation & Maintenance Expenditures[3]	Clean and inspection of 2 chlorine contact chambers (every 5 years)[4]	$480,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every 5 years)[4]	$160,000
Operation & Maintenance Expenditures[3]	Unidirectional flushing program (every 5 years)[4]	$307,200
Operation & Maintenance Expenditures[3]	Swabbing program (every 20 years)[4]	$154,000

Component	Subcomponent	Preliminary Cost[1]
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$325,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$2,483,800**
Net Present Value	Capital Investment (Discounted)	$6,526,028
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$2,138,261
Net Present Value	**Total Whole Life Cost**	**$8,664,288**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2026. Costs associated with the residual management system are not included.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering low accumulation of deposits in the distribution system.

4.1.3 Alternative A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility

Conceptual Design

Alternative A6 combines the solutions of Alternatives A4 and A5. With this alternative, sequestration continues as the control method of iron and manganese only for Well 3, but with the implementation of the optimization strategies recommended in the System Capacity Optimization Study. Wells 1 & 2 Facility is upgraded with iron and manganese removal technology. Similar to Alternative A5, it was considered the removal technology as adsorptive filtration and chlorine as oxidant. A multi-filter design approach has been applied in order to minimize equipment, footprint and backwash volume requirements. The residual management system and its viable strategies are discussed in Section 4.1.5. Table 4-5 presents the key features for the concept design. Figure 4-4 presents the schematic diagram for this alternative.

Table 4-5. Alternative A6: Key Concept Design Features

Facility	Alternative	A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility
Wells 1 & 2	Design Capacity (ML/d)[1,2]	4.99
Wells 1 & 2	Filtration System[3]	10 filters of 1.2 m dia. (4 ft)
Wells 1 & 2	Residual Volume (m^3/d)[4]	60-100
Wells 1 & 2	Footprint required[5]	9 m X 5.5 m (50 m^2)
Well 3	Design Capacity (ML/d)[1]	3.27
	Total Firm Capacity (ML/d)[6]	**4.91**

Notes:

1. Maximum water taking of 4.99 ML/d (57.8 L/s) with a maximum taking per minute per well of 3.27 ML/d (37.88 L/s) per current PTTW.
2. Any combination of Wells 1 and 2.
3. Maximum design filtration flowrate of 18 m/h will all filters in service and 20 m/h with one filter out of service.
4. Each filter in operation is backwashed daily.

5. Building housing the removal technology and the associated equipment, including oxidant dosing system. Residual management requirements identified separately.
6. Considering the loss of backwash volume without air scour.

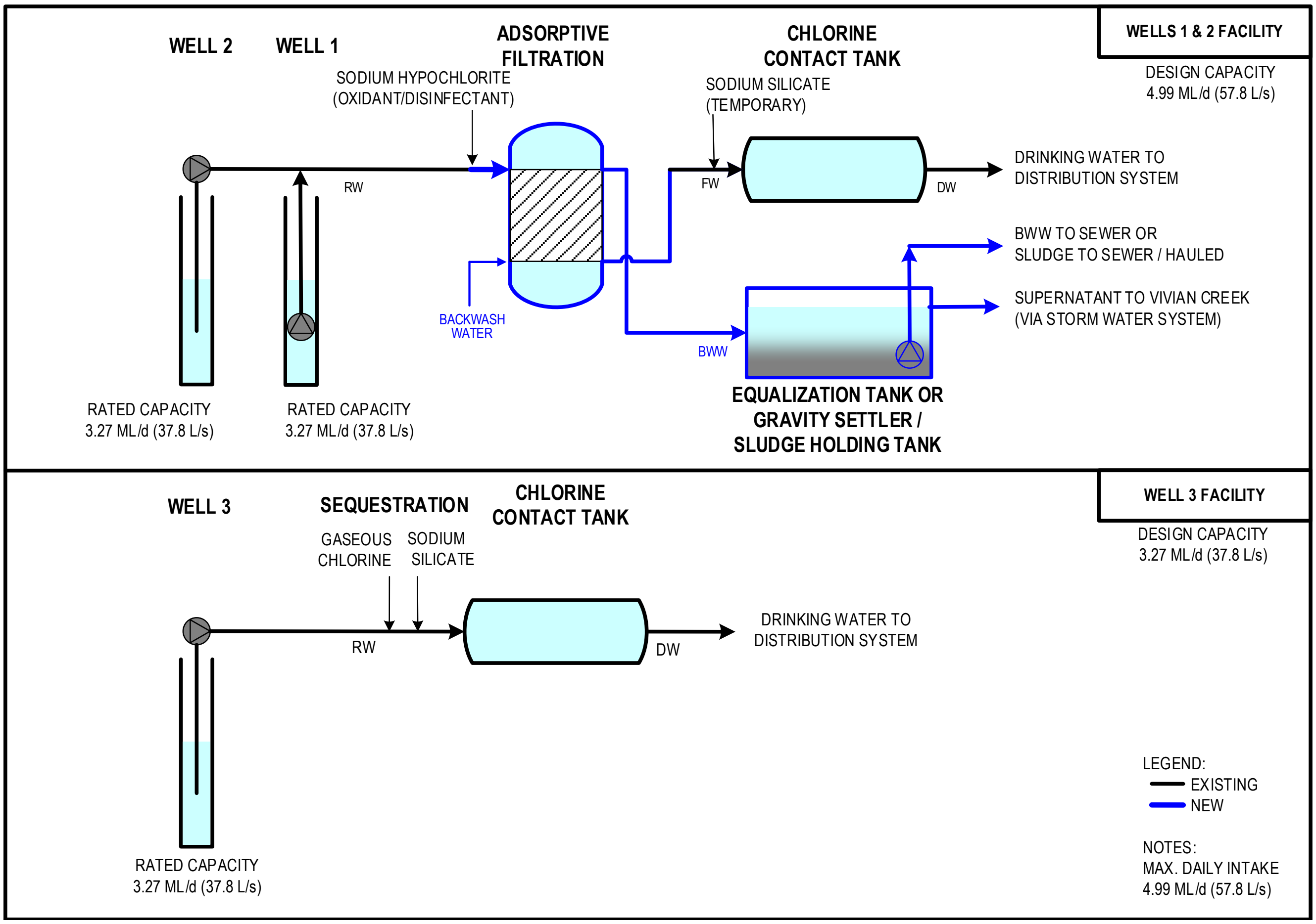

Figure 4-4. Alternative A6 Schematic Diagram

For Wells 1 & 2 Facility, a new building housing the removal technology and the associated equipment could be located north or south of the existing building, and the existing Well 3 facility has sufficient space for the identified upgrades. The final location of the new building will be defined during design. Figure 4-4 illustrates the conceptual site layout for this option. The conceptual site layout for this alternative is presented in **Appendix F**.

Technical Considerations

The addition of removal technology would allow for the aesthetic objectives and treatment goals to be achieved consistently at Wells 1 & 2 Facility; it is expected the iron levels in the treated water will be ≤ 0.01 mg/L, and the manganese levels will be ≤ 0.005 mg/L.

With the comparatively better raw water quality at Well 3, dosage improvements may provide more satisfactory results than current operations. However, the potential for interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process cannot be easily avoided, and the potential for water quality issues remains. It is also recognized that there are likely many compounding influences on the effectiveness of sequestration, in addition to raw water characteristics, including sodium silicate dosage control and the condition of the contact chambers, water distribution system and North ET.

The alternative can accommodate the potential implementation of the new manganese guidelines for the treated water; however, as iron and manganese would still be present in the sequestered supply from Well 3, the potential remains for deposition of manganese in the distribution system at moderate levels (1-10 g/m/year). This could result in the accumulation and subsequent release of legacy manganese in the distribution system. Focused operation and maintenance efforts would be required to monitor the sequestration effectiveness throughout the distribution system and maintain the chlorine contact chamber at Well 3 Facility, North ET and the distribution system free of deposition to minimize the release of legacy manganese and resulting customer complaints.

As the quality of treated water from each facility will be considerably different, the blending of the supplies may generate water quality issues. For instance, the stability of sequestered iron from Well 3 supply could be disturbed by the presence of oxidized iron and manganese in the system and result in deposition across the distribution system.

It is noted that continued sodium silicate dosing at Wells 1 & 2 Facility, along with distribution system cleaning practices, would be required after commissioning to mitigate the remobilization of legacy deposits in the distribution system. The sequestrant dose would be decreased over time (typically within the first two years of operation) as the distribution system stabilizes with new water quality.

Although the wells have elevated hardness, the hardness concentrations are typical to groundwater sources and do not approach levels that would impact the selected removal technology, but it remains an important role in the maintenance of the system. Provision can be made in the design to include the media cleaning measures (soaking in phosphoric acid) to facilitate the maintenance activities. The wells present low phosphate levels, and it is anticipated that phosphate complexation is not an expected concern. Bench tests performed as part of the Groundwater Treatment Strategy (GWTS) studies suggested that organic complexation and colloidal formation are not expected concerns. It is recommended to conduct pilot testing of the selected iron and manganese removal technology to confirm preferred media, efficiency, and design guidelines. It is estimated that the removal technology will increase the headloss of each well facility by 69 kPa (10 psi); however, this would not impact the well pumps' ability to pump the TWL of the North ET, nor distribution system pressures.

No modification of the PTTW is required, but an amendment of the DWWP and the MDWL will be required to include the removal technology and the residual management system. Additional permits and approvals related to the residual management system are discussed in Section 4.1.5. It is anticipated that the current system classification will change from Class II to Class III.

This alternative provides flexibility to incorporate Well MW18, if replacement of Well 1 or 2 is required in the future due to their age or condition. In the event that sequestration cannot be implemented effectively at Well 3, the opportunity also exists to either implement iron and manganese removal technology at Well 3 Facility or to connect to treatment at Wells 1 & 2 Facility as the Well 1&2 Facility would have a future design capacity of 4.99 ML/d.

The timeline for implementation of Alternative A6 is at least 4 years, considering 3 months for detailed design procurement, 18 months for design, 3 months for construction procurement, and 2 years for construction.

Whole Life Cost for Alternative A6

To implement Alternative A6, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-6 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A6, except the costs associated with the residual management system. Detailed calculations are presented in **Appendix G**.

- Silicate dosing system improvement at Well 3 Facility
- New building housing removal technology at Wells 1 & 2 Facility
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank

- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-6. Alternative A6: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

	Component	Preliminary Cost[1]
Capital Investment[2]	Silicate dosing system improvement at Well 3 Facility	$200,000
Capital Investment[2]	New Treatment Building at Wells 1 & 2 Facility	$2,250,000
Capital Investment[2]	Design & Construction Administration (20%)	$491,000
Capital Investment[2]	Contingency (30%)	$885,000
Capital Investment[2]	York Region Project Management (5%)	$193,000
Capital Investment[2]	HST (1.76%)	$73,000
Capital Investment[2]	**Total Capital Costs**	**$4,092,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$59,300
Operation & Maintenance Expenditures[3]	Chlorine Gas for Oxidation	$30,300
Operation & Maintenance Expenditures[3]	O&M Labour	$624,000
Operation & Maintenance Expenditures[3]	Power Consumption	$33,000
Operation & Maintenance Expenditures[3]	Clean and inspection of 2 chlorine contact chambers (every 2 years)[4]	$750,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every 2 years)[4]	$250,000
Operation & Maintenance Expenditures[3]	Unidirectional flushing program (every 2 years)[4]	$480,000
Operation & Maintenance Expenditures[3]	Swabbing program (every 10 years)[4]	$220,000
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$550,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$2,996,600**
Net Present Value	Capital Investment (Discounted)	$3,850,035
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$2,546,574
Net Present Value	**Total Whole Life Cost**	**$6,396,609**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2025. Costs associated with the residual management system are not included.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering low accumulation of deposits in the distribution system.

4.1.4 Alternative A7: Connect New Well (MW18) to Mount Albert Water Supply System and Remove Wells 1 and/or 2

Conceptual Design

Alternative A7 involves connecting Well MW18 to the Mount Albert Water Supply System and decommissioning Wells 1 and/or 2. With this alternative, sequestration continues as the control method of iron and manganese, at least for Well 3 and the new well MW18. Therefore, the implementation of the optimization strategies recommended in the System Capacity Optimization Study is required. This alternative is divided into three sub-options:

- A7a: Replace Well 1 with Well MW18 and continue sequestration at both facilities;
- A7b: Replace Wells 1 and 2 with Well MW18, re-rate Wells 3 and MW18, and continue sequestration; and
- A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and upgrade Wells 1 & 2 Facility with iron and manganese removal technology.

Alternatives A7a and A7c are based on the current capacity of 37.88 L/s (3.27 ML/d) for Wells 2 and 3 and the development of Well MW18 to that same capacity. With Alternative A7b, the Wells 3 and MW18 maximum taking per minute is increased to 39.4 L/s (3.4 ML/d) to match the forecasted MDD without Wells 1 and 2 in service.

Similar to Alternative A5, it was considered the removal technology as adsorptive filtration and chlorine as oxidant for Alternative A7c, and multi-filter design approach. The residual management system and its viable strategies are discussed in Section 4.1.5. Table 4-7 presents the key features for the concept design. Figure 4-5, Figure 4-6, and Figure 4-7 present the schematic diagrams for each sub-option of this alternative.

Table 4-7. Alternative A7: Key Concept Design Features

Facility	Alternative	A7a: Replace Well 1 with Well MW18 and continue sequestration for all wells	A7b: Replace Wells 1 and 2 with Well MW18, re-rate Wells 3 and MW18, and continue sequestration	A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and provide iron and manganese removal technology at Wells 1&2 Facility
Wells 1 & 2	Design Capacity (ML/d)	3.27[1]	N/A	3.27[1]
Wells 1 & 2	Filtration System[2]	N/A	N/A	8 filters of 1.2 m dia. (4 ft)
Wells 1 & 2	Residual Volume (m^3/d) [3]	N/A	N/A	50-80
Wells 1 & 2	Footprint required[4]	N/A	N/A	7.5 m X 5.5 m (40 m^2)
Well 3	Design Capacity (ML/d)	4.99[5]	4.99[6]	4.99[5]
Well 3	Footprint required[7]	10 m X 4.0 m (40 m^2)	10 m X 4.0 m (40 m^2)	10 m X 4.0 m (40 m^2)
Total Firm Capacity (ML/d)[8]		**4.99**	**3.40**	**4.93**

Notes:

1. Well 2 only with a maximum taking per minute per well of 3.27 ML/d (37.88 L/s) per current PTTW.
2. Maximum design filtration flowrate of 18 m/h will all filters in service and 20 m/h with one filter out of service.
3. Each filter in operation is backwashed once daily.
4. Building housing the removal technology and the associated equipment, including oxidant dosing system. Residual management requirements identified separately.
5. Any combination of Wells 3 and MW18 with a maximum taking per minute per well of 3.27 ML/d (37.88 L/s).
6. Any combination of Wells 3 and MW18 with a maximum taking per minute per well of 3.4 ML/d (39.4 L/s).

7. Building housing the removal technology and the associated equipment, including oxidant dosing system
8. Maximum water taking of 4.99 ML/d (57.8 L/s) per current PTTW, and considering the loss of backwash volume without air scour.

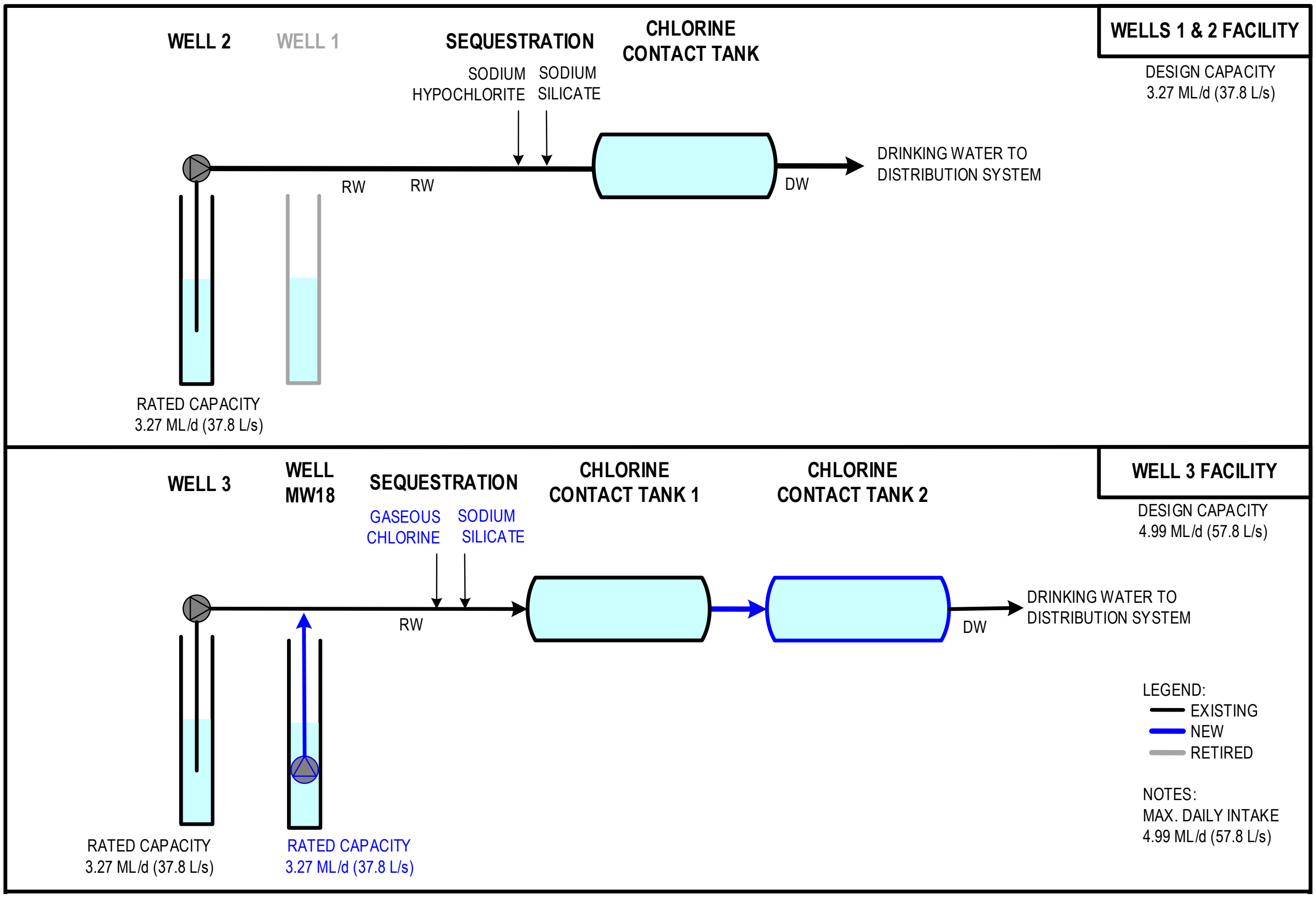

Figure 4-5. Alternative A7a Schematic Diagram

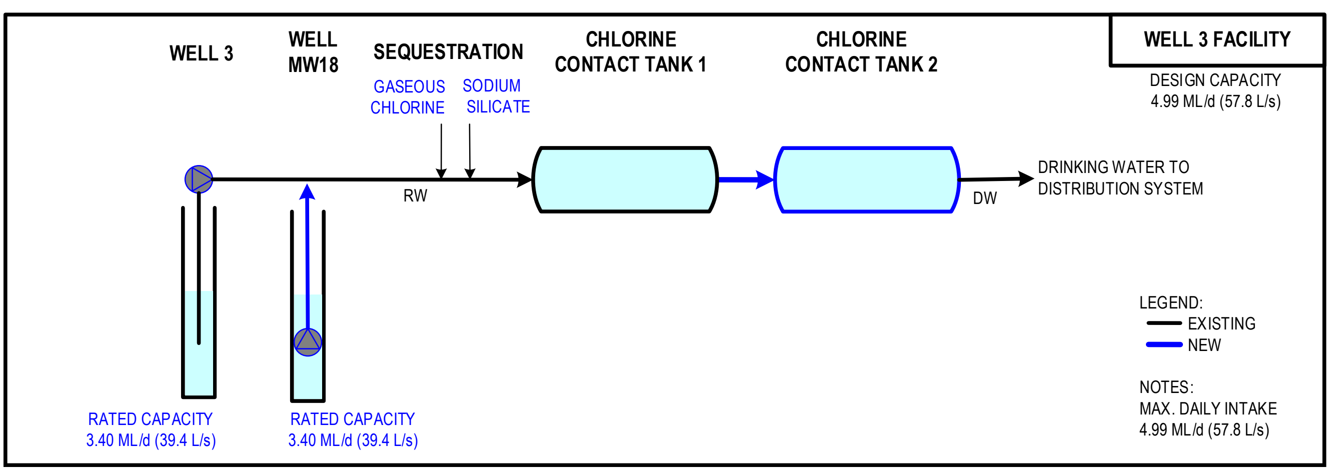

Figure 4-6. Alternative A7b Schematic Diagram

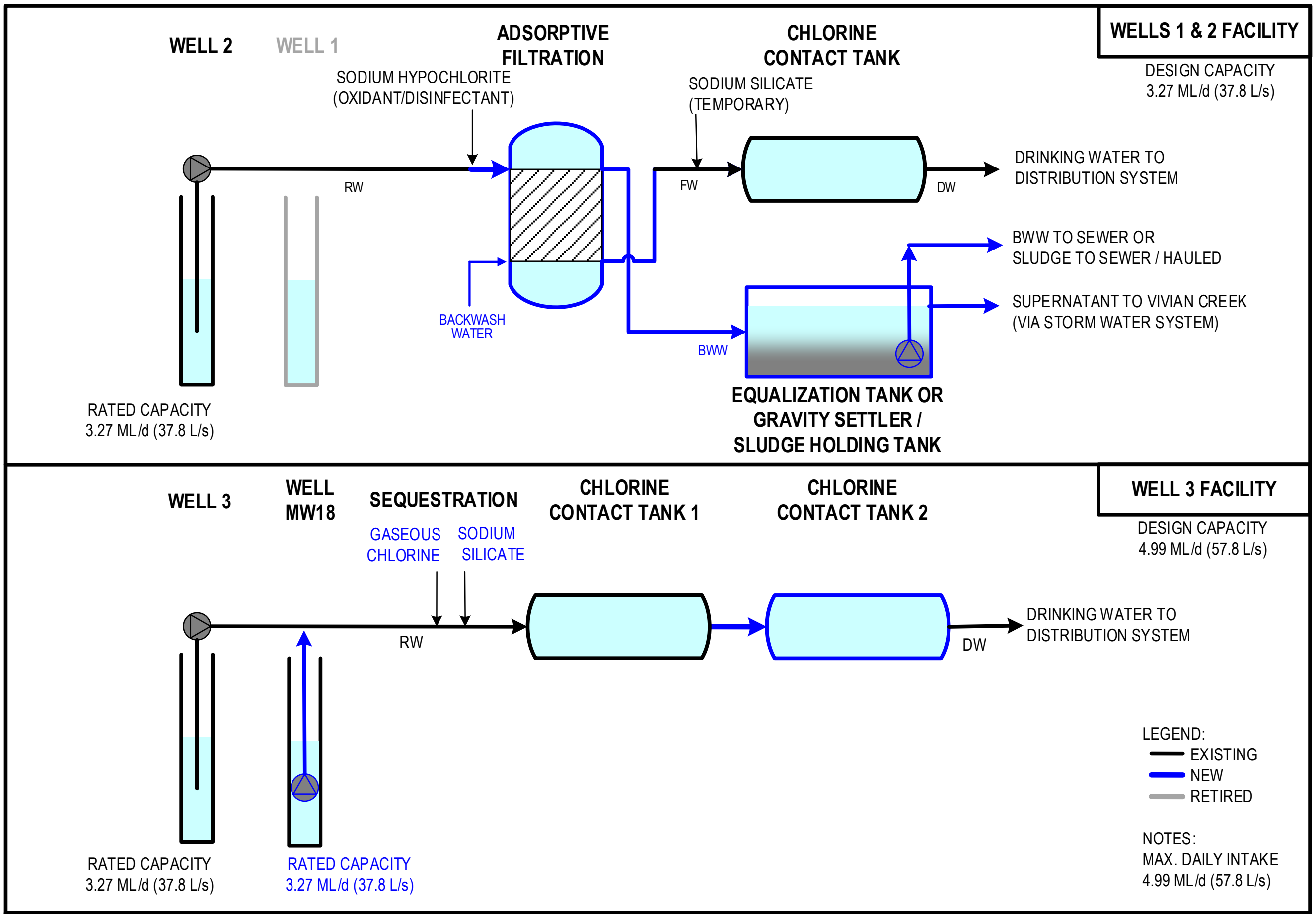

Figure 4-7. Alternative A7c Schematic Diagram

Both treatment facilities sites have the potential for building expansion. For Wells 1 & 2 Facility, a new building housing the removal technology and the associated equipment is considered north or south of the existing building. For Well 3 Facility, a building extension northeast of the existing building is considered to house the equipment associated with Well MW18. The final location of the new buildings will be defined during design. Expansion of chlorine dosing system, sodium silicate dosing system and chlorine contact tank is required for Well 3 Facility. The conceptual site layout for each sub-option is presented in **Appendix F**.

Technical Considerations

Additional hydrogeological study is required to confirm the projected long-term capabilities and water quality of Well MW18. The preliminary investigation indicated Well MW18 presents higher levels of iron than Well 3.

Well 3 is not currently able to provide its rated capacity of 37.88 L/s (3.27 ML/d) according to the hydraulic analysis undertaken in the first phase of this Class EA study. In order to reach an output of 39.4 L/s, additional hydrogeological study to confirm the projected long-term capabilities of Well 3 is required, as well as the reconstruction of Well 3 to increase screen transmitting capacity and pumping capacity.

Since the raw water quality at Well 3 and Well MW18 is comparatively better than Wells 1 and 2, dosage improvements may provide more satisfactory results than current operations. However, the interference of the identified factors of hardness, alkalinity and potentially phosphate on the treatment process cannot be easily avoided, and the potential for water quality issues remains.

For Alternative A7c, it is expected the iron levels in the treated water will be ≤ 0.01 mg/L, and the manganese levels will be ≤ 0.005 mg/L. Therefore, the quality of treated water in each facility is considerably different. Depending on the sequestration effectiveness, the blending of treated water from different processes, removal technology removal and sequestration, may present issues. If non-sequestered iron is still available from Well 3 Facility, the remaining oxidized iron may disturb the metals' stability and contribute to iron and manganese deposition across the distribution system. It is noted that continued sodium silicate dosing at Wells 1 & 2 Facility along with distribution system cleaning practices would be required after commissioning to mitigate the remobilization of legacy deposits in the distribution system. The sequestrant dose would be decreased over time (typically within the first two years of operation) as the distribution system stabilizes with new water quality.

Although the wells have elevated hardness, the hardness concentrations are typical to groundwater sources and do not approach levels that would impact the selected removal technology, but it remains an important role in the maintenance of the system. Provision can be made in the design to include the media cleaning measures (soaking in phosphoric acid) to facilitate the maintenance activities. The wells present low phosphate levels, and it is anticipated that phosphate complexation is not an expected concern. Bench tests performed as part of the Groundwater Treatment Strategy (GWTS) studies suggested that organic complexation and colloidal formation are not expected concerns. It is recommended to conduct pilot testing of the selected iron and manganese removal technology to confirm preferred media, efficiency, and design guidelines.

Also, sodium silicate dosing would be required to be maintained at Wells 1 & 2 Facility to mitigate the remobilization of legacy deposits. The sequestrant dose would be decreased over time as the distribution system stabilizes with new water quality. It is considered the silicate dosing would be phased out during the first two years in operation of the removal technology.

The iron and manganese deposition in the distribution system is considered moderate (1-10 g/m/year). Focused operation and maintenance efforts are expected to monitor the sequestration effectiveness across the distribution system and to keep the chlorine contact chamber at Well 3 Facility, North ET and the distribution system free of deposition, in order to achieve ≤2.5 total complaints per 1000 customer accounts (AWWA Partnership for Safe Water, 2014) and apparent colour in distribution system ≤25 from sampling stations samples and ≤40 from hydrant samples (AWWA M58).

Also, the alternative can accommodate the potential implementation of the new manganese guidelines, which are the MAC of 0.12 mg/L and the aesthetic objective (AO) of 0.02 mg/L for total manganese in drinking water, in case MECP harmonizes with Health Canada Guidelines. However, careful consideration needs to be given to the potential for the accumulation and subsequent release of manganese in the distribution system.

Preliminary hydraulic modelling suggests minor impact on the distribution system pressures, water age and fire flow when only Well 3 or MW18 are in operation. With the greater distance from the community, maximum water age would increase slightly, and fire flow shows a slight decrease at the higher elevations, without Wells 1 and 2 in operation. More detailed hydraulic modelling validation is required to assess these impacts for Alternative A7b during design in order to investigate mitigation measures, including distribution system improvements

The addition of removal technology in Alternative A7c will increase the headloss of each well facility by 69 kPa (10 psi), the well pump 2 is still able to fill the North ET. Preliminary hydraulic modelling shows no impact on the distribution system pressures. It should be noted the conditions of low pressure in the distribution system occurs when the well pumps are not in service, and the water level in the North ET is low. The additional headloss by the treatment technology will not worsen the low-pressure concerns. Therefore, there is no need to implement additional pumping and operational storage at Wells 1 & 2 Facility.

The PTTW needs to be amended to add Well MW18 and re-rate Well 3 maximum taking per minute for Alternative A7b only, but the total permitted capacity will not change. The amendment of the DWWP and the MDWL will be required to include the new well equipment, the removal technology and the residual management system, as well as remove the retired wells. It is anticipated current system classification will change from Class II to Class III for Alternative A7c. Additional permits and approvals related to the residual management system are discussed in Section 4.1.5 applicable to Alternative A7c.

The security of supply becomes entirely dependent on a single facility and a long-run single transmission main with the decommissioning of Wells 1 & 2 Facility for Alternative A7b, and water supply would be compromised in the case of a transmission main break or major failures at Well 3 Facility.

Alternative A7c allows for a phased approach by implementing removal technology at Wells 1 & 2 Facility first (with design capacity of 3.27 ML/d), then implementing at Well 3 Facility or expanding the removal technology at Wells 1& 2 Facility (for centralized treatment with capacity of 4.99 ML/d) in the event continued sequestration does not yield satisfactory results after replacing Well 1 with Well MW18 and the optimization strategies recommended in the System Capacity Optimization Study.

The timeline for implementation of Alternative A7a is at least 5 years, considering 3 months for detailed design procurement, 18 months for hydrogeological study and design, 3 months for construction procurement, and 3 years for construction. The timeline for implementation of Alternative A7b is at least 4 years, considering 3 months for detailed design procurement, 18 months for hydrogeological study and design, 3 months for construction procurement, and 2 years for construction. The timeline for implementation of Alternative A7c is at least 5.5 years, considering 3 months for detailed design procurement, 18 months for hydrogeological study and design, 3 months for construction procurement, and 3.5 years for construction.

Whole Life Cost for Alternative A7a

To implement Alternative A7a, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-8 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A7a. Detailed calculations are presented in **Appendix G**.

- Well MW18 hydrogeological study
- Silicate dosing system improvement at Wells 1 & 2 Facility (flow switch and sodium silicate storage)
- New MW18 submersible well pump and pumping house at Well 3 Facility
- Silicate dosing system improvement and expansion at Well 3 Facility
- Chlorine dosing system and contact tank expansion at Well 3 Facility
- Decommissioning of Well 1
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank
- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-8. Alternative A7a: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Subcomponent	Preliminary Cost[1]
Capital Investment[2]	Well MW18 hydrogeological study	$400,000
Capital Investment[2]	Silicate dosing system improvement at Wells 1 & 2 Facility	$100,000
Capital Investment[2]	New MW18 submersible well pump and pumping house at Well 3 Facility	$800,000
Capital Investment[2]	Silicate dosing system improvement and expansion at Well 3 Facility	$200,000
Capital Investment[2]	Chlorine dosing system and contact tank expansion at Well 3 Facility	$700,000
Capital Investment[2]	Decommissioning of Well 1	$100,000

Component	Subcomponent	Preliminary Cost[1]
Capital Investment[2]	Design & Construction Administration (20%)	$376,000
Capital Investment[2]	Contingency (30%)	$798,000
Capital Investment[2]	York Region Project Management (5%)	$176,000
Capital Investment[2]	HST (1.76%)	$65,000
Capital Investment[2]	**Total Capital Costs**	**$3,695,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$115,200
Operation & Maintenance Expenditures[3]	Power Consumption	$28,800
Operation & Maintenance Expenditures[3]	Clean and inspection of 2 chlorine contact chambers (every 2 years)[4]	$720,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every 2 years)[4]	$240,000
Operation & Maintenance Expenditures[3]	Unidirectional flushing program (every 2 years)[4]	$460,800
Operation & Maintenance Expenditures[3]	Swabbing program (every 10 years)[4]	$211,200
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$520,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$2,296,000**
Net Present Value	Capital Investment (Discounted)	$3,517,744
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$1,975,827
Net Present Value	**Total Whole Life Cost**	**$5,493,571**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2025.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering low accumulation of deposits in the distribution system.

Whole Life Cost for Alternative A7b

To implement Alternative A7b, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-9 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A7b. Detailed calculations are presented in **Appendix G**.

- Well MW18 and Well 3 hydrogeological study
- New MW18 submersible well pump and pumping house at Well 3 Facility
- Well 3 upgrades, including well reconstruction and new pump
- Silicate dosing system improvement and expansion at Well 3 Facility
- Chlorine dosing system and contact tank expansion at Well 3 Facility
- Decommissioning of Wells 1 & 2 Facility
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank
- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-9. Alternative A7b: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Subcomponent	Preliminary Cost[1]
Capital Investment[2]	Well MW18 and Well 3 hydrogeological study	$800,000
Capital Investment[2]	New MW18 well pump and pumping house at Well 3 Facility	$800,000
Capital Investment[2]	Well 3 upgrades, including well reconstruction and new pump	$700,000
Capital Investment[2]	Silicate dosing system improvement and expansion at Well 3 Facility	$200,000
Capital Investment[2]	Chlorine dosing system and contact tank expansion at Well 3 Facility	$700,000
Capital Investment[2]	Decommissioning of Wells 1 & 2 Facility	$500,000
Capital Investment[2]	Design & Construction Administration (20%)	$580,000
Capital Investment[2]	Contingency (30%)	$1,285,000
Capital Investment[2]	York Region Project Management (5%)	$280,000
Capital Investment[2]	HST (1.76%)	$105,000
Capital Investment[2]	**Total Capital Costs**	**$5,950,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$115,200
Operation & Maintenance Expenditures[3]	Power Consumption	$28,800
Operation & Maintenance Expenditures[3]	Clean and inspection of 2 chlorine contact chambers (every 2 years)[4]	$720,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every 2 years)[4]	$240,000
Operation & Maintenance Expenditures[3]	Unidirectional flushing program (every 2 years)[4]	$460,800
Operation & Maintenance Expenditures[3]	Swabbing program (every 10 years)[4]	$211,200
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$520,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$2,296,000**
Net Present Value	Capital Investment (Discounted)	$5,692,508
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$1,975,827
Net Present Value	**Total Whole Life Cost**	**$7,668,335**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2025. Costs associated with the residual management system are not included.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering low accumulation of deposits in the distribution system.

Whole Life Cost for Alternative A7c

To implement Alternative A7c, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-10 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative A7c, except the costs associated with the residual management system. Detailed calculations are presented in **Appendix G**.

- Well MW18 hydrogeological study
- New MW18 submersible well pump and pumping house at Well 3 Facility
- Silicate dosing system improvement and expansion at Well 3 Facility
- Chlorine dosing system and contact tank expansion at Well 3 Facility
- New building housing removal technology at Wells 1 & 2 Facility
- Decommissioning of Well 1
- Clean and inspect chlorine contact chambers at Wells 1 & 2 Facility and Well 3 Facility
- Clean and inspect the Mount Albert North Elevated Tank
- Tailored monitoring program for the distribution system
- Unidirectional flushing and swabbing program

Table 4-10. Alternative A7c: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Subcomponent	Preliminary Cost[1]
Capital Investment[2]	Well MW18 hydrogeological study	$400,000
Capital Investment[2]	New MW18 well pump and pumping house at Well 3 Facility	$800,000
Capital Investment[2]	Silicate dosing system improvement and expansion at Well 3 Facility	$200,000
Capital Investment[2]	Chlorine dosing system and contact tank expansion at Well 3 Facility	$700,000
Capital Investment[2]	New Treatment Building at Wells 1 & 2 Facility	$2,250,000
Capital Investment[2]	Decommissioning of Well 1	$100,000
Capital Investment[2]	Design & Construction Administration (20%)	$811,000
Capital Investment[2]	Contingency (30%)	$1,581,000
Capital Investment[2]	York Region Project Management (5%)	$344,000
Capital Investment[2]	HST (1.76%)	$130,000
Capital Investment[2]	**Total Capital Costs**	**$7,316,000**
Operation & Maintenance Expenditures[3]	Sodium Silicate for Sequestration	$83,625
Operation & Maintenance Expenditures[3]	Chlorine Gas for Oxidation	$16,400
Operation & Maintenance Expenditures[3]	O&M Labour	$665,600
Operation & Maintenance Expenditures[3]	Power Consumption	$62,400
Operation & Maintenance Expenditures[3]	Clean and inspection of 2 chlorine contact chambers (every 2 years)[4]	$720,000
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert North Elevated Tank (every 2 years)[4]	$240,000

Component	Subcomponent	Preliminary Cost[1]
Operation & Maintenance Expenditures[3]	Unidirectional flushing program (every 2 years)[4]	$460,800
Operation & Maintenance Expenditures[3]	Swabbing program (every 10 years)[4]	$211,200
Operation & Maintenance Expenditures[3]	Tailored Monitoring Program for the distribution system[4]	$520,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$2,980,025**
Net Present Value	Capital Investment (Discounted)	$6,903,838
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$2,526,232
Net Present Value	**Total Whole Life Cost**	**$9,430,070**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2026. Costs associated with the residual management system are not included.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering low accumulation of deposits in the distribution system.

4.1.5 Residual Management for Alternatives with Iron and Manganese Removal Technology

Conceptual Design

The adsorptive filtration technology generates residuals from backwashing the filters, which contain elevated levels of iron and manganese oxides. Iron concentration can reach up to 50 mg/L, and manganese concentration can reach up to 5.6 mg/L in the backwash wastewater. Other constituents of the source water are not expected to become more concentrated and do not influence the selection of the residual management strategy. Details regarding the backwash wastewater characteristics are presented in the Surface Water Study (**Appendix D**).

The most common residual management solutions are direct sanitary sewer discharge or on-site treatment. When the backwash wastewater cannot be directly disposed of in the sanitary sewer system, a clarification process can provide required on-site treatment allowing the supernatant to be directed to the local receiving body, stormwater system or infiltrate to the subsurface soil. Gravity settling is the primary method of clarification when limited space is available. The sludge generated can be discharged in the sanitary sewer collection system, hauled offsite, or dewatered on-site. It is noted that while the return of the supernatant to the head of the treatment facility may be possible in certain circumstances, this optimization has not been considered in the current concept design because a solution for the discharge would still be required when the supernatant quality exceeds a certain turbidity level (as determined through piloting).

Neither of the treatment facilities currently have a direct connection to the sanitary sewer collection system or stormwater system. The sanitary sewer collection system at Center Street, north of Mount Albert Road, is 400 m from Wells 1 & 2 Facility and 2,000 m from Wells 3 Facility. The closest local receiving body is Vivian Creek, which is 800 m from Wells 1 & 2 Facility and 400 m from Wells 3 Facility. Wells 1 & 2 Facility is 420 m from the closest sub-district stormwater system, which discharges to Vivian Creek.

The residual management alternatives considered viable and carried for further evaluation are detailed below. Infiltration to subsurface soil of the supernatant and on-site dewatering of the sludge were not considered because these solutions require a large footprint, which the treatment facility sites cannot accommodate.

Discharge of the supernatant to the Stormwater system from Well 3 Facility was not considered because of the distance.

- **Alternative R1:** Direct connection to sanitary sewer collection system.

  This alternative involves the discharge of backwash wastewater to an on-site equalization tank where it is pumped through a new forcemain to a connection to the existing local sanitary sewer collection system for treatment at the Mount Albert WRRF.

- **Alternative R2:** On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system.

  This alternative involves the installation of on-site treatment to treat the backwash wastewater. Treated backwash wastewater (supernatant) would be discharged to Vivian Creek, either directly or via the nearest sub-district stormwater system. The gravity settling process and dechlorination are both considered to be part of the on-site treatment. The sludge generated would be pumped to the sanitary sewer and treated at the Mount Albert WRRF.

- **Alternative R3:** On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site.

  This alternative involves the installation of a gravity settling tank to treat the backwash wastewater, similar to Alternative R2; however, the sludge is discharged to tanker trucks and hauled to the Duffin Creek WPCP for further treatment and disposal.

Table 4-11 presents the key features for the concept design of the feasible residual management alternatives for each alternative solution with iron and manganese removal technology. The conceptual site layout for Alternatives A5a, A5b, A6 and A7c presented in **Appendix F** illustrates the alternative R2 for the residual management system.

Table 4-11. Residual Management System Key Concept Design Features

Residual Management Alternative	Features	A5a: Centralized Removal Technology at Wells 1 & 2 Facility Location: Wells 1 & 2 Facility [1]	A5b: Decentralized Removal Technology at both Facilities Location: Wells 1 & 2 Facility[1]	A5b: Decentralized Removal Technology at both Facilities Location: Well 3 Facility[2]	A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility Location: Wells 1 & 2 Facility[1]	A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and provide iron and manganese removal technology at Wells 1&2 Facility Location: Wells 1 & 2 Facility[1]
Alternative R1: Direct connection to sanitary sewer collection system	Residual Volume (m^3/d)[3]	60-100	60-100	50-80	60-100	50-80
Alternative R1: Direct connection to sanitary sewer collection system	Equalization Tank Volume (m^3)[4]	16	16	16	16	16
Alternative R1: Direct connection to sanitary sewer collection system	Sewage Pumping System (L/s)[4]	4.3	4.3	4.3	4.3	4.3
Alternative R1: Direct connection to sanitary sewer collection system	Sanitary Sewage Connection	400 metres, 75 mm diam. forcemain	400 metres 75 mm diam. forcemain	2,000 metres 75 mm diam. forcemain	400 metres 75 mm diam. forcemain	400 metres 75 mm diam. forcemain
Alternative R1: Direct connection to sanitary sewer collection system	Footprint Required on Site[5]	6 m X 10 m (60 m^2)	6 m X 10 m (60 m^2)	6 m X 10 m (60 m^2)	6 m X 10 m (60 m^2)	6 m X 10 m (60 m^2)
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Settling Tank Volume (m^3)[6]	80	80	65	80	65
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Supernatant Volume (m^3/d)[7]	72	72	59	72	59
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Supernatant Pumping System (L/s)[8]	10	10	8	10	8
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Discharge to Vivian Creek	420 m via stormwater system 100 mm diam. forcemain	420 m via stormwater system 100 mm diam. forcemain	400 m for a direct discharge 100 mm diam. forcemain	420 m via stormwater system 100 mm diam. forcemain	420 m via stormwater system 100 mm diam. forcemain
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Sludge Volume (m^3/d)[7]	8	8	6	8	6
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Sewage Pumping System (L/s)[8]	1.1	1.1	1.0	1.1	1.0
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Sanitary Sewage Connection	400 m 75 mm diam. forcemain	400 m 75 mm diam. forcemain	2,000 m 75 mm diam. forcemain	400 m 75 mm diam. forcemain	400 m 75 mm diam. forcemain
Alternative R2: On-site treatment with supernatant discharged to Vivian Creek and sludge discharged to sanitary sewer collection system	Footprint Required on Site[5]	13.5 m X 7.5 m (100 m^2)	13.5 m X 7.5 m (100 m^2)	12.5 m X 7.5 m (95 m^2)	13.5 m X 7.5 m (100 m^2)	12.5 m X 7.5 m (95 m^2)
Alternative R3: On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site	Settling Tank Volume with Sludge Holding (m^3)[6,9]	130	130	105	130	105
Alternative R3: On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site	Supernatant Volume (m^3/d)[7]	75	72	59	72	59
Alternative R3: On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site	Supernatant Pumping System (L/s)[8]	10	10	8	10	8
Alternative R3: On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site	Discharge to Vivian Creek	420 m via stormwater system 100 mm diam. forcemain	420 m via stormwater system 100 mm diam. forcemain	400 m for a direct discharge 100 mm diam. forcemain	420 m via stormwater system 100 mm diam. forcemain	420 m via stormwater system 100 mm diam. forcemain
Alternative R3: On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site	Sludge Volume (m^3/d)[7]	8	8	6	8	6
Alternative R3: On-site treatment with supernatant discharged to Vivian Creek and sludge hauled off-site	Footprint Required on Site[5]	14.5 m X 9.0 m (130 m^2)	14.5 m X 9.0 m (130 m^2)	12.5 m X 9.0 m (110 m^2)	14.5 m X 9.0 m (130 m^2)	12.5 m X 9.0 m (110 m^2)

Notes:

1. Removal technology with design capacity of 4.99 ML/d.
2. Removal technology with design capacity of 3.27 ML/d.
3. Considering one backwash per day per filter.
4. Volume of one backwash pumped to sanitary sewer over a 1-hour period.
5. Considering tankage depth of 4 m, excavation slope of 3:1 and including valve chamber and yard piping.
6. Considering 24-hour batch settling with two compartments.
7. Considering 10% of the backwash wastewater is the solid stream from the settling process (sludge), per AWWA Iron and Manganese Removal Handbook.
8. Considering pumping supernatant to Vivian Creek (directly or via stormwater system) or sludge to sanitary sewer collection system over a 2-hour period.
9. Considering weekly haulage of the sludge.

Technical Considerations

Given the depth of the wells, in accordance with O. Reg. 372, the siting of the residual management system assumes a separation distance of at least 15 m from the production wells. For Wells 1 & 2 Facility, the available space for the residual management facility is very limited; the system can be located in the south of the existing building and north of South ET to minimize modification of live yard piping, or consideration can be given to demolishing the South ET to create additional space. At Well 3 Facility, the residual management system could be located in the northeast corner of the property.

The Mount Albert sanitary sewer collection system is owned and operated by the Town of East Gwillimbury. The existing sanitary sewer capacity analysis (Cole, October 2017) indicates that the system has 8.3 L/s of available capacity at the most charged section, while the proposed backwash wastewater discharge rate is 4.3 L/s and the sludge discharge rate is 1.1 L/s. Therefore, it is presumed that the sanitary sewer collection system has sufficient capacity to collect the backwash wastewater or the sludge. The discharge limits for sewer discharge established by York Region’s By-Law No. 2011-56, entitled “Discharge of Sewage, Storm Water and Land Drainage Bylaw”, must be followed. The residual constituent concentrations are expected to be within the By-law No. 2011-56, except for manganese for Alternative R2. Manganese levels in the sludge can reach up to 49.5 mg/L for Alternative R2, in comparison with the 5 mg/L limit required by the By-law No. 2011-56; thus, the relaxation of this parameter by York Region and the Town of East Gwillimbury is required. There is no concern of potential issues of iron and manganese deposition in the sanitary sewer collection system since scouring velocities are enough to carry the sediments.

The Mount Albert SPS has a firm capacity of 5.96 ML/d (69 L/s) and the Mount Albert WRRF has a design capacity of 2.04 ML/d. Preliminary analysis of the SPS historical flowrates from 2015 to 2017 indicates that the maximum raw wastewater flowrate was 74.47 L/s. The discharge to the sanitary may be programmed to be performed off-peak hours if required, and the interlock with the SPS SCADA is recommended in order to avoid surcharging the sanitary sewer collection system and SPS during high flow events. As detailed in the Surface Water Study (**Appendix D**), the backwash wastewater and sludge contain mainly iron and manganese that would have negligible impact on the Mount Albert WRRF hydraulic capacity, treatment performance and operation for all alternatives. For the purpose of this study, it is presumed that the Mount Albert SPS and the Mount Albert WRRF have sufficient capacity to collect, treat and discharge the backwash wastewater under its current Environmental Compliance Approval (ECA).

For Wells 1& 2 Facility, the supernatant would be discharged to Vivian Creek via the stormwater system at east of the facility. The Mount Albert stormwater system is owned and operated by the Town of East Gwillimbury. It is estimated that the supernatant discharge flowrate of 10 L/s for Alternatives R2 and R3 from Wells 1 & 2 Facility occupies 0.25% of the stormwater system capacity at the pond inlet of 3,866.70 L/s (Cole, May 2017). The discharge limits for storm discharge established by York Region’s By-Law No. 2011-56, entitled “Discharge of Sewage, Storm Water and Land Drainage Bylaw”, must be followed. The supernatant constituent concentrations are expected to be within the By-law No. 2011-56. Manganese levels in the supernatant can reach up to 0.55 mg/L, in comparison with the 0.15 mg/L limit required by the By-law No. 2011-56; thus, the relaxation of this parameter by York Region is required. For the purpose of this study, it is presumed that the stormwater system has sufficient hydraulic capacity to collect and discharge the supernatant from Wells 1 & 2 Facility. An ECA amendment of the stormwater system by the MECP and reviewed by LSRCA, may be required to capture the supernatant as a new source.

The nearest wastewater treatment facility equipped with a haulage station is the Duffin Creek WPCP, which is where Mount Albert WRRF solid residuals are sent. The anticipated sludge quantity represents up to 0.05% of the average septage and imported dry solids received by Duffin Creek WPCP from 2017 to 2019. Therefore, it is considered that this facility has sufficient capacity to receive and treat the anticipated sludge volumes under its current ECA.

Consideration can be given for both alternatives to include an option to haul the backwash wastewater, supernatant or sludge to maximize operational flexibility in the event of emergency or repairs/rehabilitation of the primary system. Haulage to Aurora PS, instead of Duffin Creek WPCP, can also be considered to mitigate impacts if required.

Effluent quality and permissible periods of discharge to the environment, either directly or via the stormwater system, are stipulated as a result of receiving water assessment studies to confirm that the discharge will not impact aquatic life, or other water uses downstream where there is continuous streamflow. The effluent discharge requirements of the supernatant to Vivian Creek will be part of the amended DWWP. Per the preliminary assessment presented in the Surface Water Study (**Appendix D**), the following constituents are potential concerns for discharge into Vivian Creek that would be part of the effluent discharge requirements: chlorine, suspended solids, total iron, and total manganese. The study also indicated that there is limited data to assess the impacts to Vivian Creek at the moment, but it is possible that Vivian Creek could assimilate these constituents given the low volume of the supernatant with the anticipated degree of treatment. However, further investigation and assessments would be required to assess the treatment requirements for the backwash wastewater and effluent discharge limits. In case the anticipated degree of treatment required to achieve the effluent limits to minimize the impacts to Vivian Creek cannot be achieved with the gravity settling process alone, enhanced on-site treatment of the residuals would be required. The type of required on-site treatment will be studied based on the piloting results, but it can vary from a filter bag to nanofiltration depending on the effluent limits established by MECP. Once the new assessment is available, a pre-consultation with MECP is recommended to discuss the new proposed effluent discharge limits, before design and updating the DWWP.

As there is no local stormwater connection at Well 3 Facility, supernatant would be discharged directly to Vivian Creek. This would require the construction of an outfall through the privately owned property, relying on the landowners cooperation, and within LSRCA regulated areas, and some interference with natural features in the area. Therefore, a permit from LSRCA is required under the Conservation Authorities Act and O.Reg.179/06. The implementation of the residual management alternative will be in parallel with the alternative solution to improve water quality; no additional timeline is required.

Whole Life Cost for Alternative R1

To implement Alternative R1, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-12 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative R1. Detailed calculations are presented in **Appendix G**.

- Onsite residual management system, including equalization tank, sewage pumping system, and yard piping
- Connection to sanitary sewer collection system

Table 4-12. Alternative R1: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Subcomponent	A5a: Centralized Removal Technology at Wells 1 & 2 Facility	A5b: Decentralized Removal Technology at both Facilities	A6: Provide Iron and Manganese Removal Technology at Wells 1&2 Facility and Continue Sequestration at Well 3 Facility	A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and provide iron and manganese removal technology at Wells 1&2 Facility
		Preliminary Cost[1,2]	Preliminary Cost[1,3]	Preliminary Cost[1,2]	Preliminary Cost[1,4]
Capital Investment	Onsite residual management system	$450,000	$850,000	$450,000	$450,000
Capital Investment	Connection to sanitary sewer collection system	$270,000	$1,350,000	$270,000	$270,000
Capital Investment	Design & Construction Administration (20%)	$144,000	$447,000	$144,000	$144,000
Capital Investment	Contingency (30%)	$261,000	$805,000	$261,000	$261,000
Capital Investment	York Region Project Management (5%)	$58,000	$176,000	$58,000	$58,000
Capital Investment	HST (1.76%)	$24,000	$66,000	$24,000	$23,000
Capital Investment	**Total Capital Costs**	**$1,207,000**	**$3,719,000**	**$1,207,000**	**$1,206,000**
Operation & Maintenance Expenditures[5]	Sanitary Sewer discharge	$1,022,400	$1,022,400	$681,700	$364,400
Operation & Maintenance Expenditures[5]	O&M Labour	$156,000	$312,000	$156,000	$166,400
Operation & Maintenance Expenditures[5]	**Total O&M Costs**	**$1,178,400**	**$1,334,400**	**$837,700**	**$530,800**
Net Present Value	Capital Investment (Discounted)	$1,133,320	$3,450,526	$1,133,320	$1,152,364
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$940,063	$1,064,342	$668,222	$427,677
Net Present Value	**Total Whole Life Cost**	**$2,073,383**	**$4,514,868**	**$1,801,542**	**$1,580,040**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2025.
3. Implementation timeline of the alternative (and capital investment) between 2021 to 2026.
4. Implementation timeline of the alternative (and capital investment) between 2021 to 2024.
5. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.

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Whole Life Cost for Alternative R2

To implement Alternative R2, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-13 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative R2. Detailed calculations are presented in **Appendix G**.

- Onsite residual management system, including settling tank, supernatant pumping system, sewage pumping system, and yard piping.
- Connection to sanitary sewer collection system
- Connection to discharge to Vivian Creek (direct or via storm sewer system)

Table 4-13. Alternative R2: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Alternative Solution to Improve Water Quality – Component	Alternative Solution to Improve Water Quality – Subcomponent	Sub-option A5a: Centralized Removal Technology at Wells 1 & 2 Facility	Sub-option A5b: Decentralized Removal Technology at both Facilities	Alternative A6: Upgrade Wells 1&2 Facility with Iron and Manganese Removal Technology and Continue Sequestration at Well 3 Facility	Sub-option A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and upgrade Wells 1 & 2 Facility with iron and manganese removal technology
		Preliminary Cost[1,3]	Preliminary Cost[1,4]	Preliminary Cost[1,3]	Preliminary Cost[1,5]
Capital Investment[2]	Onsite residual management system	$1,130,000	$2,110,000	$1,130,000	$1,080,000
Capital Investment[2]	Connection to discharge to Vivian Creek	$280,000	$570,000[5]	$280,000	$280,000
Capital Investment[2]	Connection to sanitary sewer collection system	$270,000	$1,375,000	$270,000	$270,000
Capital Investment[2]	Design & Construction Administration (20%)	$336,000	$832,000	$336,000	$327,000
Capital Investment[2]	Contingency (30%)	$608,000	$1,499,000	$608,000	$590,000
Capital Investment[2]	York Region Project Management (5%)	$134,000	$328,000	$134,000	$130,000
Capital Investment[2]	HST (1.76%)	$51,000	$122,000	$51,000	$49,000
Capital Investment[2]	**Total Capital Costs**	**$2,809,000**	**$6,936,000**	**$2,809,000**	**$2,726,000**
Operation & Maintenance Expenditures[6]	Dechlorination	$88,200	$88,200	$59,200	$32,200
Operation & Maintenance Expenditures[6]	Sewer discharge	$103,300	$103,300	$68,600	$37,300

Alternative Solution to Improve Water Quality – Component	Alternative Solution to Improve Water Quality – Subcomponent	Sub-option A5a: Centralized Removal Technology at Wells 1 & 2 Facility	Sub-option A5b: Decentralized Removal Technology at both Facilities	Alternative A6: Upgrade Wells 1&2 Facility with Iron and Manganese Removal Technology and Continue Sequestration at Well 3 Facility	Sub-option A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and upgrade Wells 1 & 2 Facility with iron and manganese removal technology
		Preliminary Cost[1,3]	**Preliminary Cost[1,4]**	**Preliminary Cost[1,3]**	**Preliminary Cost[1,5]**
Operation & Maintenance Expenditures[6]	O&M Labour	$312,000	$624,000	$312,000	$332,800
Operation & Maintenance Expenditures[6]	**Total O&M Costs**	**$503,500**	**$815,500**	**$439,800**	**$402,300**
Net Present Value	Capital Investment (Discounted)	$2,637,188	$6,444,236	$2,637,188	$2,604,597
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$401,336	$649,894	$350,531	$323,810
Net Present Value	**Total Whole Life Cost**	**$3,038,525**	**$7,094,130**	**$2,987,720**	**$2,928,407**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Excludes costs to secure easements across private property for direct discharge of supernatant to Vivian Creek.
3. Implementation timeline of the alternative (and capital investment) between 2021 to 2025.
4. Implementation timeline of the alternative (and capital investment) between 2021 to 2026.
5. Implementation timeline of the alternative (and capital investment) between 2021 to 2024.
6. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.

Whole Life Cost for Alternative R3

To implement Alternative R3, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on NPV. Table 4-14 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative R3. Detailed calculations are presented in **Appendix G**.

- Onsite residual management system, including settling tank, supernatant pumping system, and yard piping
- Connection to discharge to Vivian Creek (directly or via storm system)

Table 4-14. Alternative R3: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Alternative Solution to Improve Water Quality – Component	Alternative Solution to Improve Water Quality – Subcomponent	Sub-option A5a: Centralized Removal Technology at Wells 1 & 2 Facility	Sub-option A5b: Decentralized Removal Technology at both Facilities	Alternative A6: Upgrade Wells 1&2 Facility with Iron and Manganese Removal Technology and Continue Sequestration at Well 3 Facility	Sub-option A7c: Replace Well 1 with Well MW18, continue sequestration at Well 3 Facility, and upgrade Wells 1 & 2 Facility with iron and manganese removal technology
		Preliminary Cost[1,3]	**Preliminary Cost[1,4]**	**Preliminary Cost[1,3]**	**Preliminary Cost[1,5]**
Capital Investment[2]	Onsite residual management system	$1,100,000	$2,120,000	$1,100,000	$1,020,000
Capital Investment[2]	Connection to discharge to Vivian Creek	$280,000	$570,000[5]	$280,000	$280,000
Capital Investment[2]	Design & Construction Administration (20%)	$276,000	$539,000	$276,000	$260,000
Capital Investment[2]	Contingency (30%)	$498,000	$971,000	$498,000	$469,000
Capital Investment[2]	York Region Project Management (5%)	$110,000	$212,000	$110,000	$103,000
Capital Investment[2]	HST (1.76%)	$43,000	$82,000	$43,000	$40,000
Capital Investment[2]	**Total Capital Costs**	**$2,307,000**	**$4,494,000**	**$2,307,000**	**$2,172,000**
Operation & Maintenance Expenditures[6]	Dechlorination	$88,200	$88,200	$59,200	$32,200
Operation & Maintenance Expenditures[6]	Sludge Hauling	$1,101,300	$1,101,300	$734,600	$393,100
Operation & Maintenance Expenditures[6]	O&M Labour	$312,000	$624,000	$312,000	$332,800
Operation & Maintenance Expenditures[6]	**Total O&M Costs**	**$1,501,500**	**$1,813,500**	**$1,105,800**	**$758,100**
Net Present Value	Capital Investment (Discounted)	$2,165,910	$4,183,366	$2,165,910	$2,075,276
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$1,197,653	$1,446,211	$881,912	$610,615
Net Present Value	**Total Whole Life Cost**	**$3,363,562**	**$5,629,577**	**$3,047,822**	**$2,685,891**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Excludes costs to secure easements across private property for direct discharge of supernatant to Vivian Creek.
3. Implementation timeline of the alternative (and capital investment) between 2021 to 2025.
4. Implementation timeline of the alternative (and capital investment) between 2021 to 2026.
5. Implementation timeline of the alternative (and capital investment) between 2021 to 2024.
6. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.

4.2 Alternative Solutions to Improve Feasibility of Storage Maintenance

4.2.1 Alternative B2: Rehabilitation of Mount Albert South Elevated Tank and Return it to Service

Conceptual Design

The South ET is currently offline due to its poor asset condition, and the condition assessment of the tank performed in November 2019 (Landmark, 2020) noted that the repair works required to allow the temporarily return of the South ET for maintenance of the North ET consisted of interior lining replacement, reinforcement of the tank roof and reinforcement or replacement the access and safety equipment. It is understood that these repairs would be considered temporary without significantly extending the useful life of the tank.

The South ET has sufficient storage to provide equalization storage for the Mount Albert Water Supply System when the North ET is out-of-service, offering a cushion between production and demand to meet the diurnal variation of water demand. Table 4-15 presents the key features for the concept design.

Table 4-15. Alternative B2: Key Concept Design Features

Alternative	Alternative B2: Rehabilitation of Mount Albert South Elevated Tank and Return it to Service
Required Fire Storage (A) (m^3)[1]	1,200
Required Equalization Storage (B) (m^3)[1]	850
Required Emergency Storage (C) (m^3)[1]	513
Total Storage Required (m^3)[1]	2,563
Storage Volume in Operation (m^3)[2]	910
Storage Deficit (m^3)	**1,653**

Notes:

1. Projected storage requirements for Mount Albert Water Supply System considering a MDD of 3.4 ML/d in 2021 and a fire flow demand of 10,000 L/min for a duration of 2 hours.
2. Considering South ET in operation and North ET out-of-service.

Technical Considerations

Returning the South ET temporarily to service will allow for increased pressures in the elevated areas of the distribution network in the vicinity of the Wells 1 & 2 Facility caused by hydraulic limitations. However, the volume is not sufficient to meet all storage needs when the North ET is out-of-service. A contingency plan would need to be developed for operation during the maintenance period, to bring on additional wells on an emergency basis and investigate alternate means to meet fire flow demands with Fire Protection Services. Consultation with and approval from MECP for emergency relief of the PTTW permitted taking is required to allow operation of all wells at the same time in case of fire.

2019 Condition Assessment (Landmark, 2020) identified that major structural rehabilitation of the South ET is required. Given the degree of structural rehabilitation identified in order to return the tank to service, even on a limited basis, there is some potential that the tank cannot be successfully rehabilitated and would be required to be demolished.

Whole Life Cost

To implement Alternative B2, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on Net Present Value (NPV). Table 4-16 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative B2. Detailed calculations are presented in **Appendix G**.

- South ET Rehabilitation for limited service

Table 4-16. Alternative B2: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Sub-Component	Preliminary Cost[1]
Capital Investment[2]	South ET Rehabilitation	$550,000
Capital Investment[2]	Design & Construction Administration (20%)	$110,000
Capital Investment[2]	Contingency (30%)	$200,000
Capital Investment[2]	York Region Project Management (5%)	$44,000
Capital Investment[2]	HST (1.76%)	$17,000
Capital Investment[2]	**Total Capital Costs**	**$921,000**
Operation & Maintenance Expenditures[3]	Clean and inspect the Mount Albert South Elevated Tank (every two years)[4]	$170,000
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$170,000**
Net Present Value	Capital Investment (Discounted)	$888,477
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$138,198
Net Present Value	**Total Whole Life Cost**	**$1,026,675**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2023.
3. Additional O&M costs produced by the alternative, including chemicals, electricity and labour.
4. Considering moderate accumulation of deposits in the distribution system, which means cleaning every 2 years.

4.2.2 Alternative B3: Operate the Distribution System in Pressure Mode

Conceptual Design

Alternative B3 involves operating the distribution system in pressure mode when the North ET is by-passed during inspection and maintenance activities. The well pumps are equipped with VFDs, which can be controlled for pressure mode operation. However, the minimum pumping capacity is identified at 12 L/s for efficient operation based on minimum pump speed. However, the demand during nighttime can be as low as 3 L/s. Since the minimal flow supplied by the well pumps exceed the current minimum demand, there is a risk of overpressurization of the distribution system if the exceeding flow is not bled off.

Overpressurization of the system can be mitigated through use of the distribution system autoflushers or the surge anticipator valve of Well 3 Facility. Temporary installation of smaller well pump or a pressure tank system, may also be considered should a prolonged shutdown period be required for the North ET during major rehabilitation.

There are four autoflushers in the distribution system sized for discharge up to 12 L/s (200 gpm), and some of them discharge to the Stormwater system. They are equipped with a digital controller allowing the flushing cycles to be adjusted for different flowrates and frequency.

Based on documentation available, the Well 3 Facility surge anticipator valve (Tag V732-WEL-SRV1) has an integrated pressure relief function and could be used as last resort. A field validation study is required to identify the pressure setpoint at the valve that would maintain the distribution system within the optimal pressure range.

This alternative includes the implementation of equipment and controls to facilitate the pressure operation of facilities that would not require major capital investment.

Technical Considerations

To avoid wasting significant amounts of water through autoflushers or surge anticipator valve, it is recommended that irrigation and other outdoor water uses be encouraged during off-peak demand periods.

While North ET is out-of-service, no fire storage is available and the minimum fire flow of 10,000 L/min will not be adequately achieved even with all wells in operation (6,800 L/min). A contingency plan needs to be developed with Fire Services for operation during the maintenance period, to bring on the additional wells on an emergency basis and investigate alternate means to meet fire flow demands. This requires the development of a detailed operational strategy and response procedures to prevent over-pressurization of the water system and potential watermain damage. The maximum permitted taking flow condition also must be temporarily waived, pending consultation with and approval from MECP.

More detailed hydraulic modelling validation and field testing is recommended to validate operational setpoints required for pressure-mode operation during design.

Whole Life Cost

To implement Alternative B3, the key infrastructure upgrades and O&M initiatives are proposed below. The WLC analysis was estimated on Net Present Value (NPV). Table 4-17 summarizes the Capital Investment Costs, O&M Expenditures and NPV related to Alternative B3. Detailed calculations are presented in **Appendix G**.

- Implementation of equipment and controls to facilitate pressure operation (provision)

Table 4-17. Alternative B3: Capital Investment and Operation & Maintenance Expenditures, and Whole Life Costs

Component	Sub-Component	Preliminary Cost[1]
Capital Investment[2]	Improvements to Facilitate Pressure Mode Operation (provision)	$150,000
Capital Investment[2]	Design & Construction Administration (20%)	$30,000
Capital Investment[2]	Contingency (30%)	$56,000
Capital Investment[2]	York Region Project Management (5%)	$13,000
Capital Investment[2]	HST (1.76%)	$6,000
Capital Investment[2]	**Total Capital Costs**	**$255,000**

Component	Sub-Component	Preliminary Cost[1]
Operation & Maintenance Expenditures[3]	Wasted Water	$115,600
Operation & Maintenance Expenditures[3]	**Total O&M Costs**	**$115,600**
Net Present Value	Capital Investment (Discounted)	$246,083
Net Present Value	Operation & Maintenance Expenditures (Discounted)	$93,975
Net Present Value	**Total Whole Life Cost**	**$340,058**

Notes:

1. Prices are 2019/2020 based, in CAD.
2. Implementation timeline of the alternative (and capital investment) between 2021 to 2023.
3. Additional O&M costs produced by the alternative, including York Region 2020 water rate.
4. Considering moderate accumulation of deposits in the distribution system, which means cleaning of North ET every 2 years, and 9 L/s of water wasted for 8 h/day during 15 days of North ET out of service.

5. Evaluation Framework and Criteria

To determine the most appropriate solution for the Mount Albert Water Supply System, an evaluation framework was developed to allow comparative assessment of the short-listed alternatives.

A set of evaluation criteria reflecting four overarching categories of the environment, Natural, Socio-Cultural, Technical, and Economic, were established as described in Table 5-1. These criteria are based on the triple-bottom-line approach described in the Class EA process and were established through consultation with York Region, consideration of the existing conditions of the Study Area as outlined in TM-1, the alternative solutions being considered, and the Problem/Opportunity Statement.

Table 5-1 also presents the main considerations for each criterion to ensure the following guidelines were achieved.

- **Mutually Exclusive and Collectively Exhaustive** – to avoid double counting of possible consequence and to ensure that no important considerations are neglected
- **Concise** – to focus the analysis only on those objectives necessary to make a decision
- **Operational** – to ensure that the information necessary to measure objectives can be obtained with reasonable time and effort
- **Measurable** – to define objectives precisely and to specify the degree to which objectives may be achieved
- **Understandable** – to facilitate the communication of insights from the decision-making process

Table 5-1. Comparative Evaluation Criteria

Comparative Criteria	Comparative Sub-Criteria	Description	Main Considerations for Each Criterion
Natural Environment	Aquatic Vegetation and Wildlife	Potential impact on local aquatic species and habitats, aquatic species at risk and locally significant aquatic species	Presence of aquatic species potentially affected temporarily and/or permanently Area of temporary or permanent loss of aquatic feature
Natural Environment	Terrestrial Vegetation and Wildlife	Potential impact on local terrestrial species and habitats, designated areas, species at risk and locally significant species	Presence of terrestrial species potentially affected temporarily and/or permanently Area of temporary or permanent loss of terrestrial feature
Natural Environment	Surface water	Potential impact on the quantity and quality of surface water	Temporarily and/or permanently changes in quantity and quality of surface water bodies, such as wetlands and streams Discharge of wastewater to local water receiving bodies Impact on private wells users
Natural Environment	Soil and Geology	Geology, hydrogeology, contamination considerations	Potential contamination, erosion, impact on soil permeability
Socio-cultural Environment	Archaeological Sites	Potential impact on registered/known archaeological features	Disruption of potential archeological resources

Comparative Criteria	Comparative Sub-Criteria	Description	Main Considerations for Each Criterion
		during construction or ongoing operations	
Socio-cultural Environment	Cultural/Heritage Features	Potential impact on known cultural landscapes and built heritage features during construction or ongoing operations	Removal of area from cultural/heritage landscape
Socio-cultural Environment	Impacts During Construction	Potential construction impacts due to noise, dust, odour or traffic and duration of adverse effects	Effect of noise, vibration and dust on existing residences and agricultural land within the vicinity of Wells 1 & 2 Facility and Well 3 Facility and along Centre Road due to construction of new building, new yard piping, watermains or forcemains Temporary disruption of traffic Temporary disruption of existing utilities
Socio-cultural Environment	Long-Term Community Impact	Long-term impact on local community and business including land-use compatibility	Water quality impact on private fixtures and Point-of-Use (POU) softeners/filters Long-term impact on traffic, noise, vibration and dust on existing residences and agricultural land within the vicinity of Wells 1 & 2 Facility and Well 3 Facility Expansion of Wellhead Protection Area Change to approved land use designation Effect on active agricultural operations Ability to provide fire flow during North ET maintenance
Socio-cultural Environment	Planning Policy Compliance	Compliance with Local and Regional Planning Policies	Growth Plan for the Greater Golden (2019) Horseshoe Greenbelt Plan (2017) Oak Ridges Moraine Conservation Plan (2017) Lake Simcoe Protection Plan (2008) York Region Official Plan (2010) and Its Amendments 2016 Water and Wastewater Master Plan Update York Region Energy Conservation and Demand Management Plan (2019) York Region By-Law No. 2011-56 (quantity and quality, including iron, manganese, sulphate and sodium) Town of East Gwillimbury Official Plan (2010) and Its 2018 Consolidation East Gwillimbury Water & Wastewater Master Plan (2009)
Technical Considerations	Ease of Implementation	Ease of implementation in terms of available space, accessibility, new infrastructure, constructability, easements, and land acquisition needs	Implementation in phases Construction complexity Effect on available space at each facility Construction on York Region owned property or Right of Way (ROW) Need for property acquisition
Technical Considerations	System Redundancy	Improvement in redundancy of supply/service to allow	Infrastructure/equipment available (duty/standby)

Comparative Criteria	Comparative Sub-Criteria	Description	Main Considerations for Each Criterion
		continuous water supply and proper maintenance	Longevity of supply (potential decline of well capacity/efficiency) Feasibility of contact tank and storage tank maintenance
Technical Considerations	Reliability of Supply	Ability to provide reliable water quality on a consistence basis	Sequestration effectiveness Number of customer complaints (water quality and pressure) Capability to manage pressure issues (hydraulic grade) Ability of residual management system to consistently achieve effluent limits and reduce impact on surface water
Technical Considerations	Operations	Requirement for additional and new Operations resources at regional and municipal level. The complexity and operability of new assets.	Addition of removal technology and residual management, along with the need for specialized operation staff Ability to maximize operations flexibility Distribution system monitoring program to track sequestration Operational water usage (cleaning distribution system, backwashing)
Technical Considerations	Maintenance	Requirement for additional and new Maintenance resources at regional and municipal level. The complexity and maintainability of new assets.	Contact tank and storage cleaning frequency Raw watermain and distribution system cleaning frequency Addition of removal technology and residual management, along with the need for specialized maintenance staff
Technical Considerations	Alignment with Other Infrastructure	Potential impacts on functions or performance of other infrastructure, such as wastewater, conveyance, transportation and utility projects	Impact on Mt. Albert WRRF and SPS Connection to sanitary system and to storm system Repurpose of transmission main Sustainable use of existing infrastructure (One Water Approach) Conflict with other existing or planned infrastructure, systems, or services
Technical Considerations	Flexibility	Flexibility in being able to meet future demands/expansion requirements; or future regulatory requirements	Ability to accommodate potential future development beyond current planning Ability to accommodate future removal technology Ability to comply with Health Canada Manganese and Enteric Virus Guidelines Ability to comply with MECP ToR: Determination of Minimum Treatment for Municipal Residential Drinking Water Systems using Subsurface Raw Water Supplies

Comparative Criteria	Comparative Sub-Criteria	Description	Main Considerations for Each Criterion
Technical Considerations	Permits and Approvals	Ease of receiving permits and approvals, including the agency approvals necessary	MECP PTTW for Well addition or re-rating MECP DWTP/DWWP for addition of removal technology, including effluent discharge requirements MECP Amended Source Water Protection Plan Approval EASR - Construction dewatering LSRCA Permit under the Conservation Authorities Act and O.Reg.179/06 MECP/LSRCA ECA Review - Stormwater DFO Fisheries Act - Project review
Economic Evaluation	Life Cycle Cost	Net Present Value Whole Life Cost	Initial capital investment, including engineering and construction costs. Commissioning of the asset and services, including testing, vesting and fit-out costs. Operational expenditure incurred throughout the life of the asset, including labour, power and consumables and asset monitoring. Asset decommissioning, disposal and revenue received through the disposal of assets.

The evaluation criteria are used to comparatively evaluate alternative solutions and identify the preferred solution. For each comparative criterion, the alternatives are assigned a ranking of least preferred, moderately preferred, and most preferred, as illustrated at Figure 5-1. The preference is established based on the alternative solutions' level of impacts and benefits. Then, these rankings are summed, such that each criterion is equally weighted, to provide an overall recommended solution.

Most Impacts/Least Benefits **Least Preferred**	Moderate Impacts/ Moderate Benefits **Moderately Preferred**	Least Impacts/Most Benefits **Most Preferred**

Figure 5-1. Evaluation Scoring

The evaluation criteria were presented to the public at the Public Consultation Center No. 1 (PCC-1) for review and comment. Those responding to the PCC-1 questionnaire provided no additional criterion to include for assessing alternatives, but comments were collected regarding the relative importance of each criterion. The respondents generally ranked the evaluation categories and criteria within each category equally, with the exception of the Reliability of Supply being scored by 91% of participants as Extremely Important. As consistency among the criteria was observed in general, it is considered appropriate to apply equal weighting to each criterion for evaluation.

6. Comparative Evaluation of Short-Listed Alternative Solutions

The short-listed alternatives were evaluated using the criteria provided in Table 5-1. Table 6-1 **and** Table 6-2 provide a summary of the comparative evaluation of the alternatives. Detailed comparative evaluation with scoring rationale is presented in **Appendix H**.

The **Alternative A5a-R1: Provide Iron and Manganese Removal Technology for All Wells, with Centralized removal technology at Wells 1 & 2 Facility and Direct connection to sanitary sewer collection system** identified as the preliminary preferred alternative to improve water quality in Mount Albert Water Supply System with the least possible overall impact based on the currently available information.

Although Alternatives A4, A5a, and A5b scored similarly, A5a offers the following benefits:

- Addition of removal technology achieves the aesthetic objectives and treatment goals, providing consistently reliable water quality that meets current and upcoming regulations
- Low deposition in the distribution system will reduce distribution system operation and maintenance requirements, minimize POU softeners fouling, and reduce customer concerns
- Can accommodate potential future development as firm capacity (4.91 ML/d) exceeds projected MDD (3.4 ML/d)
- Allows future connection of Well MW18 in the event that existing well replacement is required in future due to its age or condition.
- Although additional linear construction is required to connect Well 3 to Wells 1 and 2 Facility, this is offset by the savings of centralizing treatment at one facility.
- The ability to connect directly to the sanitary sewer system for disposal of backwash wastewater reduces the impact on the natural environment as impact on Vivian Creek is avoided.
- There are no anticipated impacts on the cultural environment since construction adjacent to the burial/cemetery lands is within previously disturbed right of way.
- Although there will be short-term disruption to the community during construction of the sanitary forcemain, watermain and treatment facility at Wells 1 & 2 Facility, the new linear infrastructure length will be minimized and the anticipated routing avoids impacts on the natural environment.
- Increases security of supply and redundancy by having multiple well sites and allows for continuation of disinfected supply from Well 3 in emergency conditions, if the Well 1&2 facility is off-line.
- While it represents a higher capital cost than A4, it provides for more consistent and stable operation, reducing requirements for operator intervention and system monitoring.

The **Alternative B3: Operate the Distribution System in Pressure Mode** was selected as the preliminary preferred alternative to improve the feasibility of storage maintenance in Mount Albert Water Supply System with the least possible overall impact based on the currently available information. This alternative was selected as the preliminary solution for the following reasons:

- The significant operational water usage to avoid overpressurization during pressure mode operation and low demand periods are expected to happen on an infrequent basis while returning South ET to service would require recurrent maintenance efforts.
- Additional operation and maintenance efforts restricted to periods when North ET is out of service.
- No anticipated impacts on natural environment and cultural environment.
- Provides a better cost-benefit when compared to Alternative B2.

Table 6-1. Comparative Evaluation Summary of Alternative Solutions to Improve Water Quality

Comparative Criteria	Comparative Sub-Criteria	A4	A5a-R1	A5a-R2	A5a-R3	A5b-R1	A5b-R2	A5b-R3	A6-R1	A6-R2	A6-R3	A7a	A7b	A7c-R1	A7c-R2	A7c-R3
Natural Environment	Aquatic Vegetation and Wildlife	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Least Preferred	Least Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred
Natural Environment	Terrestrial Vegetation and Wildlife	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Natural Environment	Surface water	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Least Preferred	Least Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred
Natural Environment	Groundwater	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Natural Environment	Soil and Geology	Most Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred
Socio-cultural Environment	Archaeological Sites	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Least Preferred	Least Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred
Socio-cultural Environment	Cultural/Heritage Features	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred
Socio-cultural Environment	Impacts During Construction	Most Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Least Preferred
Socio-cultural Environment	Long-Term Community Impact	Least Preferred	Most Preferred	Most Preferred	Moderately Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred
Socio-cultural Environment	Planning Policy Compliance	Most Preferred	Most Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Least Preferred	Least Preferred	Most Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Technical Considerations	Ease of Implementation	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Technical Considerations	System Redundancy	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Most Preferred	Most Preferred	Most Preferred
Technical Considerations	Reliability of Supply	Least Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Technical Considerations	Operations	Least Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred	Least Preferred
Technical Considerations	Maintenance	Least Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Technical Considerations	Alignment with Other Infrastructure	Most Preferred	Least Preferred	Least Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Least Preferred	Moderately Preferred
Technical Considerations	Flexibility	Least Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred
Technical Considerations	Permits and Approvals	Most Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred
Economic Evaluation	Life Cycle Cost	Most Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred	Least Preferred
Overall Results		Most Preferred	Most Preferred	Moderately Preferred	Moderately Preferred	Most Preferred	Least Preferred	Least Preferred	Least Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Moderately Preferred	Least Preferred	Least Preferred

Table 6-2. Comparative Evaluation Summary of Alternative Solutions to Improve Feasibility of Storage Maintenance

Comparative Criteria	Comparative Sub-Criteria	B2: Rehabilitation of Mount Albert South Elevated Tank and Return it to Service	B3: Operate the Distribution System in Pressure Mode By-passing the North Elevated Tank
Natural Environment	Aquatic Vegetation and Wildlife	Most Preferred	Most Preferred
Natural Environment	Terrestrial Vegetation and Wildlife	Most Preferred	Most Preferred
Natural Environment	Surface water	Most Preferred	Moderately Preferred
Natural Environment	Groundwater	Most Preferred	Most Preferred
Natural Environment	Soil and Geology	Most Preferred	Moderately Preferred
Socio-cultural Environment	Archaeological Sites	Most Preferred	Most Preferred
Socio-cultural Environment	Cultural/Heritage Features	Most Preferred	Most Preferred
Socio-cultural Environment	Impacts During Construction	Most Preferred	Most Preferred
Socio-cultural Environment	Long-Term Community Impact	Most Preferred	Most Preferred
Socio-cultural Environment	Planning Policy Compliance	Most Preferred	Most Preferred
Technical Considerations	Ease of Implementation	Least Preferred	Most Preferred
Technical Considerations	System Redundancy	Most Preferred	Least Preferred
Technical Considerations	Reliability of Supply	Least Preferred	Most Preferred
Technical Considerations	Operations	Most Preferred	Least Preferred
Technical Considerations	Maintenance	Least Preferred	Most Preferred
Technical Considerations	Alignment with Other Infrastructure	Most Preferred	Most Preferred
Technical Considerations	Flexibility	Least Preferred	Moderately Preferred
Technical Considerations	Permits and Approvals	Moderately Preferred	Moderately Preferred
Economic Evaluation	Life Cycle Cost	Least Preferred	Most Preferred
Overall Results		Least Preferred	Most Preferred

7. Summary and Next Steps

The **Alternative A5a-R1: Provide Iron and Manganese Removal Technology for All Wells, with Centralized removal technology at Wells 1 & 2 Facility and Direct connection to sanitary sewer collection system** and **Alternative B3: Operate the Distribution System in Pressure Mode** are identified as preliminary preferred alternatives for the Mount Albert Water Supply System. Together, these alternatives will allow the mitigation of the aesthetic water quality issues and compliance with future manganese regulation, while improving the overall system redundancy and reliability with the least possible overall impact.

For the successful implementation of these alternatives, the following is recommended:

- Pilot the selected iron and manganese removal technology to confirm preferred media, its efficiency, backwash wastewater characteristics and settleability, and design guidelines;
- Include flexibility for future expansion of treatment and residual management system, as well as the connection of a new well from Well 3 Facility in design concepts.
- Consider maintaining the existing treatment at Well 3 Facility for redundancy purposes, in case of emergency event or maintenance at Wells 1 & 2 Facility.
- Develop a monitoring plan and collect additional data for Vivian Creek that allow future consideration of discharge of supernatant to Vivian Creek, should more effective utilization of existing wastewater infrastructure be required. Design to also for future addition of gravity settling system.
- Develop Fire Contingency Plan with Fire Services during tank maintenance activities.
- Perform detailed hydraulic modelling validation and field testing to validate operational setpoints required for pressure-mode operation, as well as testing of all three well pumps in operation to assess the ability to increase the permitted taking requirement.

To complete the Phase 2 of the Class EA process, the next steps will generally include the following tasks:

- Based on the results of this technical memorandum, present the preliminary preferred alternative solution for the Mount Albert Water Supply System Class EA study to the public and stakeholders for comments and feedback.
- Conduct Stakeholder consultations, including Public Contact through the Public Consultation Center No. 2.
- Consolidate input and feedback from stakeholder consultation and PIC and confirm the preferred alternative.
- Consolidate the study into the Project File to be filed on the public record for the 30-day review period.

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Appendix A. Subsurface Utility Engineering Study

CH2M HILL Canada Limited

Mt. Albert Water Supply System EA

PSS No. 145000717

Report
Subsurface Utility Engineering Services

Project #61001460

Report Date: October 22, 2019

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by T2 Utility Engineers Inc. ("Consultant") for the benefit of JACOBS ("Client") and Regional Municipality of York ("Owner"). The report was prepared in accordance with the agreement between Consultant and Client (the "Agreement"), and the prime agreement between Client and Owner including the scope of work detailed therein.

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations"), represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports, may be based on information provided to Consultant which has not been independently verified, has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued, must be read as a whole and sections thereof should not be read out of such context, was prepared for the specific purposes described in the Report and the Agreement, in the case of subsurface conditions, may be based on limited inspections and on the assumption that such conditions are uniform and not variable either geographically or over time.

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

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This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

Report Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	PO	10/22/19	Addressing Comments from the Client and the Owner

Signatures

Report Prepared By:

Prince Oguejiofor, EIT
Project Manager

Acronyms and Abbreviations

ABND	Abandoned
AC	Asbestos Cement
APPROX	Approximate
BE	Buried Electrical
BFD	Bitumous Fibre Duct
BOC	Bottom of Chamber
BR	Brick
BT	Buried Telecommunication
CB	Catch Basin
CC	Cast Iron Cement Lined
CCTV	Closed Circuit Television
CI	Cast Iron
COMB	Combined
CONC	Concrete
CPP	Concrete Pressure Pipe
CSE	Confined Space Entry
CSP	Corrugated Steel Pipe
CU	Copper
DBC	Direct Buried Cable
DI	Ductile Iron
DI	Ditch Inlet
EOP	Edge of Pavement
EOS	End of Signal
EXP	Exploratory
FDC	Foundation Drain Collector
FDI	Fiber Distribution Interface
FH	Fire Hydrant
FM	Flush Mount
FOC	Fiber Optic Cable
FOTS	Fiber Optic Transmission System
FRE	Fiberglass Reinforced Epoxy
FTG	Flush to Grade (Pedestal)
G	Gas (Natural Gas)
GLB	Grade Level Box
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GRP	Glass Fiber Reinforced Plastic
GS	Gas Service
GV	Gas Valve
HDPE	High Density Poly Ethylene
HP	High Pressure (Gas)
HW	Hand Well
HYD	Hydrant
INV	Invert
IP	Intermediate Pressure (Gas)
JUT	Joint Utility Trench
LAT	Lateral Connection (Sewer)
LS	Light Standard (Pole)
MCGPR	Multi Channel Ground Penetrating Radar
MET	Metallic
MH	Maintenance Hole
MP	Medium Pressure (Gas)
OBV	Obvert
OPI	Outside Plant Interface
PE	Polyethylene
PED	Pedestal (Telecommunication)
PH	Primary Hydro (Electrical)
PL	Plastic
P/L	Property Line
PVC	Polyvinyl Chloride
QL	Quality Level
RC	Reinforced Concrete
REF	Reference
SAN	Sanitary
S C&W	Steel Coated & Wrapped
SC	Steel Coated
S CT	Steel Coated
SH	Secondary Hydro (Electrical)
SL	Street Light
SSA	Support Structures Agreement
ST	Steel
STM	Storm
SUE	Subsurface Utility Engineering
S YJ	Steel Yellow Jacketed
TCB	Traffic Control Box
TEL	Telecommunication
TH	Test Hole
TL	Traffic Light
TOP	Top of Pipe
TRS	Transite
TS	Traffic Signal
TV	Cable Television
TX	Transformer
UP / UTP	Utility Pole
UNK	Unknown
VC	Vitrified Clay
WC	Water Chamber
WK	Water Service Key
WM	Water Main
WS	Water Service
WV	Water Valve
XHP	Extra High Pressure

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Appendix A – SUE Mapping Drawing

Appendix B – Utility Circulation Contact List

1. Project Summary

T2 Utility Engineers (T2ue) completed a Subsurface Utility Engineering (SUE) investigation in accordance with Construction Institute/American Society of Civil Engineers (CI/ASCE) Standard 38-02, for JACOBS. The project is a consulting service for the Mt. Albert Water Supply Systems Upgrades Schedule 'B' Class Environmental Assessment and Preliminary Design. The objective of the SUE investigation is to identify alignment of existing mainline utilities that may impact the project and reduce the uncertainty that existing utilities create on the project. T2ue's investigation involves Record Request Circulation, Utility Designating, and Invert Investigations.

1.1 Project Area

The Mt. Albert Water Supply System is a stand-alone system that is distinct from the York Water System and the Georgina Water System. It includes the Region's production, storage and transmission system and the local municipal distribution system. The Regional system consists of three (3) groundwater wells and one (1) elevated storage tank in service.
Wells No. 1 and 2 are located within the same treatment facility while Well No. 3 is located in a separate facility. The Elevated Tank is located at the north end of Ninth Line, approximately two kilometers northeast of the Wells 1 and 2 Pumphouse.

According to the record documents obtained and field investigations the project area contains subsurface utilities.

Underground utilities within the project area include:

- Hydro One electric power,
- Bell and Rogers telecommunications,
- Enbridge natural gas mains,
- Regional Municipality of York watermains,
- Regional Municipality of York sanitary sewers and
- Storm sewers.

1.2 Limits of Investigation

Property limits including 10m beyond property limits where feasible for the following sites:

- Mount Albert Well #1 & 2 Facility.
- Mount Albert Well #3 Facility.
- Mount Albert North Elevated Tank Facility.

2. Equipment and Techniques

The following paragraphs provide a description of the equipment and techniques used by T2ue to complete the investigation. T2ue used the latest equipment and techniques available to designate varieties of subsurface utilities and underground structures. The merits of each technology are assessed as outlined in the CI/ASCE Standard 38-02 and CSA S250-11 for use in utility designating. Field Technicians utilized each technology according to the manufacturer's instructions and the project conditions. Based on the project scope, T2ue selected the appropriate equipment to gather the required information to assist with the designation of underground utilities.

2.1 Electromagnetic Designating Equipment

T2ue used single frequency and multi-frequency electromagnetic designating equipment. Electromagnetic designating equipment did not locate the actual pipes or cables, but instead located the magnetic fields. Electromagnetic fields were either naturally present on conductors or were induced onto a target line using a transmitter. Signals may have been distorted by any of the following:

- ground conductivity,
- construction layout (i.e. bends, connections),
- utility congestion causing bleed off of magnetic fields,
- materials and/or age (i.e. PVC without tracer wire, corrosion in metallic pipes),
- construction debris, overhead wires, conductive structures (i.e. reinforcing bars, guard rails).

2.2 Measuring Rod (Invert and Chamber Investigations)

Measurements were collected within the chambers from the surface using measuring rods with adjustable offset gauge and measuring tapes. Inspections measured the pipe depth (top and bottom) and pipe offsets from surface. Each pipe was measured to the closest edge of the metal frame on surface. Reference elevation, where provided for the chamber lid, was used to calculate the pipe elevations. Chamber type (i.e. sewer, water), pipe material and pipe diameter were confirmed from surface, where possible. Inspections and accuracy may be affected by; variations in frame (i.e. slanted), debris in pipes, line of sight, maintenance platforms, large offsets or excessively deep chambers. Information gathered within the chamber inspections was specific to the project requirements.

Measurements that are obtained using a measuring rod (from surface) are within +/- 2.5mm, in ideal conditions.

2.3 Survey Technologies

T2ue utilized Global Positioning System (GPS) based survey equipment to collect the field information using recognized industry best practices. T2ue survey crews collected the field data (i.e. designating marks) from the SUE investigation. There was no topographic survey or established project control provided by the client.

3. SUE Investigation Methodology

T2 Utility Engineers Inc. performed SUE investigations in accordance with the CI/ASCE Standard 38-02: Standard Guideline for the Collection and Depiction of Existing Subsurface Utility.

3.1 CI/ASCE Standard 38-02 Summary:

All utility information was assigned a quality level in accordance with the CI/ASCE Standard 38-02:

Quality Level D (QL-D) – Information derived from existing utility records, or verbal recollections.

Quality Level C (QL-C) – Information obtained by verifying and plotting visible above-ground utility features and used professional judgment in correlating information to Quality Level D information.
Quality Level B (QL-B) – Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities.
Quality Level A (QL-A) – Precise horizontal and vertical location of utilities obtained by the actual exposure (or verification of previously exposed and surveyed utilities) and subsequent measurement of subsurface utilities, usually at a specific point.

3.2 SUE Investigation Scope of Work

The following is a breakdown of the methodology used for the SUE investigation:

- Records research completed by T2ue included the review of record documents obtained through the Utility Circulation Request (see Appendix B), information received from JACOBS and gathered records information for the entire project area. JACOBS provided T2ue with a property fabric for the area that is tied into UTM 83-17 coordinate systems.
- Utilized the as-built drawings provided to verify the position of surface features such as valves and pedestals that indicate the possible presence of underground utilities.
- Utilized geophysical utility designating techniques to determine the horizontal position of conductive utilities identified within the project limits. Utilities investigated included water, gas, electric power and telecommunications. The investigation also included induction scanning in key areas to help identify utilities that were not identified on the record drawings. Equipment used included single frequency and multi-frequency electromagnetic designating equipment.
- Conductive signals that were not identified by the records research are termed "unknown". T2ue used reasonable means in an attempt to determine the existence of unknowns however cannot certify that all utilities within the project limits were identified and depicted.
- Inspected sewer chambers from the surface to confirm the actual pipe sizes, materials, offsets and measure downs. Mapping of the system, alignments and interconnections are shown on the SUE Mapping Drawings based on a combination of record information received, results of the inspections, surveyed MH's/CB's and professional judgment.
- Inspected water chambers from the surface to confirm actual pipe sizes, materials, offsets and top of pipe elevation, and verified information obtained from record documents.
- All designating marks were collected with survey equipment in UTM 83-17 coordinates. The information was referenced into the provided property fabrics.
- T2ue produced the SUE Mapping Drawing (Quality Level D, C and B as per CI/ASCE Standard 38-02) showing the horizontal alignment of the underground utilities at the described quality level over the project area.
- T2ue reviewed the results, updated the SUE Mapping Drawings and prepared the final report.

4. Utility Circulation Request

T2ue completed the utility circulation request on March 28, 2019. Record documents have been provided by the utility companies for the project area. Additional records for municipal infrastructure / private utility were provided by JACOBS. A summary of the Utility Circulation Request completed by T2ue is attached in Appendix B.

5. Field Investigation and Analysis

The field investigation was completed in May, 2019 within the limits described above. The details are provided in the following sections. Refer to the SUE Mapping Drawings (Appendix A) for details.

In areas where an "LOSS OF SIGNAL" note is shown the information collected in the field has been unable to designate the alignment beyond a specific point (as shown). In cases where records are available the alignment has been shown according to the available information. Where no further information exists the alignment should be investigated further to determine if the buried conductive ends at this location or continues beyond where no signal could be detected from the surface.

The property fabrics provided contained no features (i.e. Water chambers, Water Valves, Pedestals, and Maintenance Holes). T2ue has included notes where possible to highlight the missing information. These notes should be reviewed to ensure accuracy of the location of the associated underground features.

Utility Ownership shown on the drawings has been indicated based on record information and field investigations. Leasing agreements between the utility companies for joint use structures may exist throughout the project area. Ownership that has been indicated on the drawings may need to be verified with the individual utility owners for pending sales, transfer of ownership and leasing agreements.

The alignment of the buried utilities shown on the SUE Mapping Drawings are not intended to accurately locate connection details, unless they have been visually verified and exposed with test holes. Alignments that have been designated in the field and shown on the drawings are not intended to depict the connection detail (i.e. BEND, ELBOW, TEE or CROSS). Further investigations may be required to confirm the connection details and precise locations of connections.

5.1 Municipal Watermains

Watermains within the project area are primarily owned by the Municipality Region of York.

In Well No. 1 & 2 facility, Ex. Well No. 2 was opened and there was no tracer wire to designate the 200mm PVC Watermain running from the pumping station.

Service connections along the project area were included within the investigation. In areas where the connections could not be field verified notes have been indicated on the drawings. The possible alignment has been shown according to field observations.

The Watermain alignment shown on the SUE Mapping Drawings are not intended to accurately locate connection details, unless they have been visually verified and exposed with test holes. Alignments that have been designated in the field and shown on the drawings are not intended to depict the connection detail (i.e. BEND, ELBOW, TEE or CROSS). Further investigations may be required to confirm the connection details and precise locations of connections.

6. Conclusion

The SUE investigation for this project provided key information regarding the location of the existing underground utilities to be used during the project. A combination of data from the field investigations and utility record information was used to create the SUE Mapping Drawings (as per CI/ASCE Standard 38-02). The SUE Mapping Drawings show the horizontal alignment of the underground utilities at the described quality level over the project area.

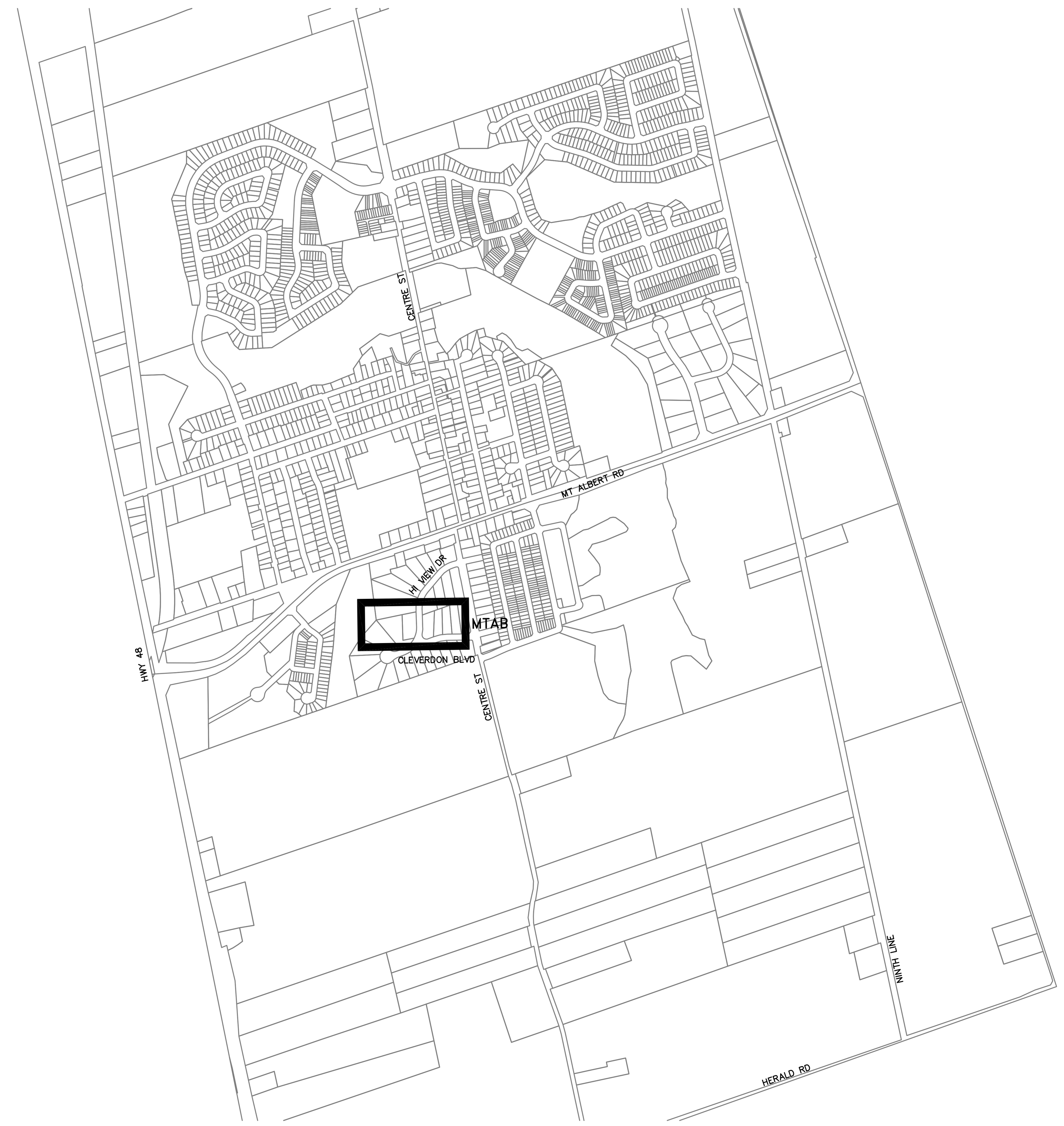
The data currently shown on the SUE Mapping Drawing will provide the designers adequate information to move forward with the design. During detailed design, a topographic survey with established project control and test holes may be required to further define any new areas that may be considered if revisions are made.

T2ue recommends additional investigations for consideration by JACOBS to further reduce uncertainty including:

- A topographic survey tied into proper coordinate systems with established control.
- Test holes to confirm size, material and precise horizontal and vertical alignment, final locations to be confirmed by JACOBS. Locations may include conflict locations, utility crossings, connection points or to confirm record information and alignment shown on the SUE Mapping Drawings.
- Test holes to confirm the existing connections present (ie. BEND, ELBOW, TEE CROSS) or proposed tie in locations to verify the precise horizontal and vertical alignment. Note that locations may require isolation and de-energizing of the pressurized system where restrained connections or thrust blocks may be disturbed.
- Test holes at UNKWOWN Conductive Signals to determine the material and size and assist in gathering additional information or possibly identifying the unknown conductive signal, final locations to be confirmed by JACOBS.
- CCTV inspections of the sewers may assist in identifying the location of service lateral connections within the main that have not been included the record information, or shown in the wrong location.
- If critical, additional investigations to confirm the alignment of plants on Quality Level D that was unable to be designated in areas that may impact the design or construction.

APPENDIX A

SUE MAPPING DRAWING



NOT TO SCALE

LEGEND

GAS	GAS
G.S.	GAS SERVICE
WM	WATER
W.S.	WATER SERVICE
SAN	SANITARY SEWER
SAN LAT.	SANITARY LATERAL
STM	STORM SEWER
STM. LAT.	STORM LATERAL
BE	ELECTRIC
BE SL	ELECTRIC STREET LIGHT
BE TL	ELECTRIC TRAFFIC LIGHT
UNK	UNKNOWN
FOC	FIBRE OPTIC CABLE
TV	CABLE TV
BT	TELECOMMUNICATIONS
	WIDTH OF PIPE
	QUALITY LEVEL "B"
	QUALITY LEVEL "C"
	QUALITY LEVEL "D"
	TEST HOLE (QL-A)
	CONTINUATION ARROW
	FLOW ARROW
( )	BRACKETS INDICATE INFORMATION OBTAINED FROM RECORDS
*	FEATURE NOT PROVIDED AS PART OF THE BASE PLAN, LOCATION BASED ON FIELD OBSERVATION
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ASCE NOTES

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QUALITY LEVEL "C" – INFORMATION OBTAINED BY SURVEYING AND PLOTTING VISIBLE ABOVE GROUND UTILITY FEATURES AND BY USING PROFESSIONAL JUDGEMENT IN CORRELATING THIS INFORMATION TO THE QUALITY LEVEL "D" INFORMATION.

QUALITY LEVEL "B" – INFORMATION OBTAINED THROUGH THE APPLICATION OF APPROPRIATE SURFACE GEOPHYSICAL METHODS TO DETERMINE THE EXISTENCE AND APPROXIMATE HORIZONTAL POSITION OF THE UTILITIES.

QUALITY LEVEL "A" – PRECISE HORIZONTAL AND VERTICAL LOCATION OF UTILITES OBTAINED BY THE ACTUAL EXPOSURE AND SUBSEQUENT MEASUREMENT OF SUBSURFACE UTILITIES.

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2. LIMIT OF INVESTIGATION:
PROPERTY LIMITS OF:
MOUNT ALBERT WELL #1&2 FACILITY (MTAB) AND UP TO 10m BEYOND WHERE FEASIBLE.

3. FIELD VERIFICATION OF UTILITIES WAS COMPLETED USING A COMBINATION OF ELECTROMAGNETIC PIPE AND CABLE LOCATE EQUIPMENT.

4. EMPTY CONDUITS, SERVICES, LATERALS TO BUILDINGS, ABANDONED FACILTIES SUCH AS STREET LIGHT CABLES, WITHIN THE INVESTIGATION AREA MAY NOT BE SHOWN ON THE DRAWING.

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No.	DATE	REVISIONS	BY

York Region

JACOBS

DESIGN	
DRAWN	M.T.
CHECKED	J.S.

MOUNT ALBERT WATER SUPPLY
SUBSURFACE UTILITY ENGINEERING INVESTIGATION

DWG. NO.	61001460
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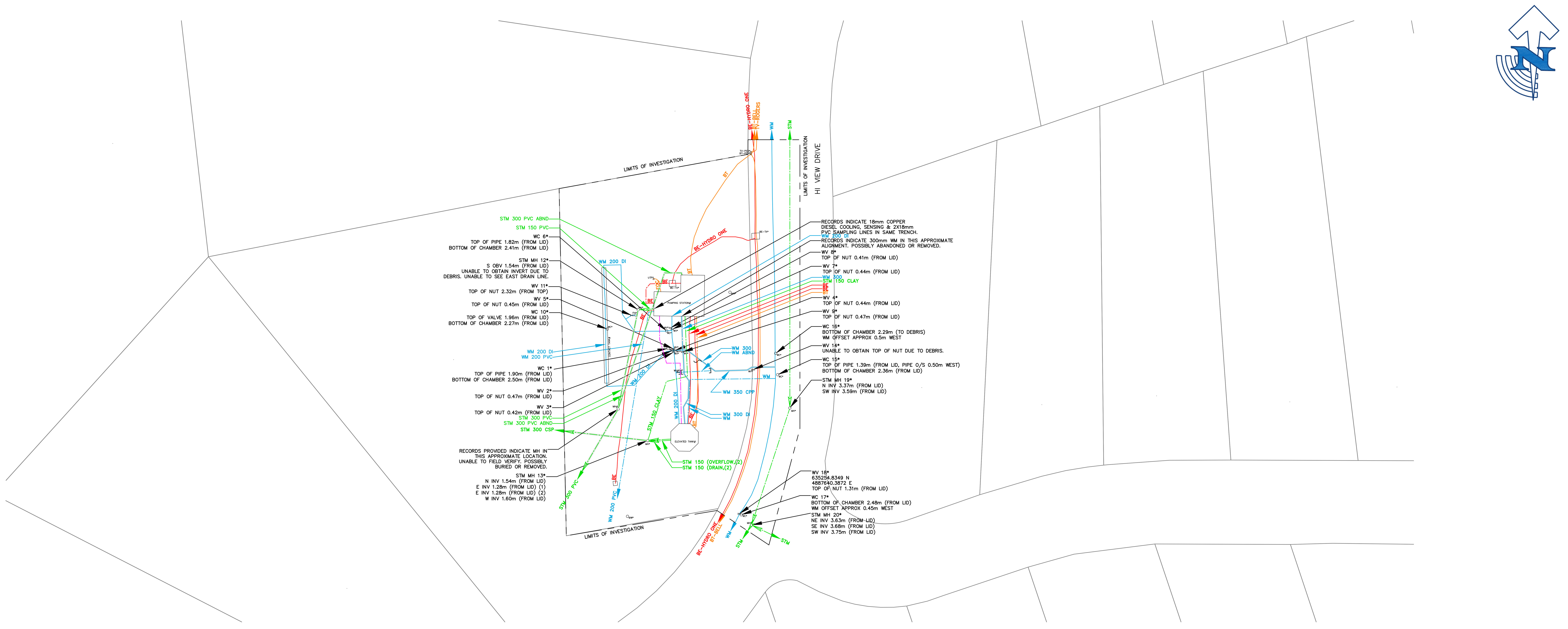
SHEET NO.	COVER



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LEGEND

GAS	GAS
G.S.	GAS SERVICE
WM	WATER
W.S.	WATER SERVICE
SAN	SANITARY SEWER
SAN LAT.	SANITARY LATERAL
STM	STORM SEWER
STM. LAT.	STORM LATERAL
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No.	DATE	REVISIONS	BY

York Region

JACOBS

DESIGN

DRAWN M.T.

CHECKED J.S.

MOUNT ALBERT WELL 1&2 (MTAB)

MOUNT ALBERT WATER SUPPLY

SUBSURFACE UTILITY ENGINEERING INVESTIGATION

DWG. NO. 61001460

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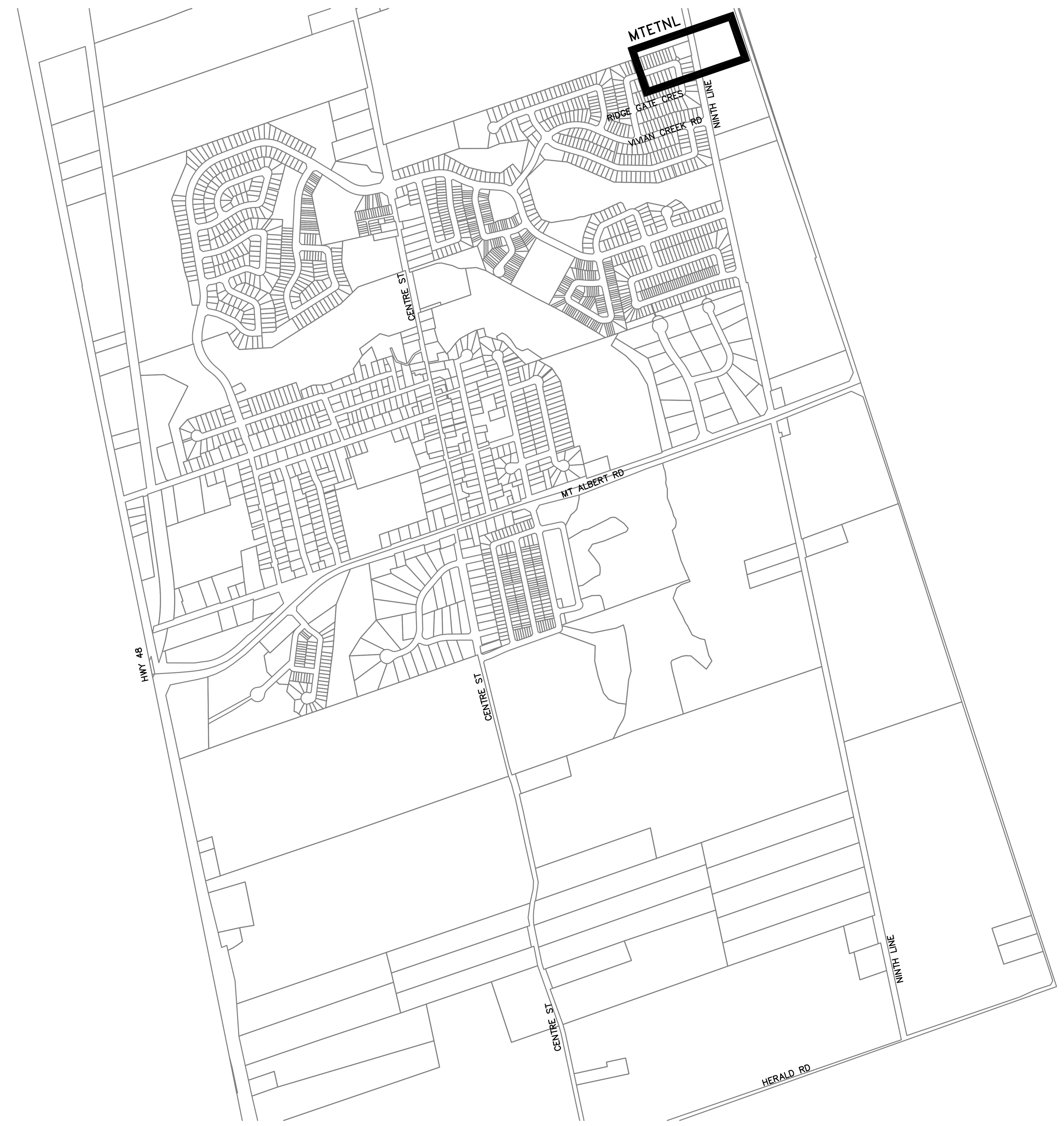

LEGEND

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W.S.	WATER SERVICE
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No.	DATE	REVISIONS	BY

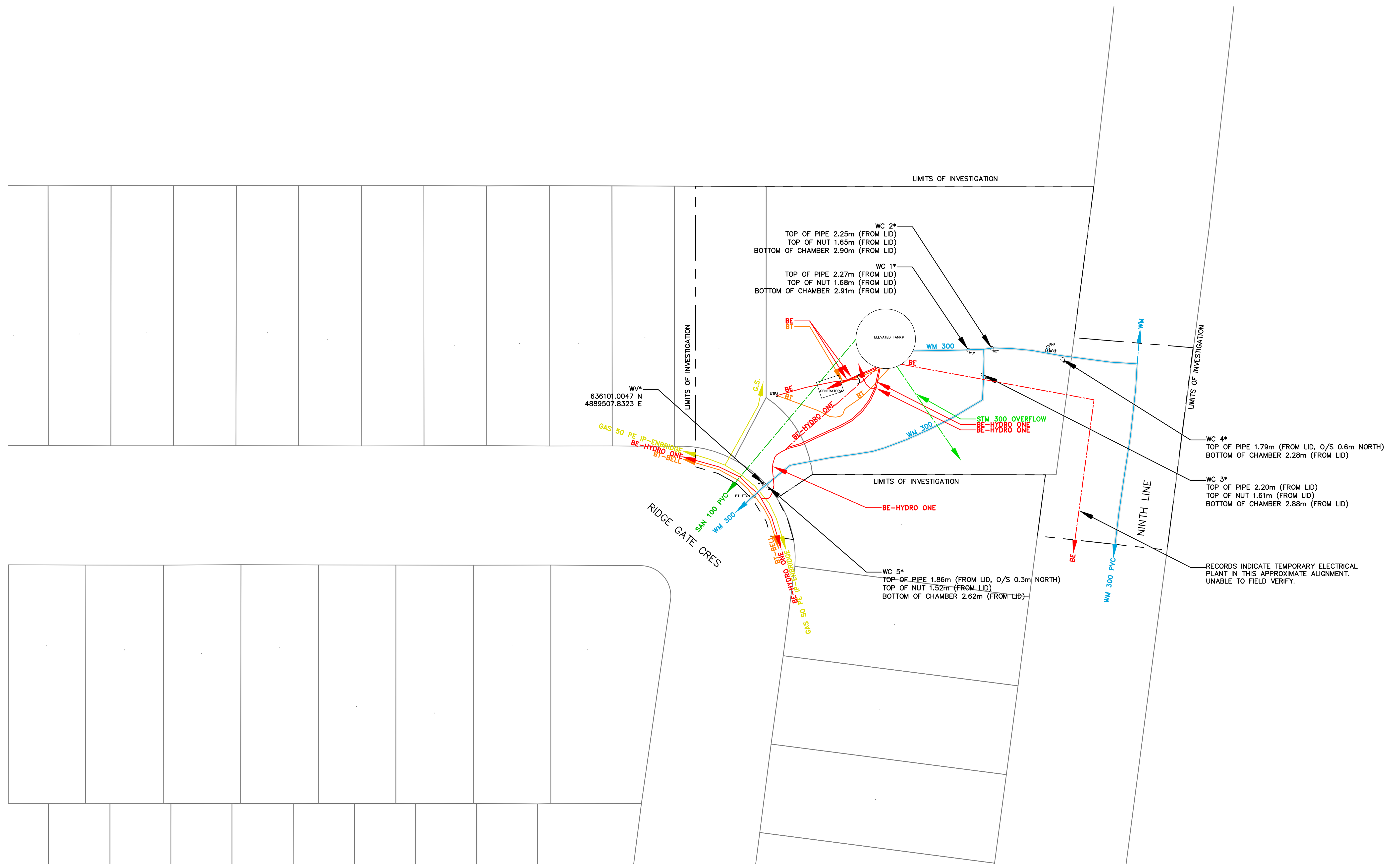
York Region

JACOBS

DESIGN	
DRAWN	M.T.
CHECKED	J.S.

MOUNT ALBERT WATER SUPPLY
SUBSURFACE UTILITY ENGINEERING INVESTIGATION

DWG. NO.	61001460
CONT. NO.	–
SHEET NO.	COVER



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LEGEND

GAS	GAS
G.S.	GAS SERVICE
WM	WATER
W.S.	WATER SERVICE
SAN	SANITARY SEWER
SAN LAT.	SANITARY LATERAL
STM	STORM SEWER
STM. LAT.	STORM LATERAL
BE	ELECTRIC
BE SL	ELECTRIC STREET LIGHT
BE TL	ELECTRIC TRAFFIC LIGHT
UNK	UNKNOWN
FOC	FIBRE OPTIC CABLE
TV	CABLE TV
BT	TELECOMMUNICATIONS
	WIDTH OF PIPE
———	QUALITY LEVEL "B"
- - - -	QUALITY LEVEL "C"
— - — -	QUALITY LEVEL "D"
	TEST HOLE (QL-A)
	CONTINUATION ARROW
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( )	BRACKETS INDICATE INFORMATION OBTAINED FROM RECORDS
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No.	DATE	REVISIONS	BY

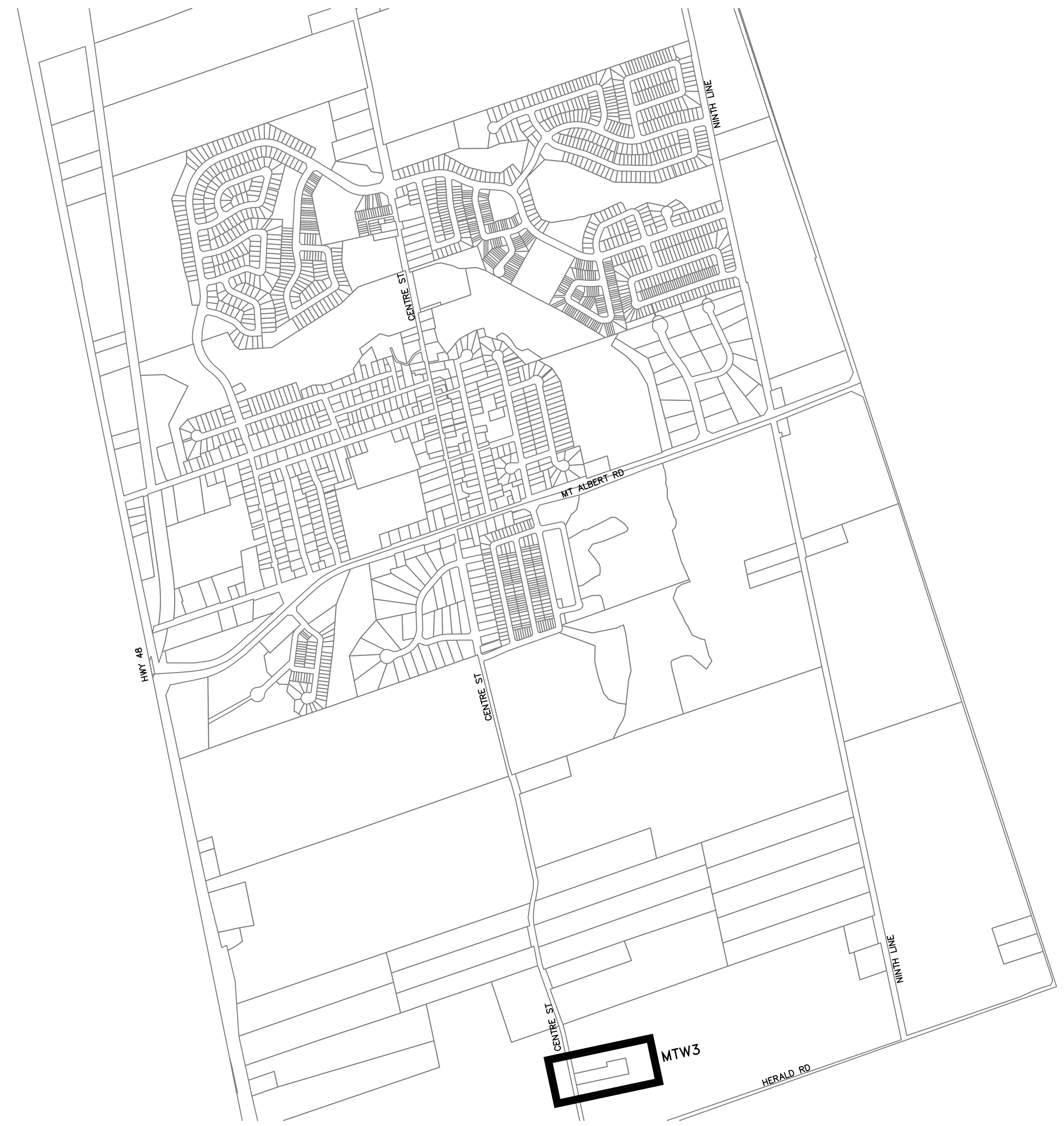
York Region

JACOBS

DESIGN	
DRAWN	M.T.
CHECKED	J.S.

MOUNT ALBERT NORTH ET (MTETNL)
MOUNT ALBERT WATER SUPPLY
SUBSURFACE UTILITY ENGINEERING INVESTIGATION

DWG. NO.	61001460
CONT. NO.	–
SHEET NO.	1 OF 1



NOT TO SCALE

LEGEND

GAS	GAS
G.S.	GAS SERVICE
WM	WATER
W.S.	WATER SERVICE
SAN	SANITARY SEWER
SAN LAT.	SANITARY LATERAL
STM	STORM SEWER
STM. LAT.	STORM LATERAL
BE	ELECTRIC
BE SL	ELECTRIC STREET LIGHT
BE TL	ELECTRIC TRAFFIC LIGHT
UNK	UNKNOWN
FOC	FIBRE OPTIC CABLE
TV	CABLE TV
BT	TELECOMMUNICATIONS
	WIDTH OF PIPE
	QUALITY LEVEL "B"
	QUALITY LEVEL "C"
	QUALITY LEVEL "D"
	TEST HOLE (QL-A)
	CONTINUATION ARROW
	FLOW ARROW
( )	BRACKETS INDICATE INFORMATION OBTAINED FROM RECORDS
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DRAWN	M.T.
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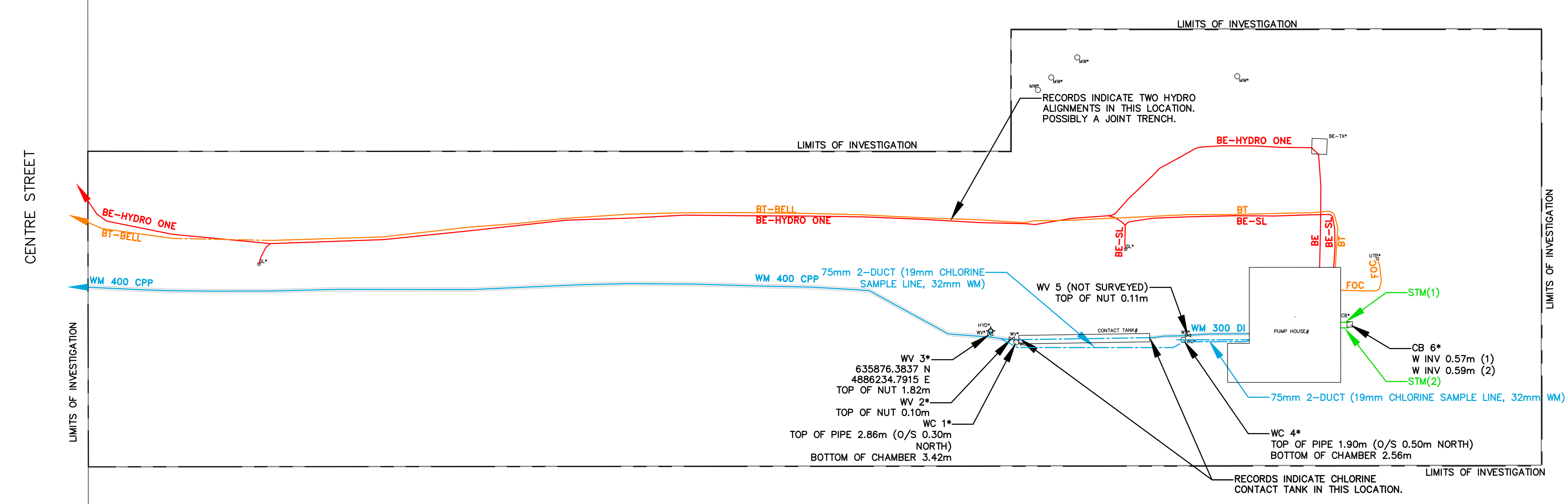
MOUNT ALBERT WATER SUPPLY
SUBSURFACE UTILITY ENGINEERING INVESTIGATION

DWG. NO.	61001460
CONT. NO.	–
SHEET NO.	COVER



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W.S.	WATER SERVICE
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SAN LAT.	SANITARY LATERAL
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York Region

JACOBS

DESIGN	
DRAWN	M.T.
CHECKED	J.S.

MOUNT ALBERT WELL 3 (MTW3)
MOUNT ALBERT WATER SUPPLY
SUBSURFACE UTILITY ENGINEERING INVESTIGATION

DWG. NO.	61001460
CONT. NO.	–
SHEET NO.	1 OF 1

APPENDIX B
UTILITY CIRCULATION CONTACT LIST

Utility Contact Sheet: EAST GWILLIMBURY

Project Name:	Mount Albert Water Supply
Project Number:	61001460
Client:	Jacobs
Client Number:	61001460

Completed by:	P.M.
Checked by:	M.T.
Project Manager:	P.O.
Updated (dd/mm/yy)	08/15/19

Job Limits:

Utility	Email Address	Contact Name	Contact Information	First Request Date Requested (DD/MM/YY)	First Request Date Received (DD/MM/YY)	Second Request Date Requested (DD/MM/YY)	Second Request Date Received (DD/MM/YY)	MATERIAL RECEIVED	Notes
Alectra Utilities			Josie Ilari 1-877-963-6900 Ext 25021	-	-	-	-	-	NOT WITHIN ALECTRA AREA.
Bell Canada	moc.bell@bell.ca bell.moc@telecon.ca	Elaine Oakley (Toronto) Chris Gill (Hamilton)	100 Borough Drive, Floor F5 Toronto, ON M1P 4W2 tel: 416-296-6587	28-Mar-19	13-Apr-19			DGN/DWG	
Cogeco Data Services Inc.	utility.circulations@cogecodata.com dennis.ramdass@cogecodata.com			28-Mar-19	28-3-2019			NO CONFLICT	
Enbridge Gas Distribution	mark-ups@enbridge.com	Joe Marozzo	500 Consumers Road 4th Floor - Post A2 - VPC North York, ON M2J 1P8 tel: (416) 758-7956 fax:(416) 758-4374	28-Mar-19	15-Apr-19			PDF	
Group Telecom	GT.moc@telecon.ca	Ambar Mendes	Telecon Design Inc. 200 Town Centre Blvd., Suite 300, Markham, ON. L3R 8G5 Tel: 905-470-2112 ext. 40305	28-Mar-19	16-Apr-19			NO CONFLICT	
Hydro One	tpumarkup@hydroone.com	Mark Hamilton	49 Sarjeant Dr. Barrie, ON L4N 4V9 tel: 705-797-4142 fax: 705-792-3116	28-Mar-19	10-Apr-19			NO CONFLICT	
Hydro One	zone3ascheduling@HydroOne.com		tel: 888-871-3514 x 3341 fax: 705-743-9890	28-Mar-19	10-Apr-19			PDF	
Rogers Cable Communications Inc.	GTA.Markups@rci.rogers.com	Manel De Silva	Markup Coordinator, OPE GTAC Tel: 416 446-6794	28-Mar-19	18-Apr-19			DWG	
Telus	telusutilitymarkups@telecon.ca	Stephen Hoy	2696 Matheson Blvd. E, 1st Floor, West Tower, Mississauga, ON L4W 4V5 tel: 905-804-6219	28-Mar-19	4-Apr-19			NO CONFLICT	
York, Region of	drawings@york.ca	Steve Murphy	17250 Yonge Street Newmarket, ON L3Y 6Z1 Tel: (905) 895-1200 Ext.5784 Fax: (905) 830-6927	28-Mar-19	29-3-2019			PDF	
York Region	alexandra.crasnanic@york.ca	Alexandra Crasnanic		28-Mar-19	1-Apr-19			PDF	
Zayo (formerly MTS-Allstream)	Utility.Circulations@Zayo.com	Corey Knight	50 Worcester Rd Etobicoke, ON M9W 5X2 tel: 416-649-7509	28-Mar-19	10-Apr-19			NO CONFLICT	

Appendix B. Geotechnical Study

JACOBS

Memorandum

245 Consumers Road, Suite 400
Toronto, Ontario M2J 1R3
Canada
T +1.416.499.9000
www.jacobs.com

Subject	**Geotechnical Study Report - Final**	**Project Name**	Mount Albert Water Supply System Upgrades
Prepared for	Region of York, Town of East Gwillimbury	**Project No.**	CE731500
Prepared by	James Rybicki, EIT / Frank Cesario, P. Eng.		
Reviewed by	Pedram MolkAra, M.Sc., M.Eng., P.Geo., P.Eng. Ella Murphy, M.Eng., P.Eng., Allanna Yahoda, P.Eng		
Date	July 25, 2019		

1 Introduction

The Regional Municipality of York (Region) requires a Schedule 'B' Class Environmental Assessment (EA) and Preliminary Design for the Mount Albert Water Supply System Upgrades project. Jacobs was retained by the Region to complete the EA and Preliminary Design of the water supply system upgrade which will utilize recommendations from the Region's Groundwater Treatment Strategy to determine preferred alternatives for the upgrades. As part of the due diligence efforts, a geotechnical study is required to support the alternatives for the geotechnical aspects of the Project.

This geotechnical study has been completed in a desktop format and has not included any field investigation. The desktop study is based on the available information, available background reports and a site visit conducted by Jacobs geotechnical engineer. It is intended to support the development and evaluation of alternatives to select the preferred alternative. The scope of the study includes reviewing available information specifically at the Mount Albert Wells No. 1 and 2 facility, the Mount Albert Well No. 3 facility, and the Mount Albert North Elevated Tank Facility (Site). A Location Plan showing the facilities has been included as Figure 1. The findings of the desktop study are intended to confirm whether the available information warrants concern for the geotechnical aspects of the Project.

2 Background Information

The available relevant background information for this desktop study includes one historical geotechnical investigation report within the Study Area (see Exhibit 1), geological maps published by the Ontario Geological Survey (OGS), a groundwater management study of the Oak Ridges Moraine, and Ministry of Environment, Conservation and Parks (MECP) well records.

2.1 Ontario Geological Survey (OGS) Maps

Geological maps published by the Ontario Geological Survey (OGS) were reviewed to determine the local geology within the Study Area. According to the OGS maps, the Study Area primarily lies in the physiographic region known as the Peterborough Drumlin Field and to the west, the Simcoe Lowlands border the Study Area (Chapman and Putnam, 2007). The physiographic landforms characterizing the Study Area are predominantly drumlins, till plains and sand plains (Chapman and Putnam, 2007). The physiographic landforms within the study area based on Chapman and Putnam are shown on Figure 2.

The surficial soils vary across the Study Area. The Mount Albert north elevated tank, south elevated tank, and Wells No. 1, No. 2, and No. 3 are all located in regions characterized by till material consisting of stone-poor, sandy silt to silty sand on Paleozoic Terrain. Fine and coarse-textured glaciolacustrine deposits, alluvial deposits and organic deposits can also be expected at the surface across the Study Area (OGS, 2010). The surficial soils that can be expected within the study area based on OGS data are shown on Figure 3.

The quaternary geology of the Study Area consists of gravel and sand associated with glaciofluvial ice; sand, gravelly sand and gravel affiliated with glaciolacustrine deposits; and undifferentiated sandy silt to silt till (OGS, 2000). A profile of the quaternary deposits that can be found within the study area was summarized by Eyles (Eyles, N., 2002) and a graphic of this profile has been references as Figure 4.

The local bedrock of the Study Area is the Georgian Bay Formation (OGS, 2011). The Georgian Bay Formation consists primarily of shale interbedded with dolomitic siltstone and minor limestone and dips to the southeast at approximately 5 metres per kilometre (m/km) (Sharpe, 1980).

2.2 Past Investigations

The geotechnical report that was made available for review in the preparation of this desktop is described in Exhibit 1.

Exhibit 1. Geotechnical Background Information from Past Investigation

Report Title	*Report on Geotechnical Investigation 400 mm Centre St. Watermain Mount Albert*
Report Date	September 2007
Report Number	G-07.0401
Prepared By	Geo-Canada Limited
Prepared For	MMM Group, 80 Commerce Valley Drive East, Thornhill, ON, L3T 7N7

The geotechnical investigation was completed to provide information on subsurface conditions for the proposed route of a 400 millimeter (mm) watermain along Centre Street in the community of Mount Albert, Ontario.

The subsurface investigation consisted of drilling eleven (11) boreholes to a depth of 4 to 6.2 meters below ground surface (mbgs), and two (2) boreholes to a maximum depth of 1.8 mbgs. The boreholes were drilled at approximately 200 m intervals along Centre Street between Hi-View Drive and the Well 3 Facility site. The approximate locations of the historical boreholes have been shown on Figure 1.

Nine of the boreholes were advanced through the surficial asphaltic concrete on Centre Street. Fill was encountered within eleven of the boreholes that extended to depths ranging from 0.9 mbgs to 2.3 mbgs. Generally, a sand and gravel fill was encountered within the road structure and was underlain by a clayey silt to silty clay fill within several boreholes. The recorded Standard Penetration Test ‘N’-values within the fill soils ranged from 5 to 25 indicating some of the fill did not receive construction compaction effort during placement.

The native soils encountered during the investigation generally consisted of sandy silt to silty sand deposits. Occasionally, these soils were interbedded with either silt to clayey silt or sand. The native soil was characterized by Standard Penetration Test ‘N’-values ranging between 12 and 27 within 2 m of the surface indicating a compact density, and values greater than 30 below this depth representing dense to very dense material density.

Grain size analysis laboratory testing was completed on several samples of the native soil deposits. By mass, the sampled contained 1 to 19% gravel 11 to 82% sand, 25 to 59% silt, and 7 to 18% clay sized particles. Moisture content analysis was also completed and based on the values plotted on the borehole logs, the moisture content generally ranged from about 5 to 25%, indicating a damp to moist condition.

Monitoring wells were installed within seven (7) of the boreholes to depths ranging from 3.8 to 6.0 mbgs. All monitoring wells were found to be dry during water level monitoring completed 2 and 3 weeks following well installation. Temporal fluctuations in the ground water table were not accounted for due to the lack of ground water monitoring completed during the investigation.

2.3 Groundwater Modelling of the Oak Ridges Moraine Area

A groundwater management study of the Oak Ridges Moraine was reviewed (Kassenaar and Wexler, 2006). The groundwater study included a series of cross-sections of the hydro-stratigraphic features along relevant profiles to the Mount Albert study area, specifically, a north to south cross-section along the York-Durham Line which travels along the eastern boundary of the current study area, and an east to west cross-section along Mount Albert Road which travels through the central portion of the current study area. Excerpts of the plan view and the cross-sectional profiles have been provided for reference as Figures 5 through 7.

According to the Mt. Albert Road Cross Section and York-Durham Line Cross Section from the study, the summary of strata was observed in the Study Area is presented in Exhibit 2.

Exhibit 2. Stratigraphic Units (Kassenaar and Wexler, 2006)

	Stratigraphic Unit (from Youngest to Oldest)	Mount Albert Road Cross-Section ~ Thickness (metres)	York-Durham Line Cross Section ~ Thickness (metres)
1	Most Recent Deposits	0 – 15	0 – 5
2	Halton Till	0 – 5	0 – 8
3	Oak Ridges Moraine (ORM)	0 – 20	0 – 8
4	Newmarket Till	15 – 35	2 – 15
5	Thorncliffe Formation	30 – 40	15 – 25
6	Sunnybrook Diamict	0 – 25	5 – 20
7	Scarborough Formation	2 – 10	0 – 3

Based on these observations, it is anticipated that the surficial soils of the Study Area will primarily consist of *most recent deposits*, Halton Till, the Oak Ridges Moraine (ORM), and Newmarket Till. The Halton Till is described as having a clayey-silt to silt particle size with low stone content, typically 1% to 2%, by mass (Sharpe and Russell, 2013). The Oak Ridges Moraine predominantly consists of interbedded fine sand and silts. Coarse, diffusely-bedded sands and heterogenous gravel are also prominent locally in the ORM (Kassenaar and Wexler 2006). The Newmarket Till is composed of stony and dense silty sand diamicton with calcite-cemented sandy silt to silty sand (Barnett et al., 1991). Comparatively, the Newmarket Till has a predominantly sandy texture which differentiates from the finer-grained Halton Till (Sharpe and Russell, 2013).

3 Site Visit

A site visit was carried out on April 26th by an experienced geotechnical engineer to observe the terrain and surficial physiographic features at the existing Well No. 3 Facility, Well No. 1&2 Facility and the North Elevated Tank area. A description of the findings is presented below and photos of the site visit have been provided in Appendix A.

3.1 Well No. 3 Facility

The Well No. 3 Facility is located south of the main community of Mount Albert, east of Centre Street and north of Herald Road. The facility is situated between agricultural fields immediately to the north, south and west of the property. The topography is slightly undulating and slopes down to the north and east. The immediate area is relatively clear of mature trees or dense vegetation; however, a forested area is located near the northeast corner of the property over which the groundwater discharge from current well pumping tests flows. The groundwater discharge flows above the surface along a preferential pathway towards a forested area. No observations were made of the final destination of the surficial groundwater discharge. It was noted that there are two small ponds located northeast of the property that may eventually discharge to Vivian Creek (tributary of the Black River). It has also been noted that the forested area down gradient of the site is treed swamps and marsh. Natural and environmental features of the study area will be documented through the EA process and potential impacts will be included in the evaluation of alternatives.

The Well No. 3 Facility consists of a single storey building which houses the groundwater well and mechanical treatment equipment. A catch-basin system was observed along the eastern exterior wall of the building and the surficial soil was observed to be saturated east of the building which was likely due to the rainy conditions prior to and during the Site Visit. A surficial asphaltic concrete parking area surrounds the building along the north and western edge and the asphalt roadway connects the parking area to Centre Street to the west of the property. Surficial rutting and erosion channels were observed north of the parking lot area due to ongoing construction and pumping test equipment and water discharge. The rutting and erosion channels may have been restored post-construction.

3.2 Well No 1 & 2 Facility and South Elevated Tank

The Well No. 1 & 2 Facility and the South Elevated Tank are located south of the main community of Mount Albert, west of Centre Street and south of Mount Albert Road. The facility is situated between residential properties on all sides and near the intersection of Hi View Drive and Cleverdon Boulevard; two residential roadways that both connect to Centre Street to the east. The topography is undulating and slopes down to the south and west. The property appears to have been built up relative to the surrounding area, the surface of the property is above the adjacent roadway and surrounding residential properties. A swale surrounds the eastern and southern perimeter of the property, adjacent to the roadways. Mature trees and dense vegetation border the western and northern perimeter of the property with a relatively steep slope that tapers into the adjacent residential properties.

The Well No. 1 & 2 Facility consists of a single storey building within the northeast area of the property and an elevated water tank reservoir in the southcentral area. There is also a below grade chlorine contract tank to the west of the pump house. A surficial asphaltic concrete parking area surrounds the building along the eastern edge and the asphalt roadway connects the parking area to Hi View Drive, east of the property.

3.3 North Elevated Tank

The North Elevated Tank property is located within the northeast corner of the community of Mount Albert, west of York-Durham Line and north of Ninth Line. The facility is situated between residential properties to the east, west and south and agricultural fields to the north. The residential property to the east consists of a sloping, relatively clear field and a small pond at the toe of the slope. The topography is undulating and slopes down to the east and south at a relatively steep gradient. The tank is relatively large compared to the property area which consists of a few mature trees and vegetation along the northern perimeter. Ninth Line terminates into a gravel roadway that continues north, towards the property.

The North Elevated Tank property currently consists of the tank and a small mechanical trailer-building west of the tank. A surficial asphaltic concrete roadway connects the gravel road to the tank base.

3.4 Site Visit Conclusions

The following conclusions are based on our visual site observations and are to be confirmed via further geotechnical intrusive investigation. The Well No.3 Facility appears to be suitable for potential future expansion from a geotechnical perspective should the site be selected for new infrastructure as part of the alternatives development. The property offers the least restrictions compared to the other properties that were visited, with respect to size, topography, neighboring structures and surficial features. The groundwater discharge location, that is currently being utilized to the northeast of the property, would not be suitable for future foundations or structures due to the existing topography of the terrain draining towards that location. Significant earth work efforts would be required of the local area to divert the existing preferential surficial runoff towards the groundwater discharge location which would not be preferable. There appears adequate area to expand away from the current discharge location and remain within the property boundary. As noted Section 3.1 natural and environmental features of the study area will be documented through the EA process and potential impacts to the adjacent natural features will be assessed along with regulatory agency impacts through the evaluation of alternatives.

The Well No. 1 & 2 Facility is located within a residential neighborhood which will restrict the size of the new/expanded infrastructure should the site be selected for new infrastructure as part of the alternatives development. The property appears to have considerable amount of fill that was placed to raise the property above adjacent properties. This fill would require characterization to determine if it is suitable for re-use which should be explored further.

The North Elevated Tank property is situated on unfavorable terrain, with relatively steep gradients which may require significant earthworks. The property itself is also located amongst a relatively dense distribution of residential properties which will restrict the potential area available for future infrastructure, should the site be selected for new infrastructure as part of the alternatives development.

4 Data Gaps

The EA alternative solutions have not yet been defined, however, general consideration has been given to development that may be considered on the existing sites for the Well No. 1&2 Facility or the Well No. 3 Facility. At the time of preparation of this desktop study, limited historical geotechnical reports for the existing sites (North Elevated Tank, Well No.1& 2 Facility site, Well No. 3 Facility site) was available. The following data gaps have been summarized based on the Site Visit and background information review of the Study Area:

- No geotechnical data was found in the proximity of the North Elevated Tank facility.
- The closest boreholes from the reviewed geotechnical report, to the Well No.1&2 Facility Site, and South Elevated Tank Facility are located approximately 200 m southeast and 250 m northeast of the site. The geotechnical conditions can vary considerably across these distances and is not reliable for geotechnical consideration for the specific areas of concern.
- Reviewed MECP well records close to the Well No. 1&2 Facility, Well No. 3 Facility, and North Elevated Tank did not contain relevant geotechnical data as the soil characterization noted on the well records was inconsistent and considered unreliable.

The Site Visit provided observations of the surficial physiographical features, terrain and topography at the existing Sites and recommendations with respect to these observations have been provided. The underlying, subsurface conditions and engineering characteristics will be required for any future foundations or structure considerations.

5 Recommendations

Based on the Site Visit and available background information reviewed, the study area has several unique physiological features which would require significant efforts for potential future foundations/structures. The modern alluvial deposits that are encountered near creeks, rivers and other similar water bodies, will typically contain organics and loose soils that would require removal or foundations that extend below these incompetent soils. The topography of the local terrain typically slopes towards these surficial alluvial deposits which was observed at the existing Sites. If any of the alternative solutions are located in relatively close proximity to a water body or similar, the construction efforts could be significantly costly compared to locating away from these physiographical features.

The study area also has several surficial organic, peat and muck deposits that were observed through the review of the available background information. These soils are unsuitable for supporting any facilities and would require removal or extending foundations significantly deep, below these soils. Limited historical geotechnical data was available for review in the development of this desk top study, therefore additional historical geotechnical reports have been requested however sufficient data was available to allow for geotechnical considerations to be incorporated in the evaluation of alternative solutions as part of the Class EA process..

Further geotechnical investigation would be required in the design phase at any of the properties where new structures are being considered. The purpose would be to characterize the soils from a geotechnical perspective for the specific infrastructure that is being designed. General geotechnical considerations in the design phase would include but not be limited to determining the bearing capacity of soils/rock for shallow/deep foundations, excavation approach, temporary support systems, foundation subgrade preparation, characterizing existing fill or native soils for re-use, backfilling, pavement and slab construction, geotechnical monitoring, adjacent structures and foundations that may be impacted and seismic considerations.

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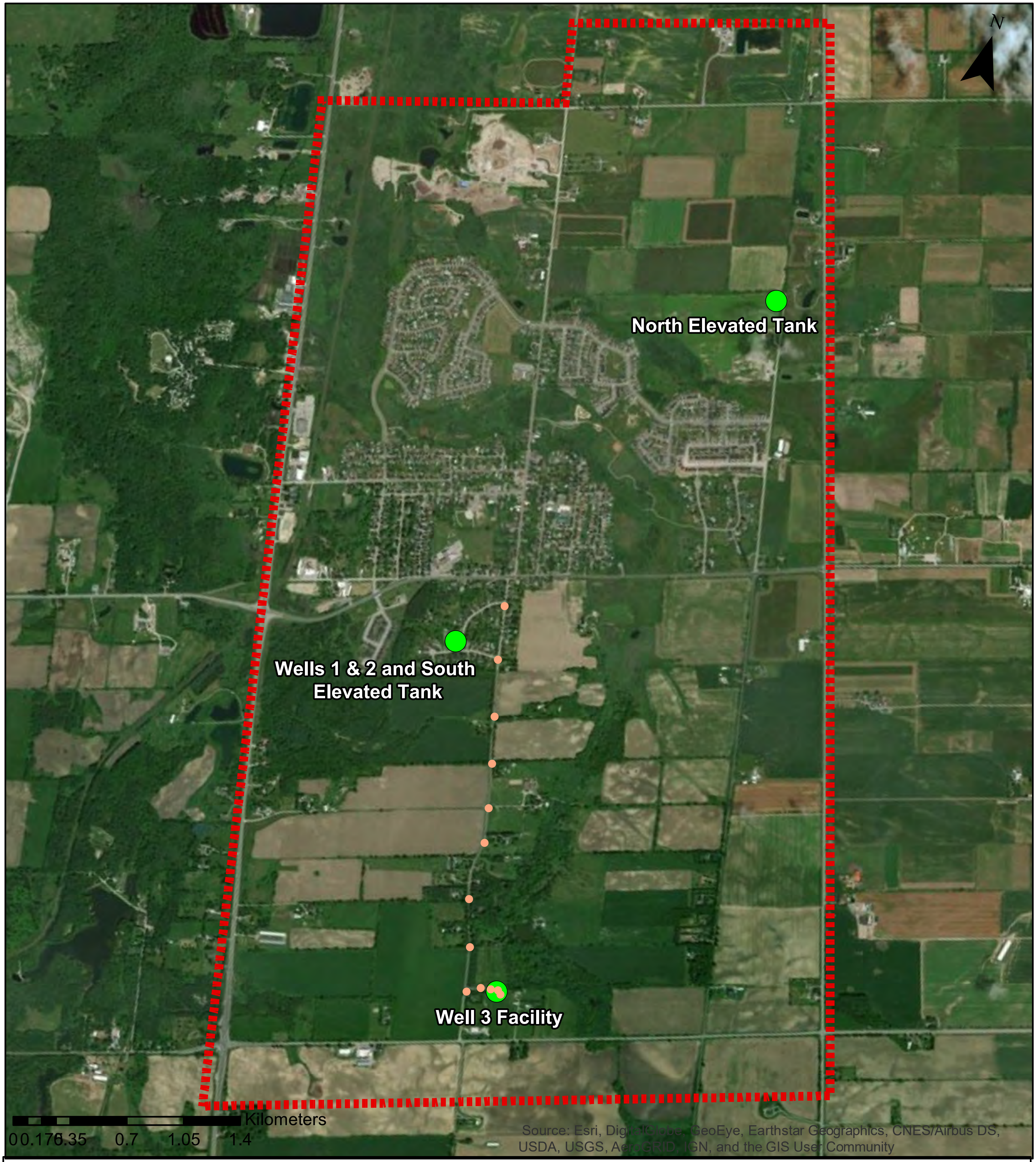
Figures



Mount Albert Water Supply System Upgrades Schedule 'B' Class EA

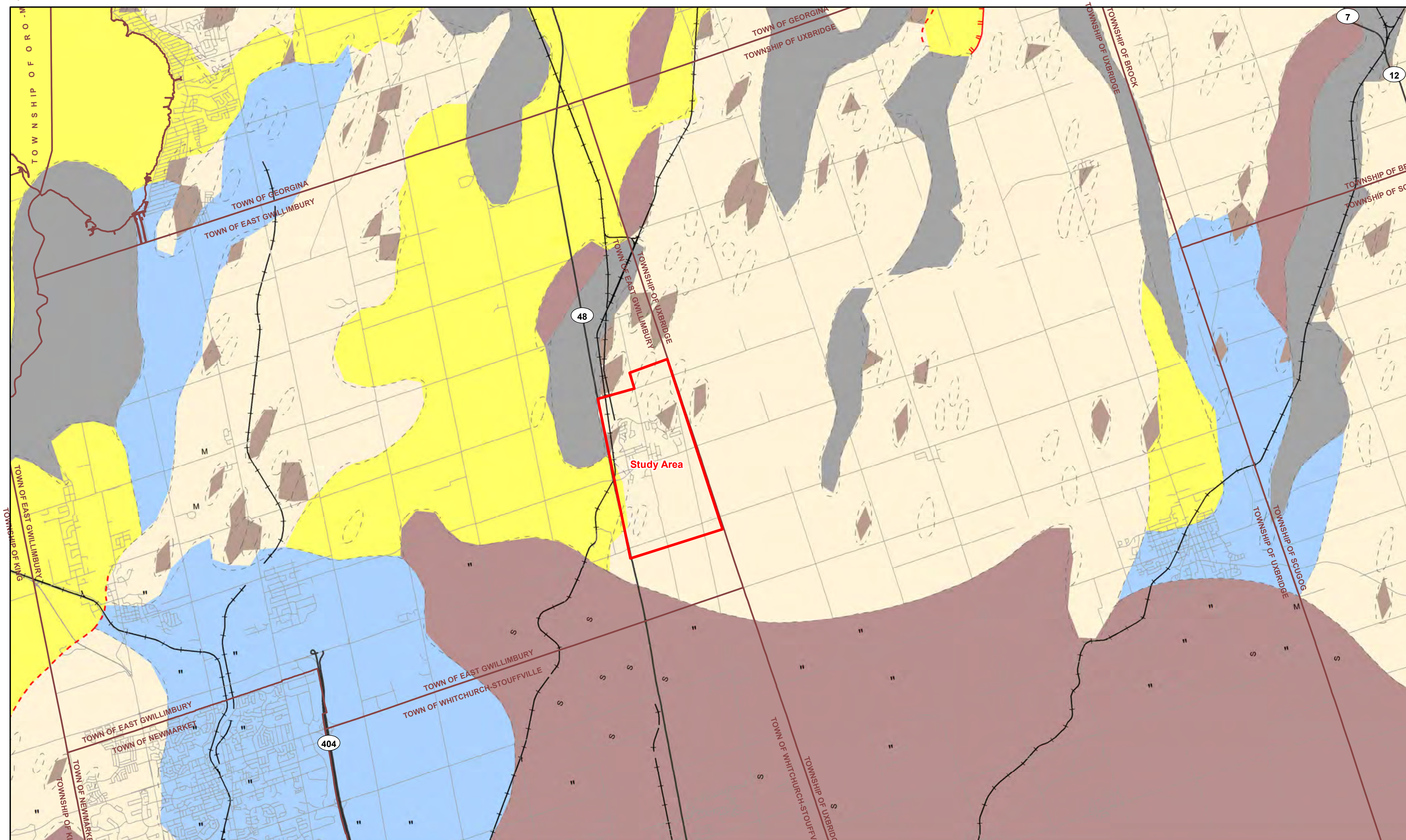
Figure 1. Existing Facilities and Historical Borehole Location Plan

Legend

- Historical Borehole
- Existing Facilities
- Project Area

NOTES:
Locations of historical boreholes are approximate. Please refer to Report on Geotechnical Investigation 400mm Centre St. Watermain Mount Albert for exact location of boreholes.

Source: DigitalGlobe, GeoEye, Earthstar Geographics,ONES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



N

0 1 2 3 4
Kilometers

Study Area Boundary
Municipal Boundary
Highway
Road
Railway

Physiography (Chapman & Putnam)
17: Peat And Muck
12: Clay Plains
11: Sand Plains
7: Drumlins
6: Till Plains (Drumlinized)
4: Kame Moraines
contact
shorecliff
shorecliff (weakly developed)
" Dissected Terrain
M Mud Flow Scars
S Sand Dunes

Notes:
1. Chapman, L.J. and Putnam, D.F. 2007. Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228 ISBN 978-1-4249-5158-1

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Figure 2
Regional and Project Area Physiography
Mount Albert Water Supply System Upgrades Class EA
Region of York
Mount Albertl, Ontario

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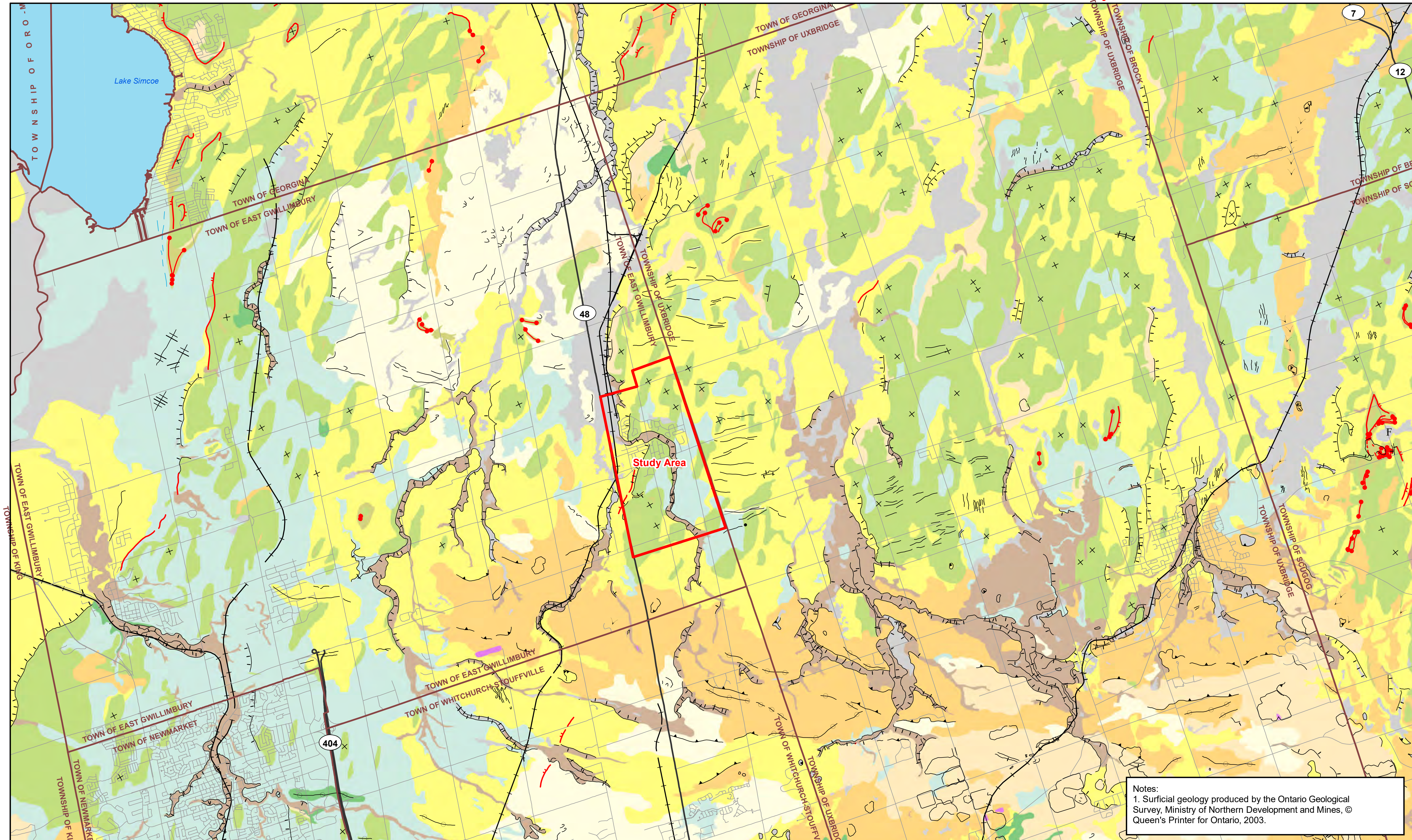

N

0 1 2 3 4
Kilometers

- Study Area Boundary
- Municipal Boundary
- Water Body
- Highway
- Road
- Railway

Surficial Geology

- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 6: Ice-contact stratified deposits
- 7: Glaciofluvial deposits
- 8a: Massive-well laminated
- 9b: Littoral-foreshore deposits
- 9c: Foreshore-basinal deposits
- 12: Older alluvial deposits
- 17: Eolian deposits
- 19: Modern alluvial deposits
- 20: Organic deposits
- 21: Man-made deposits

- beach
- bluff
- crevasse
- dcrest
- eskern
- iceberg
- icslope
- linfeat
- moraine
- pitsg
- ribl
- slidel
- terrace
- drumlin
- fossil

Notes:
1. Surficial geology produced by the Ontario Geological Survey, Ministry of Northern Development and Mines, © Queen's Printer for Ontario, 2003.

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Figure 3
Regional and Project Area Surficial Geology
Mount Albert Water Supply System Upgrades Class EA
Region of York
Mount Albertl, Ontario

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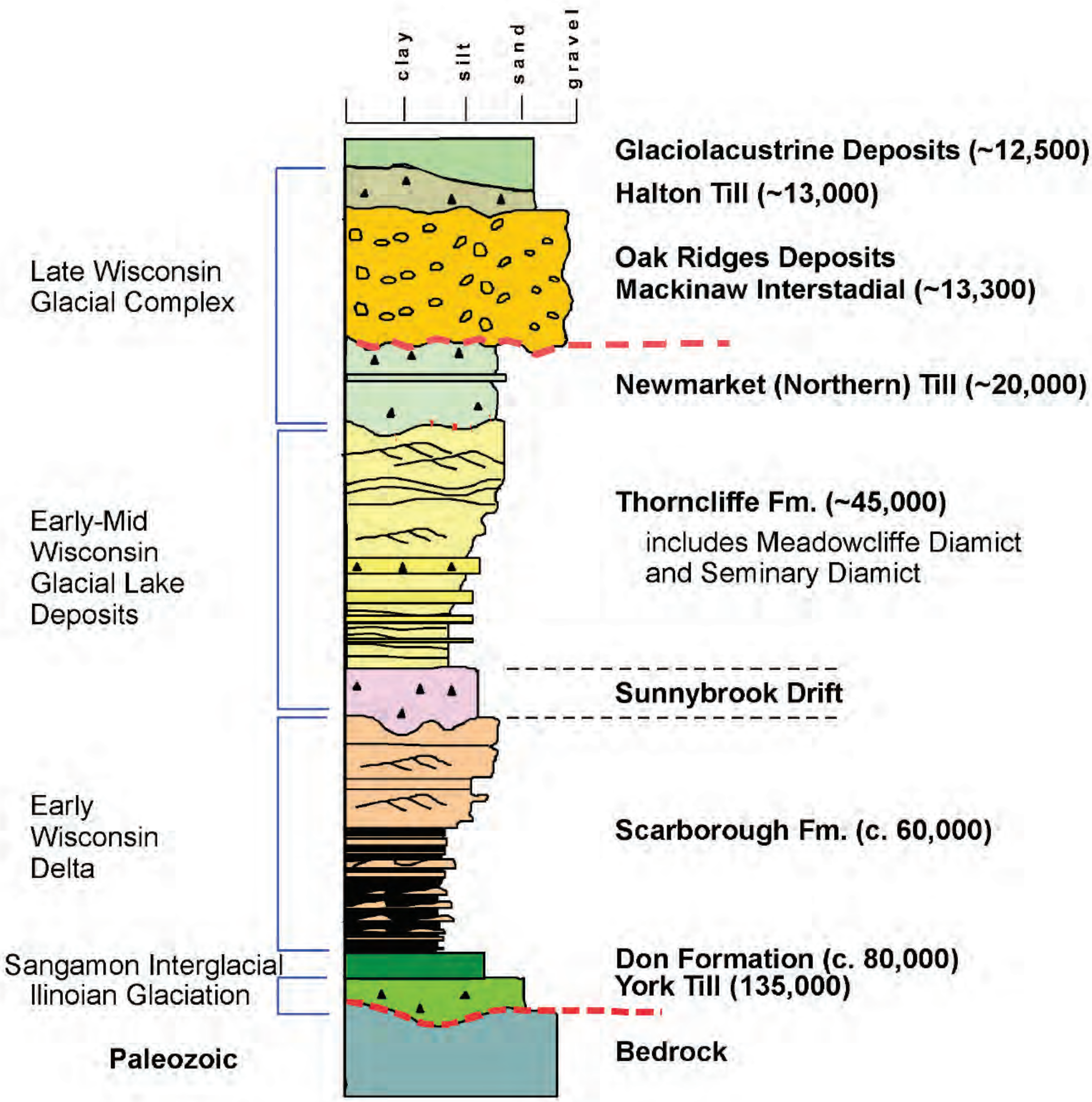

Figure 4

Geological Stratigraphic Column

Mount Albert Water Supply System Upgrades Class EA

Quaternary deposits found within the study area (from Eyles, 2002).

Reference: Eyles, N. 2002. Ontario Rocks: Three Billion Years of Environmental Change. Fitzhenry and Whiteside, Markham, Ontario.

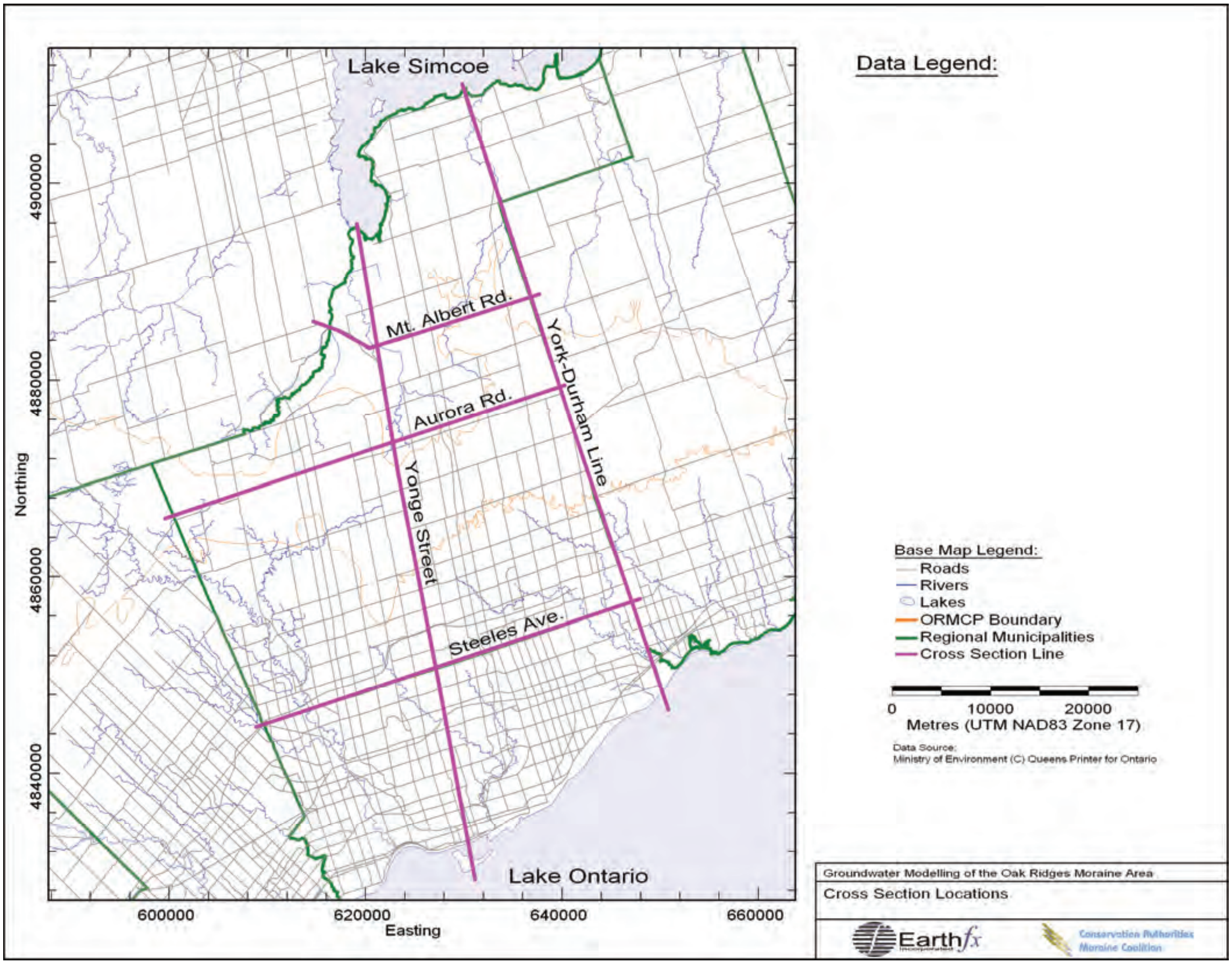

Figure 5

Plan View of Cross Sections

Mount Albert Water Supply System Upgrades Class EA

JACOBS

Reference: Kassenaar, J.D.C. and Wexler, E.J., 2006. Groundwater Modelling of the Oak Ridges Moraine Area. CAMC-YPDT Technical Report #01-06.

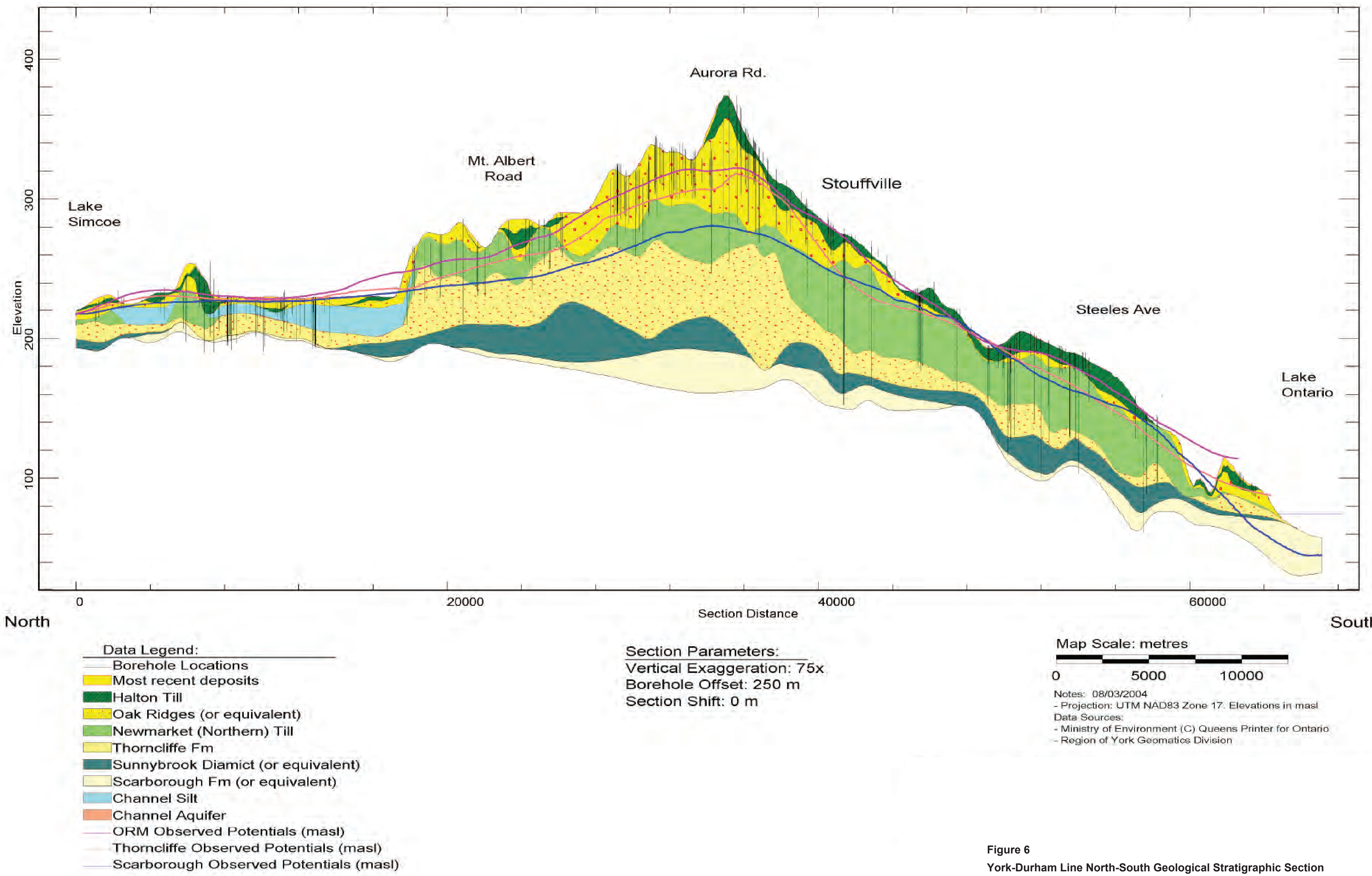

Figure 6

York-Durham Line North-South Geological Stratigraphic Section

Mount Albert Water Supply System Upgrades Class EA

North-south cross section along the York-Durham line

JACOBS

Reference: Kassenaar, J.D.C. and Wexler, E.J., 2006. Groundwater Modelling of the Oak Ridges Moraine Area. CAMC-YPDT Technical Report #01-06.

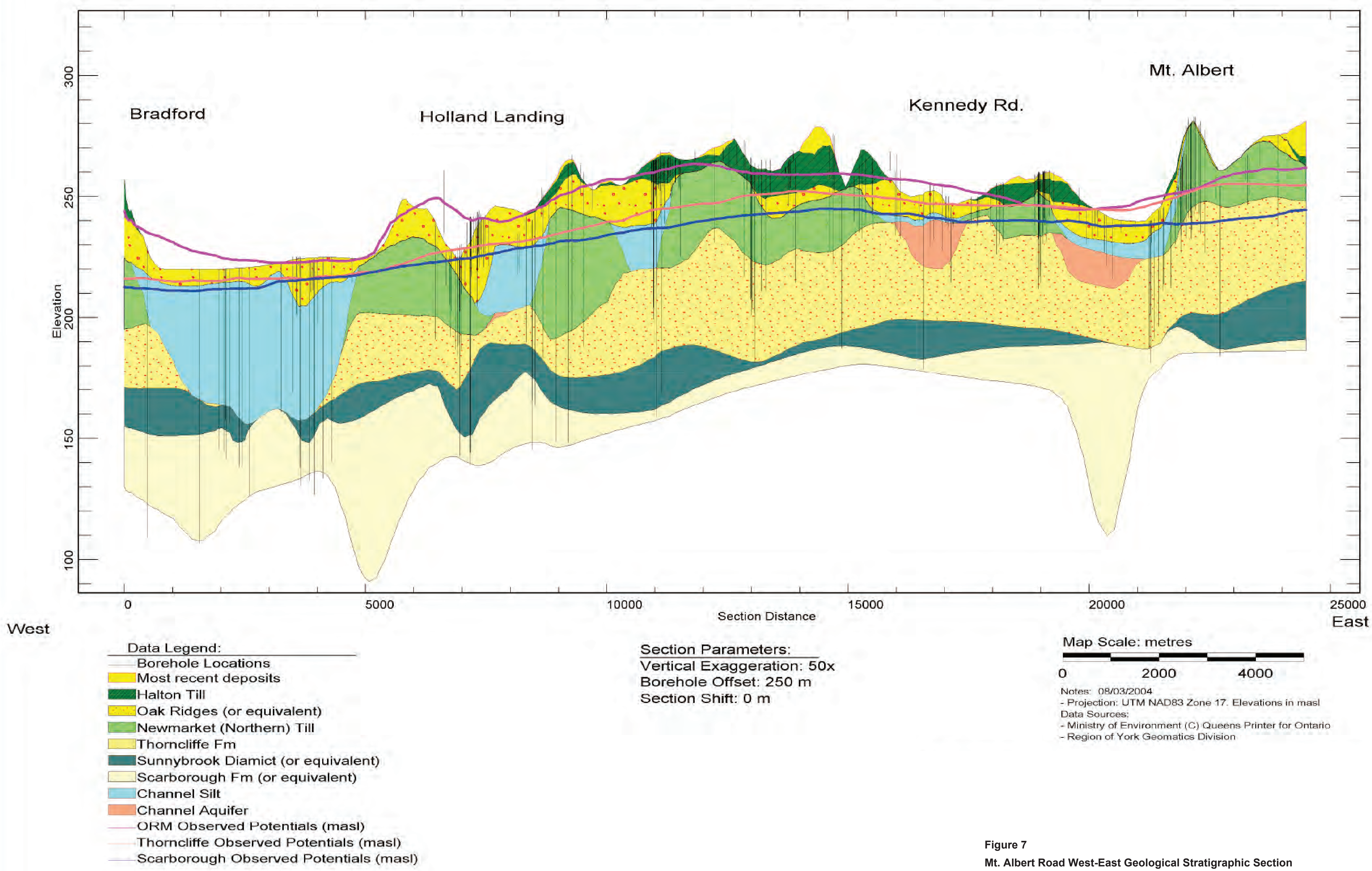

Figure 7

Mt. Albert Road West-East Geological Stratigraphic Section

Mount Albert Water Supply System Upgrades Class EA

West-east cross section along Mt. Albert Road

JACOBS

Reference: Kassenaar, J.D.C. and Wexler, E.J., 2006. Groundwater Modelling of the Oak Ridges Moraine Area. CAMC-YPDT Technical Report #01-06.

Appendix A – Photo Logs

JACOBS	Title: **Well 3 Facility**	Client Name: **Regional Municipality of York**	Project Name: **Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**
		Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500** / Photo Log: **A1**

JACOBS

Title: **Well 3 Facility**

Client Name: **Regional Municipality of York**	Project Name: **Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**
Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500** — Photo Log: **A2**

JACOBS	Title: **Well 3 Facility**	Client Name: **Regional Municipality of York**	Project Name: **Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**
		Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500** — Photo Log: **A3**

JACOBS

Title: **Well 1 & 2, and South Elevated Tank**

Client Name:
Regional Municipality of York

Project Name:
Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report

Project Location:
Town of East Gwillimbury, Ontario

Project Number: **CE731500**

Photo Log: **A4**

JACOBS

Title: **Well 1 & 2, and South Elevated Tank**

Client Name:	Project Name:	
Regional Municipality of York	**Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**	
Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500**	Photo Log: **A5**

JACOBS	Title: **Well 1 & 2, and South Elevated Tank**	Client Name: **Regional Municipality of York**	Project Name: **Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**	
		Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500**	Photo Log: **A6**

JACOBS

Title: **North Elevated Tank**

Client Name:
Regional Municipality of York

Project Name:
Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report

Project Location:
Town of East Gwillimbury, Ontario

Project Number: **CE731500**

Photo Log: **A7**

JACOBS®	Title: **North Elevated Tank**	Client Name: **Regional Municipality of York**	Project Name: **Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**	
		Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500**	Photo Log: **A8**

Title: **North Elevated Tank**

Client Name: **Regional Municipality of York**	Project Name: **Mount Albert Water Supply System Upgrades, Geotechnical Desktop Study Report**		
Project Location: **Town of East Gwillimbury, Ontario**	Project Number: **CE731500**	Photo Log: **A9**	

Appendix C. Hydrogeological Study

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Memorandum

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Subject	**Hydrogeological Study**	**Project Name**	Mount Albert Water Supply System Upgrades
Prepared For	Region of York	**Project No.**	CE731500
Prepared By	Jeremy Piper, M.Sc.		
Reviewed By	Dave Belanger, M.Sc., P.Geo.		
Date	December 3, 2019		

1. Introduction

Mount Albert (Town of East Gwillimbury) within the Regional Municipality of York (Region) has experienced historical customer complaints with the current water quality from its municipal water supply system. The Region has engaged Jacobs to undertake a Schedule ‘B’ Class Environmental Assessment (Class EA) to upgrade the Mount Albert Water Supply System to identify the best approach for resolving customer complaints with current water quality, meeting anticipated changes in manganese water quality standards and providing system redundancy and reliability (including optimization of system storage).

The purpose of this technical memorandum (TM) is to provide a high-level characterization of the hydrogeological setting of the study area and to provide supporting analysis to inform the evaluation of alternatives for the Class EA project.

2. Physical Setting

The available relevant background information for this desktop study are the geological maps published by the Ontario Geological Survey (OGS), a groundwater management study of the Oak Ridges Moraine, Ministry of Environment, Conservation and Parks (MECP) well records, the York Region Groundwater Treatment Strategy, the Groundwater Exploration Assessment Report for MW18, historical groundwater investigation reports, and historical groundwater quantity and quality information supplied by York Region.

For the purposes of this high-level hydrogeological study, the study area was defined as a 3 km radius from each of the York Region municipal water supply wells PW1, PW2, PW3, and the north elevated tank (Figure 2.1).

2.1 Well No 1 & 2 Facility and South Elevated Tank

The Well No. 1 & 2 Facility (PW1 and PW2) and the South Elevated Tank are located south of the main community of Mount Albert, west of Centre Street and south of Mount Albert Road. The facility is situated between estate residential properties on all sides and near the intersection of Hi View Drive and Cleverdon Boulevard; two residential roadways that both connect to Centre Street to the east. The topography is undulating and slopes down to the south and west. The property appears to have been built up relative to the surrounding area, the surface of the property is above the adjacent roadway and surrounding residential properties. A swale surrounds the eastern and southern perimeter of the property, adjacent to the roadways. Mature trees and dense vegetation border the western and northern perimeter of the property with a relatively steep slope that tapers into the adjacent residential properties.

The PW1 and PW2 Facility consists of a single-story building within the northeast area of the property and an elevated water tank reservoir in the south-central area. There is also a below grade chlorine contact tank to the west of the pump house. An asphalt driveway and parking area surrounds the building along the eastern edge and the asphalt roadway connects the parking area to Hi View Drive, east of the property.

2.2 Well No. 3 Facility

The Well No. 3 (PW3) Facility is located south of the main community of Mount Albert, east of Centre Street and north of Herald Road. The facility is situated between agricultural fields immediately to the north, south, east and west of the property. The topography is slightly undulating and slopes down to the north and east. The immediate area is relatively clear of mature trees or dense vegetation; however, a forested area is located near the northeast corner of the property. It was noted that there are two small ponds located northeast of the property that may eventually discharge to Vivian Creek (tributary of the Black River). It has also been noted that the forested area down gradient of the site is treed swamps and marsh. Natural and environmental features of the study area will be documented through the Class EA process and potential impacts will be included in the evaluation of alternatives.

The PW3 Facility consists of a single-story building which houses the groundwater well and mechanical treatment equipment. An asphalt driveway and parking area surrounds the building along the north and western edge and the asphalt roadway connects the parking area to Centre Street to the west of the property.

2.3 North Elevated Tank

The North Elevated Tank property is located within the northeast corner of the community of Mount Albert, west of York –Durham Line and north of Mount Albert Road. The facility is situated between residential properties to the east, west and south and agricultural fields to the north. The residential property to the east consists of a sloping, relatively clear field, a paved driveway and a small pond at the toe of the slope. The topography is undulating and slopes down to the east and south at a relatively steep gradient. The tank is relatively large compared to the property area which consists of a few mature trees and vegetation along the northern perimeter. The North Elevated Tank property currently consists of the tank and a small mechanical trailer-building west of the tank.

2.4 Topography and Physiography

Ground surface topography in the study area ranges from a high of approximately 309 m above sea level (mASL) at the southern extent of the study area to a low of 228 mASL in the northwestern study area (Figure 2.2).

The study area primarily lies in the physiographic region known as the Peterborough Drumlin Field and to the west, the Simcoe Lowlands border the study area (Chapman and Putnam, 2007). The physiographic landforms characterizing the PSA are predominantly drumlins, till plains, sand plains, and peat and muck (Chapman and Putnam, 2007). The physiographic landforms within the study area based on Chapman and Putnam are shown on Figure 2.3.

The surficial soils vary across the PSA. The Mount Albert north elevated tank, south elevated tank, and Wells No. 1, No. 2, and No. 3 are all located in regions characterized by till material consisting of stone-poor, sandy silt to silty sand on Paleozoic Terrain. Fine and coarse-textured glaciolacustrine deposits, alluvial deposits and organic deposits can also be expected at the surface across the PSA (OGS, 2010). The surficial soils that can be expected within the study area based on OGS data are shown on Figure 2.4.

The quaternary geology of the study area consists of gravel and sand associated with glaciofluvial ice; sand, gravelly sand and gravel affiliated with glaciolacustrine deposits; and undifferentiated sandy silt to silt till (OGS, 2010).

N

0 0.5 1 1.5 2
Kilometers

- Municipal Well
- North Elevated Tank
- Study Area Boundary
- Municipal Boundary
- Highway
- Road
- Railway

Notes:
1. Image Source: Esri, DigitalGlobe, Earthstar Geographics

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Figure 2.1
Site Plan of Study Area and Existing Facilities
Mount Albert Water Supply System Upgrades Class EA
Region of York
Mount Albert, Ontario

JACOBS

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A profile of the quaternary deposits that can be found within the study area was summarized by Eyles (2002). The local bedrock of the study area is the Georgian Bay Formation (OGS, 2011). The Georgian Bay Formation consists primarily of shale interbedded with dolomitic siltstone and minor limestone and dips to the southeast at approximately 5 metres per kilometre (m/km) (Sharpe and Russell, 2013).

2.4.1 Hydrologic Features

Surface water features (i.e., rivers, streams, wetlands, and lakes) impact shallow groundwater flow and are an important part of the development of a Site conceptual model. The study area is located in the Lake Simcoe Watershed within the Black River Subwatershed and is within the Lake Simcoe Region Conservation Authority jurisdiction. Main surface water features within the study area include Vivian Creek, Mount Albert Creek and the Black River (Figure 2.2). Water courses tend to flow north and west.

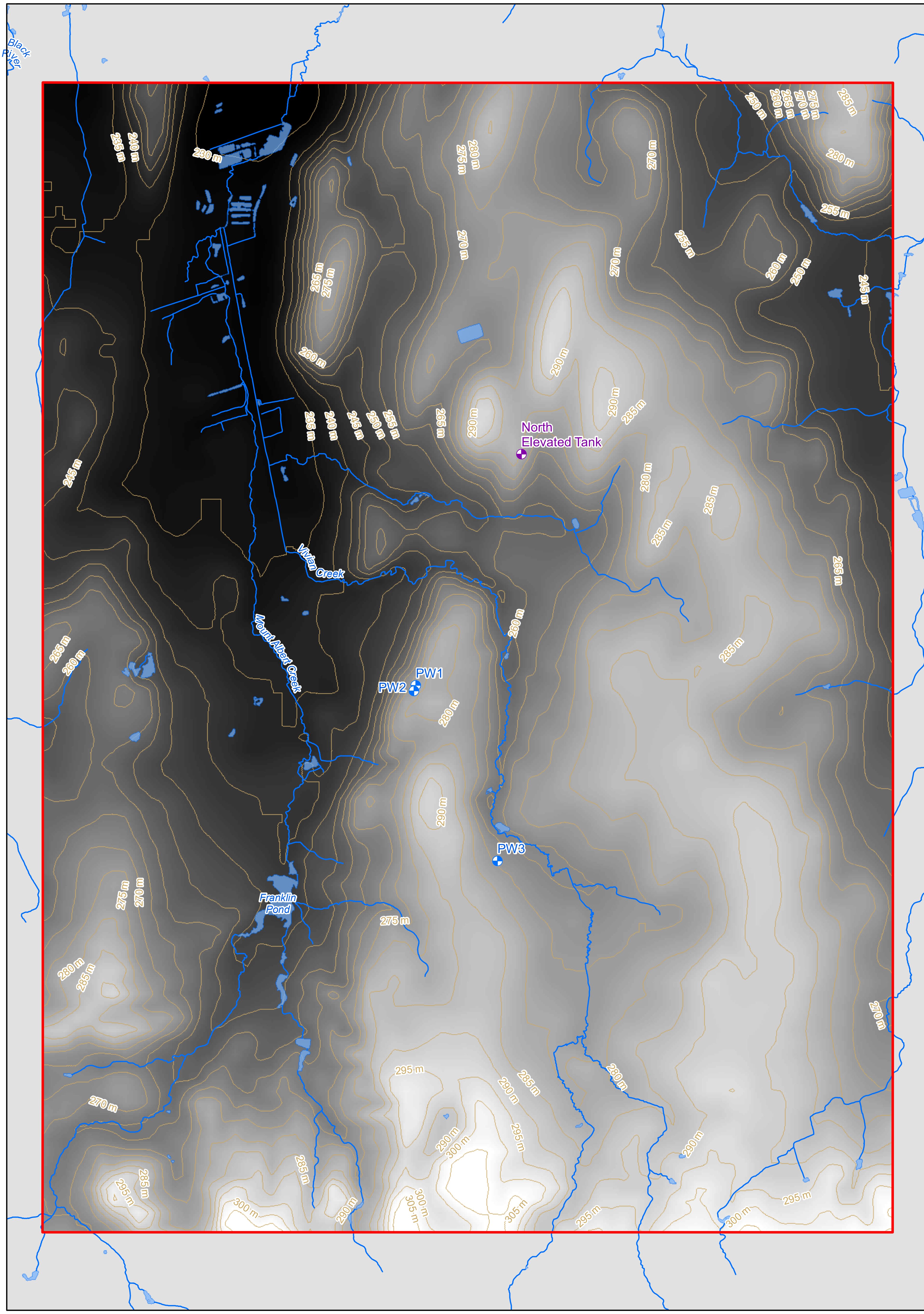
2.5 Regional Geology and Hydrogeology

The York Region hydrogeological setting is dominated by the Oak Ridges Moraine, a major geologic/hydrogeologic feature in Southern Ontario. The moraine is a major source of groundwater recharge and a large number of creeks and rivers are derived from groundwater discharge from the moraine. The moraine marks the boundary between the Lake Simcoe ice lobe advancing from the north and the Lake Ontario ice lobe advancing from the south. It is a ridge of high land separating drainage to the north to Lake Simcoe and drainage to the south to Lake Ontario (CH2M, 2017).

Based on a review of the regional geologic cross-sections developed from the Tier 3 Conceptual Geologic Model through the study area (Figure 2.2, Figure 2.5 through Figure 2.10), the regional geology typically consists of the following (Table 2.1):

Table 2.1: Regional Stratigraphic Layers from Tier 3 Conceptual Geological Model

Stratigraphic Layers	Stratigraphic Sublayers
Post Glacial Deposits (Recent Deposits)	Not applicable
Oak Ridges Moraine Aquifer Complex	Upper Oak Ridges Moraine Aquifer Complex (ORAC) Sand
	ORAC Silt
	Lower ORAC Sand
Channel Sediments	Channel Silt
	Channel Sand
Newmarket Till	Upper Newmarket Till
	Inter-Newmarket Sediments
	Lower Newmarket Till
Thorncliffe Formation	Not applicable
Sunnybrook Drift	Not applicable
Scarborough Formation	Not applicable
Bedrock	Not applicable



N

0 500
Metres

- Municipal Well
- North Elevated Tank
- Topographic Contour
- Watercourse
- Study Area Boundary
- Waterbody

DRAFT

Figure 2.2
Topography
Mount Albert Water Supply System Upgrades Class EA
Region of York
Mount Albert, Ontario

JACOBS

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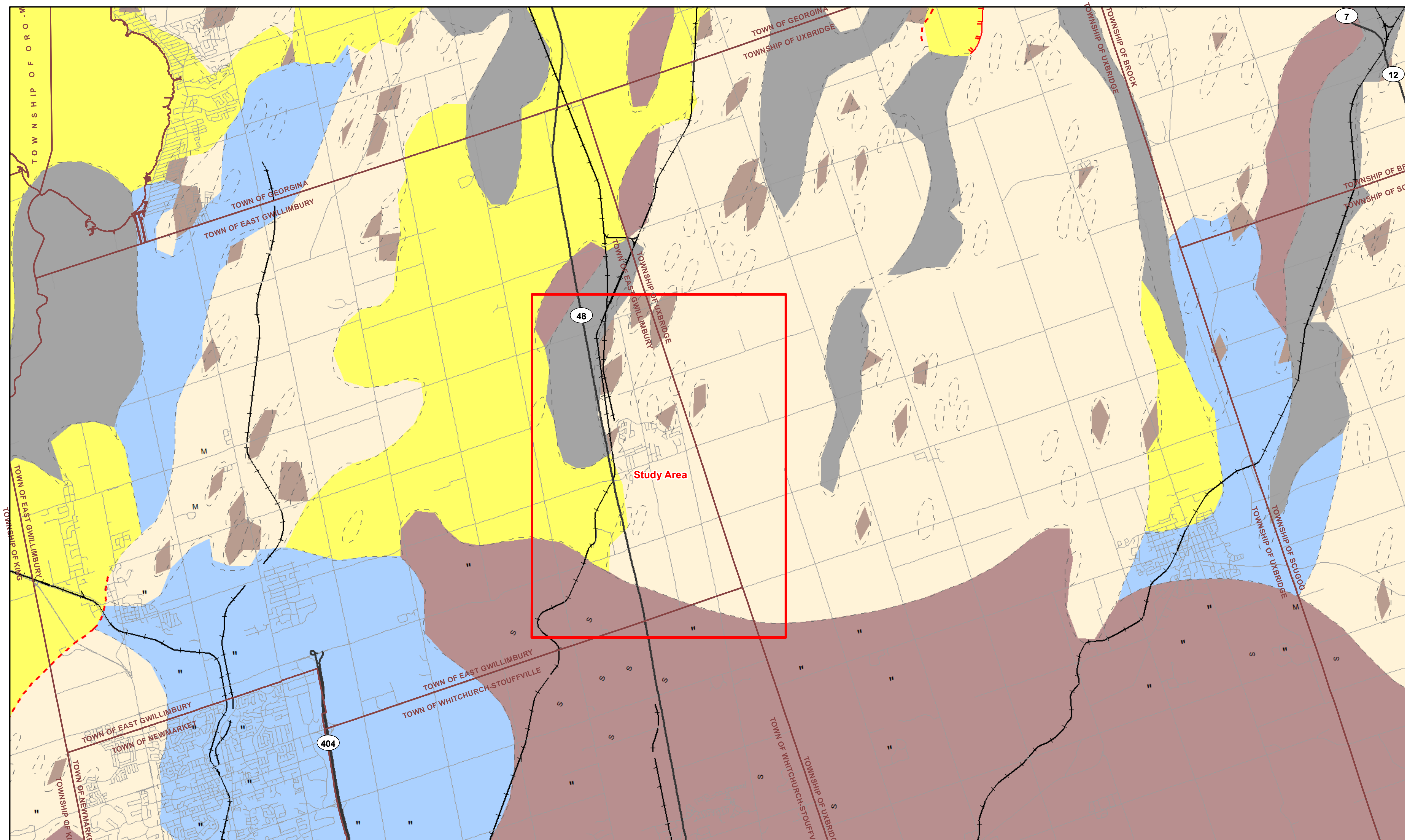

Study Area Boundary
Municipal Boundary
Highway
Road
Railway

Physiography (Chapman & Putnam)
17: Peat And Muck
12: Clay Plains
11: Sand Plains
7: Drumlins
6: Till Plains (Drumlinized)
4: Kame Moraines
contact
shorecliff
shorecliff (weakly developed)
" Dissected Terrain
M Mud Flow Scars
S Sand Dunes

Notes:
1. Chapman, L.J. and Putnam, D.F. 2007. Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228 ISBN 978-1-4249-5158-1

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Figure 2.3
Regional and Project Area Physiography
Mount Albert Water Supply System Upgrades Class EA
Region of York
Mount Albert, Ontario

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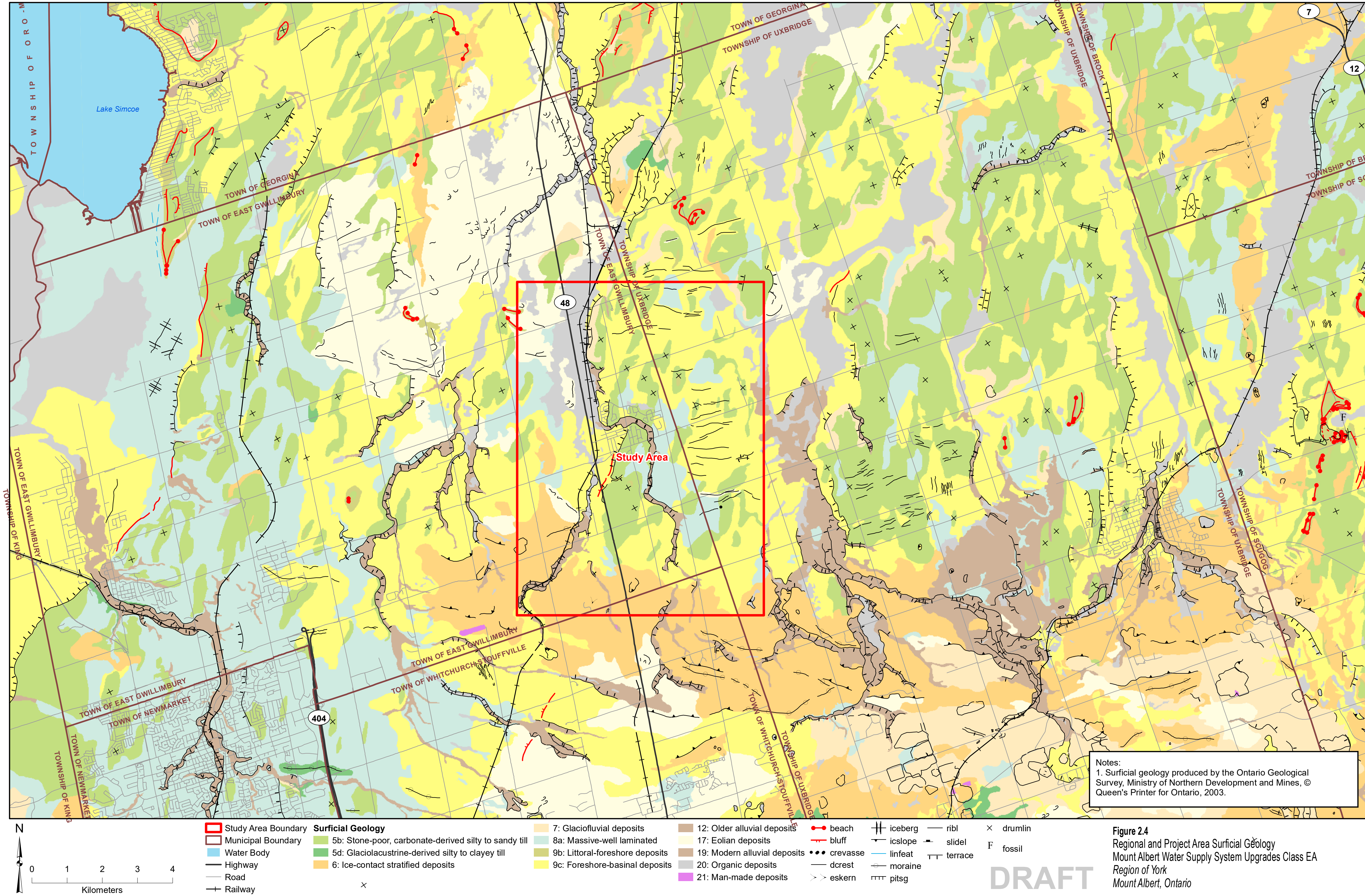


Figure 2.4
Regional and Project Area Surficial Geology
Mount Albert Water Supply System Upgrades Class EA
Region of York
Mount Albert, Ontario

\\BROOKSIDEFILES\GIS_SHARE\ENBG\00_PROJ\Y\YORKREGION\MOUNTALBERTWATERSUPPLY\MAPFILES\GEOTECHNICALDESKTOPSTUDY\SURFICIALGEOLOGY.MXD MJOZWIAK 8/8/2019 8:41:16 PM

In the direct vicinity of the Well No 1 & 2 Facility, Well No 3 Facility, and the North Elevated Tank, the regional geology (Figure 2.5 through Figure 2.11) is characterized by the following stratigraphic layers (from youngest to oldest) (Table 2.2):

Table 2.2: Regional Stratigraphic Layers at Project Sites from Tier 3 Conceptual Geological Model

Location	Stratigraphic Layer	Stratigraphic sublayer	Thickness (metres)
Wells 1 & 2 Facility	Post Glacial Deposits (Recent Deposits)	Not Applicable	0 to 3
Wells 1 & 2 Facility	Newmarket Till	Upper Newmarket Till	6
Wells 1 & 2 Facility		Inter-Newmarket Sediments	15 to 18
Wells 1 & 2 Facility		Lower Newmarket Till	14
Wells 1 & 2 Facility	Thorncliffe Formation	Not Applicable	32
Wells 1 & 2 Facility	Sunnybrook Drift	Not Applicable	11
Wells 1 & 2 Facility	Scarborough Formation	Not Applicable	18
Wells 1 & 2 Facility	Bedrock	Not Applicable	
Well No 3 Facility	Post Glacial Deposits (Recent Deposits)	Not Applicable	2
Well No 3 Facility	Newmarket Till	Upper Newmarket Till	4
Well No 3 Facility		Inter-Newmarket Sediments	6
Well No 3 Facility		Lower Newmarket Till	24
Well No 3 Facility	Thorncliffe Formation	Not Applicable	55
Well No 3 Facility	Sunnybrook Drift	Not Applicable	6
Well No 3 Facility	Scarborough Formation	Not Applicable	2
Well No 3 Facility	Bedrock	Not Applicable	
North Elevated Tank	Post Glacial Deposits (Recent Deposits)	Not Applicable	6
North Elevated Tank	Newmarket Till	Upper Newmarket Till	15
North Elevated Tank		Inter-Newmarket Sediments	15
North Elevated Tank		Lower Newmarket Till	4
North Elevated Tank	Thorncliffe Formation	Not Applicable	33
North Elevated Tank	Sunnybrook Drift	Not Applicable	17
North Elevated Tank	Scarborough Formation	Not Applicable	3
North Elevated Tank	Bedrock	Not Applicable	

Notes:

1 Well No 1 & 2 Facility – Cross sections A – A' and B – B' (Figures 2.6 and 2.7)

2 Well No 3 Facility – Cross section C – C' and D – D' (Figures 2.8 and 2.9)

3 North Elevated Tank – Cross section E – E' and F – F' (Figures 2.10 and 2.11)

Earthfx (2014) and York Region (2019) summarized the stratigraphic layers as follows:

1) Post Glacial Deposits (Recent Deposits)

   The post glacial deposits are generally the product of sedimentation in Glacial Lake Algonquin and are typically comprised of sand, silt and/or clay sediments that form relatively thin and locally discontinuous layers. These sediments may also include organic deposits, man-made deposits, as well as modern alluvial deposits along present day rivers and streams.

2) Oak Ridges Moraine Aquifer Complex (ORAC)

   The ORAC is a sediment complex which was formed as a result of rapid sedimentation in subglacial, ice-marginal and proglacial lacustrine environments during the Wisconsinan glaciation. It is comprised of interlobate glacial deposits whose texture ranges from silt to gravelly sand but that typically consist of sand and gravel sediments which can be up to 150 m thick. Based on the regional geologic cross-sections (Figure 2.5 through Figure 2.10), the ORAC is discontinuous and absent at each of the sites but is present as a shallow discontinuous layer nearby each of the three sites.

   The sand and gravel deposits are typically unconfined aquifers but can be confined by till units on the flanks of the moraine. Where the ORAC deposits are unconfined, typically to the north and the crest of the moraine, the aquifer may be susceptible to surface sources of contamination (CH2M, 2017), including road de-icing applications, agricultural operations and septic systems, as evidenced by the generally higher concentrations of chloride, sodium and nitrate measured in the groundwater from production and monitoring wells screened in the ORAC. Additionally, this shallow aquifer is understood to be more prone to influence from surface water systems, shallow private well systems and associated groundwater receptors. As such, while the ORAC is a common groundwater source for private water wells where the required yield is relatively small, it is not utilized for municipal water supply in Mount Albert.

3) Channel Sediments

   Channel sediments are the result of the partial or full erosion of the Newmarket Till by glacial meltwater in certain areas. These eroded features are termed “tunnel channels” and were largely infilled with sand and silt deposits as meltwater energy waned. The regional geologic cross-sections show that channel sediments underlie the ORAC approximately 500 m to the west of the PW1 and PW2 Facility, 1.1 km to the west of the PW3 Facility, and 1.2 km to 1.3 km northwest and west, and 1.5 km northeast of the Northern Elevated Tank.

4) Upper and Lower Newmarket Till, and Inter-Newmarket Sediments (UNT, LNT, INS)

   The Newmarket Till is comprised of dense sand to silty sand diamicton sediments that were deposited when the Laurentide ice sheet was at its maximum extent approximately 20,000 years ago. The till unit can be up to 100 m thick but is typically 20 m to 30 m in thickness. It generally acts as an aquitard and serves as a protective barrier to the underlying Thorncliffe Formation.

   Around the beginning of the Mackinaw Phase, approximately 13,000 to 13,500 years ago, this unit was divided into discreet till units as a result of the erosional events which created the tunnel channels. In York Region, the major surface till is the Upper Newmarket Till, which is separated from the Lower Newmarket Till by Inter-Newmarket Sediments (INS). The INS form an intermediate aquifer unit comprised of glaciofluvial and glaciolacustrine sediments, including esker deposits, subaqueous fan deposits and fine-grained lacustrine sediments.

   The regional geologic cross-sections (Figure 2.5 through Figure 2.10) indicates that the UNT is found at all three sites, though is absent in areas to the west and east of the three sites, and absent to the immediate north and south of the PW3 Facility. At each of the sites, the UNT is underlain by the INS and LNT. As presented in Table 2.2, the UNT in the vicinity of PW1 and PW2, and PW3 Facility is relatively thin, though the LNT in these two locations is of greater thickness, acting as the confining layer to the underlying Thorncliffe Aquifer Complex.

5) Thorncliffe Formation

The Thorncliffe Formation was deposited approximately 45,000 years ago and acts as a regional aquifer referred to as the Thorncliffe Aquifer Complex (TAC). It is composed of lacustrine, fluvio-deltaic, and subaqueous fan sediments ranging from clayey silt to sand and minor gravel, with significant thickness beneath the Oak Ridges Moraine (CH2M, 2017). It is confined above by the Upper and Lower Newmarket Till (aquitards). Based on the regional cross-sections, the TAC is continuous across the study area. The TAC is generally well protected from anthropogenic contaminant sources due to the overlying till units, but in places, the deep aquifer may be in direct contact with the Oak Ridges Moraine deposits and therefore may be more susceptible to surface sources of contaminants (CH2M, 2017).

6) Sunnybrook Drift

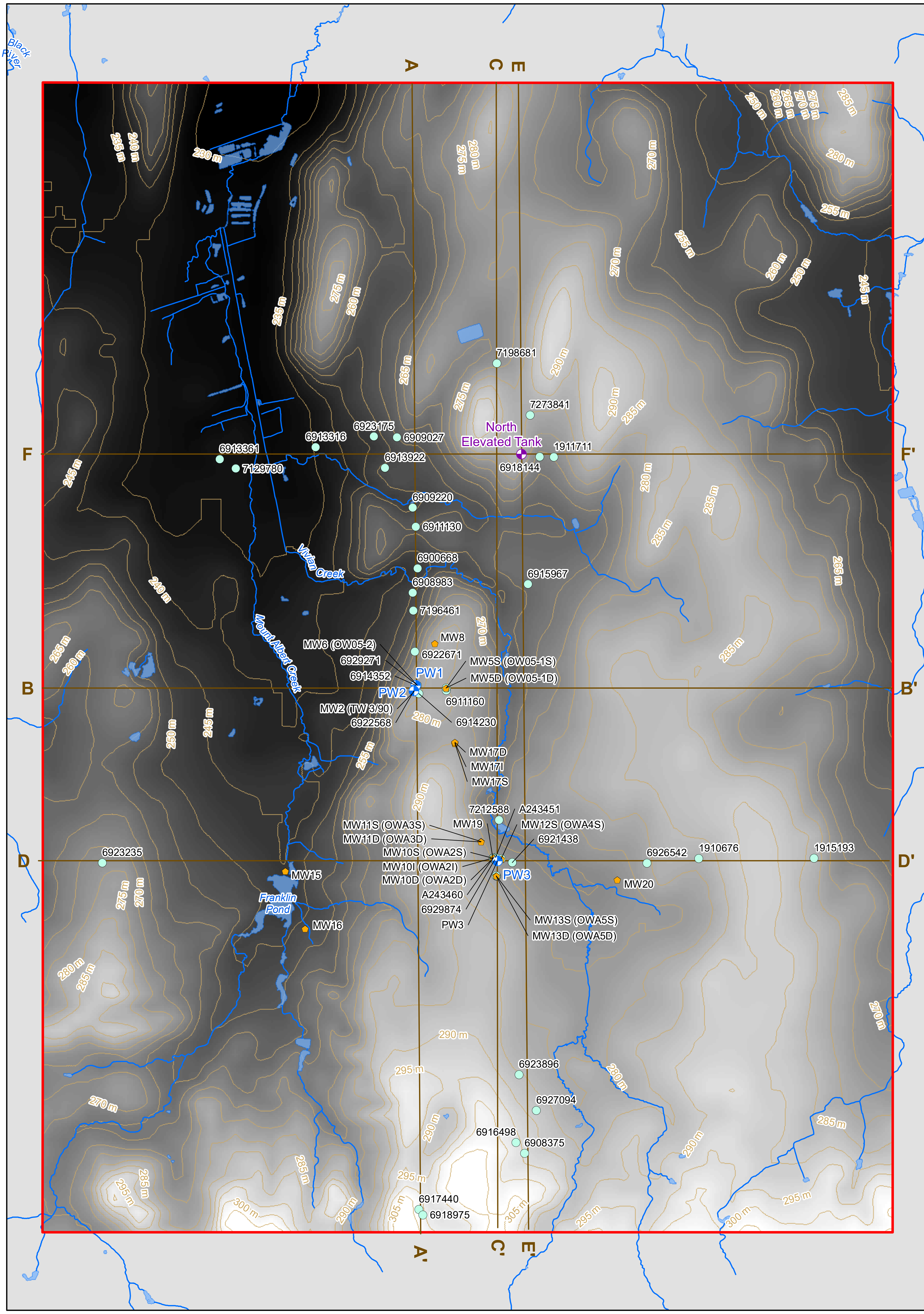
The Sunnybrook Drift generally acts as an aquitard which separates the Thorncliffe Formation from the underlying Scarborough Formation. It is comprised of clast-poor silt and clay deposited by glacial and lacustrine processes.

7) Scarborough Formation

The Scarborough Formation marks the start of the Wisconsinan glaciations approximately 100,000 years ago and acts as a regional aquifer referred to as the Scarborough Aquifer Complex (SAC). The unit consists of a lower clay layer overlain by sands which were deposited as a result of fluvio-deltaic processes. It is mainly found within bedrock valleys and thins laterally away from the valleys. The regional cross-sections show that the SAC is discontinuous approximately 500 m to 1 km to the northwest and north of the North Elevated Tank, respectively. The SAC is generally well protected from anthropogenic contaminant sources due to the overlying till units, but in places, the deep aquifer may be in direct contact with the Oak Ridges Moraine deposits and therefore may be more susceptible to surface sources of contaminants (CH2M, 2017).

8) Bedrock

The bedrock geology in the Site area is characterized primarily by Georgian Bay Formation (OGS, 2011). The Georgian Bay Formation consists primarily of shale interbedded with dolomitic siltstone and minor limestone



N

0 500

Metres

Municipal Well

North Elevated Tank

York Region Monitoring Well

MECP Water Well Record

Cross Section Location

Topographic Contour

Watercourse

Study Area Boundary

Waterbody

DRAFT

Figure 2.5

Cross Section Alignments

Mount Albert Water Supply System Upgrades Class EA

Region of York

Mount Albert, Ontario

JACOBS

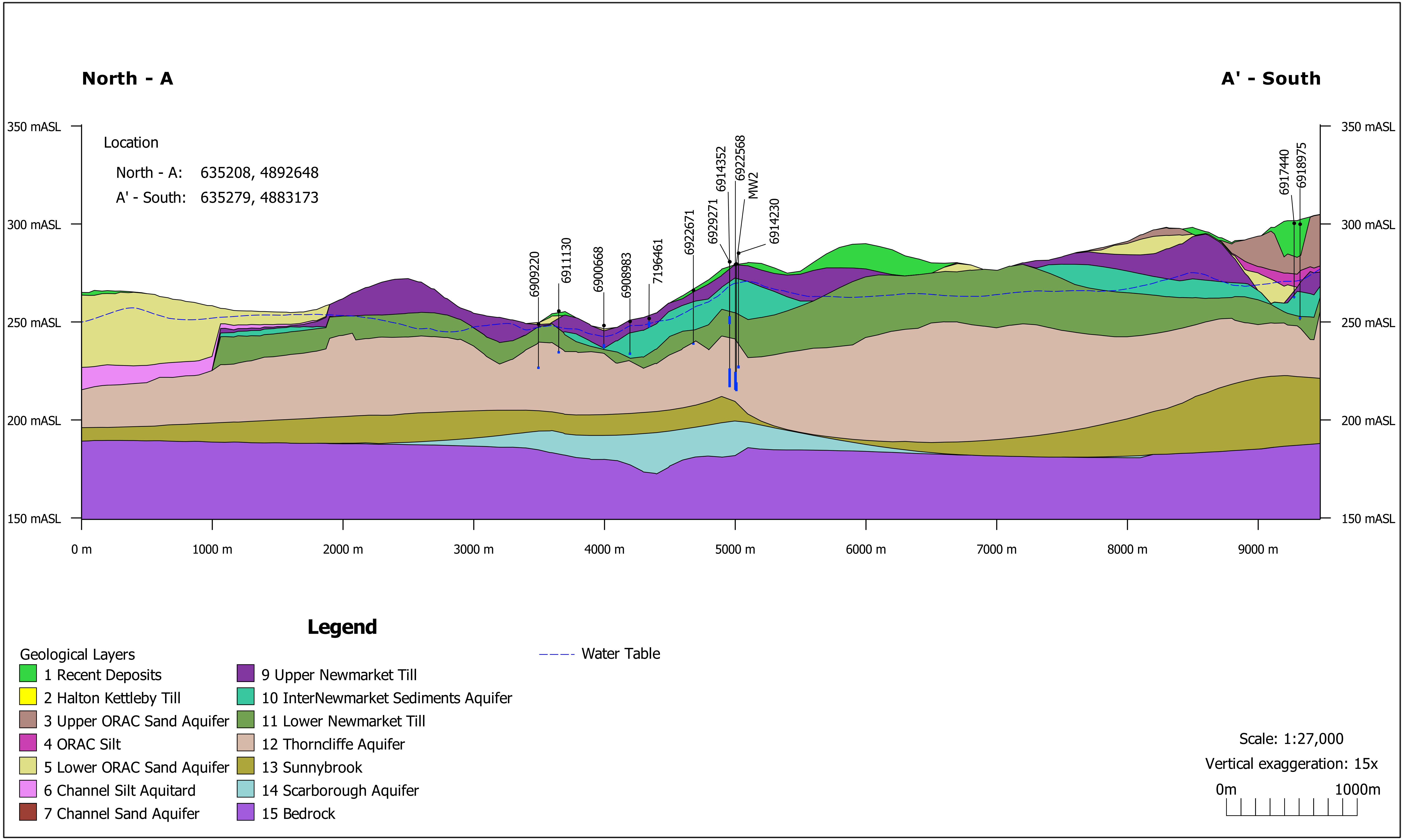


FIGURE 2.6
Tier 3 Conceptual Geological Cross Section A - A'
Mt Albert Water Supply System Upgrades EA
York Region

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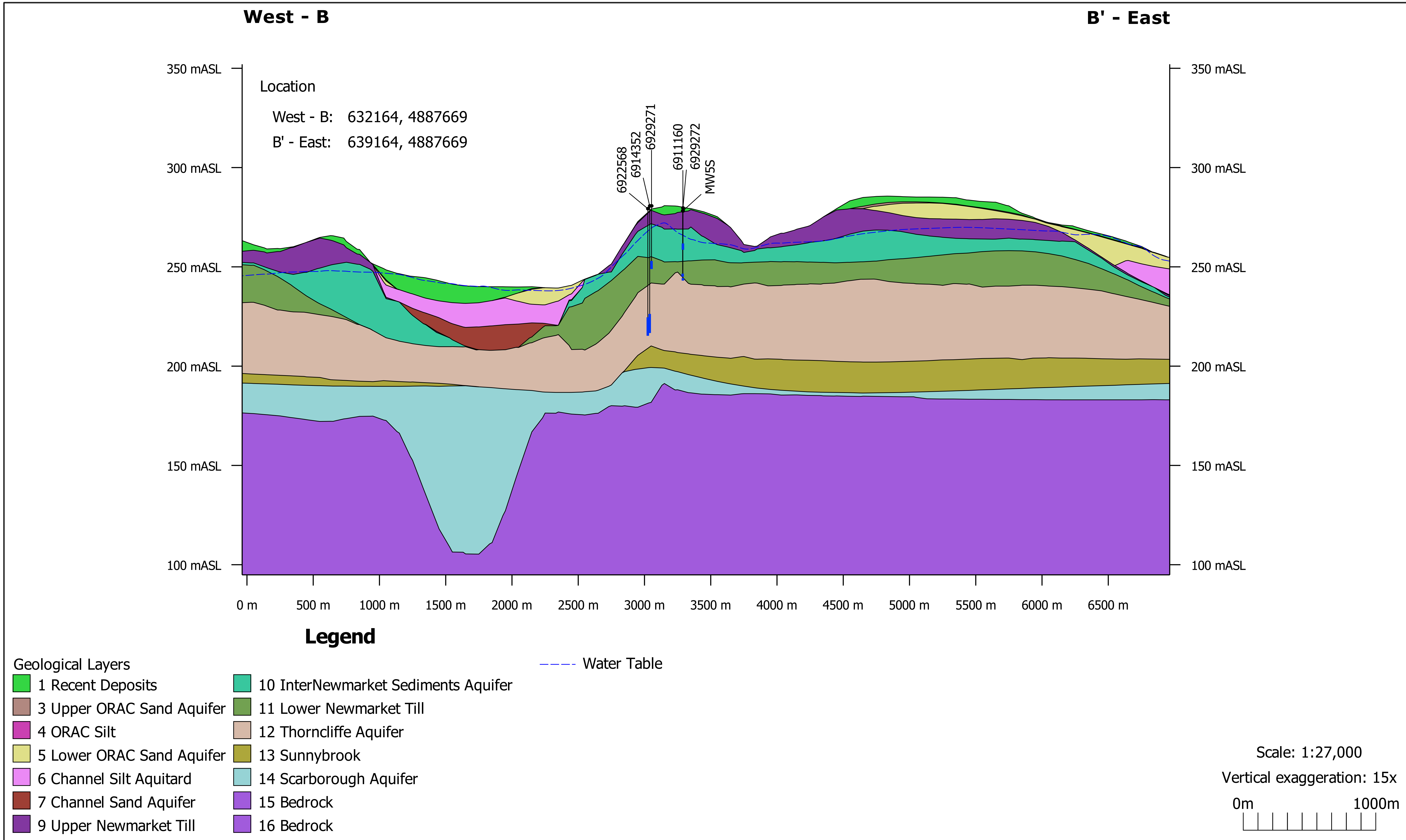

FIGURE 2.7
Tier 3 Conceptual Geological Cross Section B - B'
Mt Albert Water Supply System Upgrades EA
York Region

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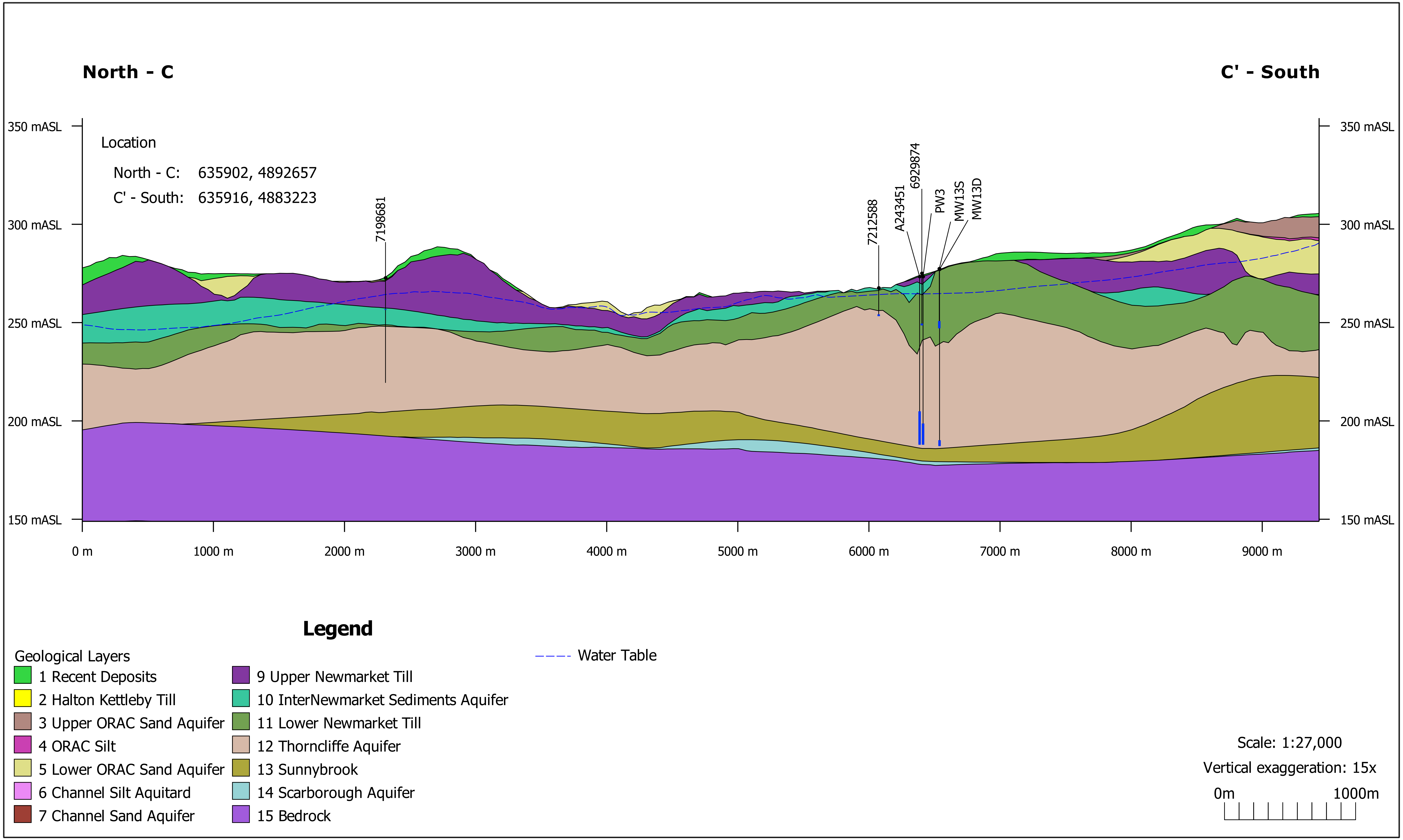

FIGURE 2.8
Tier 3 Conceptual Geological Cross Section C - C'
Mt Albert Water Supply System Upgrades EA
York Region

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