

Appendix H

Facility Characteristics Report



REPORT

Facility Characteristics Report

South Landfill Phase 2 - Environmental Assessment

Submitted to:

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CA0048740.3263

June 2026



REVISION LOG

Revision	Date	Description	Initials
Draft 00	July 2025	Initial Draft	DF
Draft 01	September	Updated draft incorporating figures	DF
Draft 02	November	Draft issued to WSP to format / review	DF
Draft 03	December 9, 2025	Draft issued for Walker / GHD to review	SCL
Draft 04	December 16, 2025	Draft issued for Walker / GHD to review	DSM
01	December 17, 2025	Final.01	SCL
02	March 31, 2026	Rev.02 Final	SCL
03	May 26, 2026	Rev.03 Final / Appendices	SCL
04	June 2, 2026	Rev.04 Final	SCL
05	June 11, 2026	Rev.05 Final	SCL

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1 INTRODUCTION

1.1 Background

Walker's Resource Management Campus (Campus) is located at 2800 Thorold Townline Road in the City of Niagara Falls. The South Landfill is a central component of Walker's fully integrated Campus and has been operating since 2009 under Environmental Compliance Approval (ECA) No. 0084-78RKAM, as amended. It has a total approved site capacity of 17.7 million cubic metres (m³). The South Landfill provides safe, reliable, and affordable disposal capacity for solid, non-hazardous waste from residential and industrial, commercial, and institutional (IC&I) sources.

In 2023, Walker Environmental Group (Walker) initiated a Comprehensive Environmental Assessment (EA) under the Ontario *EA Act* seeking approval to expand the capacity of its existing South Landfill (Phase 1) as it is expected to reach its current maximum capacity by 2029 to 2031. The proposed Phase 2 of the South Landfill would extend its approved capacity by approximately 19.8 million m³ over a 20-year period, ensuring Walker can continue to provide essential residual waste disposal services to its existing customer base. Walker is proposing to locate the additional disposal capacity (Phase 2) to the east of the existing South Landfill Phase 1 within the area currently occupied by Walker's Southeast Quarry. The proposal would maintain the existing landfill service area, as well as the annual volume of solid, non-hazardous waste from the sources currently accepted.

The Minister-approved Terms of Reference (ToR) committed to providing details on the proposed Alternative Methods of Carrying Out the Undertaking (Alternative Methods) during the EA. The proposed Alternative Landfill Configuration Options and Leachate Management Options were assessed through a comprehensive evaluation process where each option was evaluated against a number of environmental criteria and in consideration of feedback received from stakeholders and the general public. The evaluation process, documented separately under the **Alternative Methods Report**, led to the identification of Landfill Configuration Option A and the Leachate Management Option A as the Recommended Alternative Methods. The feedback received during the public, Indigenous community and agency consultation process following the distribution of the draft Alternative Methods Report confirmed the Recommended Alternative Methods as the Preferred Alternative Methods. Subsequently, the design of Landfill Configuration Option A was refined in response to feedback received during consultation to reduce its visual impact and improve compatibility with a future agricultural end use. Furthermore, the Limit of Fill boundaries were adjusted to avoid natural features and to accommodate necessary infrastructure within the buffer.

1.2 Objectives of this Document

This document is the Facility Characteristics Report (FCR) produced for the purposes of integrating key facility characteristics that describe the conceptual design and operations assumptions for the proposed South Landfill Phase 2. The FCR provides a standardized set of assumptions of the proposed design and operations of the Preferred Landfill Expansion Option and the Preferred Leachate Management Option ('the Preferred Alternative Methods') for the use by Walker's technical consultants for the purposes of finalizing work plans and conducting technical studies and detailed impact assessments.

This report contains a set of key facility design assumptions which combine the Preferred Alternative Methods and incorporates normal mitigation measures required for a facility of this size and type.

The facility characteristics assumptions described in this document are subject to ongoing refinement based on:

- Consultation and input from interested persons, Indigenous communities and government agencies;

- Further mitigation requirements recommended during the detailed impact assessment;
- Development of the final design and operating plans with approval from the Ministry of Environment, Conservation and Parks (MECP); and
- Conditions or amendments established by the MECP as part of the site approvals.

This report has been prepared by WSP Canada Inc. (WSP) with input from Walker.

2 EXISTING SITE CONDITIONS

The proposed South Landfill Phase 2 is located within Walker's Resource Management Campus. The Campus includes, but is not limited to, the following key facilities:

- Walker Head Offices;
- Walker Brothers Quarry (Extraction Area and Aggregate Processing Area);
- South Landfill Phase 1 (active);
- Residential Waste & Recycling Drop-Off;
- East Landfill;
- Niagara Compost Facility (developed on top of the former West Landfill);
- Niagara Biosolids Facility;
- Walker Resource Recovery Area; and
- Niagara Renewable Natural Gas Facility (and associated landfill gas control & utilization facilities).

Figure 1 illustrates the Walker's Resource Management Campus.

South Landfill Phase 2 represents a continuation of the existing waste disposal operations currently occurring in Phase 1. Existing waste disposal infrastructure will be utilized as part of the South Landfill Phase 2 project and will include:

- The existing landfill site entrance located on Taylor Road;
- Weight scales and inspection station (current location);
- Leachate treatment lagoons, force main and gravity main (to the Niagara-on-the-Lake sanitary sewer);
- Landfill gas control and utilization system;
- Surface water and groundwater control & collection systems;
- Garner Road visual screening berm; and
- Taylor Road screening vegetation.

South Landfill Phase 2 will be developed within the footprint of the to-be depleted Walker Brothers Southeast Quarry.

It is noted that quarry operations at the Campus will cease by 2033. The reduction in activities at the Campus will result in a decrease in existing quarry related truck traffic of approximately 10 trucks per hour (80 trucks per day) during periods of peak production (e.g. June).

In addition to a decrease in existing traffic, other quarry related impacts will also cease when quarry operations at the Campus stops which may include decreases in existing:

- Dust;
- Noise;
- Vibration;
- Asphalt plant operation; and
- Employment.

3 REGULATORY CONSIDERATIONS

The South Landfill Phase 2 project will be subject to, but not limited to, the following regulatory requirements:

- Environmental Protection Act;
- Ontario Water Resources Act;
- Aggregate Resources Act;
- Niagara Escarpment Planning and Development Act;
- Niagara Sewer Use Bylaw;
- O. Reg. 347;
- O. Reg 232/98 (a site-specific liner design is proposed, representing a modification to the typical Generic Design Option II -Double Liner system requirements under O. Reg. 232/98);
- O. Reg. 419/05;
- O. Reg. 387/04;
- Existing Environmental Compliance Approvals and permits; and
- Local planning regulations.

4 LAND USE

4.1 Existing Land Use

The existing land use within and surrounding the South Landfill Phase 2 site area has been documented in the **Land Use Existing Conditions Report**.

- The existing land use within the South Landfill Phase 2 site is an active quarry operation, under a licence (Licence 11175) regulated by the Ministry of Natural Resources (MNR) under the *Aggregate Resources Act*.

- Landscaped berms and vegetation are situated around the perimeter of the site for screening purposes.

The land use surrounding the South Landfill Phase 2 site area is characterized by a mix of Walker-owned industrial uses, agricultural uses and a limited number of residential properties (**Figure 2**).

- **West:** Existing Walker's Resource Management Campus, which comprises a number of waste management and aggregate-related facilities, including two open landfills, one closed landfill, a landfill gas control and utilization facility, a biosolids and compost facility, stockpile areas and an asphalt plant.
 - There are no residential dwellings <1 km away located directly west of the site as the area is occupied by the Campus. The closest residential dwelling and farm to the southwest of the site is located approximately 760 metres away.
- **North:** Mountain Road borders the South Landfill Phase 2 site, beyond which are agricultural lands, two residential properties and a garden centre. The area also contains woodlands, some of which are used for outdoor recreation purposes.
 - The closest residential dwelling to the north of the South Landfill Phase 2 site is located 501 m away.
- **East:** A TransCanada Pipeline easement runs adjacent the boundary of the South Landfill Phase 2 site. Beyond this area are wooded and agricultural parcels and a number of single residential dwellings.
 - The closest residential dwelling to the east of the South Landfill Phase 2 site is located 492 m away.
- **South:** Mainly consists of agricultural lands, vacant and undeveloped lots, woodlands, and three single residential dwellings, which lie within a wider agricultural area.
 - The closest residential dwelling to the south of the South Landfill Phase 2 site is located 788 m away.

4.2 Land Ownership

In addition to the Walker's Resource Management Campus, Walker owns a significant amount (approximately 67%) of land within a 1 km radius of the South Landfill Phase 2 site. A majority of the lands owned by Walker, aside from the Campus, are undeveloped and primarily agricultural lands and act as a buffer to the Campus.

4.3 Future Land Use

Under the existing aggregate extraction licence (Licence 11175), the quarry currently occupying the South Landfill Phase 2 site is to be rehabilitated to an agricultural condition similar to pre-extraction capabilities.

In the case of the South Landfill Phase 2 EA approval, the final end use of the landfill will be determined at the time of closure and subject to community input and any applicable regulatory approvals.

4.4 Land Use Designations and Amendments Required

Some nearby land use designations and future land use plans of note near the South Landfill Phase 2 site are as follows:

- The Northwest Secondary Plan is located approximately 1.5 km east of the South Landfill Phase 2 site, immediately east of Kalar Road. It is currently in the early stages of the planning process which entails the undertaking of background studies and the initiation of public consultation.

- Two Agri-Tourism Zones (AT1 and AT2) were established via a Minister's Zoning Order on the lands east of the South Landfill Phase 2 site, south of Mountain Road between Garner Road and Kalar Road.
- The South Landfill Phase 2 site is located outside of the Greenbelt Plan Area and the Niagara Escarpment Plan Area.

The necessary changes to land use designations to establish South Landfill Phase 2 are as follows:

- Amendments to the Niagara Region Official Plan, the City of Niagara Falls Official Plan and the City of Niagara Falls Zoning By-law will be required to implement the land use approvals as determined by the Class EA process prior to the expansion of the existing landfill facility.
- Under the existing License (11175), any change to the site plan, or surrender of the license, will require approval through MNR in accordance with the requirements of the *Aggregate Resources Act*.

5 PLANNING HORIZONS

This section provides an overview of key timelines associated with several core facilities/operations at Walker's Campus.

South Landfill Phase 1 (SLF1)

- Anticipated to reach 99% of approved capacity by July 1, 2030.
- Final filling/grading will occur until 2033.
- Closure in 2034.

South Landfill Phase 2 (SLF2)

- Operations (i.e. waste receipt) anticipated to start July 1, 2030.
- Closure anticipated in approximately 2050.

East Landfill (Cell 16) (ELF)

- No waste receipt until approximately 2034 when Cell 16 can be developed (once the quarry is closed).
- 1 year of filling operations.
- Closure anticipated in 2035.
- The current soil transfer facility located on top of the East Landfill will remain active and serve as a stockpile for daily cover soils to be utilized by South Landfill Phase 2.

Walker Brothers Quarry

- Depletion anticipated by July 1, 2033.

Landfill Operation Scenario Summary

A summary of operations scenarios at the landfill facilities is provided in **Table 1**.

Table 1: Summary of Landfill Operations Scenario

	Annual Waste Receipt ('000's tonnes/yr)					
	2030	2031	2032	2033	2034	2035
SLF1	200	150	100	100	Closed	
SLF2	1,100	1,100	1,100	1,100	1,100	1,100
ELF	0	0	0	0	400	Closed

6 DESIGN

6.1 Waste Characteristics

Service Area	Province of Ontario
Waste Type	Solid, non-hazardous waste
Annual Waste Disposal Rate	<p>Up to 1,100,000 tonnes per year of solid, non-hazardous waste consisting of the following breakdown:</p> <ul style="list-style-type: none"> Up to 858,000 tonnes of solid non-hazardous waste. For the purposes of this EA, it is assumed up to 70% of this waste is putrescible. 242,000 of solid, non-hazardous waste that meets the description of waste permitted for use as a daily/intermediate cover. <p>Daily and intermediate cover materials will be selected from applicable waste materials approved for receipt at the landfill. Where daily and intermediate cover materials are sourced from applicable and approved waste materials, these materials will be included in annual waste receipt limitations set out by the site approvals.</p> <p>Alternative daily and intermediate cover materials that are not considered a waste as defined in O. Reg. 347/98 will/can be sourced from various Ontario suppliers and would not be included in annual waste receipt limitations set out by the site approvals. The same applies to daily and intermediate cover soils obtained from the on-site quarry operation.</p>
Maximum Daily Waste Disposal Rate	10,000 tonnes/day.

6.2 Site Geometrical Characteristics

Total Landfill Site Area	81.30 ha (Figure 3)
Waste Fill Area	62.59 ha (Figure 3)
Site Capacity	<p>Total Volume: approx. 19,800,000 cubic metres</p> <p>Estimated total disposal capacity: 19,800,000 tonnes (density of waste assumed to be 1.0 tonnes/cubic metre)</p>

Height and Depth	<p>Maximum top of landfill elevations:</p> <ul style="list-style-type: none"> • Top of Waste: 211 masl • Top of Cap: 211.75 masl <p>Maximum height above grade (top of final cover): 31.75 m</p> <p>Max. depth below grade: approx. 21 m</p> <p>Average waste thickness: approx. 30 m</p> <p>The draft contour plan (Figure 3) and cross-section drawings (Figure 4) illustrates the shape, height and depth of the proposed landfill.</p>
Buffer Area	<p>The buffer area between the limit of waste fill and the landfill site property boundary (Figure 3) provides space for:</p> <ul style="list-style-type: none"> • Monitoring; • Maintenance; • Surface water management; • Environmental controls; • Vehicle access and internal traffic; • Structures and buildings (offices, works, etc.); and • Equipment parking and maintenance. <p>The buffer area ranges from a minimum of 30 metres¹ to a maximum of 150 metres wide surrounding the waste fill area.</p>

6.2.1 Landfill Liner & Final Contour Slopes

- Below-ground (e.g. liner) slopes will not be steeper than 3:1 (horizontal:vertical).
- Above-ground slopes will not be shallower than 16:1 (to ensure effective surface drainage), or steeper than 3.5:1 (to minimize the potential for waste fill and final cover instability).

6.3 Landfill Development Stages

6.3.1 Construction and Development Phase (Pre-Operations)

During the construction and development stage, the following key infrastructure will be constructed:

- Tunnel – a new tunnel/under-pass crossing Taylor Road located approximately 75 m south of the existing quarry tunnel/under-pass. The location and orientation of the landfill under-pass is illustrated on **Figure 5**;
- Roads – new internal primary roadways will be constructed. Specifically, the internal primary roadway leaving the weigh station and connecting to the tunnel/under-pass and then from the under-pass south alongside Taylor Road to the southern limit of South Landfill Phase 2 and on the floor of the quarry to the Stage 1 area. These primary internal roads are illustrated on **Figure 5**;
- Key Facility Infrastructure (as further illustrated on **Figure 6**);

¹ A 30 m buffer area was determined adequate for a landfill of similar size and conditions (e.g. South Landfill). The impact assessment will evaluate if 30 m buffer for this EA is adequate as described in O. Reg. 232/98.

- Electrical servicing to the Leachate Station and Ancillary Infrastructure Area;
- Leachate Pump Station;
- Leachate force main to the existing on-site pre-treatment lagoons.
- Two new pre-treatment lagoons and ancillary buildings near the existing lagoons and any associated upgrades to the leachate gravity/forcemain to the municipal sanitary sewer connection;
- Storm water management facilities (as required);
- Landfill Equipment Maintenance Shop; and
- Employee facilities (site offices, parking, employee entrances).

Existing Key Infrastructure that will be upgraded and / or maintained:

- Site entrance;
- Internal primary roads to weigh station;
- Existing leachate pre-treatment lagoons;
- Force and gravity main from the leachate pre-treatment lagoons to the Niagara-on-the-Lake sanitary sewer; and
- Existing landfill gas control and utilization facilities.

6.3.2 Landfill Stage Development

The landfill will be developed in 4 main stages (**Figure 7**) over the approximately 20-year operational life of the site.

- Each stage will accommodate approximately 4 cells.
- Stage 1 will begin in the southern portion of the site and progress in a northern direction. The capacity of Stage 1 is approximately 7,000,000 m³ and will last about 5 years at maximum filling rates.
- Stage 2 is in the middle portion of the site and will progress in a northern direction. The capacity of Stage 2 is approximately 5,300,000 m³ and will last about 5 years at maximum filling rates.
- Stage 3 is in the northeastern portion of the site. It will begin at the southern limit of Stage 2 and progress in a northeastern direction. The capacity of Stage 3 is approximately 4,300,000 m³ and will last about 5 years at maximum filling rates.
- Stage 4 is in the northwestern portion of the site. It will begin at the southern limit of Stage 2 and western limit of Stage 3 and progress in a northwestern direction. The capacity of Stage 4 is approximately 3,200,000 m³ and will last about 3 years at maximum filling rates.
- Within each of these stages, new cells will be constructed yearly, or as needed, to provide sufficient space for waste placement and landfill operations. All aspects of each new cell are connected to existing cells, and new stages to existing stages to form one contiguous waste containment system.

6.3.3 Operational Phase

During the operational phase, the following key activities will occur.

- Depending on weather, site preparations will occur and may include:
 - Road cleaning/watering;
 - Snow removing and sanding;
 - Active face preparation; and
 - Site safety inspections.
- Once the site is opened daily (in accordance with **Section 8.2 – Hours of Operation**), trucks that have arrived will proceed to the weigh and inspection stations for processing.
 - If approved to enter the site, trucks will then be directed to a designated staging and un-tarping area to prepare for unloading.
 - Once ready to unload, trucks will be directed to the active face.
 - Once at the active face, trucks will unload.
 - Once unloaded, trucks will move to a designated cleanout area within the waste fill boundary where any residual waste is removed before securing their doors and inspecting the vehicle prior to leaving the site.
 - Trucks will then proceed to the weigh station for final tare weight and billing information.
 - Trucks will then leave the site.
- During the operational phase, site nuisance controls will be implemented as required. See **Section 8.5** for further information regarding nuisance controls.
- There will normally be two designated working/active areas for waste placement within the stage at any given time to ensure a compact operation and flexibility depending on weather conditions (e.g. a lower active area when high wind conditions exist).
- Monitoring and reporting will be conducted throughout the Operational Phase in accordance with its Environmental Compliance Approval.
- Daily, intermediate and final cover will be applied throughout the course of the Operational Phase (see **Sections 8.4 and 7.2.4**).

6.3.4 Closure Phase

- Once an area has achieved its final approved elevation and contours, final cover will be applied as further described in **Sections 6.8 and 7.2.4**.
- Once the entire site has achieved its final contours, the site will be closed in accordance with its Closure Plan.
- Monitoring and reporting will continue to be conducted in accordance with the site's Environmental Compliance Approval.

- Infrastructure not required during the Closure phase will be removed. It is anticipated that some key infrastructure will be retained or repurposed in the Closure Phase. The anticipated outcomes for key facility infrastructure is outlined in **Section 9.1**.

6.4 Infrastructure

6.4.1 Haul Route

- The dedicated haul route for traffic entering from areas west of the site will remain the same as the current South Landfill Phase 1, which is from Highway 406 to Highway 58 to Taylor Road to the existing site entrance on the west side of Taylor Road.
 - See **Figure 8** for an illustration of the existing haul route.
- Waste collection trucks from areas east and north of the site will use the existing Regional and Municipal road networks that provide direct access to the site.

6.4.2 Site Entrances

- The site entrance for landfill customer traffic (waste receipt) is located at the existing site entrance on the west side of Taylor Road.
- Secondary maintenance access points will be developed for employee access or intermittent maintenance access specific to heavy construction vehicles that may not be able to cross through the tunnel/under-pass.
 - These two secondary access points are located in the northwestern corner and southern end of the site (**Figure 5**).

6.4.3 Internal Roads/Tunnel

- **Primary Roads (Figure 5)** – The primary internal access road originates at the landfill site entrance at Taylor Road and connects to the weigh scales. From there, it progresses to the Taylor Road tunnel/under-pass to South Landfill Phase 2 where it then splits into two paths. The lower road stays on the quarry floor once leaving the tunnel and moves south to Stage 1 and ultimately southeast and east to Stage 2 and 3 of the landfill. This lower road allows for filling of the lower portions of each stage. The upper road climbs up the quarry side slope and parallels Taylor Road south to the ancillary infrastructure area. This upper road allows for filling of the upper portions of each stage. When Stage 4 is developed, the primary road leaving the tunnel will run east across the northern perimeter of the site. The primary roads will facilitate the movement of all incoming waste traffic. See **Figure 5** for more information.
- **Temporary/Secondary Roads** – Temporary roads will be constructed and relocated as required to provide access into and through-out the landfill. These roads will facilitate the movement of waste trucks to the respective working/active areas.
- **Maintenance/Monitoring Road (Figure 5)** – The site perimeter road and other maintenance roads will be constructed around the perimeter of the site in the buffer area and other areas as required. These roads will also be used for maintenance, monitoring and operational purposes and for access to other landfill facilities such as landfill gas, leachate management and storm water systems.
- **Taylor Road Tunnel/Under-pass (Figure 5)** – A tunnel/under-pass will be developed under Taylor Road approximately 75 m south of the existing quarry tunnel. The purpose of the tunnel will be to provide access to landfill related traffic and equipment from the site entrance to the landfill (South Landfill Phase 2) without

disturbing traffic patterns on Taylor Road. The tunnel will be designed to accommodate two lanes of traffic (incoming & outgoing). See **Figure 5**.

6.4.4 Buildings, Structures and Supporting Infrastructure

South Landfill Phase 2 will utilize both new and existing landfill infrastructure. **Figure 6** further illustrates key infrastructure.

6.4.4.1 New Infrastructure

- **Electrical power** – Electrical power to the site will be established via a distribution line originating on Beechwood Road, moving east and north to the ancillary infrastructure area where it will be transformed as required to power key infrastructure such as the leachate pump stations, shops, site offices and lighting, etc.
- **Leachate Pump Station** – The leachate pump station will be developed at the south end of the site and will remove leachate from the landfill.
- **Leachate Forcemain** – The leachate forcemain will convey leachate from the leachate pump station to the existing onsite leachate pre-treatment lagoons.
- **Leachate Pre-treatment Lagoon** – 2 new leachate pre-treatment lagoons will be constructed adjacent to the existing lagoons including some ancillary buildings/equipment. See **Section 6.9.3** for additional details.
- **Site/Employee office** (approx. 30 m x 20 m x 10 m in height total) – A single or multiple permanent or semi-permanent structures will be developed to support employees.
- **Maintenance shop** (approx. 30 m x 20 m x 10 m in height) – A maintenance shop will be developed to facilitate the repair and maintenance of site equipment.
- **Landfill Gas Booster Station & Pipeline** (10m x 10m x 10m in height) – A landfill gas booster station will be developed in the southwest corner of the site. This station will increase vacuum to the landfill gas extraction wellfield on the South Landfill Phase 2 and push gas via a pipeline under Taylor Road to connect the existing landfill gas perimeter header at South Landfill Phase 1.

6.4.4.2 Existing Infrastructure

- Existing infrastructure will be maintained and upgraded as required.
- Existing infrastructure that will be utilized by South Landfill Phase 2 include:
 - Site entrance off Taylor Road
 - Weigh station/scales – approximately 3 m x 15 m x 4 m in height.
 - Surface water management facilities such as the existing 1,200 mm surface water conveyance pipe, which directs surface water from the existing quarry footprint across the Campus to the Welland Canal
 - Leachate management facilities including:
 - Leachate pre-treatment lagoons 1 & 2; and
 - Force main and gravity main connecting the pre-treatment lagoons to the Niagara-on-the-Lake sanitary sewer.

- Note that this existing force/gravity main will be modified and upgraded. See **Section 6.9.3** for additional details.
- Landfill gas control facilities (compressor/blower buildings, flares and utilization facilities). See **Section 6**.

6.5 Surface Water Management

6.5.1 Undeveloped (Landfill) / Quarry Areas

During the construction of the landfill, precipitation and groundwater seepage on the undeveloped portions of the existing quarry floor (i.e., where no liner construction or waste placement activities have yet occurred) will be segregated from the active landfill areas using berms, ditches and sumps. This water (non-contact water) will be managed through the existing approved quarry water management system. This is further described and summarized below:

- The quarry floor slopes to the south toward the existing quarry sump.
- Water in the sump then flows by gravity to manhole 7S (MH7S). (see **Figure 6**)
- At MH7S the water enters an existing 1,200 mm concrete solid pipe, which directs the flow under Taylor Road, across the Campus, and discharges to the Old Welland Canal.
- As Stage 1 and subsequent stages of the landfill are developed, a series of ditches and piping will be utilized to maintain a hydraulic connection from the upgradient areas of the quarry to MH7S.

6.5.2 Active Landfilling and Uncapped Areas

- Any precipitation or water that comes into contact with the active working area, portions of the landfill that do not have final cover or new cells once constructed will be considered as potentially contaminated (contact water).
- Berming, ditches, grading and other works will be used to contain contact water within the uncapped area of the landfill where it will be directed into the leachate collection system for treatment as landfill leachate.

6.5.3 Perimeter Areas, Final Cover & Stormwater Management

- Precipitation on areas where final cover has been applied (non-contact water) will be directed via perimeter ditching to the stormwater management areas (**Figure 3**) for sediment removal and monitoring. Discharge will be to the 10 Mile Creek and/or to the Old Welland Canal via the 1,200 mm surface water conveyance pipe. Both discharge options will be evaluated in this EA.
- Stormwater from other areas of the site such as buffer areas, parking lots and roadways will be treated similarly.

6.6 Groundwater Management

Groundwater at the Campus is controlled via the existing Groundwater Collection System (GWCS). The GWCS existing underneath the East Landfill consists of a trench and perforated pipe located in the Rochester Shale and has a higher hydraulic conductivity than the surrounding bedrock. This induces an inward groundwater gradient where groundwater from around and under the Campus flows inward towards the former quarry excavations (footprint of the existing and proposed landfills) and within the underlying Rochester shale bedrock to the GWCS, where it is controlled and monitored. See the conceptual groundwater management plan (**Figure 9**) for further details.

- Under current conditions, groundwater discharges slowly into the quarry excavation (footprint of the proposed South Landfill Phase 2) through the north, east and south rock faces and drains to the quarry sump, from where it is discharged through the 1,200 mm solid conveyance pipe to the Old Welland Canal. Groundwater in the Rochester shale below the excavation floor is drawn toward both the quarry sump and the existing GWCS.
- During construction of the South Landfill Phase 2, a continuous horizontal and vertical (rock wall) sub-drain layer will be included as part of the subgrade on the northern, eastern and southern perimeters to direct groundwater seepage from the vertical quarry rock wall down to the floor of the quarry excavation. A series of finger drains will be constructed on the floor of the quarry as part of the subgrade to provide a hydraulic connection across the quarry floor and from the perimeter subdrain layer to the 1,200 mm solid conveyance pipe at MH7S.
- MH7S will be equipped with valving to allow control of drainage to the 1,200 mm solid conveyance pipe.
- While portions of the existing quarry (landfill) floor are undeveloped (i.e., liner construction and/or waste placement activities have not yet occurred), the valve at MH7S will remain open and groundwater seepage into the quarry excavation will be directed via the subgrade drainage system to MH7S and the 1200 mm conveyance pipe along with the non-contact water from the undeveloped quarry area. Groundwater in the Rochester shale below the excavation floor will be drawn toward both the sub-drain system and the existing GWCS.
- Once the landfill floor has been fully developed with the liner and waste placement activities, the valve at the inlet of the 1200 mm conveyance pipe at MH7S will remain open. Groundwater seepage collected by the sub-drain system will drain to the 1200 mm conveyance pipe via MH7S. Groundwater in the Rochester shale below the quarry floor will be drawn toward both the sub-drain system and the GWCS.
- If required, the sub-drain system could be used to capture groundwater below the landfill liner as a contingency measure in the event of unacceptable impacts from the landfill on groundwater quality. The sub-drain system could be isolated by closing the valve at MH7S and drained by pumping from MH7S to the leachate management system.

6.7 Landfill Liner and Leachate Collection System

Liner Subgrade Engineered Fill and Sub-drain

- Compacted engineered fill will be placed between the quarry floor and the bottom of the basal and perimeter sideslope lining systems. Beneath the basal lining system, the engineered fill will be placed where required for fine grading of the quarry floor and will be less than 1 m thick. Beneath the perimeter sideslope lining system, the thickness of engineered fill will range from 0 m at the toe of the sideslope to as much as 22 m adjacent the quarry sidewall to achieve the 3(H):1(V) sideslopes required for liner construction.
- To minimize build-up of groundwater pressures beneath the engineered fill along the eastern, southern and northern perimeter sideslopes, the engineered fill will include a continuous rockfill sub-drain layer in direct contact with the quarry floor and vertical sidewall. The sub-drain layer will direct any groundwater seepage from the quarry sidewall down to the quarry floor. A series of finger drains (slots) cut into the quarry floor and backfilled with rockfill will provide hydraulic connection between the perimeter sub-drain layer and the 1200 mm non-contact groundwater/surface water discharge pipe at MH7S.

Liner and Leachate Collection System Components

- The proposed liner and leachate collection system is a site-specific design that closely resembles the O. Reg. 232/98 Generic Double Composite Liner Design Option II, with the exception that a geosynthetic clay liner (GCL) rather than a compacted clay liner will be used in the primary composite liner. A schematic of the proposed liner and leachate collection system design is provided in **Figure 8** of the **Leachate Containment System Design Description Report (Appendix A)**.
- The proposed design is expected to perform equal to or better than the O.Reg. 232/98 Generic Double Composite Liner Design.
- The GCL component consists of a layer of dry powdered bentonite clay sandwiched between two nonwoven geotextiles mechanically held together by needle punched/thermally fused fibres to give an overall thickness of approximately 6 mm. The bentonite clay has a very low permeability when hydrated under the vertical confining stress applied by the overlying waste fill. The primary role of the GCL in the primary composite liner is to minimize leakage of landfill leachate into the secondary leachate collection system via any remaining defects in the overlying geomembrane liner that go undetected by the Construction Quality Assurance inspection/testing program. Upon wetting by leachate permeating through a defect, the bentonite component swells and seals the defect, thereby minimizing any further leakage. When the overlying geomembrane reaches the end of its service life, the GCL will take on the role of the primary barrier layer, limiting leachate migration into the secondary leachate collection system.
- Key technical attributes of the proposed GCL that will make the performance of the proposed design equal to or better than that of the Generic Design Option II include:
 - i) high swelling potential on hydration – minimizes leakage through defects in the overlying geomembrane liner by sealing the defect and reducing the lateral flow transmissivity along the underside of the geomembrane;
 - ii) order of magnitude lower hydraulic conductivity than that of a compacted clay liner – minimizes leakage through defects in the overlying geomembrane liner and through the GCL itself after the primary geomembrane reaches the end of its service life;
 - iii) not susceptible to desiccation cracking;
 - iv) infinite service life – the bentonite clay component is resistant to biological and physical breakdown and is capable of self-healing any chemically induced (i.e., cation exchange) increases in hydraulic conductivity;
 - v) provides a smooth bedding surface for the overlying geomembrane liner free of protrusions and indentations – no risk of puncturing or localized stress cracking of the overlying geomembrane; and
 - vi) uniform and consistent (factory controlled) material properties – provides certainty on the performance of the GCL as a hydraulic barrier.
- Other advantages of using a GCL rather than a compacted clay liner in the primary composite liner include:
 - i) readily available from manufacturing plants in Ontario and Quebec - GCL supply is not limited by availability of on-site and/or off-site clayey soils suitable for liner construction;

- ii) requires minimal trucking and construction equipment for supply and installation - minimizes green-house gas emissions;
 - iii) reduces construction schedule - a hectare of GCL liner can be installed in a few days versus about a month for a compacted clay; and
 - iv) performance is less dependent on CQA inspection/testing - CQA is limited to visual inspection of the GCL product, subgrade, method of deployment and overlaps.
- The primary and secondary geomembranes will be 1.5 mm (60 mil) High-Density Polyethylene (HDPE) in accordance with the Reg. 232/98 requirements for 150 year and 350-year minimum service life, respectively.
 - The 0.75 m thick compacted clay component of the secondary composite liner will meet the requirements of O.Reg. 232/98 for a hydraulic conductivity of less than 1×10^{-7} cm/s and an infinite service life. The clay will be supplied from off-site sources.
 - The primary and secondary leachate collection systems will include 200 mm diameter perforated HDPE pipes, clear stone drainage layers, granular filter/bedding layers, geotextile separator layers and clean-out access pipes. The design will comply with the O.Reg 232/98 requirements for a service life of 100 years and 1000 years, respectively. The LCS piping will drain to a sump at the southwest corner of the landfill floor. The sump will have an inclined riser pipes within which a submersible pump will be installed for leachate removal. The collected leachate will be pumped via a forcemain to the existing onsite leachate lagoons for pre-treatment prior to discharge to the municipal sanitary sewer system for further treatment.

A **Leachate Containment System Design Description Report** was prepared by WSP, May 2026, to present the design of the leachate containment system required to support the development of South Landfill Phase 2. The report is included in Appendix A.

6.8 Final Cover

In accordance with the requirements of O. Reg. 232/98, final cover will consist of:

- At least 0.6 m of soils that will permit a minimum infiltration rate of 0.15 m/year;
 - At least 0.15 m of topsoil; and
 - Vegetation that will prevent wind and water erosion.
- Materials used for final cover will be sourced on-site.
 - For any agricultural end uses of the site, Walker can enhance pre-existing topsoils with soil amendments from its on-site composting operations, as has been successfully demonstrated with the East Landfill Agricultural end use area.

6.9 Leachate Management

6.9.1 Leachate Quantity

- Leachate production (including contact water) for South Landfill Phase 2 will commence once the first cell is constructed and will gradually increase as each phase of the landfill is developed.
- Predicted annual leachate volumes generated by the South Landfill Phase 2 are shown in **Figure 10**. Climate change considerations were incorporated into the predictive modelling.

- The annual leachate volume increases from approximately 30,000 m³ in the first year of landfilling (Year 2030) to 131,000 m³ at the end of the operating period in Year 2045 and then decreases to 128,000 m³ at completion of final cover construction in Year 2050. Post-closure leachate volumes gradually increase due to climate change, reaching 147,000 m³ after 20 years post-closure (Year 2070).

6.9.2 Leachate Quality

- For the purposes of liner design, Table 2 provides representative peak leachate source concentrations for key leachate parameters *per* Table 1, O. Reg. 232/98, for solid, non-hazardous waste. For comparison, Table 2 also provides representative peak concentration for these key parameters based on monitoring of leachate collected from the South Landfill Phase 1. Modelling conducted for the liner design should use the higher of the two sources.

Table 2: Typical Landfill Leachate Characteristics for Landfill Liner Design

Contaminant	Ont. Reg. 232/98 Representative Peak Leachate Concentration (mg/L)	South Landfill Phase 1 Representative Peak Leachate Concentration (mg/L)
Benzene	0.02	0.005
Cadmium	0.05	0.00012
Chloride	1,500 to 2,500	2,500
Lead	0.6	0.020
1,4-Dichlorobenzene	0.01	0.0027
Dichloromethane	3.3	0.088
Toluene	1.0	0.068
Vinyl Chloride	0.055	0.003

6.9.3 Leachate Collection, Pre-Treatment & Final Treatment

Leachate will be collected and removed from the landfill as noted in **Section 6.7**. Once leachate is pumped from within the landfill, it will be conveyed to the existing leachate pre-treatment lagoons via a new force main that will be constructed, as illustrated on **Figure 6**.

Modifications to the existing leachate pre-treatment facility will be required to manage the additional leachate generated from South Landfill Phase 2. The modification will consist of the following and are further illustrated on **Figure 6**.

- Two (2) new lagoons similar in size and located south of the existing lagoons;
 - The two (2) new lagoons will have the approximate dimensions of 70 m x 45 m; and
 - The total of four (4) lagoons will be optimized to provide aerobic (2 lagoons) and anoxic (2 lagoons) treatment.
- A new Air Circulation Building (approx. 10 m x 10 m x 4 m); and
- A new solids management building (approx. 10 m x 10 m x 5 m) housing enclosed bins for activated sludge.

After pre-treatment in the onsite leachate lagoons, leachate will be conveyed to the municipal sanitary sewer in Niagara-on-the-Lake via a force/gravity main as illustrated on **Figure 2**. This force/gravity main will require upgrades to accommodate additional leachate flows from South Landfill Phase 2. The upgrade will consist of replacement and upsizing of the existing force/gravity main with new force/gravity main along the existing alignment.

Leachate generally conforms to the Niagara Region Sewer-Use By-Law with the occasional exceedances of Total Kjeldahl Nitrogen (TKN) and Chemical Oxygen Demand (COD). The proposed modifications to leachate pre-treatment system will address these occasional exceedances.

A **Final Functional Water and Wastewater Servicing Report** was prepared by GEI Consultants Canada, May 2026, to document the wastewater treatment services required to support the development of South Landfill Phase 2. The report is included in Appendix B.

6.10 Gas Management

6.10.1 Gas Quantities

- Landfill gas will start being generated several months after waste is placed in the landfill and increase through the operational period as more waste is added.
- The landfill gas generation rate is expected to peak within a few years after the landfill is closed with all final cover in place, and then slowly decline as the organic material in the landfill decomposes.
- The peak landfill gas production rate is estimated at approximately 10,700 m³/hour.

6.10.2 Subsurface Landfill Gas Migration Controls

- The landfill liner system will be extended from the base of the landfill, up the side slopes to the ground surface at the landfill perimeter and therefore will provide a physical barrier to subsurface landfill gas migration.
- The operation of the landfill gas collection system should act to reduce or eliminate positive gas pressure within the landfill and should mitigate the potential for offsite subsurface landfill gas migration.

6.10.3 Landfill Gas Collection & Destruction

- A series of horizontal collectors and vertical wells, along with necessary collection and control infrastructure will provide vacuum to the landfill to collect the landfill gas generated by the site.
- The landfill gas collection efficiency is estimated to be 85% of the total gas production, based on Walker's operational experience where there is an engineered bottom and side slope liner, active final cover maintenance program and landfill gas utilization facilities designed to optimize landfill gas collection.
- Collected gas will be incinerated in fully enclosed flares that exist at Walker Landfill Gas Utilization Facility (see **Figure 6**).
- The flares are designed to operate at temperatures between 875 °C to 950 °C with a residence time of 0.75 seconds to ensure air quality standards are met in the exhaust.
- Flaring of the landfill gas typically converts about 98% of the methane to carbon dioxide (i.e., the destruction efficiency) and destroys more than 99.9% the trace organic compounds.

- Landfill gas utilization appliances (i.e., kilns, boilers, reciprocating engines) would have similar destruction efficiencies to the flares noted above.
- As a baseline, it should be assumed that flaring 100% of the collected landfill gas throughout the landfill gas generation period will occur.
- At operating year 5 of the landfill, landfill gas utilization may be expected. Potential utilization projects could include:
 - Direct-use as an industrial fuel at nearby industries;
 - Use in reciprocating engines onsite and/or offsite to generate renewable electricity; and
 - Processing to meet natural gas pipeline specifications and injecting into nearby natural gas distribution or transmission pipelines.
- Any impacts from utilization are expected to be less than the baseline of flaring onsite.
- The utilization of landfill gas as a renewable energy source is anticipated to have several positive impacts (i.e. displacement of non-renewable energy sources).
- Existing landfill gas control and utilization infrastructure is illustrated on **Figure 6, Site Infrastructure**.

7 CONSTRUCTION

7.1 Initial Site Preparation

- Construct key facility infrastructure in accordance with **Section 6.3 - Site Landfill Development Stages** which can be summarized as:
 - Construct the new tunnel/under-pass;
 - Construction the primary haul roads from the weigh station to the tunnel and then south alongside Taylor Road. and on the quarry floor to Stage 1;
 - Install site services to the Leachate Pump Station and Ancillary Infrastructure Area;
 - Develop the employee offices, shop and respective parking areas in the Ancillary Infrastructure Area;
 - Construct the Leachate Forcemain from the Leachate Pump Station location to the Leachate Pre-treatment Lagoons; and
 - Construct the modifications to the leachate pre-treatment system (lagoons 3 & 4) as further described in **Section 6.9.3**.

7.2 Cell Construction (Progressive)

7.2.1 Engineered Structural Backfill Layer

- Haulage, placement, and compaction of structural fill/subgrade from selected soils (obtained from onsite borrow source operations) on the quarry floor and side slopes, including sub-drain layers as required.

7.2.2 Liner and Leachate Collection System

- Haulage and stockpiling of clay, crushed stone, geomembrane, geosynthetic clay liner (GCL), geotextile, and piping to the area of the current cell construction.
- Construction of the primary and secondary composite liner systems design.
- Construction of the primary and secondary leachate collection systems.
- Construction of the Leachate Pump Station.

7.2.3 Gas Collection System

- Delivery of piping and construction material to the staging and construction areas.
- Construction of the Landfill Gas Booster Station and connection to the South Landfill Phase 1 Landfill Gas Header.
- Installation of horizontal gas collectors during the filling/operational phase.
- Drilling of vertical landfill gas extraction wells once interim and/or final cover has been achieved over an area of the landfill.
- Installation of gas collection headers, laterals, vertical and horizontal extraction wells in each cell as the cells are developed and filled.

7.2.4 Final Cover

- Construction of final cover per the requirements of O. Reg. 232/98 and other regulatory requirements.
- Final cover will be placed in areas where landfilling has ceased, and final contours have been achieved.

8 OPERATIONS

8.1 Traffic Volumes

- The number of total trucks (incoming waste trucks) was calculated based on existing waste receipt at the existing South Landfill Phase 1 using a reference year of 2023 (see **Chart 8-1, Truck Traffic Annual Distribution – 2023 Reference Year**).
- Traffic associated with other facility requirements such as employees, contractors and construction are given in **Table 3, Anticipated Traffic Related to Facility Requirements**.
- It is estimated that an average of approximately 250 trucks per day will access the landfill (see **Chart 8-2, Average Trucks per Day of Week**).
- It is estimated that a peak of approximately 425 trucks per day may occur although the frequency of these peaks is limited to only a few days per year (see **Chart 8-3, Maximum Trucks per Day of Week**).
- The estimated distribution of trucks accessing the facility throughout the day is show in **Chart 8-4, Average Trucks per Day by Hour**.
- All traffic illustrated in this section is defined as a vehicle entering the facility. The calculation does not include the vehicle leaving the facility.

- It is noted that operation of the Southeast Quarry is expected to cease and would result in a decrease in background traffic (see **Section 5 – Planning Horizons** for more information).

Chart 8-1: Truck Traffic Annual Distribution – 2023 Reference Year

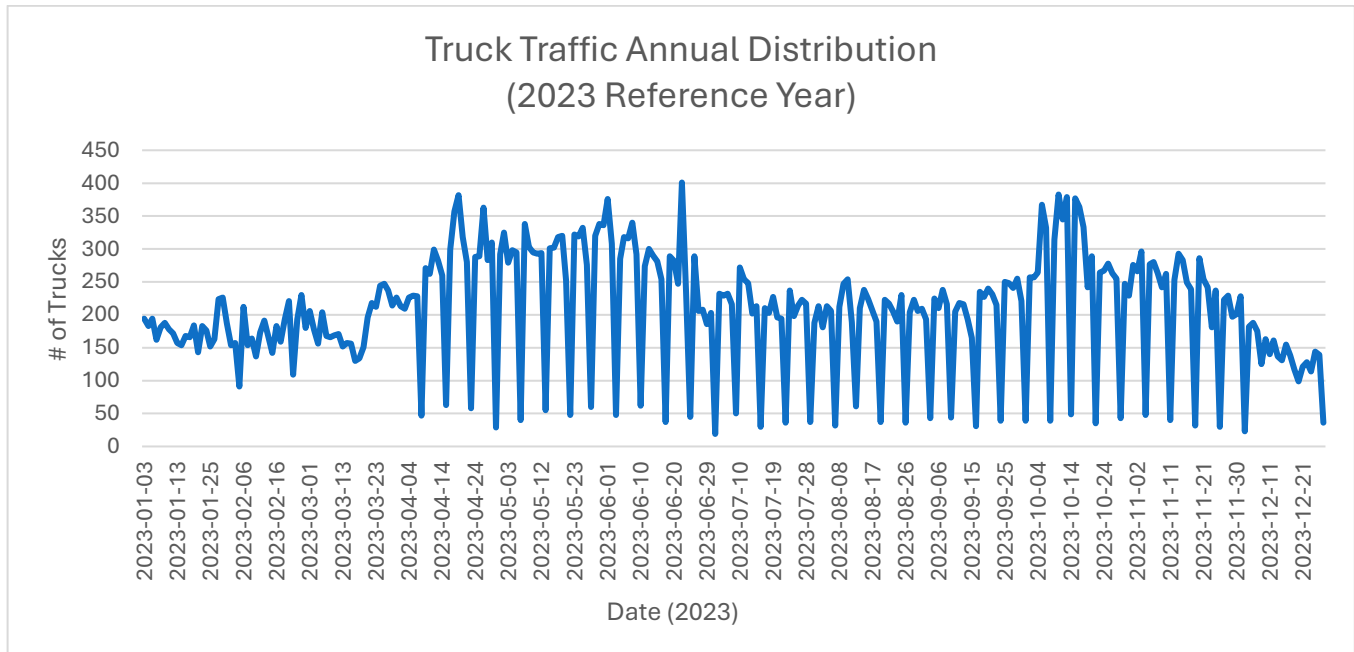


Table 3: Anticipated Traffic Related to Facility Requirements

Required Product/Service	Vehicle Type	Avg. Trips/Day
Liner Clay/Soils	End Dump – Tractor Trailer	2
Leachate Collection Stone	End Dump – Tractor Trailer	5
Misc. Construction Materials	Tractor Trailer	1
Misc. Construction Materials	Tandem Delivery Truck	1
Employees/Contractors	Pick-up Truck/Car	25

Chart 8-2: Average Trucks per Day of Week

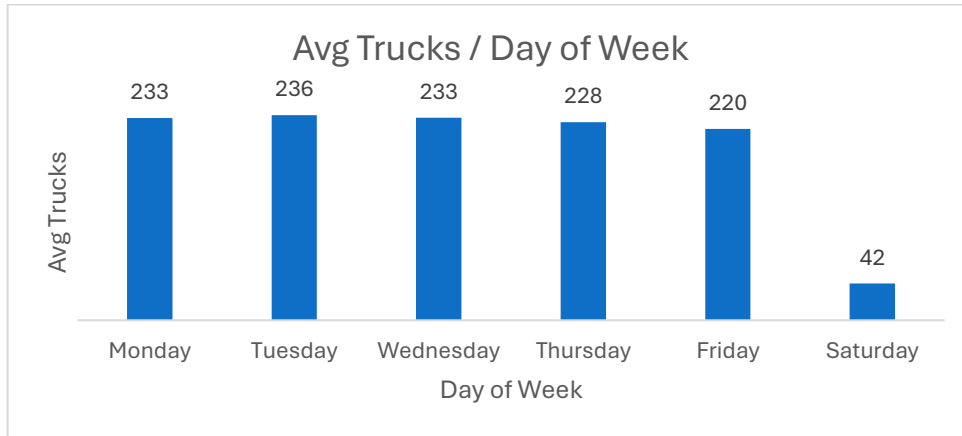


Chart 8-3: Maximum Trucks per Day of Week

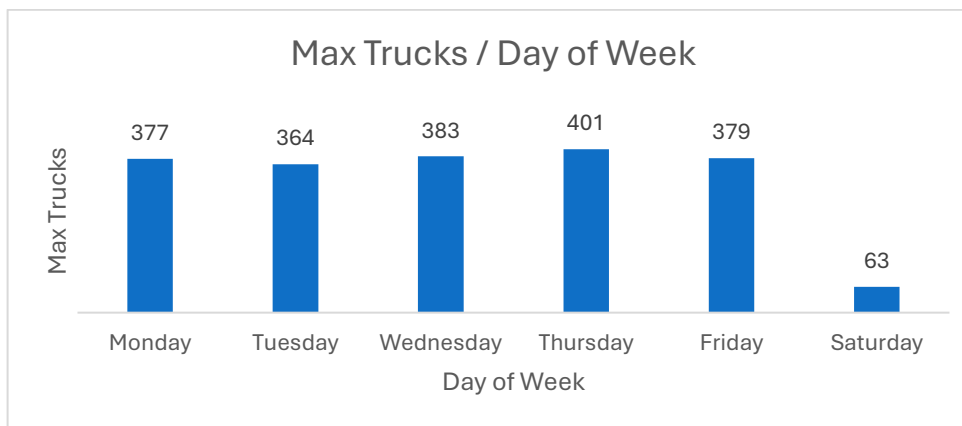
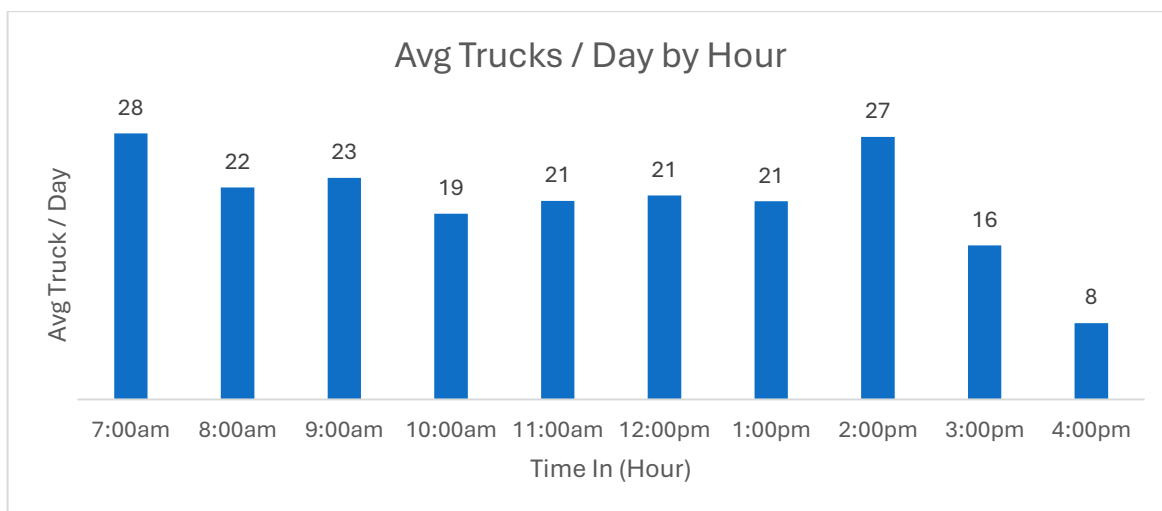


Chart 8-4: Average Trucks per Day by Hour



8.2 Hours of Operation

- South Landfill Phase 2 will have the same operational hours as Phase 1.
- Waste will only be accepted between 7:00 am to 7:00 pm – Monday to Friday (except statutory holidays), and 7:00 am to 1:00 pm on Saturdays.
- Site preparation activities (road maintenance, snow removal, etc.) will require on-site equipment operation between:
 - 6:00 am to 9:00 pm – Monday to Friday (except statutory holidays);
 - 6:00 am to 3:00 pm on Saturdays; and
 - 24 hours a day and on Sundays during emergency events such as large snow events, large melt events, large rain events and operational upset events.

8.3 Waste Receipt & Placement

- All materials received at the site are verified, recorded and weighed to ensure compliance with regulatory conditions.
- Waste trucks will be directed to offload in the designated working area (active face).
- Daily working areas (active face(s)) will generally be limited to no more than 2,000 m² in size in total.
- Waste will be placed, graded with a bulldozer and compacted in lifts ranging from 1 m to 5 m thickness.
- Burning or scavenging will not be permitted.

8.4 Daily & Intermediate Cover

- Daily cover will be applied in accordance with O. Reg. 232/98 following each day's landfilling operations to control potential nuisance effects, to facilitate vehicle access on the site, and to ensure an acceptable site appearance is maintained.
- Suitable solid, non-hazardous wastes (e.g. wood chips, soil, sand, fill materials) will be segregated from the incoming waste streams for use as daily cover; otherwise, suitable soil obtained from the quarry operations will be used as daily cover. Alternative daily cover may also be used.
- Intermediate cover will be applied to landfill areas that are not yet brought up to final grade, but will be inactive for more than several months, consistent with O. Reg. 232/98.
- Soil suitable for the establishment of temporary vegetation in order to control water and wind erosion will be used for intermediate cover (or other equivalent surface treatments that achieve the same purpose), and will be obtained from suitable solid, non-hazardous waste soils that are segregated from the incoming waste streams, or from onsite soil available onsite (i.e. quarry overburden stripping).

8.5 Nuisance Controls

- O. Reg. 232/98 requires that landfills be designed and operated to ensure that nuisance impacts are minimized.

- The facility will be operated in accordance with relevant permits and approvals while minimizing nuisance impacts including noise, litter, vectors, dust, and odour.
- Typical operating practices relating to controlling nuisances include:
 - Approximately 750 m of paved internal roads allow mud to dislodge from truck wheels before exiting the site, minimizing mud and dust on public roads;
 - Road sweepers will be used regularly (during non-freezing weather conditions) on internal paved roads, parking areas, and adjacent external roadways to remove dirt and dust, as required;
 - Dust control such as watering (during non-freezing weather conditions) will be used to minimize dust on unpaved traffic surfaces, construction areas and other dust sources;
 - Traffic speeds will be limited to control dust and noise;
 - Trucks with open tops will require tarping while moving on local roads. Once inside the site, tarps will be removed prior to unloading;
 - Permanent and temporary/mobile litter fencing will be erected at key locations around the working areas to catch blowing litter;
 - Litter collection will be regularly carried out on-site and in the vicinity of the site to remove any fugitive blowing litter;
 - Birds of prey, noisemakers and other industry standard bird control methodologies will be used as required during operating hours to discourage birds from gathering and scavenging at the landfill;
 - Pest control measures will be employed if vermin are found at the site;
 - Odour control measures will include, but are not limited to, the adaptive application of a small working face, daily cover, and ongoing refinements to the operation of the gas collection and leachate treatment systems. Odour suppressants may be used as required;
 - Visual screening will be applied to minimize views of the site and operations, as required; and
 - A formal public hotline, reporting and response procedure will be in place to identify and correct any nuisance issues (currently in place for Walker's Niagara operations).
- Additional nuisance mitigation may be identified during this environmental assessment and other regulatory requirements.

8.6 Monitoring

During operations and post closure, routine monitoring and reporting systems will be established and may include:

- Site conditions and activities (including locations of active face operations);
- Functional and operational equipment (pumps, flares, etc.);
- Leachate levels at the leachate sump and leachate clean-out riser pipe locations;
- Leachate quantity and quality;

- Groundwater levels and quality in the vicinity of the site;
- Surface water levels and quality in the vicinity of the site;
- Monitoring & maintenance of the final cover system;
- Monitoring & maintenance of site security features (fences, access, etc.); and
- Landfill gas collection and control system.

The monitoring program may be adjusted to incorporate outcomes from the Environmental Assessment and other regulatory requirements.

8.7 Personnel Requirements

The site is generally anticipated to require the following full-time personnel for the landfill operations:

- 1 operator for each piece of heavy equipment (see Sec. 8.8 below);
- 2 scale operators/inspectors;
- 1 landfill traffic coordinator;
- 2 litter control technicians;
- 1 landfill superintendent;
- 1 landfill gas control/utilization plant operator;
- 1 landfill gas wellfield technician;
- 1 wildlife control technician; and
- Various subcontracted personnel as required for construction, operation, daily / intermediate cover supply and application, closure, and maintenance activities.

8.8 Equipment Requirements

The site is anticipated to require the following landfilling and operations equipment to support typical operations of the site:

- 5 compactors for waste spreading/compaction;
- 2 tippers for truck unloading;
- 1 water truck for dust control;
- 1 fuel truck for refuelling;
- 1 sweeper truck for dust control;
- 1 loader for miscellaneous operations;
- 1 skid steer for miscellaneous operations;
- 10 site pick-up trucks for site staff;

- 3 excavators for loading of soils and miscellaneous operations;
- 6 haul trucks for transport of soils;
- 1 grader;
- 1 bulldozer for miscellaneous operations;
- 1 bulldozer for maintaining inbound cover material; and
- 4 haul trucks.

Additional equipment may be required during construction and closure phases.

9 CLOSURE AND POST-CLOSURE MONITORING & END USE

9.1 Closure

The landfill will be capped progressively as each stage achieves final contours and receives operational approval for closure. Complete closure will occur once all cells are developed, the site is filled to its final grade, and the final cover is fully applied.

Closure and post-closure (or decommissioning) of the South Landfill Phase 2 will take place in accordance with O. Reg. 232/98, including the future development of a formal Closure Plan document.

Walker must prepare the Closure Plan once the landfill reaches either 90 percent of its approved capacity or has two years of remaining capacity—whichever comes first.

At the time of closure, infrastructure associated with the landfill may be retained, repurposed, rehabilitated, or removed, depending on future needs. **Table 4** below outlines the anticipated outcomes for key facility infrastructure.

Table 4: Potential Outcome of Infrastructure at Closure

Retain/Modify for continued operation post-closure	Repurpose, or remove and rehabilitate	Remove and rehabilitate
Leachate management system	Entrance, tunnel, and internal access roads	Scale facility
Landfill gas collection system and utilization facility	Maintenance and site office facilities	
Stormwater management facilities		
Site security fencing		
Groundwater management system		
Water Monitoring Program		
Site security fencing as determined		

9.2 Post-Closure Monitoring

The site’s post-closure monitoring will include, but may not be limited to, the following:

- Monitoring & maintenance of the final cover system;
- Monitoring & maintenance of site security features (fences, access, etc);

- Groundwater monitoring;
- Surface water monitoring;
- Leachate, leachate collection & pre-treatment system; and
- Landfill gas collection and control system.

A report summarizing the results of the monitoring program will be submitted to MECP on an annual basis (or at a frequency determined in consultation with the MECP).

9.3 End Use

Potential end uses assumed for the purposes of the environmental assessment studies include:

- Agricultural use (e.g., similar to the rehabilitated portion of the East Landfill);
- Naturalization (e.g., planting with regionally native species, and improving wildlife corridors/connectivity);
- Recreational (e.g., trails for hiking or mountain biking, and sports fields); or
- A combination of the above.

The landfill will be designed with sufficient flexibility to accommodate other potential end uses while ensuring access to leachate, landfill gas and monitoring infrastructure. The final end use will be determined at the time of closure and subject to community input and any applicable regulatory approvals. A minimum time period of 30 years post-closure may be required until the landfill facility can be demonstrated to be stable and suitable for certain end uses. The design of the end use will appropriately incorporate resilience to climate change and extreme weather events.

Signature Page

WSP Canada Inc.



Frank Barone, Ph.D., P.Eng.
Geotechnical Engineer, Senior Principal

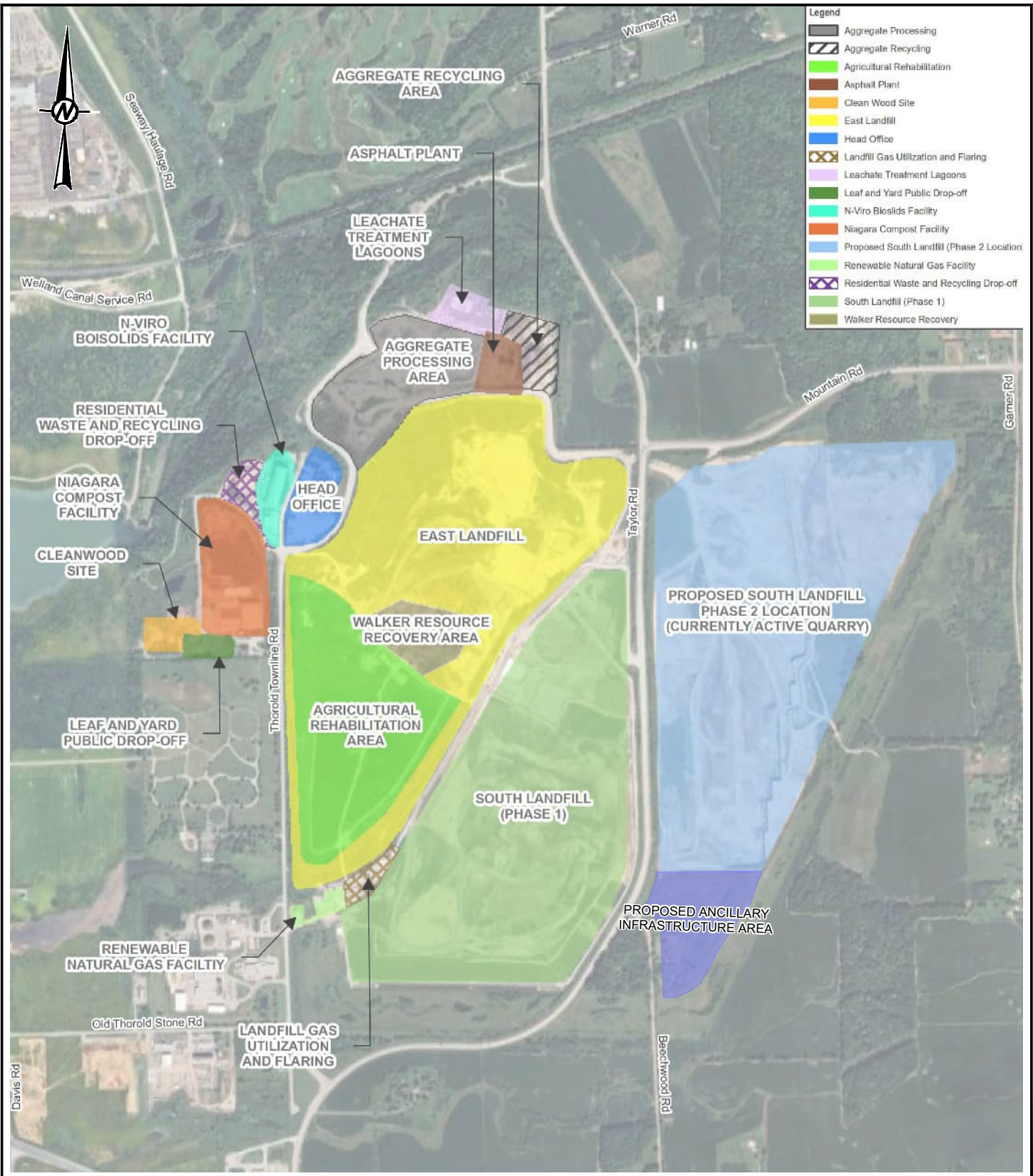


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Last Edited By: gld_lcuiffreda Date: 2025-11-28 Time: 12:22:56 PM | Printed By: gld_lcuiffreda Date: 2026-03-30 Time: 11:00:14 AM
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REFERENCE(S)
 FIGURE 1.1, SOUTH LANDFILL PHASE 2 SITE MAP, EA TOR REPORT DATED MAY 14, 2024 BY GHD.

CLIENT WALKER ENVIRONMENTAL GROUP		
CONSULTANT	YYYY-MM-DD	2026-03-30
	DESIGNED	
	PREPARED	FC
	REVIEWED	FSB
	APPROVED	CL

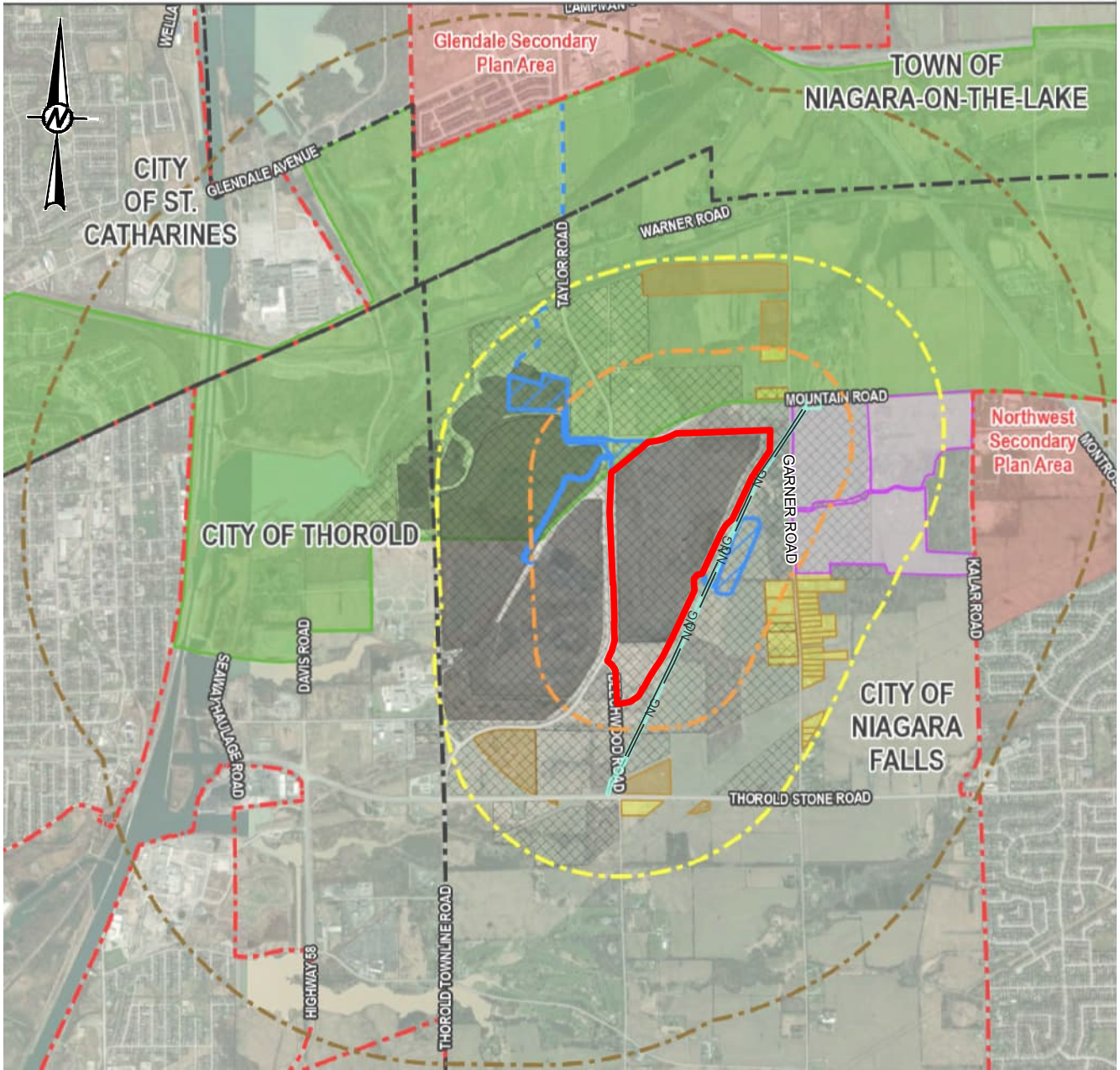
PROJECT FACILITY CHARACTERISTIC REPORT SOUTH LANDFILL PHASE 2 THOROLD, ONTARIO			
TITLE SITE LOCATION PLAN			
PROJECT NO.	CONTROL	REV.	FIGURE
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSIA 26 mm

Legend

- Site Study Area ¹
- 500m from Proposed Limit of Fill
- Local Study Area (Min. - 1km from proposed waste disposal site boundary limits) ²
- Local Study Area (Max. - 2km from Walker Resource Management Campus) ²
- Ancillary Infrastructure Outside the Site Study Area and Within the Local Study Area ³
- Force main and gravity main connecting the pre-treatment lagoons to the Niagara-on-the-Lake sanitary sewer ⁴
- Trans-Canada Natural Gas Pipeline R.O.W.
- Municipal Boundaries
- Urban Boundary
- Parcel Boundary
- Secondary Plan Area
- Niagara Escarpment Plan Boundary
- Farm with Single Detached Residential Dwellings - Properties Greater than 6.5ac in Area
- Rural Residential Lots - Lots Less than 6.5ac in Area
- Agri-Tourism Zones 1&2
- Walker Resource Management Campus
- Walker Owned Property

Note:
¹ Aligns with the proposed waste disposal site boundary limits
² The Local Study Area varies by technical discipline
³ Private sewer upgrade not currently approved and construction method is unconfirmed
⁴ This existing force/gravity main will be modified and upgraded.



REFERENCE(S)
 FIGURE 2, LAND USE CONTEXT, EA REPORT DATED MARCH 18, 2026 BY GHD.

CLIENT
 WALKER ENVIRONMENTAL GROUP

PROJECT
 FACILITY CHARACTERISTIC REPORT
 SOUTH LANDFILL PHASE 2
 THOROLD, ONTARIO

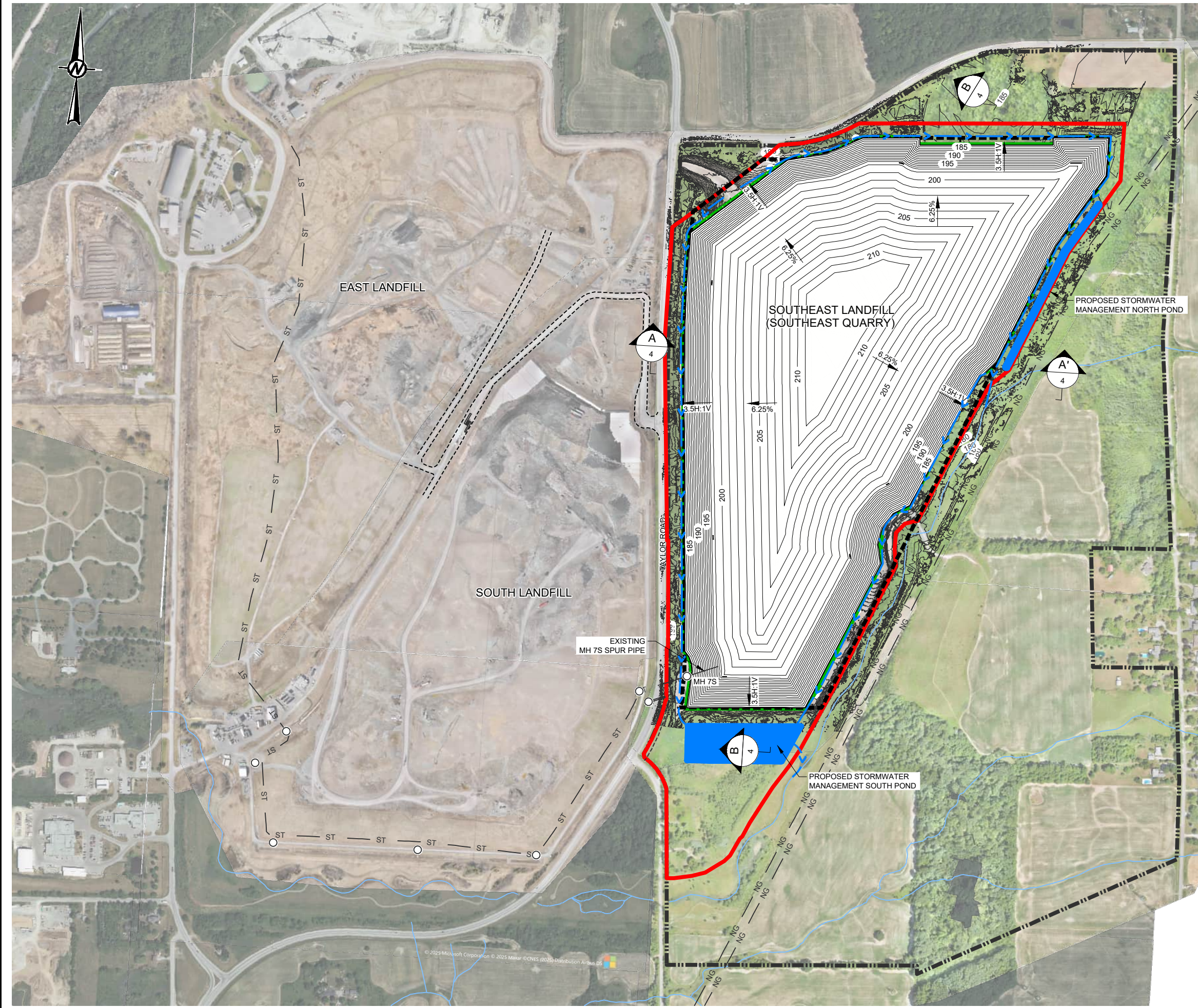
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PROJECT NO.	CONTROL	REV.	FIGURE
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LEGEND

- SITE PROPERTY LINE (177.44 Ha)
- WASTE DISPOSAL SITE BOUNDARY LIMITS (D-4 GUIDE) (81.30 Ha)
- LIMIT OF FILL (D-4 GUIDE) (62.59 Ha)
- 170 --- GROUND SURFACE CONTOUR (1.0 m INTERVAL)
- HAUL ROAD
- CREEK
- NG --- TRANS-CANADA NATURAL GAS PIPELINE R.O.W.
- STORMWATER MAINTENANCE HOLE
- ST --- STORMWATER PIPE
- 205 --- PROPOSED TOP OF FINAL COVER CONTOUR (1.0 m INTERVAL)
- 3.5H:1V 6.25% --- PROPOSED TOP OF FINAL COVER SLOPE (H:V) OR GRADE (%)
- PROPOSED STORMWATER MANAGEMENT POND
- > PROPOSED STORMWATER MANAGEMENT DITCH / FLOW

NOTE(S)

1. PROJECTION: UTM NAD83-17N (CSRS.2010).
2. ELEVATION ARE GEODETIC (masl). DATUM IS BASED ON NRCAN HT2.0 (CGVD2013).

REFERENCE(S)

1. IMAGERY: ©2025 MICROSOFT CORP. ©MAXAR ©CNES (2025) DIST. AIRBUS DS.
2. BASE PLAN FEATURES FROM OPEN DATA, CITY OF NIAGARA FALLS.
3. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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WALKER ENVIRONMENTAL GROUP

PROJECT
FACILITY CHARACTERISTIC REPORT
SOUTH LANDFILL PHASE 2
THOROLD, ONTARIO

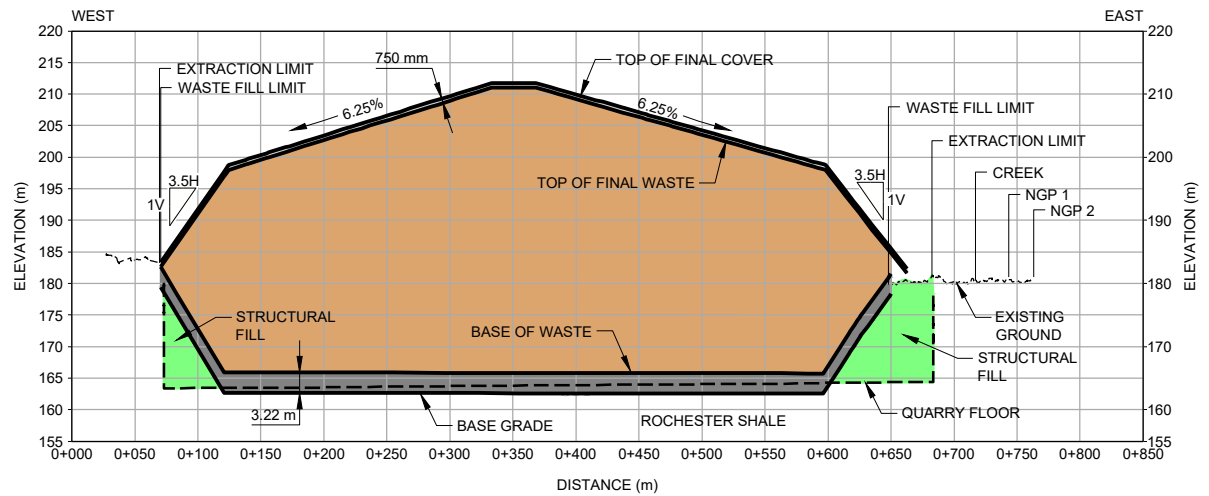
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	REVIEWED	FSB
	APPROVED	CL

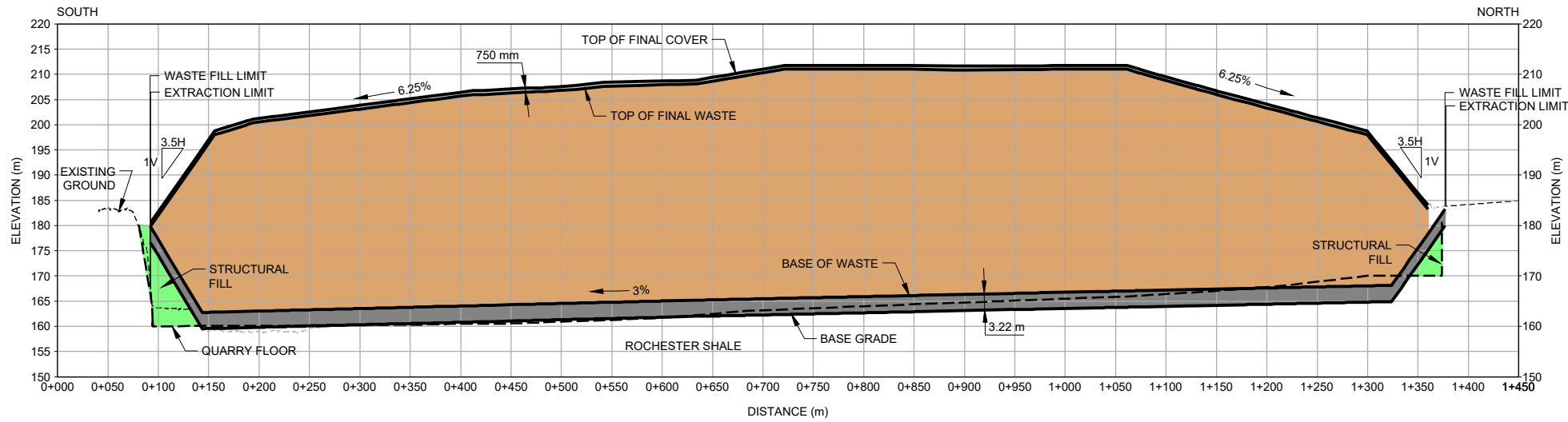
PROJECT NO. CA0018521.3292 CONTROL 0001 REV. G FIGURE 3

25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

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V.E. = 5X **A** CROSS-SECTION A-A' (WEST - EAST)
3



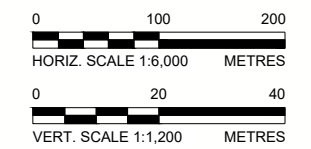
V.E. = 5X **B** CROSS-SECTION B-B' (SOUTH - NORTH)
3

LEGEND

	PROPOSED FINAL COVER
	PROPOSED WASTE FILL
	PROPOSED LINER AND LEACHATE COLLECTION SYSTEM
	PROPOSED STRUCTURAL FILL

NOTE(S)
1. ELEVATION ARE GEODETIC (masl). DATUM IS: ?.

REFERENCE(S)
1. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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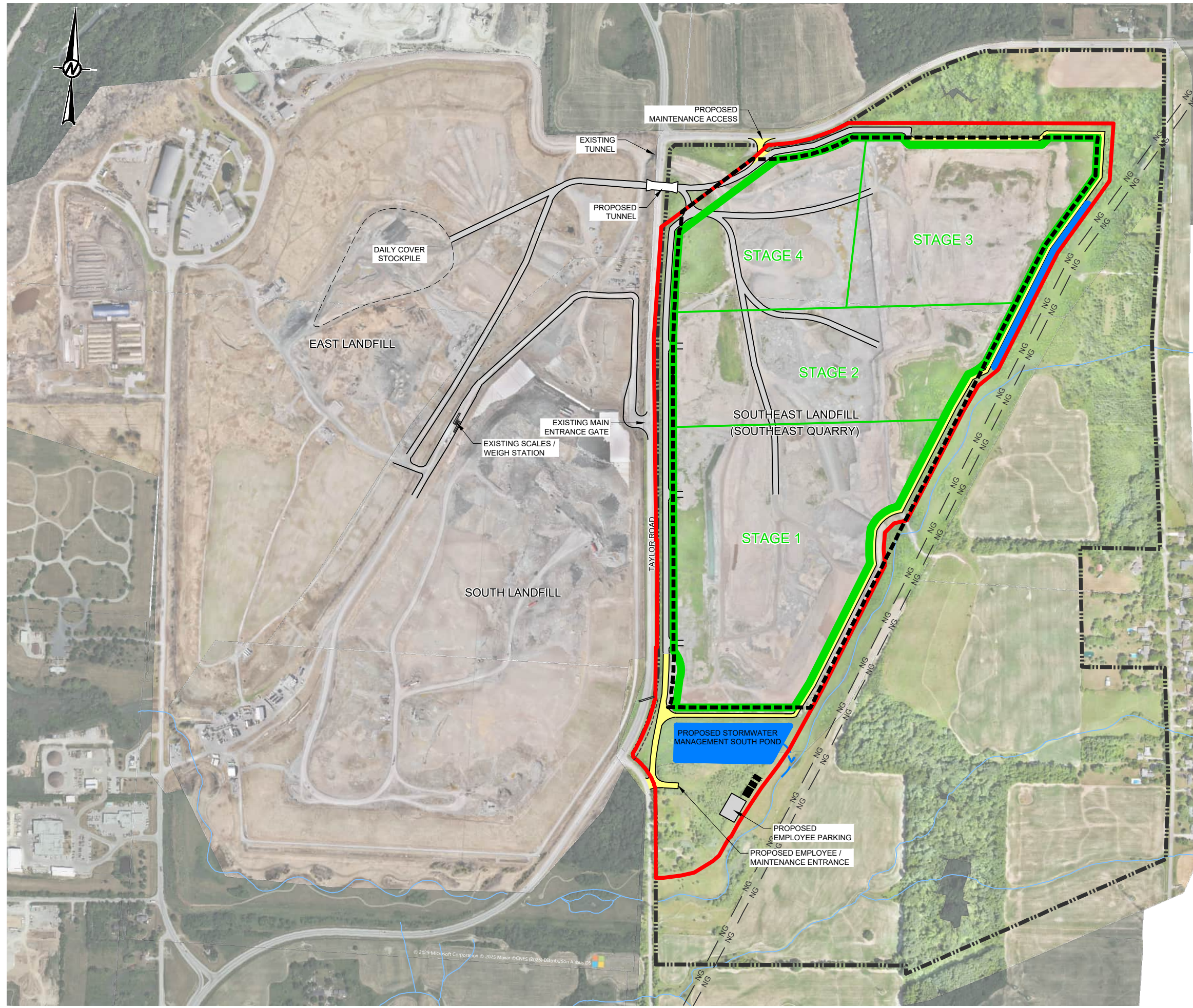
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SOUTH LANDFILL PHASE 2
THOROLD, ONTARIO
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CROSS-SECTION VIEWS

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	PREPARED	FC
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	APPROVED	CL

PROJECT NO. CA0018521.3292 CONTROL 0001 REV. G FIGURE 4

25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

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LEGEND

- SITE PROPERTY LINE
- WASTE DISPOSAL SITE BOUNDARY LIMITS (D-4 GUIDE)
- LIMIT OF EXTRACTED ROCK
- LIMIT OF FILL (D-4 GUIDE)
- HAUL ROAD
- CREEK
- NG --- TRANS-CANADA NATURAL GAS PIPELINE R.O.W.
- PROPOSED LANDFILL STAGE BOUNDARY
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD

NOTE(S)

1. PROJECTION: UTM NAD83-17N (CSRS.2010).
2. ELEVATION ARE GEODETIC (masl). DATUM IS BASED ON NRCAN HT2.0 (CGVD2013).

REFERENCE(S)

1. IMAGERY: ©2025 MICROSOFT CORP. ©MAXAR ©CNES (2025) DIST. AIRBUS DS.
2. BASE PLAN FEATURES FROM OPEN DATA, CITY OF NIAGARA FALLS.
3. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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WALKER ENVIRONMENTAL GROUP

PROJECT
FACILITY CHARACTERISTIC REPORT
SOUTH LANDFILL PHASE 2
THOROLD, ONTARIO

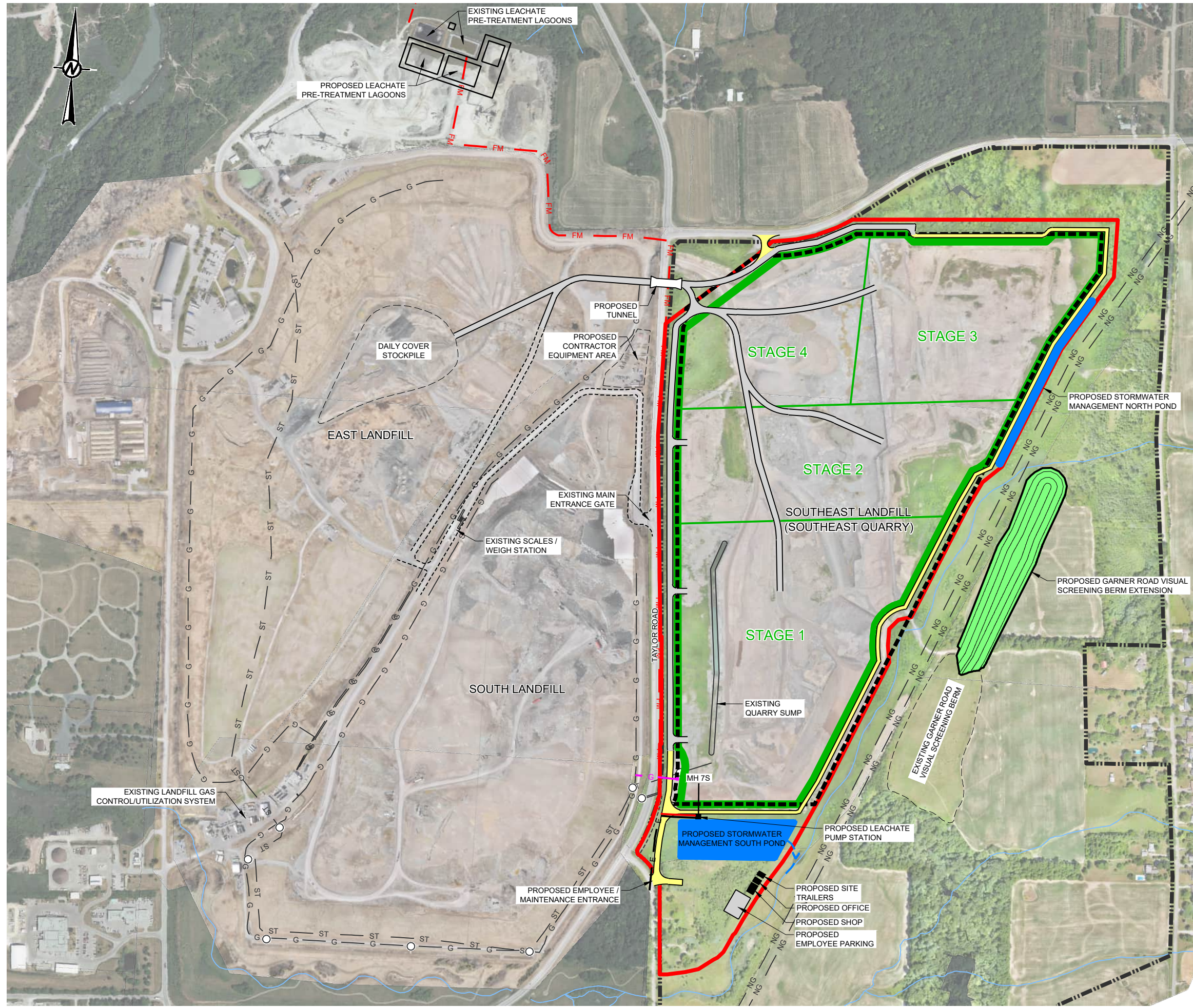
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	PREPARED	FC
	REVIEWED	FSB
	APPROVED	CL

PROJECT NO. CONTROL REV. FIGURE
CA0018521.3292 0001 G 5

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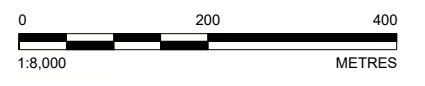
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- WASTE DISPOSAL SITE BOUNDARY LIMITS (D-4 GUIDE)
- LIMIT OF EXTRACTED ROCK
- LIMIT OF FILL (D-4 GUIDE)
- HAUL ROAD
- CREEK
- NG --- TRANS-CANADA NATURAL GAS PIPELINE R.O.W.
- STORMWATER MAINTENANCE HOLE
- ST --- STORMWATER PIPE
- G - G - LANDFILL GAS COLLECTION HEADER PIPE
- PROPOSED LANDFILL STAGE BOUNDARY
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD
- PROPOSED BUILDING
- PROPOSED STORMWATER MANAGEMENT POND
- > PROPOSED STORMWATER MANAGEMENT DITCH / FLOW
- E - E - PROPOSED ELECTRICAL SERVICE
- PROPOSED LEACHATE PUMP STATION
- FM --- PROPOSED LEACHATE FORCEMAIN
- G --- PROPOSED LANDFILL GAS BOOSTER STATION AND CROSS CONNECT

NOTE(S)

1. PROJECTION: UTM NAD83-17N (CSRS.2010).
2. ELEVATION ARE GEODETIC (masl). DATUM IS BASED ON NRCAN HT2.0 (CGVD2013).

REFERENCE(S)

1. IMAGERY: ©2025 MICROSOFT CORP. ©MAXAR ©CNES (2025) DIST. AIRBUS DS.
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3. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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PROJECT
FACILITY CHARACTERISTIC REPORT
SOUTH LANDFILL PHASE 2
THOROLD, ONTARIO

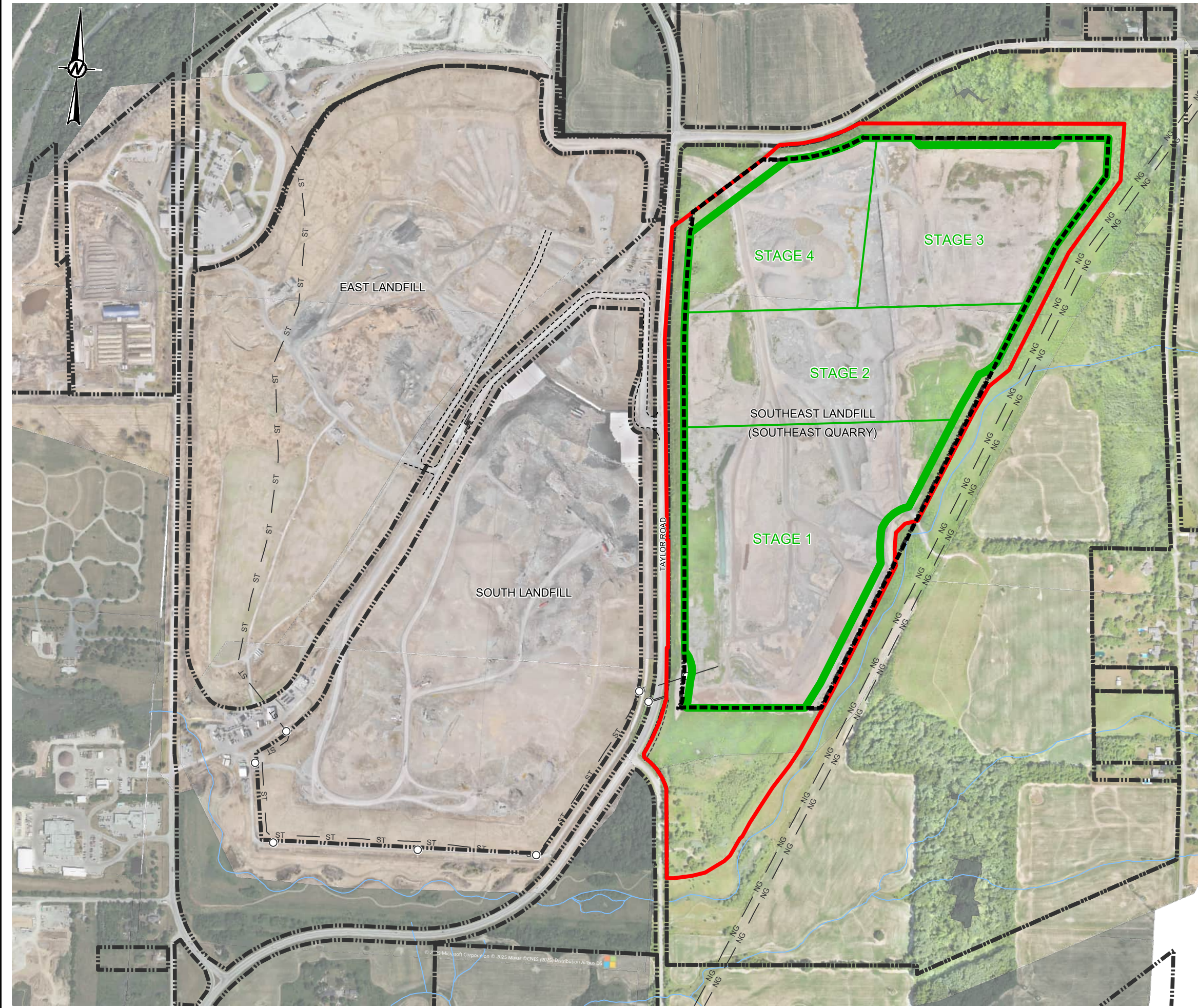
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PREPARED		FC	
REVIEWED		FSB	
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PROJECT NO. CA0018521.3292 CONTROL 0001 REV. G FIGURE 6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D 25 mm

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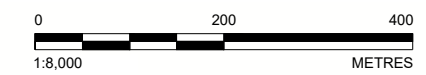
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	WASTE DISPOSAL SITE BOUNDARY LIMITS (D-4 GUIDE)
	LIMIT OF EXTRACTED ROCK
	LIMIT OF FILL (D-4 GUIDE)
	HAUL ROAD
	CREEK
	STORMWATER PIPE
	TRANS-CANADA NATURAL GAS PIPELINE R.O.W.
	PROPOSED LANDFILL STAGE BOUNDARY

NOTE(S)

1. PROJECTION: UTM NAD83-17N (CSRS.2010).
2. ELEVATION ARE GEODETIC (masl). DATUM IS BASED ON NRCAN HT2.0 (CGVD2013).

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3. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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FACILITY CHARACTERISTIC REPORT
SOUTH LANDFILL PHASE 2
THOROLD, ONTARIO

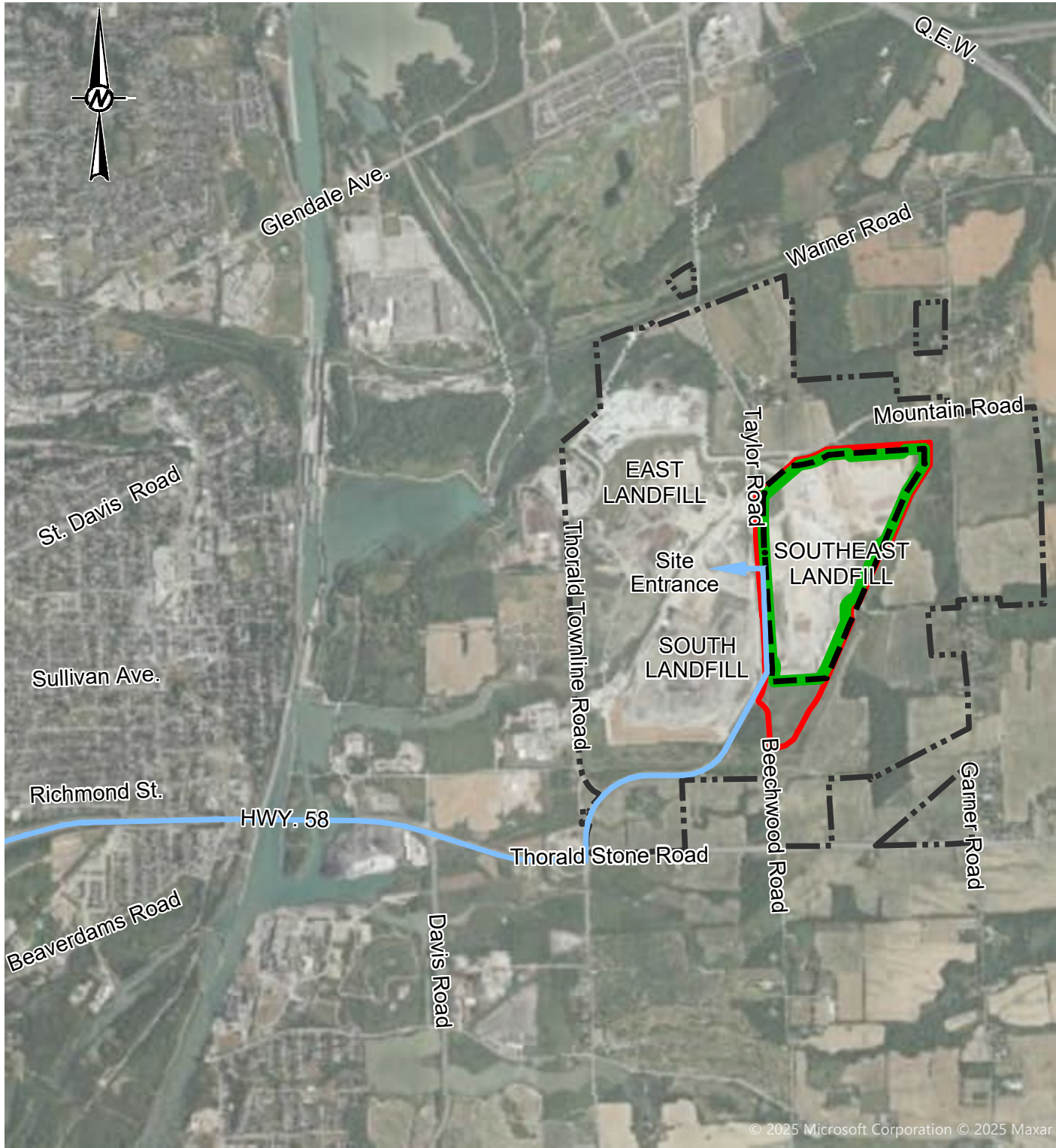
TITLE
LANDFILL STAGES & SITE DEVELOPMENT

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	PREPARED	FC
	REVIEWED	FSB
	APPROVED	CL

PROJECT NO.	CONTROL	REV.	FIGURE
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25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

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LEGEND	
	WALKER PROPERTY LINE
	PROPOSED HAUL ROUTE
	WASTE DISPOSAL SITE BOUNDARY LIMITS (D-4 GUIDE)
	LIMIT OF EXTRACTED ROCK
	LIMIT OF FILL (D-4 GUIDE)

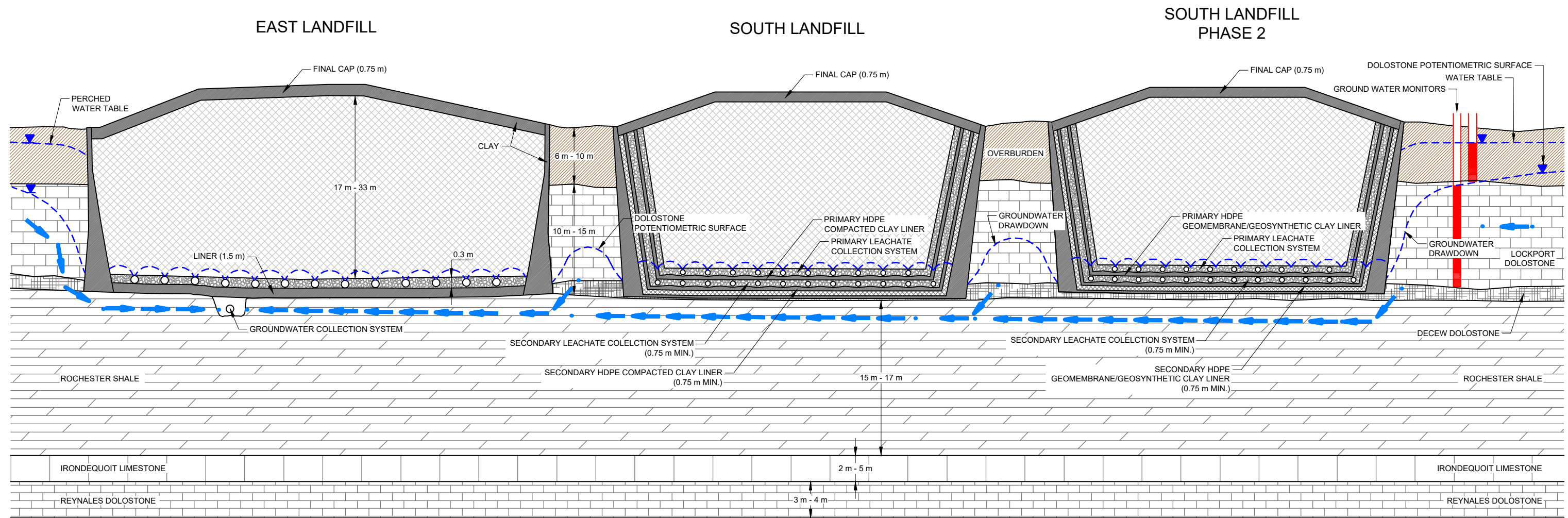



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CONSULTANT	YYYY-MM-DD 2026-03-30
	DESIGNED
	PREPARED FC
	REVIEWED FSB
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REFERENCE(S)			
PROJECT			
FACILITY CHARACTERISTIC REPORT			
SOUTH LANDFILL PHASE 2			
THOROLD, ONTARIO			
TITLE			
PROPOSED SOUTH LANDFILL PHASE 2 DESIGNATED HAUL ROUTE			
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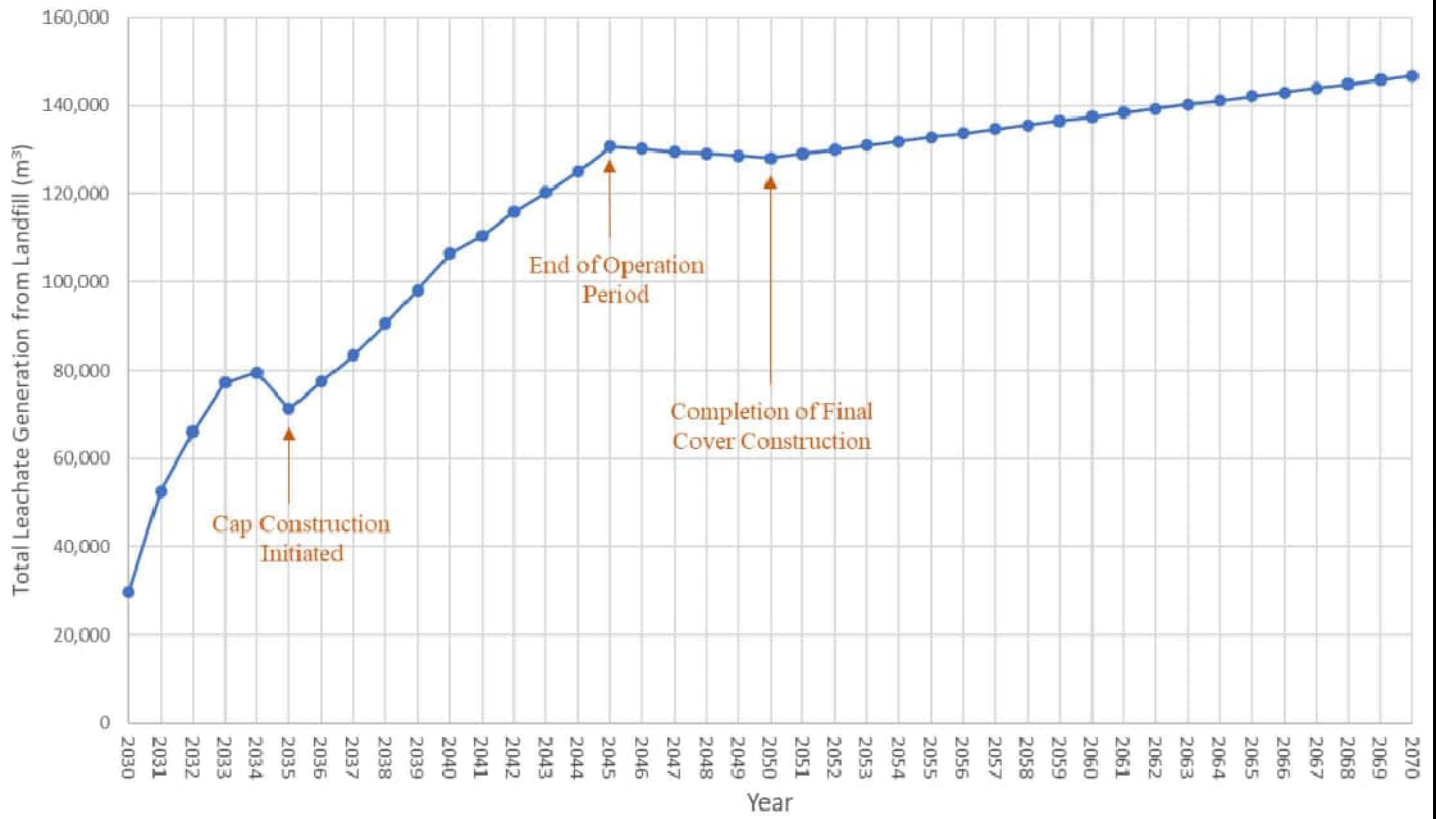
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TITLE		GROUNDWATER MANAGEMENT PLAN	
CONSULTANT	YYYY-MM-DD	2026-03-30	
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	PREPARED	FC	
	REVIEWED	FSB	
	APPROVED	CL	
PROJECT NO.	CONTROL	REV.	FIGURE
CA0018521.3292	0001	G	9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANS B 28 mm



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PROJECT
FACILITY CHARACTERISTIC REPORT
SOUTH LANDFILL PHASE 2
THOROLD, ONTARIO

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DESIGNED
PREPARED FC
REVIEWED FSB
APPROVED CL

TITLE
ESTIMATED ANNUAL LEACHATE VOLUMES

PROJECT NO. CA0018521.3292 CONTROL 0001 REV. G FIGURE 10

APPENDIX A

**Leachate Containment System
Design Description Report**



FINAL DRAFT REPORT

Walker Environmental Group
**Leachate Containment System Design
Description Report**

South Landfill Phase 2 - Environmental Assessment

2026-May-25

CA0065457.5367





Document Distribution

Walker Environmental Group

Leachate Containment System Design Description Report

South Landfill Phase 2 - Environmental Assessment

2026-May-25

CA0065457.5367

Prepared for

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Prepared by

WSP Canada Inc.
6925 Century Avenue, Suite 600
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T 905-567-4444

Revisions

Rev	Date	Details
A	2026-May-08	Draft Report
B	2026-May-25	Final Draft Report

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Table 2	Infiltration Rate, Average Head on Liner, Darcy Fluxes and Leachate Collected
Table 3	Predicted Concentrations of Key Leachate Contaminants at the Base of Attenuation Layer

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- Figure 1 Site Location Plan
- Figure 2 South Landfill Phase 2 Boundaries and Layout
- Figure 3 Proposed Base Grade (Base of Attenuation Layer) Contours
- Figure 4 Cross-Sections A-A' and B-B'
- Figure 5 Proposed Top of Leachate Containment System (Base of Waste) Contours
- Figure 6 Proposed Top of Final Waste Contours
- Figure 7 Proposed Top of Final Cover Contours
- Figure 8 Proposed Leachate Containment System Design
- Figure 9 a-h Predicted Contaminant Concentrations at Base of Attenuation Layer

APPENDICES

- Appendix A Leachate Generation Rate Calculations
- Appendix B Example Calculation for Leakage Rate Through the Primary Composite Liner

1. Introduction

This report describes the leachate containment system design for the proposed South Landfill (Phase 2) at Walker's Resource Management Campus in the City of Niagara Falls.

As shown in Figure 1, the proposed South Landfill (Phase 2) is situated within the area currently occupied by the Southeast Quarry, on the opposite side of Taylor Road from the current active South Landfill (Phase 1).

The South Landfill (Phase 1) is expected to reach its approved maximum capacity by 2029 to 2031. The proposed South Landfill (Phase 2) will extend the approved capacity of the South Landfill by approximately 19.8 million m³ over a 20-year operating period. This will allow Walker to continue to provide disposal capacity for solid, non-hazardous, residential and industrial, commercial, and institutional (IC&I) waste from the existing landfill service area.

This report presents the design of the leachate containment system for the proposed South Landfill (Phase 2). The leachate containment system includes primary and secondary liner and leachate collection systems underlain by an attenuation layer. The design is presented at a preliminary level of detail and is supported by contaminant transport modelling to demonstrate negligible long-term contaminant impacts to the natural groundwater system. The information presented in this report is intended to support the environmental impact assessments undertaken for the Environmental Assessment (EA) of the proposed landfill.

2. Phase 2 Landfill Geometrical Characteristics

The proposed South Landfill (Phase 2) has a total site area of 81.30 Ha, encompassing the existing quarry and perimeter buffer area (Figure 2). The proposed waste fill limit covers an area of 62.59 Ha within the limits of the quarry.

The waste fill area will be prepared by placing fill against the quarry sidewalls and floor area to form the base grade on which the attenuation layer will be founded. The base grade (i.e., base of attenuation layer) will have sideslopes at 3(H):1(V) and a floor area at 0.9 % grade dipping to the southwest corner as shown in Figure 3 (plan) and 4 (cross-sections). The sub-grade fill will incorporate a subdrain system for groundwater control.

As described in Section 3, the overall thickness of the leachate containment system including the attenuation layer is 3.82 m on the floor area and 2.95 m on the perimeter sideslopes. Figure 5 shows the proposed top of leachate containment system contours on which the waste fill will be placed.

The limit of waste fill coincides with the inside crest of the sidewall leachate containment system and covers an area of 62.59 Ha (Figure 5). The proposed top of waste fill contours are shown in plan in Figure 6 and in cross-section in Figure 4. The portion of waste fill above perimeter grade will have 3.5(H):1(V) sideslopes and 5% (minimum) top surface grades. The maximum thickness of waste fill including daily/interim cover materials is approximately 43 m. The average thickness is approximately 32 m. The total volume capacity for waste and daily/interim cover materials is approximately 19.8 Mm³. Assuming an apparent waste density of 1 tonne/m³, the total waste tonnage capacity is 19.8 Mt.

The proposed final cover has a total thickness of 0.75 m and consists of a 0.6 m layer of compacted clayey soil overlain by 0.15 m of topsoil. Figure 7 shows the top of final cover contours. The peak elevation of the top of final cover is approximately 212 masl, which is on average approximately 27 m higher than perimeter ground surface elevations.

3. Description of Leachate Containment System Components

The proposed leachate containment system design shown schematically in Figure 8 follows the site-specific design option under O.Reg.232/98. The design closely resembles that of the Generic Double Composite Liner Design (Option II) of the regulation, with the primary difference being that the proposed design uses a geosynthetic clay liner (GCL) rather than a compacted clay liner in the primary composite liner. The following sections describe each component of the proposed leachate containment system.

3.1 Primary Leachate Collection System

The primary leachate collection system is designed to comply with the O.Reg. 232/98 requirements for a 100-year service life. The system consists of the following (from top to bottom):

- 300 mm thick granular filter layer or equivalent (on the floor area only);
- nonwoven geotextile filter;
- 500 mm thick clear stone leachate drainage layer (50 mm clear stone);
- 200 mm diameter perforated HDPE leachate collection pipes at 0.5% minimum grade;
- nonwoven geotextile separator; and
- 300 mm thick sand cushion layer (12 mm maximum particle size) or equivalent for protection of the primary geomembrane against puncture and localized strains induced by the clear stone leachate drainage layer.

The leachate collection pipes will be positioned in an east-west direction with the high end along the central ridge shown in Figure 5 and the low end at the toe of the east and west sideslopes. The maximum lateral drainage path length for leachate in the drainage layer to reach a leachate collection

pipe is 50 m. All leachate collection pipes will be accessible for video inspection and cleaning via clean-out riser pipes that extend up the east and west sideslopes to access chambers along the landfill perimeter.

The leachate collection pipes will connect to a header pipe along the toe of the east and west sideslopes. The header pipes will convey the leachate to a pump station at the southwest corner of the landfill floor. The pump station will have an inclined riser pipe within which a submersible pump will be installed for pumping the collected leachate via a forcemain to the existing onsite leachate lagoons for pre-treatment prior to discharge to the Niagara on the Lake (NOTL) municipal sanitary sewer system.

3.2 Primary Composite Liner

The primary composite liner consists of a geomembrane underlain by a geosynthetic clay liner (GCL).

The geomembrane will be a 2.0 mm (80 mil) thick, High-Density Polyethylene (HDPE) in accordance with the O.Reg. 232/98 requirements for a 150-year minimum service life. Smooth sided geomembrane will be used on the floor area. Textured geomembrane will be used on the sideslopes to ensure sufficient interface friction with the underlying GCL and overlying nonwoven geotextile cushion layer. The geomembrane liner will have a white surface to minimize thermal expansion and wrinkle formation on exposure to sunlight during installation.

The GCL will consist of a layer of dry powdered bentonite clay sandwiched between two nonwoven geotextiles mechanically held together by needle punched/thermally fused fibres to give an overall thickness of approximately 6 mm. The bentonite clay has a very low permeability when hydrated under the vertical confining stress applied by the overlying waste fill. The primary role of the GCL in the primary composite liner is to minimize leakage of landfill leachate into the secondary leachate collection system through any defects in the overlying geomembrane liner that go undetected by the Construction Quality Assurance (CQA) inspection/testing program. Upon wetting by leachate permeating through a defect, the bentonite component swells and seals the defect, thereby minimizing further leakage. When the overlying geomembrane reaches the end of its service life, the GCL will take on the role of the primary hydraulic barrier.

Key attributes of the proposed GCL that will make the performance of the primary composite liner equal to or better than that of the O.Reg.232/98 Generic Design (Option II) with a compacted clay liner beneath the geomembrane include:

- not susceptible to desiccation cracking during construction;
- high swelling potential and very low hydraulic conductivity on hydration – minimizes leakage through defects in the overlying geomembrane liner by sealing the defect and reducing the lateral flow transmissivity between the GCL and geomembrane;
- infinite service life – bentonite clay component is resistant to biological and physical breakdown and is capable of self-healing any chemically induced (i.e., cation exchange) increases in hydraulic conductivity;

- provides a smooth bedding surface for the overlying geomembrane liner free of protrusions and indentations – no risk of puncturing or localized stress cracking of the overlying geomembrane;
- performance is less dependent on CQA inspection/testing - CQA is limited to visual inspection of the GCL product, subgrade, method of deployment and overlaps; and
- uniform and consistent (factory controlled) material properties – provides certainty on the performance of the GCL as a hydraulic barrier.

Other important advantages of using a GCL versus a compacted clay liner include:

- readily available from manufacturing plants in Ontario and Quebec, whereas supply of suitable clay soil for liner may be limited by the availability of on-site and/or off-site sources;
- requires minimal trucking and construction equipment for supply and installation - minimizes green-house gas emissions; and
- reduces construction schedule - a hectare of GCL liner can be installed in a few days versus about a month for a compacted clay.

While a clay liner is much thicker and hence a better diffusion barrier, this benefit is less important as the primary geomembrane on its own provides abundant resistance to contaminant diffusion.

3.3 Secondary Leachate Collection System

The secondary leachate collection system is designed to comply with the O.Reg. 232/98 (Schedule 2) requirements for a 1,000-year service life. The system consists of the following (from top to bottom):

- 300 mm thick granular filter layer (19 mm maximum particle size) or equivalent;
- nonwoven geotextile;
- 300 mm thick clear stone leachate drainage layer (50 mm clear stone);
- 150 mm diameter perforated HDPE pipes at 0.5% minimum grade;
- woven geotextile separator layer (floor area only);
- 300 mm thick sand cushion layer (12 mm maximum particle size) or equivalent for protection of the secondary geomembrane against puncture and localized strains induced by the clear stone leachate drainage layer (floor area only); and
- nonwoven geotextile cushion (sideslope only).

The layout of the secondary leachate collection pipes will be comparable to that of the primary leachate collection pipes except that the maximum drainage path length for leachate in the drainage layer to reach a collection pipe is 100 m. All leachate collection pipes will be accessible for video inspection and cleaning via clean-out riser pipes that extend up the east and west sideslopes to chambers along the landfill perimeter.

The secondary leachate collection pipes will drain to a sump at the southwest corner of the landfill floor. The sump will have an inclined riser pipes within which liquid level indicator and a submersible pump will be installed. Any fluid collected in the secondary leachate collection system will be pumped via forcemain to the existing onsite leachate lagoons for pre-treatment prior to discharge to the NOTL municipal sanitary sewer system.

3.4 Secondary Composite Liner

The secondary composite liner consists of a geomembrane underlain by a compacted clay liner.

The secondary geomembrane will be 2.0 mm (80 mil) thick, High-Density Polyethylene (HDPE) in accordance with the O.Reg. 232/98 requirements for a 350-year minimum service life. Like the primary geomembrane, the liner will be white surfaced/smooth on the floor and white surfaced/textured on the sideslopes.

The compacted clay liner will be 0.75 m thick and will meet the O.Reg. 232/98 requirements for a hydraulic conductivity of less than 1×10^{-7} cm/s and an infinite service life. The clay liner material will likely be supplied from off-site sources.

3.5 Attenuation Layer

A 1.0 m (minimum) thick attenuation layer will underlie the secondary composite liner on the floor and sideslopes of the landfill. The material used for the attenuation layer will be a natural clayey silt / silty clay soil with a hydraulic conductivity not exceeding 1×10^{-5} cm/s. The attenuation layer supplements the compacted clay liner in providing a barrier against contaminant diffusion once the geomembrane reaches the end of its service life. It also provides contaminant uptake by adsorption processes, particularly for the heavy metal contaminants.

4. Contaminant Transport Modelling for the Proposed Leachate Containment System

4.1 Regulatory Objectives

O.Reg. 232/98 requires that modelling be carried out to predict potential long-term groundwater quality impacts from new or expanding landfill sites where a “Site Specific” leachate containment system design is proposed rather than one of the “Generic” designs given in the regulation. The modelling is required to demonstrate that potential long-term groundwater impacts do not exceed Reasonable Use Guideline (RUG) values (MECP, 1994). The RUG establishes a quantitative benchmark for protecting off-Site groundwater quality for drinking water purposes. It makes the following statement regarding groundwater quality impact at the landfill property boundary:

“In the case of drinking water, the quality must not be degraded by an amount in excess of 50% of the difference between background and the Ontario Drinking Water Objectives for non-health related parameters and in excess of 25% of the difference between background and the Ontario Drinking Water Objectives for health-related parameters. Background is considered to be the quality of the groundwater prior to any man-made contamination.”

4.2 Contaminant Transport Model Description

Modelling to predict potential long-term groundwater quality impacts at the base of the proposed South Landfill (Phase 2) was carried out using the contaminant transport model POLLUTE (Rowe et. al., 1994). POLLUTE is a one-dimensional, analytical transport model that can simulate vertical contaminant migration through a multi-layered leachate containment system, with each layer assigned unique physical, hydraulic and geochemical properties.

Time zero for the modelling (t=0) was taken as the mid-point of the estimated twenty-year landfilling period. The simulation period was 1,000 years.

The boundary condition used for contaminant source concentrations in the landfill is that of a depleting contaminant concentration with time from an initial representative peak value occurring at t = 0 years. The depletion in contaminant source concentration is due to wash-out of contaminant mass by moisture infiltration/percolation through the waste followed by mass removal via the primary leachate collection system. For the organic contaminants, additional depletion in source concentration comes from bio-chemical decay processes. The rate of concentration decrease with time is modelled as a function of the bio-chemical decay half-life, the initial “representative peak” leachate concentration, the contaminant mass inventory in the landfill, the moisture infiltration rate through the landfill cover and the rate of leachate removal from the primary leachate collection system. The POLLUTE model does not account for mass removal of volatile organic contaminants via landfill gas collection.

Contaminant transport mechanisms modelled by POLLUTE are advection and dispersion (which includes mechanical mixing and molecular diffusion). Advection refers to the process whereby the solute is transported by leachate seepage through the containment system components. Dispersion, on the other hand, refers to spreading of the solute due to a gradient in its concentration (the diffusion mechanism), and due to mechanical mixing of the leachate seepage caused by heterogeneity in the size and geometry of pore spaces (the hydrodynamic mechanism). The model also accounts for adsorption onto the soil solids and biological/chemical decay, which are processes that remove the solute from the porewater phase and hence decrease the net rate of migration. The adsorption process is modelled according to a linear/reversible isotherm and the biological/chemical decay process according to a first order decay rate.

The POLLUTE model output can be in the form of calculated concentrations versus time at specified depths within the leachate containment system and/or concentration versus depth at specified times. For the modelling carried out for the proposed South Landfill (Phase 2), the model output was chosen to be in the form of concentrations versus time at the base of the attenuation layer, prior to mixing with groundwater flow in the underlying fractured bedrock.

4.3 Model Cross Section and Boundary Conditions

The POLLUTE modelling was carried out for cross-section A-A' along the north-south axis of the landfill as shown in Figures 3 and 4. The landfill footprint length along the cross-section is approximately 1,250 m. The average waste thickness is approximately 32 m.

The top (i.e., leachate source) boundary condition for the modelling is that of a finite contaminant mass and hence decreasing source concentration with time. The base (i.e., bottom of attenuation layer) boundary condition is that of a hypothetical porous media of similar composition as the attenuation layer. This base boundary condition gives conservatively higher predicted concentrations at the base of the attenuation layer by not accounting for any mixing of contaminants in the groundwater flow system beneath the attenuation layer.

4.4 Liner and Leachate Collection System Service Lives

As discussed in Section 3, the liner and leachate collection system components are designed for the following service lives per Schedules 1 to 4 of O.Reg.232/98:

- Primary leachate collection system – 100 years;
- Primary HDPE geomembrane liner – 150 years;
- GCL – unlimited
- Secondary leachate collection system – 1,000 years;
- Secondary HDPE geomembrane – 350 years;
- Compacted clay liner – unlimited;
- Attenuation layer – unlimited.

The above service lives are relative to the mid-point of the proposed 20-year operating period.

4.5 Key Contaminants and Associated Transport Parameters

As required by O.Reg. 232/98, the following eight key leachate contaminants were modelled to address long-term compliance with the MECP Reasonable Use Guideline (RUG):

- chloride,
- cadmium,
- lead,
- benzene,

- 1,4-dichlorobenzene,
- dichloromethane,
- toluene, and
- vinyl chloride.

These key contaminants typically have the greatest potential to cause exceedances of the RUG at municipal landfill sites due to their relatively high initial peak source concentrations in leachate compared to drinking water standards, and their relatively low bio-chemical decay and adsorption potential.

The model input parameters required for each key contaminant are the representative peak leachate source concentration and mass inventory in the landfill, bio-chemical decay half-life, and diffusion and adsorption coefficient values for the individual layers comprising the containment system. The input values used for these parameters are given in Table 1. The representative peak leachate source concentration, mass inventory and half-life values are as specified in O.Reg. 232/98 and are based on historical leachate quality monitoring for a number of large municipal solid waste landfill sites in Ontario. When compared to the actual measured leachate quality for the existing South Landfill, the O.Reg. 232/98 peak leachate source concentration values are significantly higher and therefore conservative for the purpose of the modelling.

Background bedrock groundwater concentrations beneath the landfill are given in Table 3 and are based on measured concentrations in 2025 and 2026 at monitoring wells screened in the upper portion of the Lockport Formation which represents the primary bedrock groundwater flow zone beneath the landfill.

4.6 Leachate Generation Rates

Calculations for potential leachate generation rates (mm/year) during the landfilling and post-closure periods are presented Appendix A. For the landfilling period, a leachate generation rate of 400 mm/year was estimated based on monitoring of leachate pumping rates from the existing South Landfill. For the post-closure period, a leachate generation rate of 150 mm/year reflecting infiltration through the final cover was estimated using the Hydrologic Evaluation of Landfill Performance (HELP) Model taking into account climate change.

4.7 Vertical Leakage Rates Through the Liner System

Model input values for average leachate heads and corresponding leakage rates (Darcy Fluxes) through the composite primary and secondary liner systems are presented in Table 2.

The leachate heads acting on the primary liner account for the service life of the primary leachate collection system, after which the leachate head gradually builds up in the waste fill to an ultimate steady state level where the leakage rate through the primary liner equals the infiltration rate through the final cover.

The leakage rates through the composite liner systems are based on the method of Rowe (2016) which accounts for potential leakage through geomembrane defects and spreading of the leakage along the interface between the geomembrane and underlying GCL or compacted clay liner (including along geomembrane wrinkles). A sample calculation of leakage rate through the primary composite liner during the service life of the primary leachate collection system is given in Appendix B.

4.8 Modelling Results

The results of the modelling for the key landfill leachate contaminants are summarized in Table 3 as predicted peak concentration and mass flux exiting the base of the attenuation layer. Predicted concentrations versus time at the base of the attenuation layer are plotted in Figures 10 a-h. For all key contaminants, the predicted peak concentration is less than the RUG value over the 1000-year modelling time frame. The modelling results therefore indicate acceptable performance of the proposed leachate containment system.

The predicted peak concentration for vinyl chloride came the closest to the respective RUG value (0.00030 mg/L predicted peak concentration after 55 years versus a RUG value of 0.00065 mg/L). Compared to the other key contaminants, vinyl chloride has a relatively long half life, lower adsorption coefficient and faster diffusivity through the HDPE geomembrane liners. The modelling gave negligible impact at the base of the attenuation layer for all other key contaminants, reflecting the long service lives of the containment system components.



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WSP Canada Inc.

FINAL DRAFT

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Senior Technical Director, GeoEnvironmental Engineering

FSB/al/kj

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Table 1: Key Contaminants and Associated Soil Transport Parameters

Key Contaminant	Representative Peak Leachate Source Concentration ¹ (mg/L)	Mass Proportion of Total (Wet) Mass of Waste ¹ (mg/kg)	Half-Life ¹ (years)	Soil Adsorption Coefficient ³ (mL/g)	Soil Diffusion Coefficient ² (m ² /year)	Geomembrane Diffusion Coefficient ⁴ (m ² /year)	Ontario Drinking Water Quality Objective ⁵ (mg/L)
Chloride	2,500	1,800	Infinite	0	0.0018	6.3E-08	250 (A)
Cadmium	0.05	0.035	Infinite	70	0.0018	6.3E-08	0.005 (H)
Lead	0.6	0.42	Infinite	1900	0.0018	6.3E-08	0.01 (H)
Benzene	0.02	0.014	25	2.0	0.0018	1.2E-06	0.005 (H)
1,4-Dichlorobenzene	0.01	0.007	50	10	0.0018	1.4E-05	0.005 (H)
Dichloromethane	3.3	2.3	10	1.0	0.0018	6.3E-05	0.05 (H)
Toluene	1	0.7	15	3.0	0.0018	3.8E-06	0.024 (A)
Vinyl Chloride	0.055	0.039	25	0.3	0.0018	6.3E-05	0.002 (H)

Notes:

- ¹ Values taken from Table 1 of O.Reg. 232/98 for municipal solid waste.
- ² Assumed diffusion coefficient based on literature values for similar soils.
- ³ Rowe et.al., 2004 for clayey soil. For 1,4-Dichlorobenzene, adsorption coefficient is estimated based on ratio of octanol water partitioning coefficient values for benzene and 1,4-Dichlorobenzene. For Vinyl Chloride, adsorption coefficient is estimated based on ratio of octanol water partitioning coefficient values for benzene and Vinyl Chloride.
- ⁴ Geomembrane diffusion coefficients based on literature values provided in Rowe (2001) and Rowe et.al. (2004).
- ⁵ Ontario Drinking Water Quality Standards.
- (A) Denotes aesthetic drinking water objective.
- (H) Denotes health related drinking water objective.



Table 2: Infiltration Rate, Average Head on Liner, Darcy Fluxes and Leachate Collected

Time ¹ (years)	Cover Infiltration Rate ² (m/year)	Average Leachate Head on the Primary Liner ³ (m)	Leakage/ Darcy Flux through Primary Liner ⁴ (m/year)	Leachate Collected by Primary Leachate Collection System (m ³ /m ² / year)	Leakage/ Darcy Flux through Secondary Liner (m/year)	Lateral Darcy Flux in Secondary Leachate Collection System ⁵ (m/year)
0-10	0.300	0.3	0.0047	0.295	0	19
10-100	0.232	0.3	0.0047	0.227	0	19
100-110	0.232	3.2	0.0514	0	0	211
110-120	0.232	9.0	0.1537	0	0	630
120-130	0.232	14.8	0.2665	0	0	1093
130-140	0.232	20.6	0.3889	0	0	1595
140-150	0.232	26.4	0.5205	0	0	2134
150-153	0.232	15.0	4.73*	0	0.0092***	19357
153-350	0.232	0.74	0.232**	0	0.0092***	914
350-1000	0.232	0.74	0.232**	0	0.022****	861

Notes:

- ¹ Model starts at 10 years i.e. mid-point of landfilling operating period. End of primary leachate collection system service life = 100 years. End of primary geomembrane service = 150 years. End of secondary geomembrane service life = 350 years. End of secondary leachate collection system service life = 1000 years.
- ² Cover infiltration rates were calculated using HELP model.
- ³ Leachate head of 0.3 m on the primary lining system was assumed prior to the failure of leachate collection system (years 0 to 100). Between 100 and 150 years the leachate head was increased linearly to ~29 m. After failure of the primary geomembrane at 150 years the leachate head was decreased to account for leakage through the GCL to 0.74 m (stead stage level where infiltration rate through the cover equals leakage rate through the GCL).
- ⁴ Leakage rates through the primary composite liner were calculated using method of Giroud and Bonaparte; and Rowe as presented in Attachment 1.
- * After year 150, leakage through the GCL was calculated using Darcy's Law.
- ** After year 153 the steady state leakage rate through the GCL equals the infiltration rate.
- *** Leakage rates through the secondary composite liner were calculated using method of Giroud and Bonaparte; and Rowe as presented in Attachment 2.
- **** Leakage rate through the secondary clay liner was calculated using Darcy's Law.



Table 3: Predicted Concentrations of Key Leachate Contaminants at the Base of Attenuation Layer

Contaminant	Background Groundwater Concentration in the Lockport Formation ¹ (mg/L)	Ontario Drinking Water Quality Objective ² (mg/L)	Reasonable Use Guideline ³ (mg/L)	Time of Peak Concentration at Base of Attenuation Layer ⁴ (years)	Predicted Peak Concentration at the Base of Attenuation Layer (mg/L)	Predicted Total Peak Mass Loading Out of Base of Attenuation Layer (g/year)
Chloride	155	250 (A)	203	1000*	2	1.2E+4
Cadmium	<0.00009	0.005 (H)	0.0013	1000*	1E-6	5.1E-3
Lead	<0.0005	0.01 (H)	0.0029	1000*	1E-6	5.5E-3
Benzene	<0.0004	0.005 (H)	0.0016	155	2E-8	2.3E-4
1,4-Dichlorobenzene	<0.0002	0.005 (H)	0.0014	375	4E-9	1.5E-4
Dichloromethane	<0.002	0.05 (H)	0.0140	65	7E-5	2.0
Toluene	<0.0002	0.024 (A)	0.012	155	6E-8	1.1E-3
Vinyl Chloride	<0.0002	0.002 (H)	0.00065	55	3E-4	2.8

Notes:

¹ Background concentrations based on median of Lockport formation monitoring wells data between June 2025 and March 2026.

² Ontario Drinking Water Quality Standards (ODWQS).

³ Reasonable Use Guideline = Background Concentration + X (ODWQS Criteria - Background Concentration):

where X = 0.25 for health related drinking water parameters

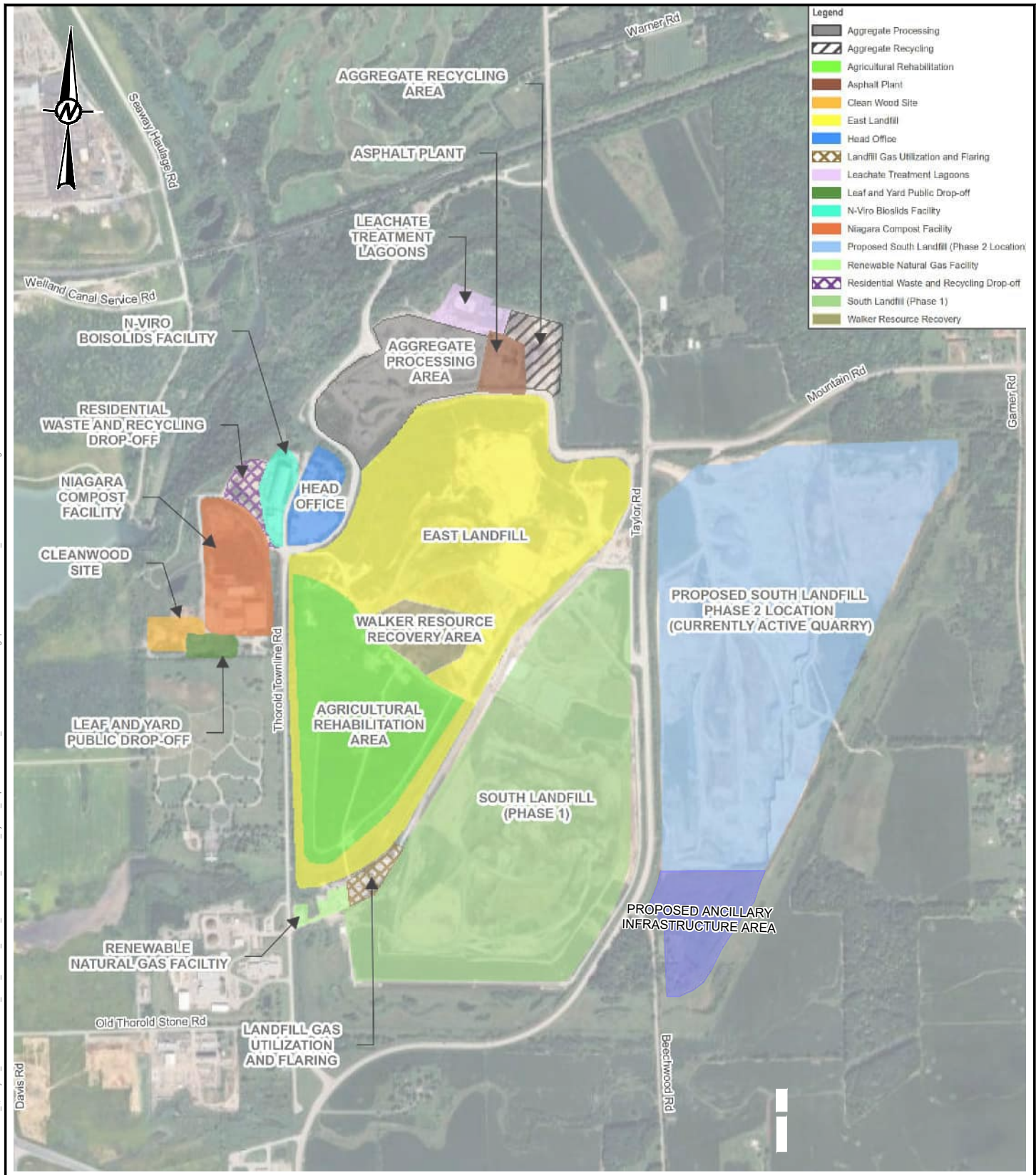
= 0.50 for aesthetic related drinking water parameters

⁴ Based on a 1000-year contaminant transport modelling time frame.

* At the end of 1000 year modelling period.

(A) Denotes aesthetic drinking water objective.

(H) Denotes health related drinking water objective.



- Legend**
- Aggregate Processing
 - Aggregate Recycling
 - Agricultural Rehabilitation
 - Asphalt Plant
 - Clean Wood Site
 - East Landfill
 - Head Office
 - Landfill Gas Utilization and Flaring
 - Leachate Treatment Lagoons
 - Leaf and Yard Public Drop-off
 - N-Viro Biosolids Facility
 - Niagara Compost Facility
 - Proposed South Landfill (Phase 2 Location)
 - Renewable Natural Gas Facility
 - Residential Waste and Recycling Drop-off
 - South Landfill (Phase 1)
 - Walker Resource Recovery

REFERENCE(S)
 FIGURE 1.1, SOUTH LANDFILL PHASE 2 SITE MAP, EA TOR REPORT DATED MAY 14, 2024 BY GHG.

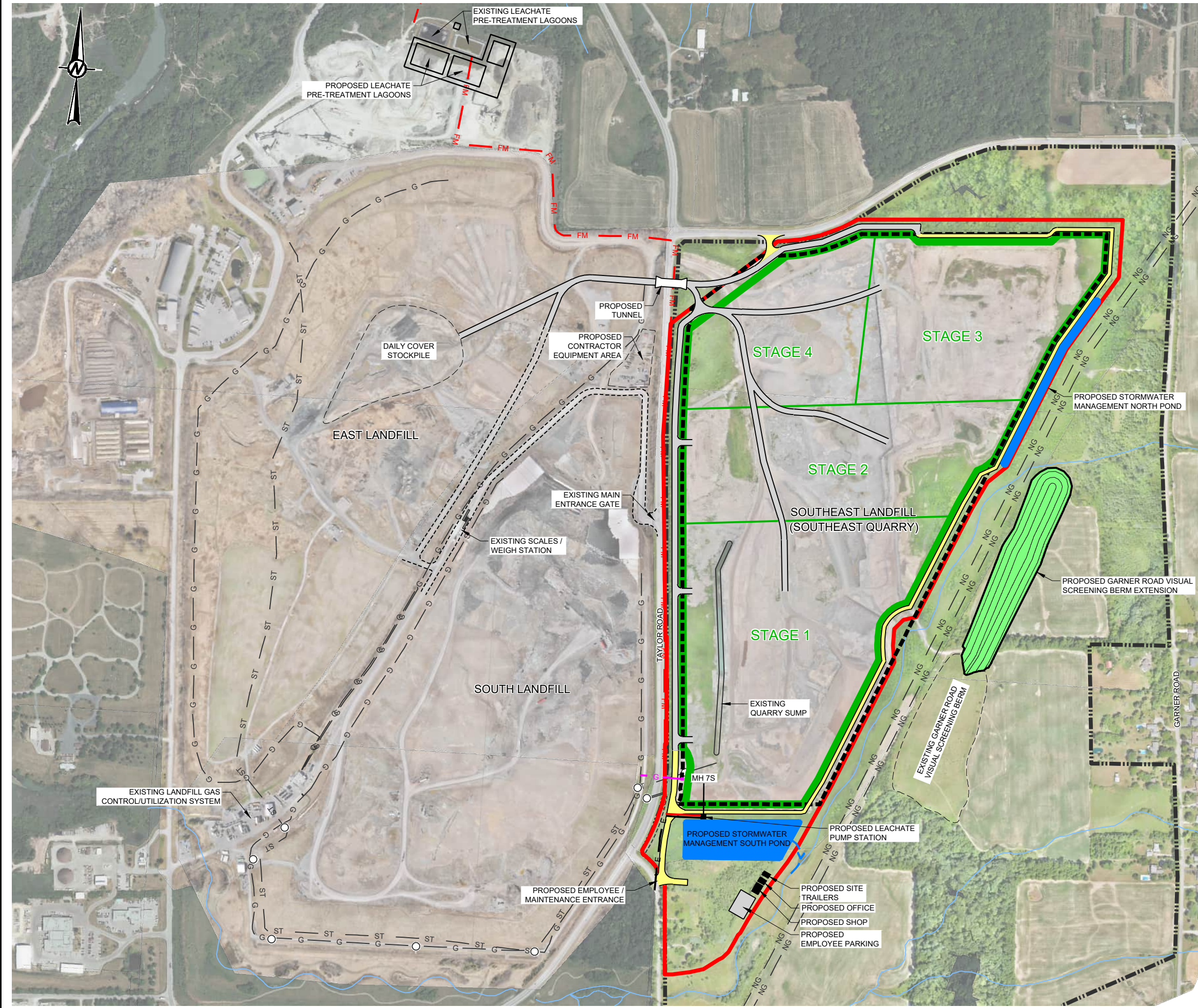
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CONSULTANT	YYYY-MM-DD	2026-05-08
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	PREPARED	FC
	REVIEWED	FSB
	APPROVED	FSB

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TITLE SITE LOCATION PLAN			
PROJECT NO.	CONTROL	REV.	FIGURE
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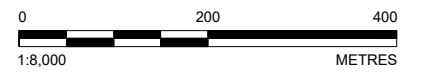
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- LIMIT OF EXTRACTED ROCK
- LIMIT OF FILL (62.59 Ha)
- HAUL ROAD
- CREEK
- NG --- TRANS-CANADA NATURAL GAS PIPELINE R.O.W.
- STORMWATER MAINTENANCE HOLE
- ST --- STORMWATER PIPE
- G --- G --- LANDFILL GAS COLLECTION HEADER PIPE
- PROPOSED LANDFILL STAGE BOUNDARY
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD
- PROPOSED BUILDING
- PROPOSED STORMWATER MANAGEMENT POND
- > PROPOSED STORMWATER MANAGEMENT DITCH / FLOW
- E --- E --- PROPOSED ELECTRICAL SERVICE
- PROPOSED LEACHATE PUMP STATION
- FM --- PROPOSED LEACHATE FORCEMAIN
- G --- PROPOSED LANDFILL GAS BOOSTER STATION AND CROSS CONNECT

NOTE(S)

1. PROJECTION: UTM NAD83-17N (CSRS.2010).
2. ELEVATION ARE GEODETIC (masl). DATUM IS BASED ON NRCAN HT2.0 (CGVD2013).

REFERENCE(S)

1. IMAGERY: ©2025 MICROSOFT CORP. ©MAXAR ©CNES (2025) DIST. AIRBUS DS.
2. BASE PLAN FEATURES FROM OPEN DATA, CITY OF NIAGARA FALLS.
3. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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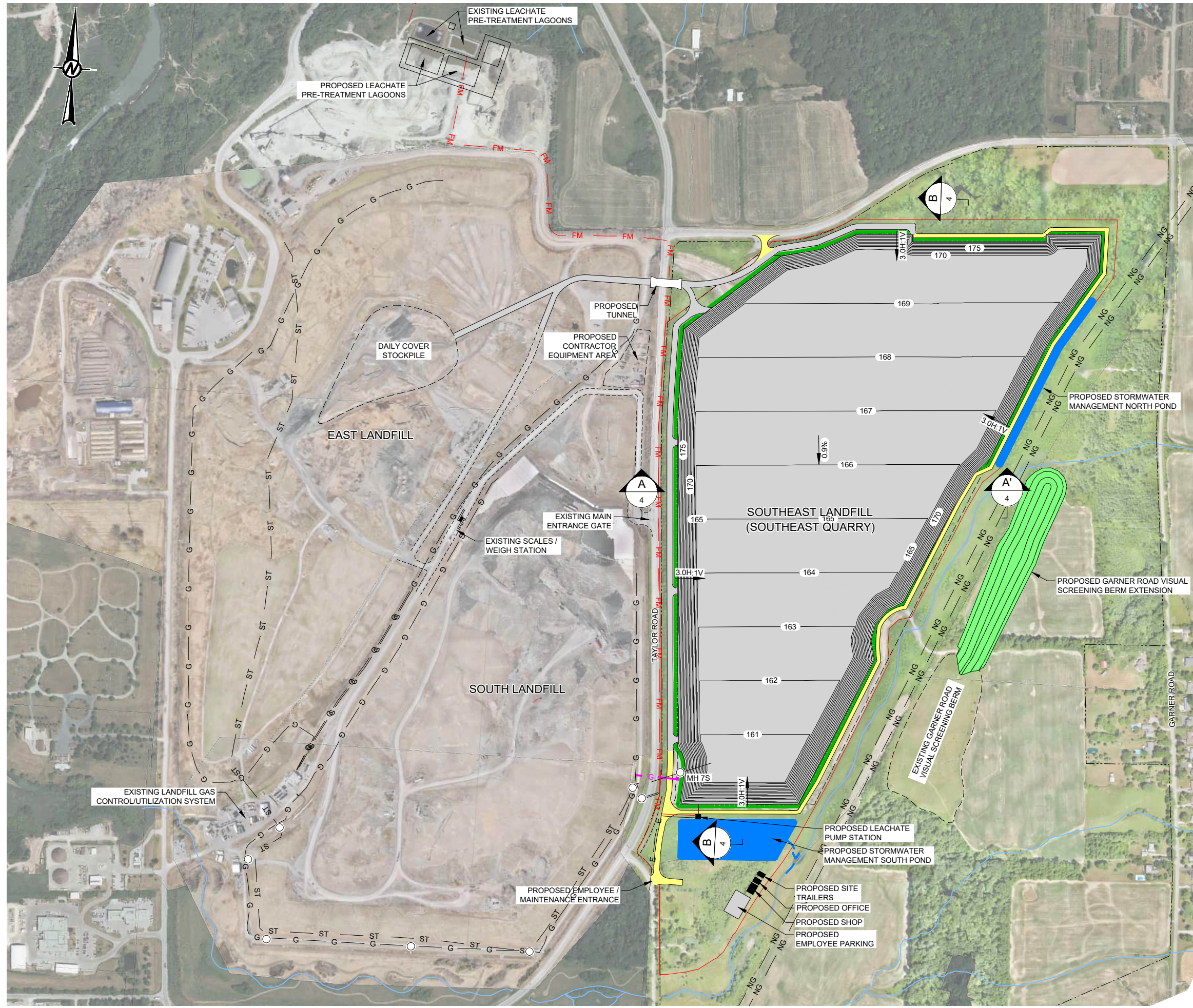
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LEACHATE CONTAINMENT SYSTEM
DESIGN DESCRIPTION REPORT
SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO
TITLE
SOUTH LANDFILL PHASE 2 BOUNDARIES AND LAYOUT

CONSULTANT	WSP	YYYY-MM-DD	2026-05-22
DESIGNED	FSB		
PREPARED	FC		
REVIEWED	FSB		
APPROVED	FSB		

PROJECT NO. CA0065457.5367 CONTROL 0002 REV. A FIGURE 2

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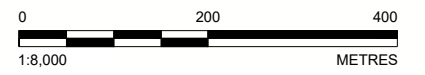
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- STORMWATER MAINTENANCE HOLE
- ST --- STORMWATER PIPE
- G --- G --- LANDFILL GAS COLLECTION HEADER PIPE
- 166 PROPOSED BASE GRADE CONTOURS (INTERVAL 1.0 m)
- 0.9% PROPOSED BASE GRADE SLOPE H:V OR GRADE %
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD
- PROPOSED BUILDING
- PROPOSED STORMWATER MANAGEMENT POND
- PROPOSED STORMWATER MANAGEMENT DITCH / FLOW
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PROJECT
LEACHATE CONTAINMENT SYSTEM
DESIGN DESCRIPTION REPORT
SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO

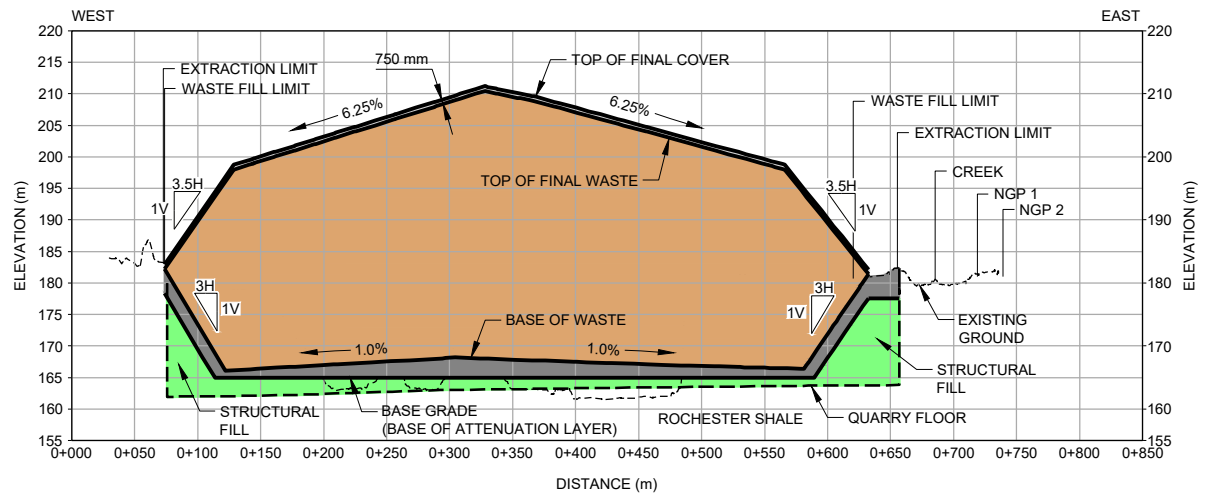
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PROPOSED BASE GRADE (BASE OF ATTENUATION LAYER)
CONTOURS

CONSULTANT	YYYY-MM-DD	2026-05-08
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	PREPARED	FC
	REVIEWED	FSB
	APPROVED	FSB

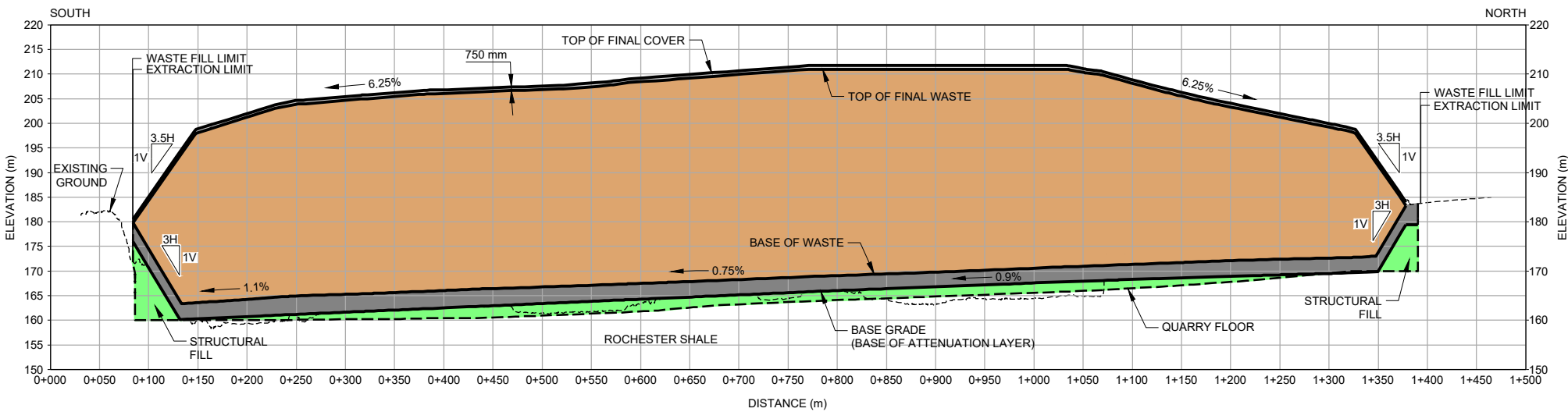
PROJECT NO. CA0065457.5367 CONTROL 0002 REV. A FIGURE 3

25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

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A CROSS-SECTION A-A' (WEST - EAST)



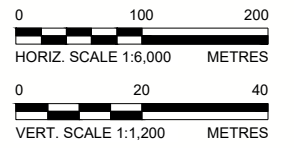
B CROSS-SECTION B-B' (SOUTH - NORTH)

LEGEND

	PROPOSED FINAL COVER
	PROPOSED WASTE FILL
	PROPOSED LINER AND LEACHATE COLLECTION SYSTEM
	PROPOSED STRUCTURAL FILL

NOTE(S)
 1. ELEVATION ARE GEODETIC (masl). DATUM IS: ?

REFERENCE(S)
 1. EXISTING GROUND IS BASED ON UAV SURVEY DATED JUNE 12, 2025 BY WALKER.



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 WALKER ENVIRONMENTAL GROUP

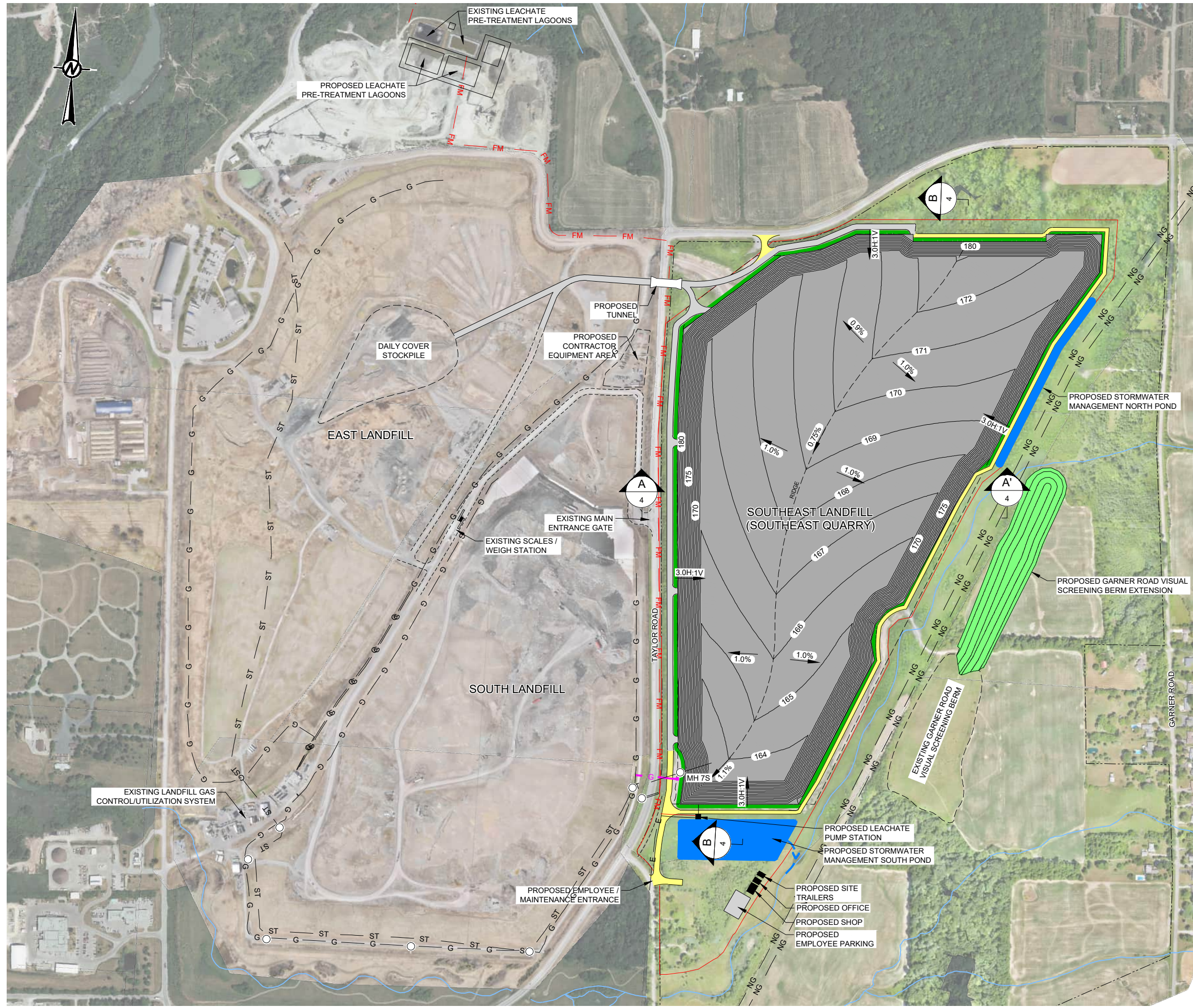
PROJECT
 LEACHATE CONTAINMENT SYSTEM
 DESIGN DESCRIPTION REPORT
 SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO

TITLE
 CROSS-SECTIONS A-A' AND B-B'

	CONSULTANT	YYYY-MM-DD	2026-05-22
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	PREPARED	FC	
	REVIEWED	FSB	
	APPROVED	FSB	

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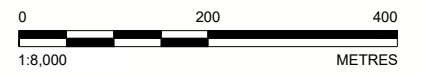
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- LIMIT OF EXTRACTED ROCK
- LIMIT OF FILL
- HAUL ROAD
- CREEK
- NG --- TRANS-CANADA NATURAL GAS PIPELINE R.O.W.
- STORMWATER MAINTENANCE HOLE
- ST --- STORMWATER PIPE
- G --- G --- LANDFILL GAS COLLECTION HEADER PIPE
- 169 PROPOSED TOP OF LEACHATE CONTAINMENT SYSTEM (BASE OF WASTE) CONTOURS (INTERVAL 1.0 m)
- 1.0% PROPOSED TOP OF LEACHATE CONTAINMENT SYSTEM (BASE OF WASTE) SLOPE H:V OR GRADE %
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD
- PROPOSED BUILDING
- PROPOSED STORMWATER MANAGEMENT POND
- PROPOSED STORMWATER MANAGEMENT DITCH / FLOW
- E --- E --- PROPOSED ELECTRICAL SERVICE
- PROPOSED LEACHATE PUMP STATION
- FM --- PROPOSED LEACHATE FORCEMAIN
- G --- PROPOSED LANDFILL GAS BOOSTER STATION AND CROSS CONNECT

NOTE(S)

- PROJECTION: UTM NAD83-17N (CSRS.2010).
- ELEVATION ARE GEODETIC (masl). DATUM IS BASED ON NRCAN HT2.0 (CGVD2013).

REFERENCE(S)

- IMAGERY: ©2025 MICROSOFT CORP. ©MAXAR ©CNES (2025) DIST. AIRBUS DS.
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PROJECT
LEACHATE CONTAINMENT SYSTEM
DESIGN DESCRIPTION REPORT
SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO

TITLE
PROPOSED TOP OF LEACHATE CONTAINMENT SYSTEM (BASE OF WASTE) CONTOURS

CONSULTANT	YYYY-MM-DD	2026-05-08
	DESIGNED	FSB
	PREPARED	FC
	REVIEWED	FSB
	APPROVED	FSB

25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

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LEGEND

- SITE PROPERTY LINE
- WASTE DISPOSAL SITE BOUNDARY LIMITS
- LIMIT OF EXTRACTED ROCK
- LIMIT OF FILL
- HAUL ROAD
- CREEK
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- STORMWATER MAINTENANCE HOLE
- ST --- STORMWATER PIPE
- G --- G --- LANDFILL GAS COLLECTION HEADER PIPE
- 210 PROPOSED TOP OF FINAL WASTE CONTOURS (INTERVAL 1.0 m)
- 3.5H:1V PROPOSED TOP OF FINAL WASTE SLOPE H:V OR GRADE %
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD
- PROPOSED BUILDING
- PROPOSED STORMWATER MANAGEMENT POND
- > PROPOSED STORMWATER MANAGEMENT DITCH / FLOW
- E --- E --- PROPOSED ELECTRICAL SERVICE
- PROPOSED LEACHATE PUMP STATION
- FM PROPOSED LEACHATE FORCEMAIN
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NOTE(S)

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SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO

TITLE
PROPOSED TOP OF FINAL WASTE CONTOURS

CONSULTANT	YYYY-MM-DD	2026-05-08
	DESIGNED	FSB
	PREPARED	FC
	REVIEWED	FSB
	APPROVED	FSB

PROJECT NO. CA0065457.5367 CONTROL 0002 REV. A FIGURE 6

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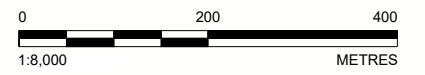
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- LIMIT OF FILL
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- 3.5H:1V PROPOSED TOP OF FINAL COVER SLOPE H:V OR GRADE %
- PROPOSED MAIN HAUL ROAD
- PROPOSED MAINTENANCE ROAD
- PROPOSED BUILDING
- PROPOSED STORMWATER MANAGEMENT POND
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WALKER ENVIRONMENTAL GROUP

PROJECT
LEACHATE CONTAINMENT SYSTEM
DESIGN DESCRIPTION REPORT
SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO

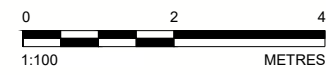
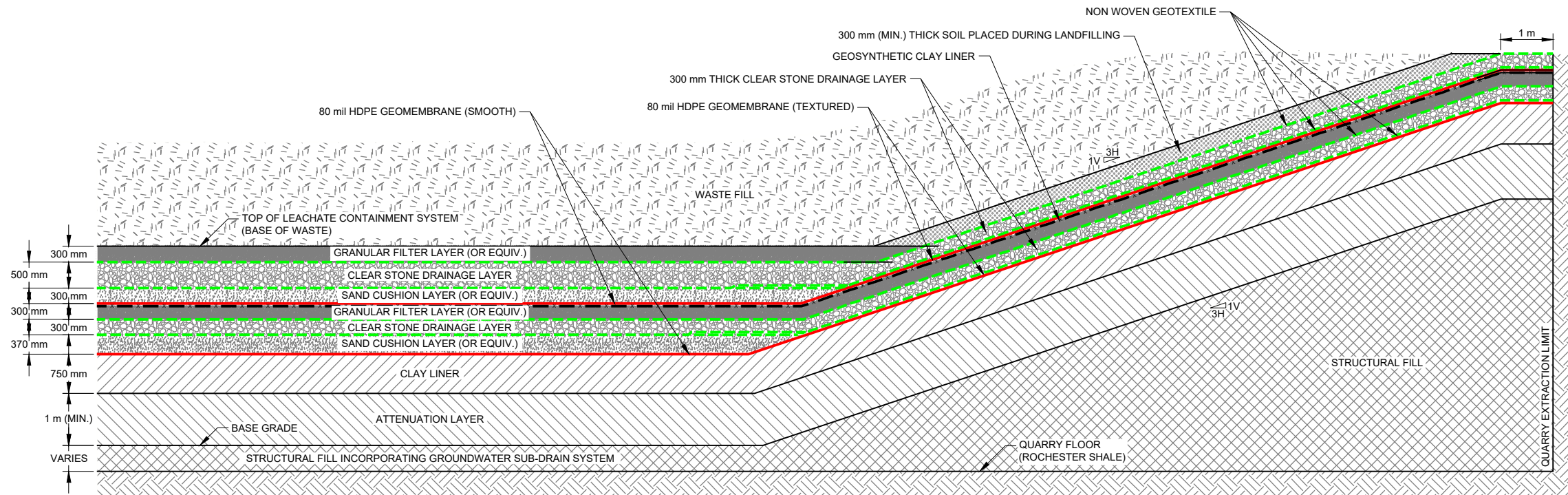
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	DESIGNED	FSB
	PREPARED	FC
	REVIEWED	FSB
	APPROVED	FSB

PROJECT NO. CONTROL REV. FIGURE
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25 mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D


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PROJECT
LEACHATE CONTAINMENT SYSTEM
DESIGN DESCRIPTION REPORT
SOUTH LANDFILL PHASE 2, THOROLD, ONTARIO

TITLE
PROPOSED LEACHATE CONTAINMENT SYSTEM DESIGN

CONSULTANT	YYYY-MM-DD	2026-05-22
	DESIGNED	FSB
	PREPARED	FC
	REVIEWED	FSB
	APPROVED	FSB

PROJECT NO. CONTROL REV. FIGURE
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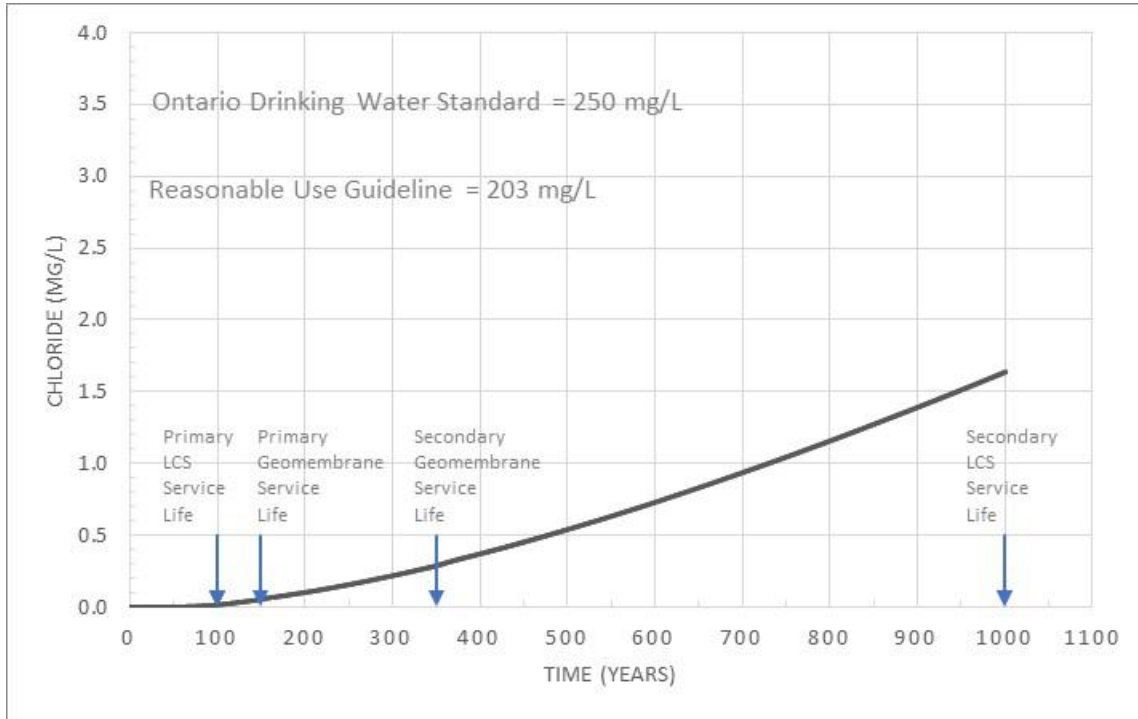


Figure 9a: Chloride Concentration Versus Time at Base of Attenuation Layer

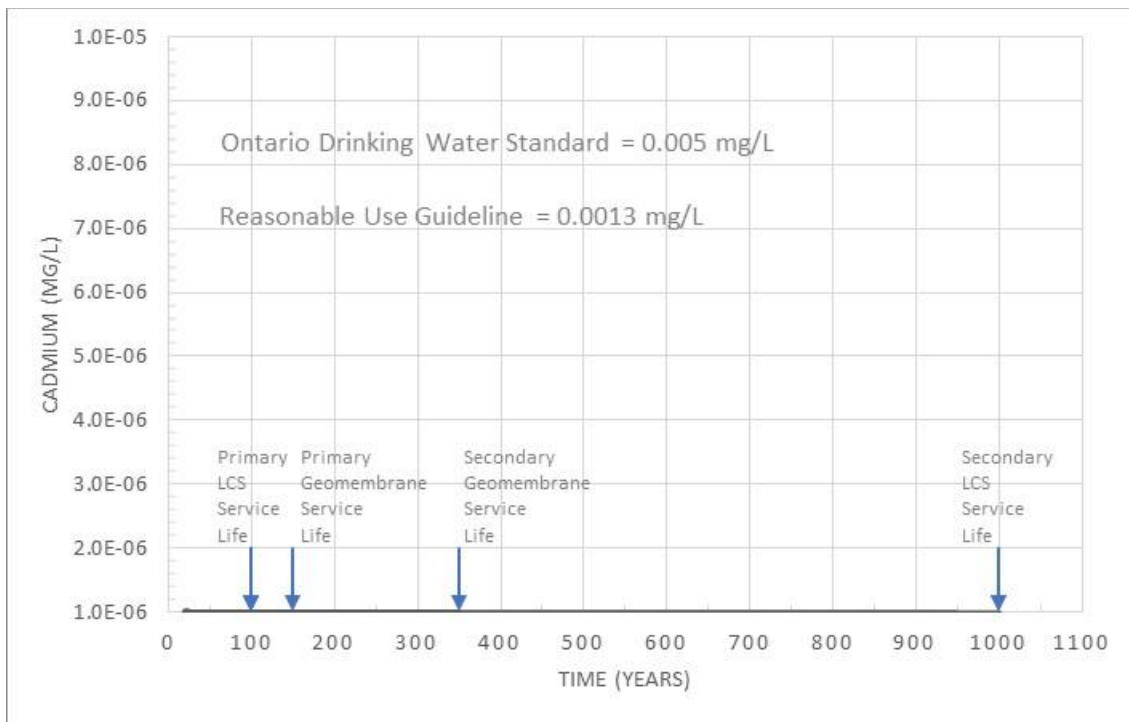


Figure 9b: Cadmium Concentration Versus Time at Base of Attenuation Layer

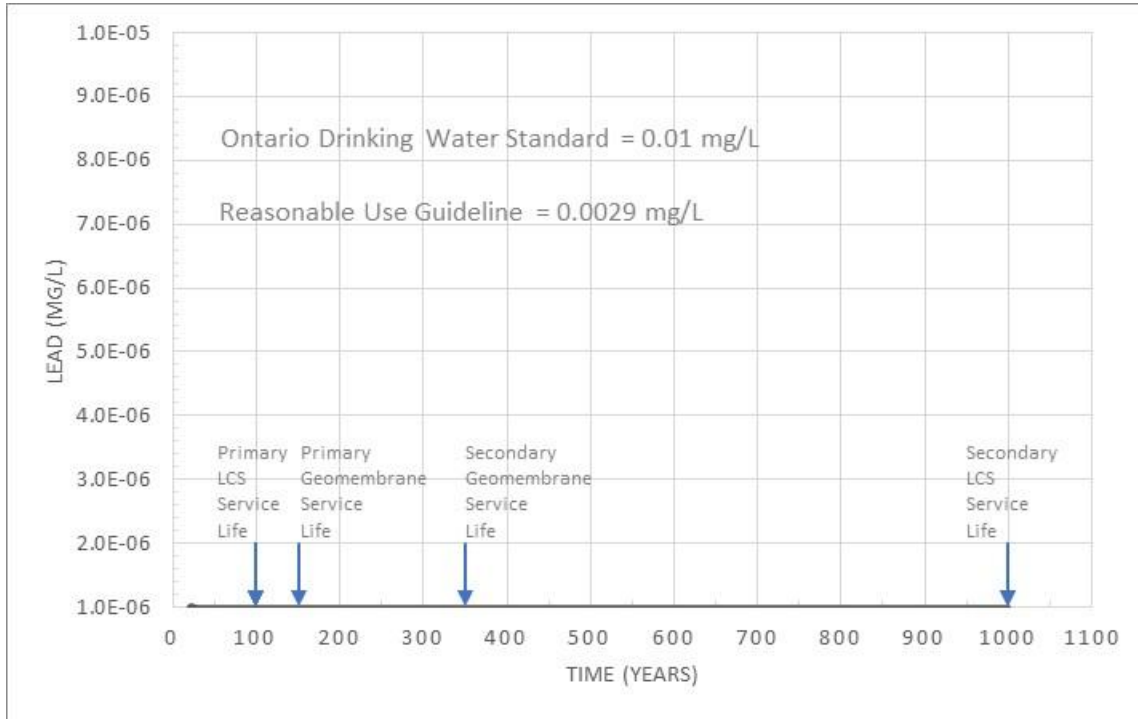


Figure 9c: Lead Concentration Versus Time at Base of Attenuation Layer

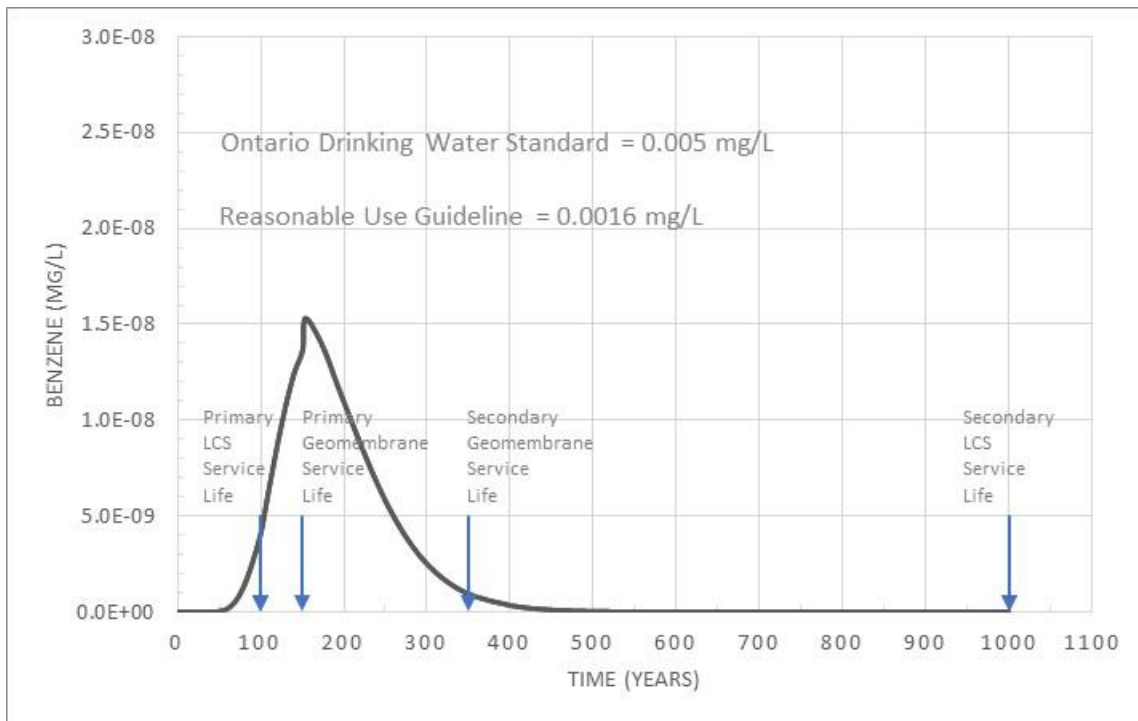


Figure 9d: Benzene Concentration Versus Time at Base of Attenuation Layer

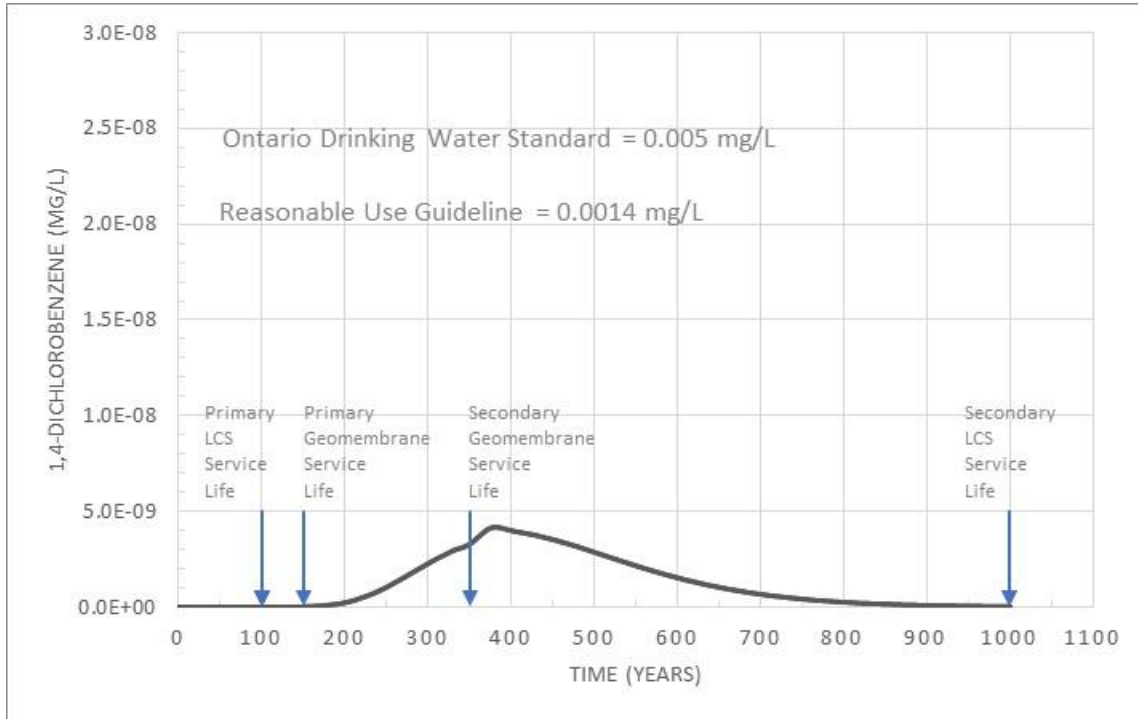


Figure 9e: 1,4-Dichlorobenzene Concentration Versus Time at Base of Attenuation Layer

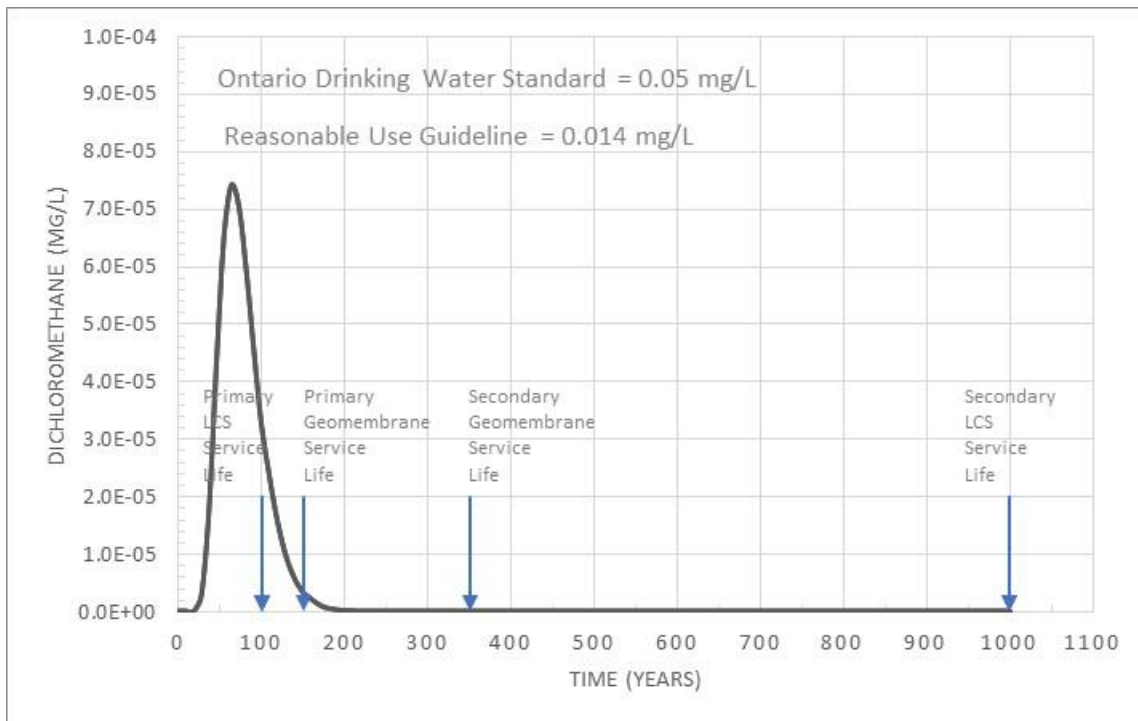


Figure 9f: Dichloromethane Concentration Versus Time at Base of Attenuation Layer

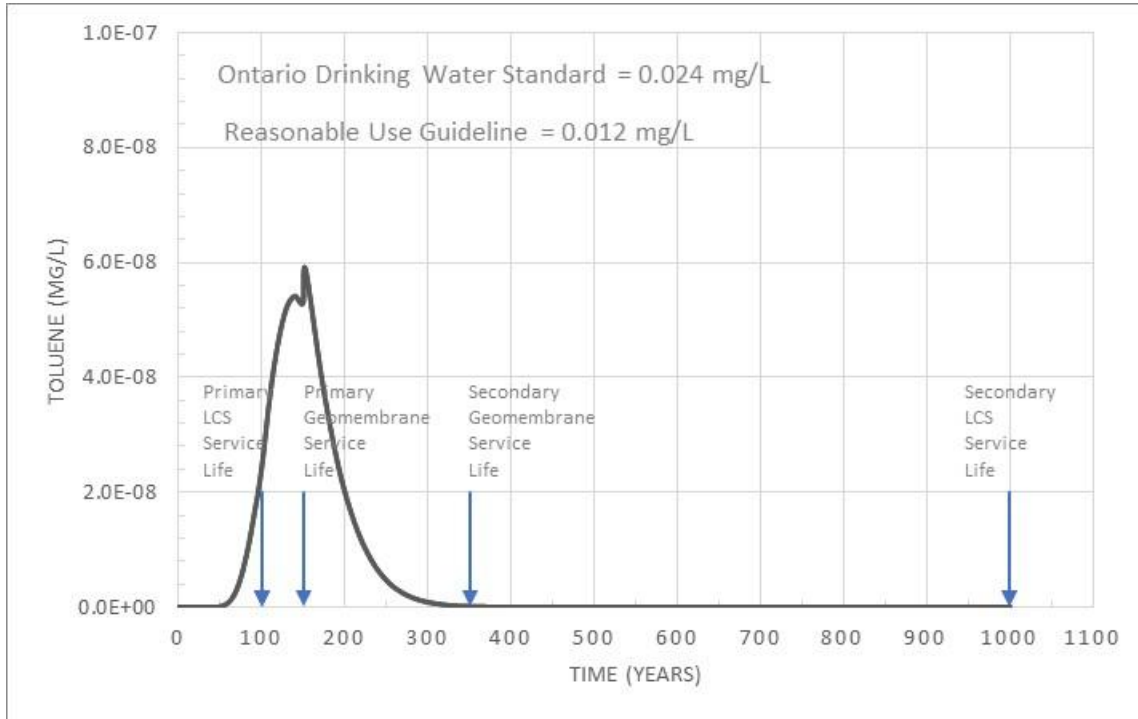


Figure 9g: Toluene Concentration Versus Time at Base of Attenuation Layer

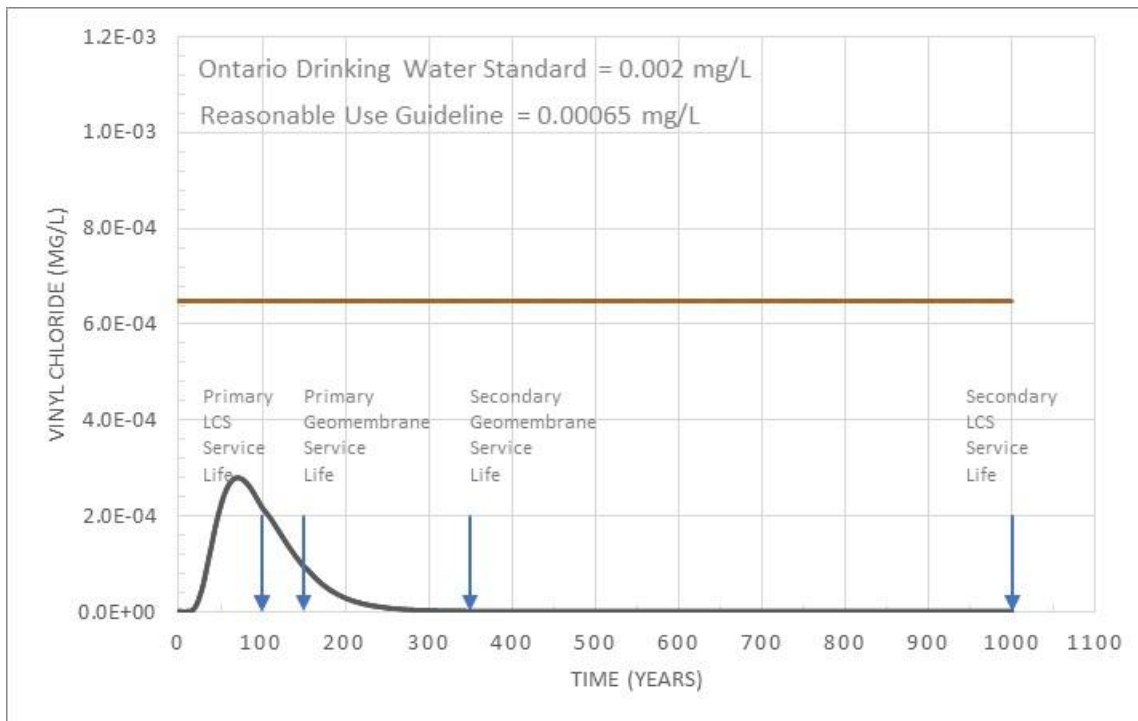


Figure 9h: Vinyl Chloride Concentration Versus Time at Base of Attenuation Layer



FINAL DRAFT

A

Leachate Generation Rate Calculations





TECHNICAL MEMORANDUM

DATE November 4, 2024

Project No. CA-WSP-131-22826-25

TO Darren Fry, A.Sc.T.
Project Director, Environmental Division
Walker Environmental Group Inc.

FROM Frank Barone, Ph.D., P.Eng.

EMAIL frank.barone@wsp.com

PREDICTED ANNUAL LEACHATE VOLUMES - PROPOSED SOUTH (PHASE II) LANDFILL

This Technical Memorandum provides initial predictions of annual leachate generation volumes for the proposed South (Phase II) Landfill at Walker Environmental Group's Thorold Campus. The leachate volumes are intended to inform the Environmental Assessment studies for the proposed landfill.

As shown in Figure 1 (attached), the initial conceptual design for the South (Phase II) Landfill has sixteen cells within a 63-hectare fill area. The cells will be landfilled over a fifteen-year period from Years 2030 to 2045, with final cover applied progressively as final waste fill contours are reached. Figure 1 and Table 1 show the progression of landfill cell development, filling and final cover placement (i.e., capping).

For each year of the landfilling period, the leachate volume generated from areas without final cover was estimated taking into consideration leachate volumes pumped from the existing South Landfill prior to the start of final cover construction in 2020. As shown in Table A.1 (Appendix A, attached), the leachate volume pumped each year from the South Landfill from the start of landfilling in Year 2010 to Year 2019, was divided by the corresponding waste fill area to obtain a leachate generation rate in millimeters per year (mm/y) for that year. The resulting leachate generation rates range from 400 to 450 mm/y for the first two years of the landfilling period and then follow a decreasing trend to a stable range between 200 and 300 mm/y after year six of operation (Figure A.1). The decreasing trend reflects moisture uptake by the waste fill as the average thickness of waste across the landfill increases. This trend was applied to the progression of cell development and capping for the proposed South (Phase II) landfill to estimate annual leachate volumes from waste fill areas without final cover. For areas with final cover, the leachate generation rate was estimated using the HELP Model considering climate change (Appendix B). The modelling gave a leachate generation rate of 188 mm/y to Year 2040 followed by an increasing trend to 232 mm/y at Year 2070. Year 2070 represents the end of the second period of climate change projections given in the Ministry of Natural Resources and Forestry Climate Change Research Report CCRR-44 (2015).

Based on the above approach, the predicted annual leachate volumes for the South (Phase II) from the start of landfilling in Year 2030 to Year 2070 are shown in Table 2 and Figure 2. The annual leachate volumes increase from approximately 30,000 m³ in Year 2030 to 131,000 m³ at the end of the operating period in Year 2045, followed by a decreasing trend to 128,000 m³ at completion of final cover construction in Year 2050. From Year 2050 to 2070, annual leachate volumes gradually increase due to climate change to 147,000 m³.

WSP Canada Inc.

DRAFT

Frank Barone, Ph.D., P.Eng.
Senior Geo-Environmental Engineer

FSB/al

Attachments: Table 1: Progression of Landfill Cell Development, Filling and Capping – Proposed South (Phase II) Landfill
Table 2: Estimated Annual Leachate Generation Rates and Volumes – Proposed South (Phase II) Landfill
Figure 1: Cell Development Plan - Proposed South (Phase II) Landfill
Figure 2: Estimated Annual Leachate Volumes – Proposed South (Phase II) Landfill
Appendix A – Leachate Generation Rates from Uncapped Waste Fill Areas (Existing South Landfill)
Appendix B – HELP Modelling for Leachate Generation Rate from Capped Waste Fill Areas – Proposed South (Phase II) Landfill

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Table 1. Progression of Landfill Cell Development, Filling and Capping – Proposed South (Phase II) Landfill

Landfill Timing				
Year	Licence Surrender Year	Cell Construction (Spring Start)	Waste Placement (Jan 1st)	Capped
2028	Stage 1			
2029		Cell 1		
2030		Cell 2	Cell 1	
2031		Cell 3	Cell 2	
2032	Stage 2	Cell 4	Cell 3	
2033		Cell 5	Cell 4	
2034		Cell 6	Cell 5	
2035		Cell 7	Cell 6	Cell 1
2036	Stage 3	Cell 8	Cell 7	Cell 2
2037		Cell 9	Cell 8	Cell 3
2038		Cell 10	Cell 9	Cell 4
2039		Cell 11	Cell 10	Cell 5
2040	Stage 4	Cell 12	Cell 11	Cell 6
2041		Cell 13	Cell 12	Cell 7
2042		Cell 14	Cell 13	Cell 8
2043		Cell 15	Cell 14	Cell 9
2044		Cell 16	Cell 15	Cell 10
2045			Cell 16	Cell 11
2046				Cell 12
2047				Cell 13
2048				Cell 14
2049				Cell 15
2050				Cell 16


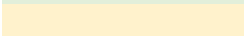
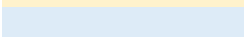
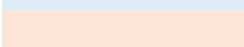
Stage 1 
Stage 2 
Stage 3 
Stage 4 

Table 2. Estimated Annual Leachate Generation Rates and Volumes – Proposed South (Phase II) Landfill

Year	Area Without Final Cover at Start of Year (m ²)	Area With Final Cover at Start of Year (m ²)	Leachate Generation from Area Without Final Cover		Leachate Generation from Area With Final Cover		Total Leachate Generation from Landfill (m ³)
			(mm/y)	m ³	(mm/y)	m ³	
2030	66,111		450	29,750			29,750
2031	125,110		420	52,546			52,546
2032	173,929		380	66,093			66,093
2033	227,198		340	77,247			77,247
2034	269,752		295	79,577			79,577
2035	235,358	66,111	250	58,840	188	12,429	71,268
2036	215,597	125,110	250	53,899	188	23,521	77,420
2037	202,992	173,929	250	50,748	188	32,699	83,447
2038	191,590	227,198	250	47,898	188	42,713	90,611
2039	189,673	269,752	250	47,418	188	50,713	98,132
2040	199,097	301,469	250	49,774	188	56,676	106,450
2041	183,477	340,707	250	45,869	189	64,553	110,422
2042	175,330	376,921	250	43,833	191	71,967	115,799
2043	158,786	418,788	250	39,697	192	80,575	120,271
2044	143,957	459,425	250	35,989	194	89,067	125,056
2045	131,748	500,566	250	32,937	195	97,777	130,714
2046	108,130	524,184	250	27,033	197	103,159	130,192
2047	80,063	552,251	250	20,016	198	109,493	129,509
2048	54,740	577,574	250	13,685	200	115,361	129,046
2049	28,932	603,382	250	7,233	201	121,400	128,633
2050	0	632,314	250	0	203	128,149	128,149
2051	0	632,314	250	0	204	129,076	129,076
2052	0	632,314	250	0	206	130,004	130,004
2053	0	632,314	250	0	207	130,931	130,931
2054	0	632,314	250	0	209	131,859	131,859
2055	0	632,314	250	0	210	132,786	132,786
2056	0	632,314	250	0	211	133,713	133,713
2057	0	632,314	250	0	213	134,641	134,641
2058	0	632,314	250	0	214	135,568	135,568
2059	0	632,314	250	0	216	136,496	136,496
2060	0	632,314	250	0	217	137,423	137,423
2061	0	632,314	250	0	219	138,350	138,350
2062	0	632,314	250	0	220	139,278	139,278
2063	0	632,314	250	0	222	140,205	140,205
2064	0	632,314	250	0	223	141,132	141,132
2065	0	632,314	250	0	225	142,060	142,060
2066	0	632,314	250	0	226	142,987	142,987
2067	0	632,314	250	0	228	143,915	143,915
2068	0	632,314	250	0	229	144,842	144,842
2069	0	632,314	250	0	231	145,769	145,769
2070	0	632,314	250	0	232	146,697	146,697

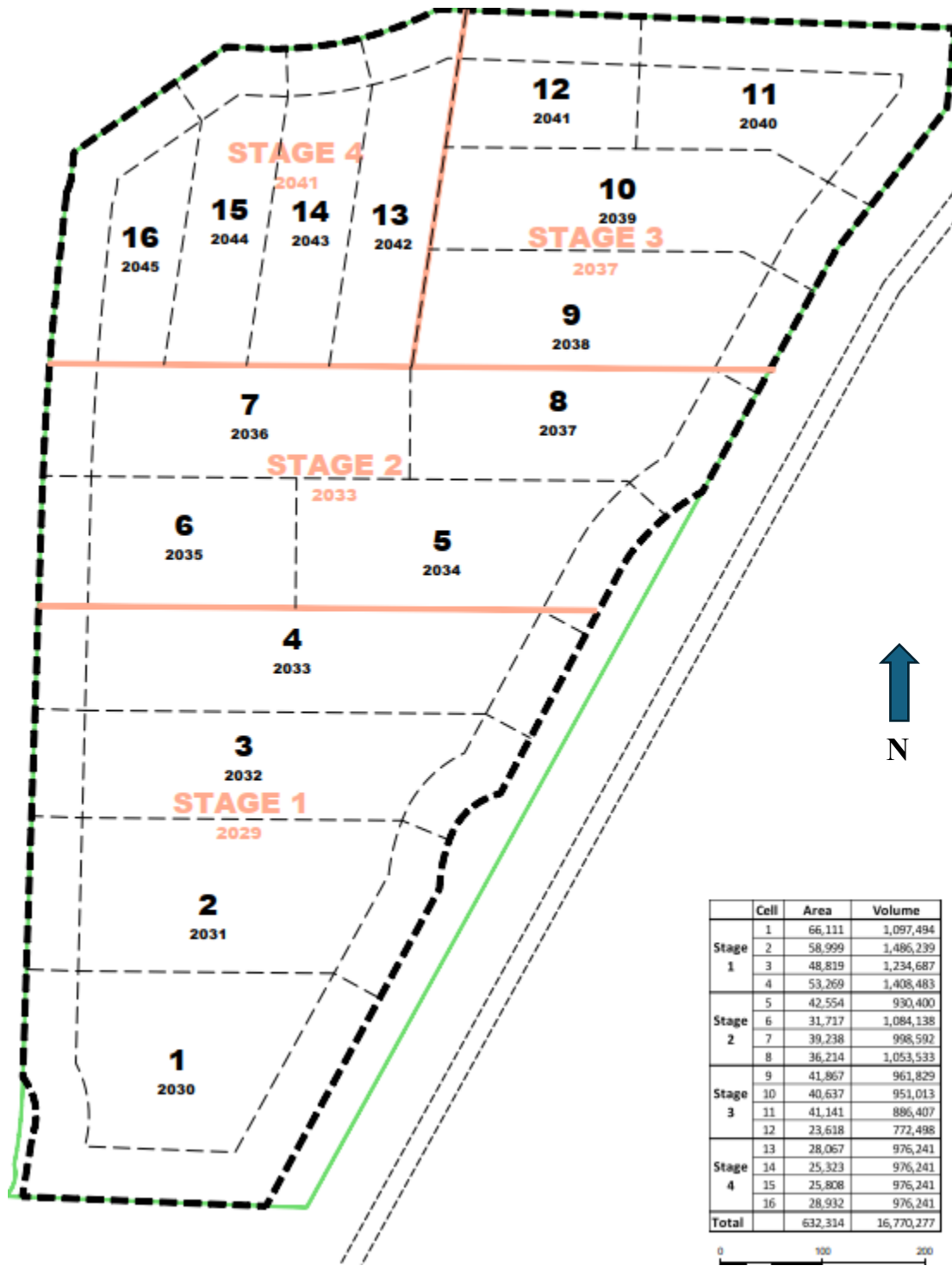


Figure 1. Cell Development Plan - Proposed South (Phase II) Landfill

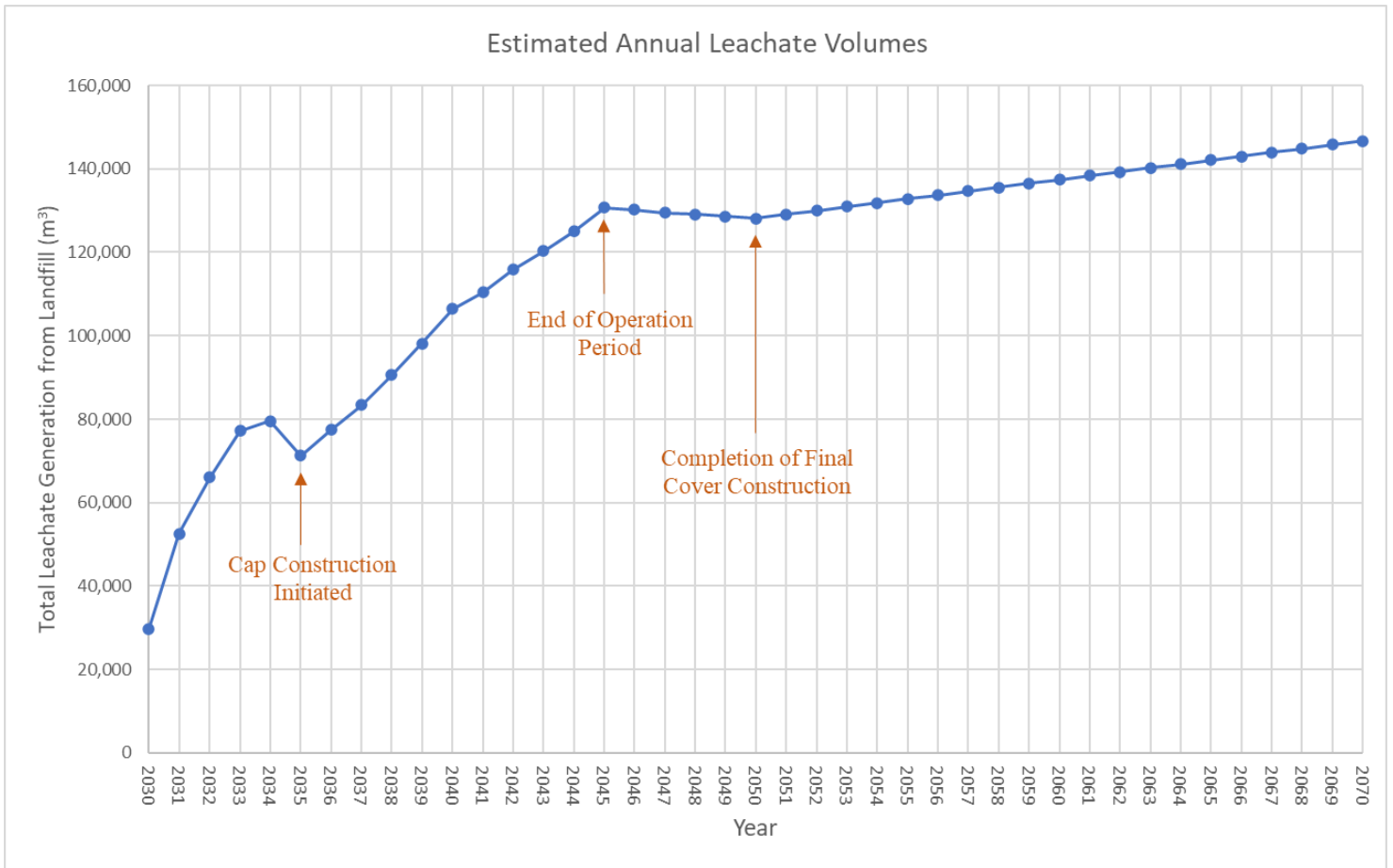


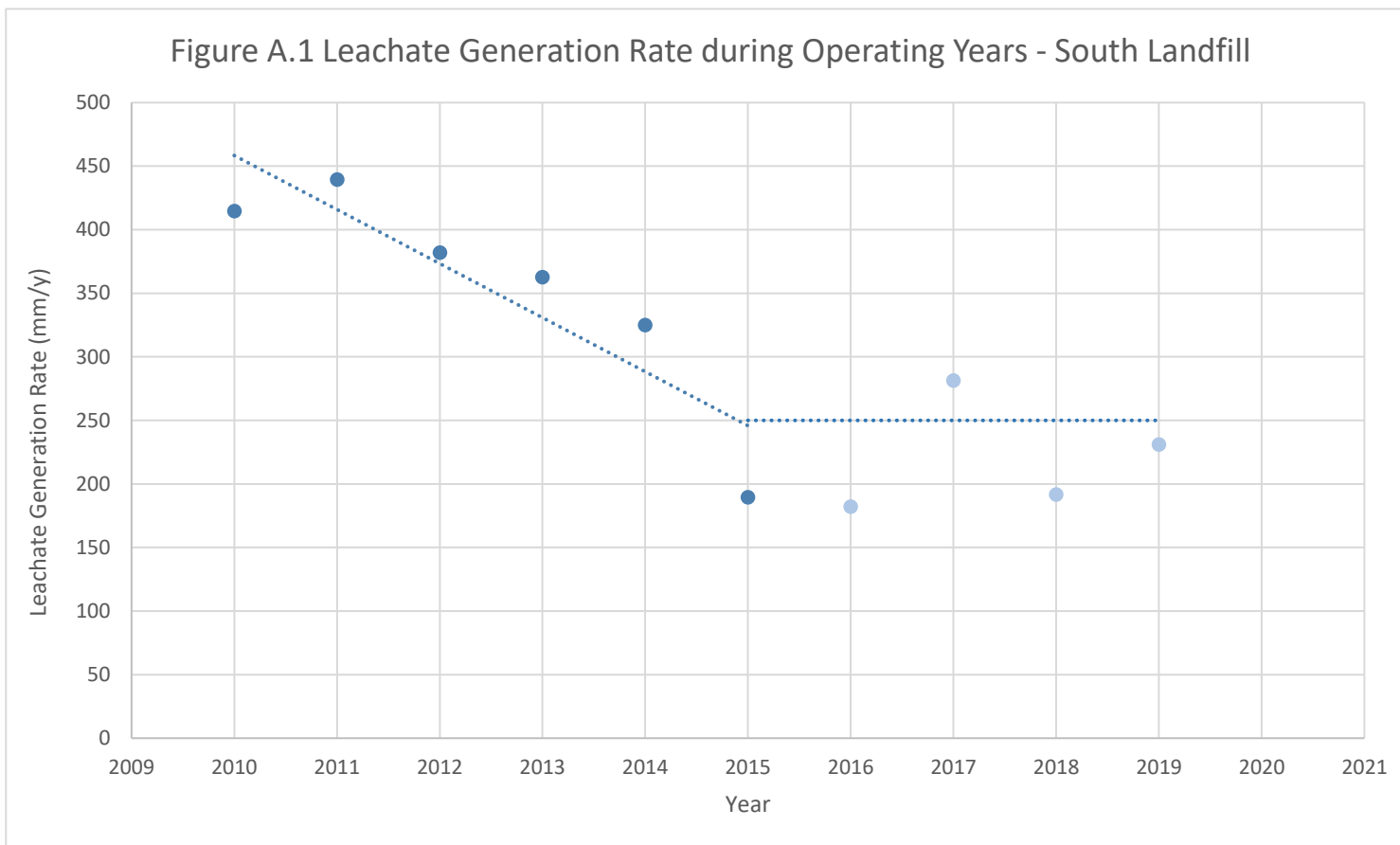
Figure 2. Estimated Annual Leachate Volumes – Proposed South (Phase II) Landfill

APPENDIX A

**Leachate Generation Rates from
Uncapped Waste Fill Areas
(Existing South Landfill)**

Table A.1. South Landfill Measured Annual Leachate Pumping Volumes and Equivalent Leachate Generation Rate Without Final Cover

Year	Area of Waste Fill Placement (m²)	Total Annual Leachate Pumping Volume (m³)	Equivalent Leachate Generation Rate (mm/y)
2010	75,222	31,179	414.5
2011	121,075	53,205	439.4
2012	144,686	55,242	381.8
2013	184,032	66,722	362.6
2014	228,183	74,138	324.9
2015	262,118	49,661	189.5
2016	316,388	57,633	182.2
2017	360,294	101,355	281.3
2018	384,638	73,673	191.5
2019	384,638	88,828	230.9



APPENDIX B

**HELP Modelling for Leachate
Generation Rate from Capped
Waste Fill Areas - Proposed South
(Phase II) Landfill**

Calculation of Leachate Generation Rates for Areas with Final Cover, Proposed Walker South (Phase 2) Landfill, Thorold, Ontario		
Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024

1.0 INTRODUCTION

The leachate generation rates due to atmospheric water infiltration through the final cover of the proposed South (Phase 2) Landfill at the Walker Environmental Group Thorold Campus was estimated using the Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07 (Ref.-1).

The HELP model is a quasi-two-dimensional water-balance model for water movement in the landfill (Ref-2.). The model accepts the weather data and landfill design data and uses solution techniques that account for the effect of different processes such as surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetation growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through liners (Ref-2. and Ref-3). The site-specific runoff, evapotranspiration, infiltration, drainage, leachate collection and liner leakage can be determined, as needed, using the HELP model.

2.0 CLIMATOLOGICAL INPUT PARAMETERS

Two different climatological scenarios were evaluated.

1. Without climate change; and
2. With climate change.

For the scenario without climate change, daily precipitation and temperature input data for the Site were synthetically generated using the HELP model (Ref. 1). This involved taking 30 years of continuous precipitation and temperature data for Buffalo, New York, USA (nearest reference station included in the HELP model database) and then adjusting the data with mean monthly precipitation and temperature values based on the average values for the St. Catherines Airport meteorological station as shown in the attached Table 1. Daily solar radiation data was synthetically generated using the HELP model by taking the Buffalo, New York solar radiation data (included in the HELP model database) and correcting the latitude for the Site. Average quarterly relative humidity and average annual wind speed for the Sarnia Airport meteorological station were used (refer to attached Table 2).

For the scenarios with climate change, the potential change in precipitation and temperature input data were based on Table 5 of Climate Change Research Report CRR-44, Lake Erie Basin, reference periods 2011-2040 and 2040-2071 and representative concentration pathway (RCP) of 4.5 W/m² (Ref. - 4). The precipitation and temperature input in for the climate change scenarios are presented in attached Table 3.

Calculation of Leachate Generation Rates for Areas with Final Cover, Proposed Walker South (Phase 2) Landfill, Thorold, Ontario		
Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024

3.0 WASTE ONLY, DAILY COVER, AND FINAL COVER INPUT PARAMETERS

The HELP model input parameters for the final cover are summarized in Table 4. The values used in the HELP model for total porosity, field capacity, wilting point are according to the HELP model default values as shown in the attached Table 3. For the soil cover layers and waste fill the initial water content was taken as equal to or greater than the field capacity water content, which is the water content at which the soil can no longer absorb/retain additional moisture under free drainage. With respect to modelling the leachate generation rate, this is a conservative assumption as it reduces the time to reach peak leachate generation.

The model for the final cover was run with a final cover slope of 5% and runoff path length of 200 m based on the final contours for the landfill.

4.0 VEGETATION INPUT PARAMETERS

The HELP model requires input data for the type and extent of vegetation growing on the cover, as well as input data for the evaporative zone depth. The leaf area index is defined as the dimensionless ratio of the leaf area of actively transpiring vegetation to the nominal surface area of the final cover. For the final cover, a ground with good stand of grass with a maximum leaf are index of 4 was used.

The evaporative zone depth is defined as the maximum depth from which water may be removed by evapotranspiration. For the final cover an evaporative zone depth of 50 cm was assumed for the sandy loam topsoil / clayey cover soil with good stand of grass.

5.0 RESULTS

The leachate generation rates obtained from the HELP modelling are provided in Table 5. The average annual leachate generation rate for the scenario without climate change is 178 mm/y. For the climate change scenarios, average annual leachate generation rates of 188 mm/y for Reference Period 2011-2040 and 232 mm/y for Reference Period 2041-2070.

Calculation of Leachate Generation Rates for Areas with Final Cover, Proposed Walker South (Phase 2) Landfill, Thorold, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
Reviewed by: F. Barone

Date: November 2024

REFERENCES

- Ref. 1 - The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07 (1 November 1997), Developed by Environmental Laboratory, USAE Waterways Experiment Station for U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, OH.
- Ref 2. – Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L. (1994). “The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3,” EPA/600/R-94/168b, September 1994, U.S. Environmental Protection Agency, Office of Research and Development, Washington DC.
- Ref 3. – Sharma, H.P. and Lewis, S.P. (1994). Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley and Sons, Inc. New York, 588p.
- Ref 4. - MNRF (2015). Climate Change Projects for Ontario: An Updated Synthesis for Policymakers and Planners, Ministry of Natural Resources and Forestry , Science and Research, Climate Change Research Report CCRR-44.

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
 Reviewed by: F. Barone

Date: November 2024

TABLE 1: NORMAL MEAN MONTHLY PRECIPITATION AND TEMPERATURE AT ST. CATHARINES AIRPORT METEOROLOGICAL STATION [1981-2010 DATA]

Climate ID: 6137287

Elevation: 97.8 masl

Latitude: 43°12'00.000" N

Longitude: 79°10'00.000" W

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Precipitation	mm	65.2	54.9	61.7	77	76.8	85.9	77.8	70.3	90.6	67	81.6	71.5
Temperature	°C	-3.8	-2.9	1.1	7.4	13.7	19	21.9	20.8	16.6	10.4	4.6	-0.9

Source: Canadian Climate Normals 1981-2010 (Environment Canada).

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
Reviewed by: F. Barone

Date: November 2024

TABLE 2: NORMAL RELATIVE HUMIDITY AND WINDSPEED AT ST. CATHARINES AIRPORT METEOROLOGICAL STATION [1981-2010 DATA]

Climate ID: 6137287

Elevation: 97.8 masl

Latitude: 43°12'00.000" N

Longitude: 79°10'00.000" W

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative Humidity at 15:00	%	73	67.7	62.9	57.6	55.9	58.1	57.5	59	60.5	64.5	69.1	71.9
Average Quarterly Relative Humidity	%	67.9			57.2			59.0			68.5		
Windspeed*	km/h	21.1	19.2	18.5	17.3	14.5	13.9	13.2	12.4	13.6	15.4	18.2	19
Average Annual Windspeed	km/h	16.4											

Source: Canadian Climate Normals 1981-2010 (Environment Canada).

*Wind Speed: Canadian Climate Normals 1971-2000 (Environment Canada).

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
Reviewed by: F. Barone

Date: November 2024

TABLE 3: MEAN MONTHLY PRECIPITATION AND TEMPERATURE FOR CLIMATE CHANGE SCENARIOS

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reference Period 2011-2040													
Total Precipitation	mm	76.1	65.8	62.9	78.2	78.0	83.1	75.0	67.5	91.8	68.2	82.8	82.4
Temperature	°C	-1.7	-0.80	3.5	9.8	16.1	21.0	23.9	22.8	19.0	12.8	7.0	1.2
Reference Period 2041-2070													
Total Precipitation	mm	75.9	65.6	70.4	85.7	85.5	85.6	77.5	70.0	99.3	75.7	90.3	82.2
Temperature	°C	0.3	1.20	4.7	11.0	17.3	22.2	25.1	24.0	20.2	14.0	8.2	3.2

Source: Mean monthly precipitation and temperature was modified using Table 5 of Ref-4 to account for climate change.

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal

Date: November 2024

Reviewed by: F. Barone

TABLE 4: HELP MODEL INPUT PARAMETERS[†]

Input Parameters	Units	Waste	Final Cover	
			Topsoil	Cover Soil
HELP Model Soil Texture Class [†]	[-]	-	6	26
USDA Soil Texture Class / Description	[-]	MSW	Sandy Loam (SL)	Silty Clay (SiCL) (Moderate)
Thickness	m	10 m	0.15	0.60
Total porosity	[-]	0.671	0.453	0.445
Field capacity	[-]	0.292	0.190	0.393
Wilting point	[-]	0.077	0.085	0.277
Initial volumetric water content	[-]	0.292	0.190	0.445
Hydraulic Conductivity*	cm/s	1.0×10^{-3}	7.2×10^{-4}	1.9×10^{-6}

Notes: [†] HELP model default soil texture class were used together with model default parameters for total porosity, field capacity, wilting point and hydraulic conductivity. HELP model default parameters for total porosity, field capacity, wilting point and hydraulic conductivity are considered representative for the waste fill at the Site. Specified hydraulic conductivity was used for the final cover soil.

* Effective saturated hydraulic conductivity.

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
Reviewed by: F. Barone

Date: November 2024

TABLE 5: PREDICTED LEACHATE GENERATION RATES WITH FINAL COVER

Month	Without Climate Change		With Climate Change Reference Period (2011-2040)		With Climate Change Reference Period (2041-2070)	
	Avg. (mm)	Potential Peak (mm)	Avg. (mm)	Potential Peak (mm)	Avg. (mm)	Potential Peak (mm)
January	28	52	40	62	41	59
February	7	14	28	55	39	65
March	8	13	13	31	34	61
April	20	26	39	57	44	62
May	13	21	23	45	20	42
June	8	16	1	4	3	10
July	7	13	0	0	0	0
August	9	12	0	0	0	0
September	12	21	0	1	0	1
October	19	29	6	17	7	19
November	25	36	13	26	16	30
December	27	36	25	35	28	38
Annual Avg.	178		188		232	



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B

**Example Calculation for Leakage Rate
Through the Primary Composite Liner**



Calculation for Leakage Rate Through Geomembrane/GCL Composite Liner		
South Landfill Phase 2, Walker Environmental Group, Thorold, Ontario		
Project No.: CA0065457.5367	Prepared by: S. Rimal Reviewed by: F. Barone	Date: April 2026

References:

Ref. 1 - Giroud J.P. (1997). "Equations for Calculating the Rate of Liquid Migration Through Composite Liners due to Geomembrane Defects." Geosynthetics International, Vol. 4, Nos. 3-4, pp. 335-348.

Ref. 2 - Giroud J.P. and Bonaparte, R. (2001). "Geosynthetics in Liquid Containing Structures." In Geotechnical and Geoenvironmental Engineering Handbook. (Edited by R. Kerry Rowe), Kluwer Academic Publishing, Norwell, Mass. pp. 789-824.

Ref. 3 - Rowe, R.K., Quigley, R.M., Brachman, R.W.I., and Booker, J.R. (2004). Barrier Systems for Waste Disposal Facilities, 2nd Edition, Spon Press, 587p.

Ref. 4 – Rowe, R.K. (2012). "Short- and Long-Term Leakage through Composite Liners. The Arthur Casagrande Lecture." Canadian Geotechnical Journal, Vol. 49, pp. 141-169.

1. LEAKAGE RATE THROUGH GEOMEMBRANE / GCL COMPOSITE LINER

Leakage through a 2 mm diameter hole in the geomembrane in good contact with geosynthetic clay liner (GCL):

The leakage rate per hole can be estimated using the Giroud equation (Ref. 1):

$$Q = 0.976 C_{qo} [1 + 0.1 (h / t_s)^{0.95}] d^{0.2} h^{0.9} k_s^{0.74} \quad [\text{Eqn. 1}]$$

Where,

Q = leakage rate per hole coincident with a wrinkle (m³/s)

C_{qo} = geomembrane / GCL contact quality factor (dimensionless)

= 0.21 where the geomembrane is installed with as few wrinkles as possible (good contact conditions, Ref. 1)

d = diameter of the circular hole (m)

= 0.002 m (Ref. 2)

h = average leachate head acting on the surface of the geomembrane liner

= 0.3 m

k_s = hydraulic conductivity of the GCL component of the composite liner

= 5 x 10⁻¹¹ m/s (e.g. for Bentofix[®] NW GCL with 4.34 kg/m² minimum bentonite mass per unit area)

t_s = thickness of GCL component of the composite liner

= 0.005 m

Calculation for Leakage Rate Through Geomembrane/GCL Composite Liner		
South Landfill Phase 2, Walker Environmental Group, Thorold, Ontario		
Project No.: CA0065457.5367	Prepared by: S. Rimal Reviewed by: F. Barone	Date: April 2026

Therefore substituting the above input values into Eqn. 1 we get:

$$Q = 2.8 \times 10^{-9} \text{ m}^3/\text{s} \text{ for 2 mm diameter hole (leakage rate per hole with geomembrane / GCL in good contact)}$$

Leakage through a 2 mm diameter hole in the geomembrane coincident with a wrinkle in the geomembrane:

The leakage rate through a hole in the geomembrane coincident with a wrinkle can be predicted using the Rowe equation (Ref. 4).

$$Q^* = 2 L [k b + (k D \theta)^{0.5}] h_d / D \quad \text{[Eqn. 2]}$$

Where,

$$Q^* = \text{leakage rate per hole (m}^3/\text{s)}$$

$$L = \text{length of interconnected wrinkles per hectare that leakage from the hole spreads out (m)}$$

$$= 500 \text{ m (Ref. 4)}$$

$$k = \text{hydraulic conductivity of the GCL beneath the wrinkle}$$

$$= 2 \times 10^{-10} \text{ m/s (assumed directly beneath the wrinkle, e.g. Ref. 4)}$$

$$2b = \text{width of the wrinkle (m) = 0.2 m (Ref. 4; for typical eastern Canadian construction season)}$$

$$D = \text{thickness of the GCL (m) = 0.005 m}$$

$$\theta = \text{transmissivity of geomembrane / GCL interface adjacent to wrinkle (m}^2/\text{s)}$$

$$= 1.8 \times 10^{-11} \text{ m}^2/\text{s (Ref. 4 Table 6 for nonwoven geotextile component of GCL in contact with textured geomembrane)}$$

$$h_d = \text{head loss across the composite liner (m) i.e. } h + D, \text{ where } h = 0.3 \text{ m is the head on the geomembrane liner}$$

$$= 0.3 \text{ m} + 0.005 \text{ m}$$

$$= 0.305 \text{ m}$$

Therefore substituting the above input values into Eqn. 2 we get:

$$Q^* = 1.5 \times 10^{-6} \text{ m}^3/\text{s} \text{ for 2 mm diameter hole (leakage rate per hole coincident with wrinkle)}$$

Overall Leakage rate through the geomembrane/GCL composite liner:

Total number of holes per hectare = 5 holes/ha (Ref. 2 and Ref 3). Assumed 4 holes in the area where geomembrane is in good contact with the GCL and 1 hole in the geomembrane coincident with a wrinkle that interconnects with 500 m of wrinkles per hectare.

Calculation for Leakage Rate Through Geomembrane/GCL Composite Liner		
South Landfill Phase 2, Walker Environmental Group, Thorold, Ontario		
Project No.: CA0065457.5367	Prepared by: S. Rimal Reviewed by: F. Barone	Date: April 2026

Therefore, total leakage rate per hectare through the composite liner where geomembrane is in good contact with the GCL is:

For 2 mm diameter hole
$Q_{\text{Total (Good Contact)}}$
= 4 holes/hectare x 2.8×10^{-9} m ³ /s per hole
= 1.1×10^{-8} m ³ /s per hectare
= 0.35 m ³ /year per hectare
= 0.035 mm/year (leakage flux)

Total leakage rate per hectare through the composite liner where a hole in the geomembrane is coincident with a wrinkle is:

For 2 mm diameter hole
$Q_{\text{Total (Wrinkle)}}$
= 1 hole per hectare x 1.5×10^{-6} m ³ /s per hole
= 1.5×10^{-6} m ³ /s per hectare
= 46.6 m ³ /year per hectare
= 4.6 mm/year (leakage flux)

Total leakage through the composite liner:

$$Q_{\text{Total}} = Q_{\text{Total (Good Contact)}} + Q_{\text{Total (Wrinkle)}}$$

For 2 mm diameter hole
Q_{Total}
= 1.5×10^{-6} m ³ /s per hectare
= 47 m ³ /year per hectare
= 4.7 mm/year (leakage flux)

Calculation for Leakage Rate Through Geomembrane/Compacted Clay Composite Liner		
South Landfill Phase 2, Walker Environmental Group, Thorold, Ontario		
Project No.: CA0065457.5367	Prepared by: S. Rimal Reviewed by: F. Barone	Date: April 2026

References:

Ref. 1 - Giroud J.P. (1997). "Equations for Calculating the Rate of Liquid Migration Through Composite Liners due to Geomembrane Defects." Geosynthetics International, Vol. 4, Nos. 3-4, pp. 335-348.

Ref. 2 - Giroud J.P. and Bonaparte, R. (2001). "Geosynthetics in Liquid Containing Structures." In Geotechnical and Geoenvironmental Engineering Handbook. (Edited by R. Kerry Rowe), Kluwer Academic Publishing, Norwell, Mass. pp. 789-824.

Ref. 3 - Rowe, R.K., Quigley, R.M., Brachman, R.W.I., and Booker, J.R. (2004). Barrier Systems for Waste Disposal Facilities, 2nd Edition, Spon Press, 587p.

Ref. 4 – Rowe, R.K. (2012). "Short- and Long-Term Leakage through Composite Liners. The Arthur Casagrande Lecture." Canadian Geotechnical Journal, Vol. 49, pp. 141-169.

1. LEAKAGE RATE THROUGH GEOMEMBRANE / COMPACTED CLAY COMPOSITE LINER

Leakage through a 2 mm diameter hole in the geomembrane in good contact with clay liner:

The leakage rate per hole can be estimated using the Giroud equation (Ref. 1):

$$Q = 0.976 C_{qo} [1 + 0.1 (h / t_s)^{0.95}] d^{0.2} h^{0.9} k_s^{0.74} \quad \text{[Eqn. 1]}$$

Where,

Q = leakage rate per hole coincident with a wrinkle (m³/s)

C_{qo} = geomembrane / clay liner contact quality factor (dimensionless)

= 0.21 where the geomembrane is installed with as few wrinkles as possible (good contact conditions, Ref. 1)

d = diameter of the circular hole (m)

= 0.002 m (Ref. 2)

h = average leachate head acting on the surface of the geomembrane liner

= 0.3 m

k_s = hydraulic conductivity of the clay liner

= 5 x 10⁻¹⁰ m/s

t_s = thickness of the clay liner

= 0.75 m

Calculation for Leakage Rate Through Geomembrane/Compacted Clay Composite Liner		
South Landfill Phase 2, Walker Environmental Group, Thorold, Ontario		
Project No.: CA0065457.5367	Prepared by: S. Rimal Reviewed by: F. Barone	Date: April 2026

Therefore substituting the above input values into Eqn. 1 we get:

$Q = 2.7 \times 10^{-9} \text{ m}^3/\text{s}$ for 2 mm diameter hole (leakage rate per hole with geomembrane / clay liner in good contact)

Leakage through a 2 mm diameter hole in the geomembrane coincident with a wrinkle in the geomembrane:

The leakage rate through a hole in the geomembrane coincident with a wrinkle can be predicted using the Rowe equation (Ref. 4).

$$Q^* = 2 L [k b + (k D \theta)^{0.5}] h_d / D \quad \text{[Eqn. 2]}$$

Where,

Q^* = leakage rate per hole (m^3/s)

L = length of interconnected wrinkles per hectare that leakage from the hole spreads out (m)
= 500 m (Ref. 4)

k = hydraulic conductivity of the clay liner beneath the wrinkle
= $5 \times 10^{-10} \text{ m/s}$

$2b$ = width of the wrinkle (m) = 0.2 m (Ref. 4; for typical eastern Canadian construction season)

D = thickness of the clay liner (m) = 0.75 m

θ = transmissivity of geomembrane / clay liner interface adjacent to wrinkle (m^2/s)
= $1.1 \times 10^{-8} \text{ m}^2/\text{s}$ (Ref. 4 Equation 4)

h_d = head loss across the composite liner (m) i.e. $h + D$, where $h = 0.3 \text{ m}$ is the head on the geomembrane liner
= $0.3 \text{ m} + 0.75 \text{ m}$
= 1.05 m

Therefore substituting the above input values into Eqn. 2 we get:

$Q^* = 2.9 \times 10^{-6} \text{ m}^3/\text{s}$ for 2 mm diameter hole (leakage rate per hole coincident with wrinkle)

Overall Leakage rate through the geomembrane/clay composite liner:

Total number of holes per hectare = 5 holes/ha (Ref. 2 and Ref 3). Assumed 4 holes in the area where geomembrane is in good contact with the clay liner and 1 hole in the geomembrane coincident with a wrinkle that interconnects with 500 m of wrinkles per hectare.

Calculation for Leakage Rate Through Geomembrane/Compacted Clay Composite Liner		
South Landfill Phase 2, Walker Environmental Group, Thorold, Ontario		
Project No.: CA0065457.5367	Prepared by: S. Rimal Reviewed by: F. Barone	Date: April 2026

Therefore, total leakage rate per hectare through the composite liner where geomembrane is in good contact with the clay liner is:

For 2 mm diameter hole
$Q_{\text{Total (Good Contact)}}$
= 4 holes/hectare x 2.7×10^{-9} m ³ /s per hole
= 1.1×10^{-8} m ³ /s per hectare
= 0.34 m ³ /year per hectare
= 0.034 mm/year (leakage flux)

Total leakage rate per hectare through the composite liner where a hole in the geomembrane is coincident with a wrinkle is:

For 2 mm diameter hole
$Q_{\text{Total (Wrinkle)}}$
= 1 hole per hectare x 2.9×10^{-6} m ³ /s per hole
= 2.9×10^{-6} m ³ /s per hectare
= 92 m ³ /year per hectare
= 9.2 mm/year (leakage flux)

Total leakage through the composite liner:

$$Q_{\text{Total}} = Q_{\text{Total (Good Contact)}} + Q_{\text{Total (Wrinkle)}}$$

For 2 mm diameter hole
Q_{Total}
= 2.9×10^{-6} m ³ /s per hectare
= 92 m ³ /year per hectare
= 9.2 mm/year (leakage flux)

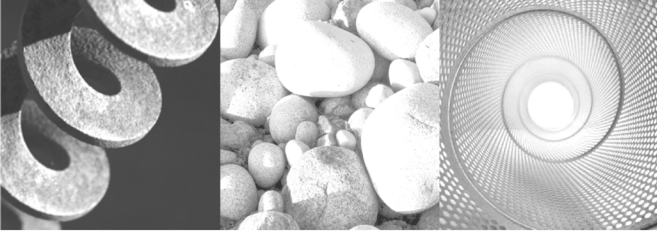


FINAL DRAFT



APPENDIX B

**Final Functional Water and
Wastewater Servicing Report**



South Landfill Phase 2 Environmental Assessment
Final Functional Water and Wastewater Servicing Report
Revision 3

Submitted to:

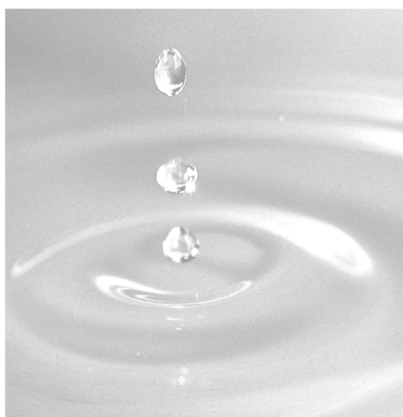
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May 2026

Project No. 2500660



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1. Introduction

1.1. Overview

Walker Environmental Group Inc. (Walker) initiated an Environmental Assessment (EA) in November 2023 to support South Landfill Phase 2 at Walker's Integrated Resource Management Campus (Walker Campus) located at 2800 Thorold Townline Road, Niagara Falls, Ontario.

In support of the EA and future development application submissions, GEI Consultants Canada (GEI) was retained to complete this Functional Servicing Report (FSR) for review and approval by Niagara Region and Town of Niagara-on-the-Lake (NOTL) to document the water and wastewater servicing required to support the proposed South Landfill Phase 2 and associated changes in leachate production. As of April 2025, the EA is in the process of developing alternative landfill site configurations and leachate management options.

1.2. Background and Existing Conditions

The Walker Campus is located south of the Glendale area in Niagara-on-the-Lake where the existing Walker wastewater outlets to the Town and Region wastewater network. The Walker Campus is not serviced by the municipal water system.

The Walker Campus is generally located north of Thorold Stone Road, west of Garner Road, and east of Thorold Townline Road, south of the CN Rail tracks in the City of Niagara Falls. The site currently contains an east and south landfill with two associated leachate treatment lagoons, as well as quarry, a biosolids facility, a composting facility, a recycling depot, an asphalt plant, and other resource recovery and waste management facilities.

1.2.1. Background Reports

There are various background studies and reports that this FSR builds on and references, including the following:

Glendale Secondary Plan Update Area Servicing Plan (August 28, 2024, GM BluePlan Engineering Ltd)

There are plans for significant growth within the downstream Glendale Area – up to 22,500 persons plus jobs as documented in the 2024 Glendale Secondary Plan. An Area Servicing Plan (ASP) was completed by GEI in support of the Secondary Plan, which is included as **Appendix E**. Both high density (~80 PPJ/ha) and low density (~60 PPJ/ha) growth scenarios were considered through the Glendale ASP. As part of the ASP, wastewater flows for the Walker Campus were included as part of the hydraulic modelling utilized (based on the Region's most recent Water and Wastewater Master Plan Update) but future increases based on the South Landfill Phase 2 project were not specifically contemplated.

Wastewater within the downstream Glendale area is conveyed by a network of local and regional sewers, ultimately discharging to the Port Weller Wastewater Treatment Plant (WWTP) in St. Catharines.

The Glendale Secondary Plan ASP indicated that the existing wastewater network had sufficient capacity to accommodate wastewater flows associated with the projected growth for the area.

The capacity of the existing sewer siphon used to convey flows in the Queenston Road trunk sewer across the Welland Canal was identified for additional review. Specifically, if the Secondary Plan's high-density growth scenario is fully achieved, the downstream siphon may be required to be upgraded near build-out of the Glendale area. The report noted that siphon capacity along with development progress and planned (and anticipated) densities for the Glendale SPA should continue to be monitored with consideration for replacement and upgrades to be incorporated into future Region-wide Master Servicing Studies.

The ASP also noted that the existing Decew Water Treatment Plant (WTP) and the existing area water network can accommodate growth within the Secondary Plan area. Additionally, a new trunk watermain to Virgil Elevated Tank and new elevated tank in Virgil are recommended for 2032 and 2043, respectively to address the storage issues in broader Niagara-on-the-Lake and continue to support growth within the Glendale area.

Niagara Region Water and Wastewater Master Servicing Plan Updates (2021 and 2026, GM BluePlan Engineering Ltd. / GEI Consultants Canada Inc.)

In 2018, Region Water and Wastewater Planning identified the hydraulic capacity for the sanitary sewer system servicing the Glendale Secondary Plan area, as well as Walker Industries and the Airport Road SPS collected through the Siphon, inclusive of the Walker Landfill maximum agreed flow rate of 17 L/s, can be considered to be **300 L/s**. A subsequent 2021 Water and Wastewater Master Servicing Plan Update (MSPU) used a planning horizon of 2031 to 2051, with consideration for post-2051 build-out.

The Glendale Secondary Plan ASP described in the previous section was completed utilizing growth projections and the water and wastewater modelling developed in support of the Region's 2021 MSPU. The Region awarded the 2026 Master Servicing Plan (MSP) to GEI in early 2025. The current MSP has not yet been progressed to include updated analysis and recommended projects. The findings and recommendations from the Glendale Secondary Plan ASP (as well as from this FSR) will inform the 2026 MSP work.

The capacity of the siphon is a Region consideration for the larger catchment area and will be reviewed again as part of the on-going Region-wide Master Servicing Plan update using updated growth projections.

1.2.2. Water System

As noted above, the Walker Campus does not currently have a potable water service from the Niagara Region's water supply system. Drinking water for offices is delivered in coolers from a private vendor. Hauled potable water is brought to site for use in office sinks, washrooms and showers and is stored in cisterns at the head office (12,000 gal / ~45,500 L) and at the Walker Environmental Facility building (30,000 gal / ~113,500 L) for a total volume of 42,000 gal (~159,000 L).

Fire flow storage is provided in underground tanks and service ponds with approximately 140,000 gallons (~530,000 L) of storage. Fire water is stored near various facilities throughout the property, including at the Landfill Gas Utilization Facility office trailer, as to comply with the Ontario building code at time of construction.

Finally, Walker has a Permit to Take Water (PTTW) last updated January 9, 2023 from the Ministry of Environment, Conservation and Parks (MECP) to take up to 14.4 MLD for dewatering to allow operation of the aggregate quarry. The 2024 Annual Monitoring Report prepared by Urban and Environmental Management Inc reported that the total volume of dewatering in 2024 was 365,259 m³. The maximum daily taking in the PTTW would amount to 5,256,000 m³/year which is substantially greater than the volumes taken. The 2024 estimated daily pumping records evaluated for this report indicated that the daily and hourly pumping rates were also below the maximum permitted rates. Groundwater removed is used for dust suppression, vehicle washing, aggregate washing and internal drainage management as a part of the quarry operation and is not potable.

1.2.3. Sanitary System

Leachate from the existing landfills is collected via the leachate collection systems that sit above the landfill bottom liner systems and is conveyed to a two-cell aerated leachate treatment lagoon system to reduce biological oxygen demand (BOD) and total solids. Leachate from the composting facility as well as site office sanitary flows are also sent to the lagoon system. Partially treated leachate is then conveyed along a Walker-owned forcemain and gravity sewer along Taylor Road before discharging into the municipal sanitary collection system in the Town of NOTL at MH-6 on Taylor Road, south of Glendale Avenue. The portion of the sanitary system up to, but not including MH 6 at the Hydro Corridor crossing on Taylor Road is owned and maintained by Walker. Refer to Figure 1-1 that illustrates the existing sanitary system from the leachate lagoons to the discharge point into the municipal sewer.

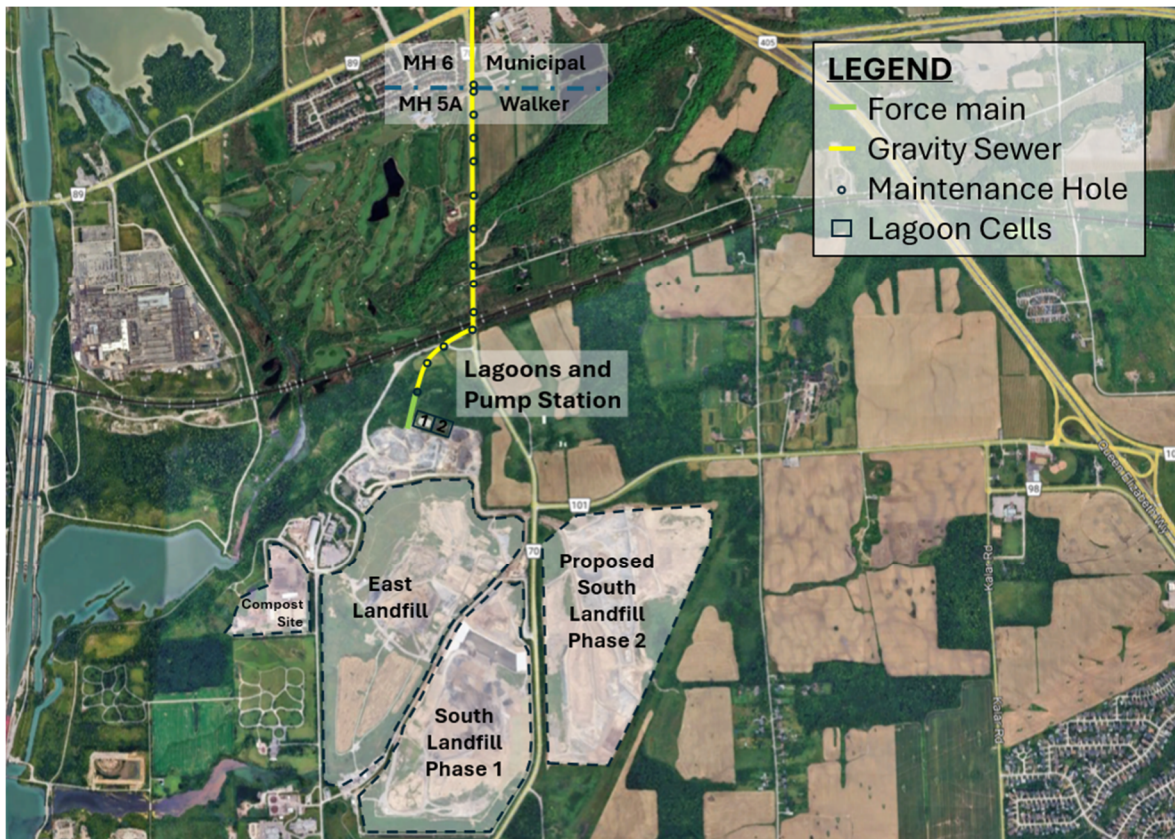


Figure 1-1: Existing Lagoon Storage and Sanitary forcemain and sewers for Walker Campus

1.2.4. Existing Municipal Sewer Use Agreements

Town of Niagara-on-the-Lake

The volume of sanitary flow from the Walker Campus into the municipal collection system is dictated by the Sewer Use Agreement authorized between Niagara Waste Systems Limited (now Walker) and NOTL on July 27, 2009. The maximum allowable flow to the municipal sewer in the agreement is 17 L/s. Only sanitary sewage from the office washrooms and building floor drains is approved to be sent directly to the collection system without pretreatment and testing. The agreement also stipulates that Walker must maintain 4,500 m³ of onsite storage.

Niagara Region

The quality of Walker's sanitary flow discharged into the municipal sewer was originally dictated by the Region's Sewer Use Agreement dated February 5th, 1996. Region staff have noted that this Agreement is no longer active. This agreement stipulates an average BOD limit of 100 mg/L and maximum limit of 2,500 mg/L. The agreement also stipulates an average TSS limit of 100 mg/L and maximum limit of 500 mg/L. BOD, TSS and a variety of other parameters specified in the agreement are to be sampled monthly. This agreement also stipulates discharge quantity limitations, but these are overridden by the more recent NOTL agreement. Quality parameters not specifically described in the agreement with the Region must follow the requirements of the latest version of the Region's Sewer Use Bylaw (BY-LAW NO. 2024-81).

2. Overview of Proposed Development

An Environmental Assessment (EA) was initiated by Walker in November 2023 to support the development of Phase 2 of the South Landfill, converting the existing quarry site to provide an additional 18 million cubic meters of solid, non-hazardous waste disposal capacity. Phase 2 of the South Landfill will generate a larger volume of leachate that must be managed. **Figure 2-1** below shows the proposed landfill under the EA, as the area outlined with a yellow dotted line. Additional details on the EA can be found at the Walker EA website: <https://southlandfillphase2.com/>.



Figure 2-1: Overview of South Landfill Phase 2 Proposed for 2030

The projected quantities of landfill leachate to be generated through the South Landfill Phase 2 were determined through the Landfill Leachate Production Study completed by WSP in 2024 provided in **Addendum B**.

This FSR will support the evaluation of alternatives being considered under the EA, specifically the continued discharge of sanitary flows from Walker to the municipal sewer. A stormwater management report will be completed in support of future Site Plan Approval, to be completed at the conclusion of the EA as part of detailed design.

3. Water Servicing

The Walker Campus currently imports all drinking water for office use by employees and additional potable water used for washrooms, sinks, and showers. The facility also stores non-potable water for fire flow storage. Current water sources and storage are summarized in the table below:

Table 3-1 – Water Supply Overview

Water Use	Source	Available Storage Volume (m3)	Type of Storage	Population Served
Drinking Water for Employees	Private vendor	n/a	Water Coolers from private vendor	70 staff (average) 140 staff (maximum)
Potable water for sinks, toilets, showers	Hauled potable water	159	Two cisterns	70 staff (average) 140 staff (maximum)
Fire Flow Storage	Hauled potable	530	Buried tanks, service ponds	--

To estimate water demand for office use, a rate of 70 L/person/day (or 210L/person/8-hour workday) was used based on values from Table 3-2 Typical Water Demand for Selected Commercial and Institutional Users in Design Guidelines for Drinking-Water Systems (Ministry of Environment, 2008). A peaking factor of 1.5 was used, as the number of fixtures is unknown. As a worst-case scenario, using the maximum population of 140 staff to be serviced, the total office water demand is calculated as follows:

$$\text{Total office water demand (L)} = 70 \text{ L/person/day} \times 140 \text{ people} \times 1.5 \text{ peaking factor} = 14,700 \text{ L/day}$$

Based on this demand, the available storage volume of 159,000 L would provide sufficient supply for 11 days. Based on the average population of 70 staff, this increases to 22 days. Refilling the cisterns at a 1.5 to 3-week interval is reasonable, and the current supply method for the office is sufficient. There are no expected increases in drinking water demand based on the proposed South Landfill Phase 2 project.

Walker staff have noted that fire storage volumes and pump capacity are sized to meet the requirements of the Ontario Building Code for fire protection at the time of construction. Fire flow requirements for this industrial facility were not provided, so the fire storage volume was not assessed as part of this study.

At this time, there is no indication to change the drinking water supply system at the Walker Campus. If there is a future requirement to connect to the municipal distribution system, an updated FSR will be required. Future Town and Region Water Master Plan Updates could potentially incorporate updated water demand information for the Walker Facility, if an application was completed by Walker and approved by the Region to extend the municipal watermain.

4. Sanitary Servicing

4.1. Future Capacity Requirements

As previously described, sanitary servicing for the site is currently provided through a connection to the Town's sanitary collection system in at MH 6 at the Hydro Corridor crossing on Taylor Road in NOTL within the Port Weller WWTP catchment. The proposed South Landfill Phase 2 is anticipated to generate leachate volumes as estimated by the *Predicted Annual Leachate Volumes – Proposed South (Phase II) Landfill* report (WSP, 2024). The estimates took into consideration the area of the landfill site with and without final cover material, and climate change impacts over time. The report provided average annual and peak monthly flow estimates for 40 years following the start of landfill use from 2030 to 2070. As shown in **Figure 4-1**, the landfill is estimated to generate a peak operating leachate volume at the end of its operation period in 2050, followed by a decline in generation as cells are capped, and finally follows a gradually rising trend based on the projected increase in precipitation intensity due to climate change.

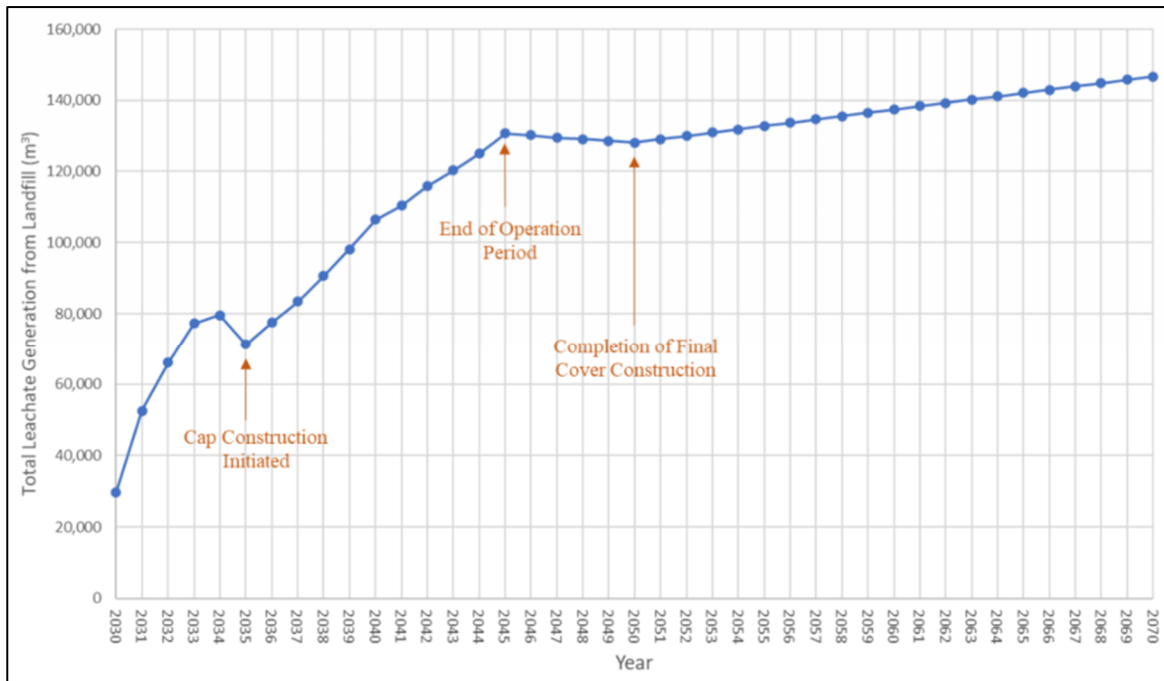


Figure 4-1: Estimated Annual Leachate Volumes from proposed South Phase II Landfill (WSP, 2024)

GEI used this information to develop peak leachate flow rates from the site for sewer capacity analysis under different scenarios:

- Existing conditions
- 2030 (beginning of operation period)
- 2050 (end of operation period); and
- 2070 (maximum estimated leachate generation).

Ideally, the leachate flow rate used for downstream sanitary sewer capacity analysis is representative of the peak flow generated from the site during a rainfall event, based on best available data. As such, for

existing peak leachate flows, GEI used a leachate rate of 460,000 m³/year based on the maximum historical annual leachate data provided by Walker staff. Future peak leachate rates were calculated using WSP’s peak monthly estimate and extrapolated to the annual trend between 2050 and 2070 for a more conservative estimate. The following table summarizes the estimated leachate flows from the site used in the GEI analysis. Calculations are provided in **Appendix A**.

Table 4-1. Existing and Anticipated Sanitary Flows to the Port Weller WWTP Catchment

	Existing Sanitary Design Flows		Estimated 2030 Total Flows		Estimated 2050 Total Flow		Estimated 2070 Total Flows	
	m ³ /year	L/s	m ³ /year	L/s	m ³ /year	L/s	m ³ /year	L/s
Annual Flows	460,000	14.6*	489,750	15.5	588,149	18.7	606,697	19.2
Peak Month Flow (extrapolated)	--	14.6	--	16.3	--	31.8	--	31.8

*Equivalent to maximum allowable instantaneous flow of leachate discharge pumps into municipal sanitary sewer.

4.1.1. Hydraulic Modelling Assessment

4.1.1.1. Modelling Approach and Assumptions

A hydraulic analysis was completed using the recently calibrated NOTL wastewater hydraulic model in PCSWMM that was updated as part of the Town’s Pollution Prevention Control Plan (2022). It should be noted that the model did not include privately owned sewers, including those within the Walker Campus site. Private landfill sewers were added to the model using as-built drawings by DeLCan De Leuw Cather Canada Limited dated December 1985. Rainfall derived inflow and infiltration (RDII) were excluded for Walker-owned private sewers, as there is limited information on the area contributing RDII, and high-level calculations based on the Region’s model criteria could not be easily validated. The model has been calibrated based on downstream flow monitoring, and RDII flows within the municipal system are accurately captured (and impacts of RDII on the existing and the future municipal system have been evaluated). Future flow monitoring at the transition from the private system to the municipal system could be implemented to validate RDII impacts on flows and private sewer capacity (as well as sewer condition) following replacement of the Walker-owned forcemain and sewer, which is planned to accommodate higher future flows. Any flow monitoring under existing conditions would not provide an accurate estimate of RDII, as these assets will be replaced before flows are increased.

The system was evaluated under both existing and future growth scenarios in the downstream system in the Glendale Secondary Plan area to gauge the impact of the estimated leachate flows on the system. The future scenarios were based on population projections from the Glendale Secondary Plan Update Area Servicing Plan dated August 2024. The Higher Density projection, which included 13,170 people and 9,200 jobs, was used for a more conservative estimate. Growth wastewater generation was estimated using the Region’s 2021 Master Servicing Plan Update (MSPU) criteria of 255 L/cap/day for residential, and 310 L/cap/d for jobs. The following scenarios were developed:

1. Existing conditions with existing landfill leachate flows, 10-year Chicago Design Storm

2. Glendale Secondary Plan High Density Growth scenario, “Future” 10-year Chicago Design Storm (2021 Region MSPU Climate Change IDF Curve) with projected 2050 leachate flow
3. Glendale Secondary Plan High Density Growth scenario, “Future” 10-year Chicago Design Storm (2021 Region MSPU Climate Change IDF Curve) with projected 2070 leachate flow

4.1.1.2. Modelling Results

For existing municipality-owned sewer capacities, sewer performance criteria were assessed using the following conditions consistent with the 2021 Region MSPU:

- Maintaining depth of flow in pipe equal to or less than obvert elevation ($d/D \leq 1$); and, if failing to do so then,
- Maintain system hydraulic grade line of a surcharging sewer below the basement protection freeboard of 1.8 meters below grade.

The system performance was reviewed under the 10-year design storm using the Town’s existing wastewater model. The results of the hydraulic modelling shown in **Appendix C** are as follows:

- Under dry weather flow conditions, no surcharging or system overflows are anticipated in the downstream municipal sewer under both existing and post-development conditions.
- With existing leachate flows of 14.8 L/s, all pipes within the catchment have sufficient capacity to safely convey the 10-year design storm (**Figure C-1**).
- With peak 2070 leachate flows of 31.8 L/s and population growth flows of 71.87 L/s in addition to existing flows, the Town-owned sewers have sufficient capacity to safely convey the 10-year design storm. However, the privately-owned sewers on Taylor Road surcharge beyond the basement flood protection freeboard of 1.8m with risk of surface flooding due to insufficient capacity and shallow cover (**Figure C-2**).
- The Region siphon that crosses under the Welland Canal was identified as a potential constraint under the high-density growth scenario considered through the Glendale ASP (**Appendix E**). This is still identified as potential constraint when the additional 14.8 L/s of flow from Walker is modelled, as shown in Figure C-4 (existing conditions) and C-5 (2051 peak 10-year storm flow). Overall, the additional flow from Walker equates to 5% of the siphon’s total capacity of 300 L/s as identified by the Region in 2018.

4.1.1.3. Impacts on Port Weller WWTP

Walker sanitary flows contribute to the catchment area of the Port Weller WWTP in St Catharines. The *additional* proposed future peak flow rate from Walker of 14.8 L/s (1.5MLD) is equal to 1.3% of the total rated Port Weller WWTP peak capacity of 112.36 MLD per the plant’s Environmental Compliance Approval (ECA). The Glendale ASP indicated that the Port Weller WWTP treatment capacity is not anticipated to constrain development within the Glendale Secondary Plan Area. The peak 2051 flow from the Glendale Secondary Plan Area is approximately 10 times greater than the proposed future flow from Walker.

Overall, the impact of sanitary flow from Walker on the Port Weller WWTP is small and should be considered along with other more significant contributing flows in the catchment, including from the Glendale Secondary Area, through the Region’s on-going Water and Wastewater MSPU.

4.1.2. Servicing Requirements

The existing 150mm Walker-owned sewer on Taylor Road does not have sufficient capacity to support the peak future sanitary flows of 31.8 L/s that incorporates higher leachate flows. Based on modelling, a preliminary recommendation of upsizing the 150mm sewer to at least 200mm is estimated to provide sufficient capacity to safely convey the peak future leachate flows (**Appendix C, Figure C-3**). The proposed minimum 200 mm diameter sanitary sewer also aligns with the requirements for new municipally owned sanitary sewers constructed within the City of Niagara Falls and Town of Niagara-on-the-Lake. As the sewer is aging and will be under capacity under future flow conditions, it is also recommended to monitor flow as the Phase 2 South landfill comes into operation to gain an understanding of inflow and infiltration rate and remaining capacity to plan for the required upgrade trigger / timing.

There are no anticipated upgrades needed for the downstream Town-owned sewers as there is sufficient capacity to convey the estimated leachate sanitary flows and High-Density Growth projections under the 10-year design storm.

4.2. Leachate Storage Capacity Review

NOTL's Sewer Use Agreement requires on-site wastewater storage of 4,500 m³. Given the maximum allowable flow of 17 L/s stipulated, this would be a requirement of 3.1 days of storage onsite. The landfill site currently has more than the required storage. As per the As-Record Drawing for the original lagoon (Proctor & Redfern, 1996), Lagoon 1 was calculated to be 4,300m³. As per the Issued for Construction Drawing for the new leachate lagoon (AECOM, 2011), was calculated to be 5,200 m³. Therefore, total existing leachate storage capacity is 9,500 m³.

At the 2070 peak month flow of 31.8 L/s, this would provide 3.4 days of onsite storage which still exceeds the residence time expected in the agreement. This residence time expectation is only based on wastewater quantity requirements to provide equalization to manage peak discharge flows and does not account for whether proper treatment is achieved in the lagoons to meet quality limits. Walker currently aerates the storage lagoon to reduce the potential for odour generation.

4.3. Quality Review

Any wastewater discharged to a sewer that conveys flow to a Region wastewater treatment plant must meet the quality requirements indicated in the Region's Sewer Use Bylaw unless the requirements for that parameter are otherwise indicated in a Sewer Use Agreement. Walker had an agreement in place with the Region signed in 1996 that allowed for higher concentration limits for BOD and TSS in wastewater discharged. This agreement is no longer active.

Appendix D provides a summary of all quality parameters required to be monitored per the 1996 agreement, as well as the 2024 Sewer Use Bylaw limits and actual quality data provided by Walker from recent years.

The average BOD value of 62 mg/L is below the average value stipulated in the Region agreement. The only BOD value above the average limit was 190 mg/L on January 24, 2023 which is below both the

maximum values in the agreement and bylaw. The TSS value of 85 mg/L was also below the average value and similarly had only one point over this maximum at 150 mg/L on January 25, 2024. This again did not violate the Region agreement or even bylaw values. Overall, there is no concern with treatment of BOD or TSS.

Of all the parameters measured, only total Kjeldahl nitrogen (TKN) was above the bylaw limits. The average TKN over all samples was 215 mg/L with the highest value seen being 460 mg/L. Walker is looking into ways to enhance onsite treatment of the current and new landfill leachates to determine the feasibility of lowering TKN in wastewater to ensure consistent compliance with the bylaw limits (100 mg/L) as well as engaging the Region regarding the TKN exceedances. An updated Sewer Use Agreement is proposed that will define an upper limit for TKN Bylaw exceedances, along with BOD, COD and TSS. Walker is open to supporting a treatability study at Port Weller WWTP to determine an appropriate upper limit for TKN in the proposed surcharge agreement.

Overall, there is an ongoing potential for TKN exceedances to the Region's Sewer Use Bylaw, in particular when additional flows from the South Landfill Phase 2 are introduced over time. As such, an updated surcharge agreement with the Region should be pursued that confirms upper limits for TKN. Further, additional onsite leachate treatment should be considered to reduce the potential for exceeding the by-law limits, particularly for TKN.

5. Maintenance Plan

5.1. Water System

As there are no plans for water servicing from the Region network, a maintenance plan for the water system is not included in this report.

5.2. Sanitary System

Walker is responsible for maintaining all infrastructure in the wastewater system up until Maintenance Hole (MH) 6 (owned by NOTL). The wastewater system includes:

1. Landfill drainage,
2. Pump stations and associated forcemains (East Landfill, South Landfill, Compost Site, Lagoon 1, Lagoon 2 and any future for South Landfill Phase 2),
3. Chambers (Valve chamber 1, Valve chamber 2, Valve chamber 3, Inlet chamber 1, Inlet chamber 2, Drop chamber, By-pass chamber, Metering Chamber),
4. Lagoons 1 and 2, and
5. Discharge sewer and associated access points (MH 1, MH 1A, MH2, MH2A.a, MH2A, MH3, MH4, MH4A, MH4B, MH 4C, MH5, MH5Aa, MH5A.a, MH5A.b, MH5A).

Walker has a repair and maintenance program for the site which includes all the infrastructure noted above. In particular, Walker has a flushing program to periodically remove sediment from the forcemain and sewer downstream of the leachate treatment lagoons that discharge to the municipal sewer. This program reduces the risk of blockages in the both the Walker and municipal owned sewers.

6. Conclusions

In summary, the findings of the FSR are as follows:

1. The site does not currently have municipal water servicing. No changes are proposed to potable water needs because of the proposed landfill, and therefore, no water servicing is proposed.
2. The wastewater discharge flows are expected to increase above the maximum allowable flow in the NOTL sewer use agreement of 17L/s by 2031 to a peak future monthly flow of 31.8 L/s.
3. Under 2070 leachate flow projections given South Landfill Phase 2 is developed and 2051 flows for high-density growth projections within the Glendale Secondary Plan area, the Municipal-owned sewers have sufficient capacity to safely convey the 10-year design storm based on hydraulic modelling completed through this servicing report. It is recommended that Walker continue discharging sanitary flows, including leachate flows, to the municipal sewer in the long term.
4. The Walker-owned sewers on Taylor Road require upsizing to meet future projected flows and mitigate risk of future surface flooding. Flow monitoring will be implemented following replacement of the forcemain and sewer to validate assumptions around RDII impacts within the private sewer system. Walker will consider opportunities for design elements that reduce potential for RDII in the new sections of forcemain and sewer, such as inflow reduction dish under maintenance hole covers.
5. The Region should continue monitoring flow at the siphon that crosses under the Welland Canal as growth comes online and consider the need for future upsizing under the on-going Water and Wastewater Servicing Master Plan. The total contribution of additional proposed flows from Walker relative to the Region's 2018 identified 300 L/s capacity limit of the siphon is 5%. In contrast, the additional projected flow from Glendale Secondary Plan Area is 50% of this 300 L/s total siphon capacity. -
6. The onsite wastewater storage volume provides greater storage time than the volume currently stipulated in Walker's current agreement with Town of NOTL. No storage upgrades are proposed.
7. All sampled wastewater parameters meet the conditions of the Region Sewer Use By-law with the exception of TKN which had an average value of 215 mg/L which is above the maximum limit of 100 mg/L. Walker would like to pursue an updated surcharge agreement with Niagara Region that clearly defines upper limits for TKN, along with BOD, COD and TSS, and is open to supporting a treatability study at Port Weller to confirm limits to be used in the aforementioned agreement.

Appendix A Leachate Flow Calculations

South Landfill Phase 2 Environmental Assessment
 Final Functional Water and Wastewater Servicing Report Revision 3

Walker Environmental Group Inc.

May 2026

Estimated Average Annual Leachate Generation Rates and Volumes - Proposed South (Phase II) Landfill

Year	WSP Report (Table 2)						GEI					
	Area Without Final Cover at Start of Year (m2)	Area With Final Cover at Start of Year (m2)	Leachate Generation from Area Without Final Cover		Leachate Generation from Area With Final Cover		Total Leachate Generation from Landfill (m3)	Total Leachate Generation from Landfill (Litre)	Total Leachate Generation (using calculations) (L/s)	Total Leachate Generation (from Google) (L/s)	Existing + Proposed Leachate Volume (m3)	Existing + Proposed Leachate Flow (L/s)
			(mm/y)	m3	(mm/y)	m3						
Existing leachate from West, East, South Phase I + compost operations + employment sanitary flows							460,000	460,000,000	14.58650	14.58465	460,000	14.58650
2030	66,111		450	29,750			29,750	29,750,000	0.94	0.94	489,750	15.53
2031	125,110		420	52,546			52,546	52,546,000	1.67	1.67	512,546	16.25
2032	173,929		380	66,093			66,093	66,093,000	2.10	2.10	526,093	16.68
2033	227,198		340	77,247			77,247	77,247,000	2.45	2.45	537,247	17.04
2034	269,752		295	79,577			79,577	79,577,000	2.52	2.52	539,577	17.11
2035	235,358	66,111	250	58,840	188	12,429	71,268	71,268,000	2.26	2.26	531,268	16.85
2036	215,597	125,110	250	53,899	188	23,521	77,420	77,420,000	2.45	2.45	537,420	17.04
2037	202,992	173,929	250	50,748	188	32,699	83,447	83,447,000	2.65	2.65	543,447	17.23
2038	191,590	227,198	250	47,898	188	42,713	90,611	90,611,000	2.87	2.87	550,611	17.46
2039	189,673	269,752	250	47,418	188	50,713	98,132	98,132,000	3.11	3.11	558,132	17.70
2040	199,097	301,469	250	49,774	188	56,676	106,450	106,450,000	3.38	3.38	566,450	17.96
2041	183,477	340,707	250	45,869	189	64,553	110,422	110,422,000	3.50	3.50	570,422	18.09
2042	175,330	376,921	250	43,833	191	71,967	115,799	115,799,000	3.67	3.67	575,799	18.26
2043	158,786	418,788	250	39,697	192	80,575	120,271	120,271,000	3.81	3.81	580,271	18.40
2044	143,957	459,425	250	35,989	194	89,067	125,056	125,056,000	3.97	3.96	585,056	18.55
2045	131,748	500,566	250	32,937	195	97,777	130,714	130,714,000	4.14	4.14	590,714	18.73
2046	108,130	524,184	250	27,033	197	103,159	130,192	130,192,000	4.13	4.13	590,192	18.71
2047	80,063	552,251	250	20,016	198	109,493	129,509	129,509,000	4.11	4.11	589,509	18.69
2048	54,740	577,574	250	13,685	200	115,361	129,046	129,046,000	4.09	4.09	589,046	18.68
2049	28,932	603,382	250	7,233	201	121,400	128,633	128,633,000	4.08	4.08	588,633	18.67
2050	0	632,314	250	0	203	128,149	128,149	128,149,000	4.06	4.06	588,149	18.65
2051	0	632,314	250	0	204	129,076	129,076	129,076,000	4.09	4.09	589,076	18.68
2052	0	632,314	250	0	206	130,004	130,004	130,004,000	4.12	4.12	590,004	18.71
2053	0	632,314	250	0	207	130,931	130,931	130,931,000	4.15	4.15	590,931	18.74
2054	0	632,314	250	0	209	131,859	131,859	131,859,000	4.18	4.18	591,859	18.77
2055	0	632,314	250	0	210	132,786	132,786	132,786,000	4.21	4.21	592,786	18.80
2056	0	632,314	250	0	211	133,713	133,713	133,713,000	4.24	4.24	593,713	18.83
2057	0	632,314	250	0	213	134,641	134,641	134,641,000	4.27	4.27	594,641	18.86
2058	0	632,314	250	0	214	135,568	135,568	135,568,000	4.30	4.30	595,568	18.89
2059	0	632,314	250	0	216	136,496	136,496	136,496,000	4.33	4.33	596,496	18.91
2060	0	632,314	250	0	217	137,423	137,423	137,423,000	4.36	4.36	597,423	18.94
2061	0	632,314	250	0	219	138,350	138,350	138,350,000	4.39	4.39	598,350	18.97
2062	0	632,314	250	0	220	139,278	139,278	139,278,000	4.42	4.42	599,278	19.00
2063	0	632,314	250	0	222	140,205	140,205	140,205,000	4.45	4.45	600,205	19.03
2064	0	632,314	250	0	223	141,132	141,132	141,132,000	4.48	4.47	601,132	19.06
2065	0	632,314	250	0	225	142,060	142,060	142,060,000	4.50	4.50	602,060	19.09
2066	0	632,314	250	0	226	142,987	142,987	142,987,000	4.53	4.53	602,987	19.12
2067	0	632,314	250	0	228	143,915	143,915	143,915,000	4.56	4.56	603,915	19.15
2068	0	632,314	250	0	229	144,842	144,842	144,842,000	4.59	4.59	604,842	19.18
2069	0	632,314	250	0	231	145,769	145,769	145,769,000	4.62	4.62	605,769	19.21
2070	0	632,314	250	0	232	146,697	146,697	146,697,000	4.65	4.65	606,697	19.24

Red text means the volume decreased from the immediate previous year

**South Landfill Phase 2 Environmental Assessment
Final Functional Water and Wastewater Servicing Report Revision 3**

Walker Environmental Group Inc.
May 2026

Estimated Peak Monthly Leachate Generation Rates and Volumes - Proposed South (Phase II) Landfill

WSP Report (Table 2)			GEI									
Year	Area Without Final Cover at Start of Year (m2)	Area With Final Cover at Start of Year (m2)	Leachate Generation from Area Without Final Cover		Leachate Generation from Area With Final Cover		Total Leachate Generation (m3/month)	Phase II Leachate Generation (L/month)	Phase II Leachate Generation (using calculations) (L/s)	Phase II Leachate Generation (from Google) (L/s)	Existing + Proposed Leachate Volume (m3/year)	Existing + Proposed Leachate Flow (L/s)
			(mm/month)	m3/month	(mm/month)	m3/month						
Existing leachate from West, East, South Phase I + compost operations + employment sanitary flows												
							38,333	38,333,333	14.78909	1.21539	460,000	14.78909
2030	66,111		62	4,099			4,099	4,098,882	1.53035	0.13	509,187	16.32
2031	125,110		62	7,757			7,757	7,756,820	2.89606	0.25	553,082	17.69
2032	173,929		62	10,784			10,784	10,783,598	4.02613	0.34	589,403	18.82
2033	227,198		62	14,086			14,086	14,086,276	5.25921	0.45	629,035	20.05
2034	269,752		62	16,725			16,725	16,724,624	6.24426	0.53	660,695	21.03
2035	235,358	66,111	62	14,592	62	4,099	18,691	18,691,078	6.97845	0.59	684,293	21.77
2036	215,597	125,110	62	13,367	62	7,757	21,124	21,123,834	7.88674	0.67	713,486	22.68
2037	202,992	173,929	62	12,586	62	10,784	23,369	23,369,102	8.72502	0.74	740,429	23.51
2038	191,590	227,198	62	11,879	62	14,086	25,965	25,964,856	9.69417	0.82	771,578	24.48
2039	189,673	269,752	62	11,760	62	16,725	28,484	28,484,350	10.63484	0.90	801,812	25.42
2040	199,097	301,469	62	12,344	62	18,691	31,035	31,035,092	11.58718	0.98	832,421	26.38
2041	183,477	340,707	65	11,926	65	22,146	34,072	34,071,960	14.08	1.08	868,864	28.87
2042	175,330	376,921	65	11,396	65	24,500	35,896	35,896,315	14.84	1.14	890,756	29.63
2043	158,786	418,788	65	10,321	65	27,221	37,542	37,542,310	15.52	1.19	910,508	30.31
2044	143,957	459,425	65	9,357	65	29,863	39,220	39,219,830	16.21	1.24	930,638	31.00
2045	131,748	500,566	65	8,564	65	32,537	41,100	41,100,410	16.99	1.30	953,205	31.78
2046	108,130	524,184	65	7,028	65	34,072	41,100	41,100,410	16.99	1.30	953,205	31.78
2047	80,063	552,251	65	5,204	65	35,896	41,100	41,100,410	16.99	1.30	953,205	31.78
2048	54,740	577,574	65	3,558	65	37,542	41,100	41,100,410	16.99	1.30	953,205	31.78
2049	28,932	603,382	65	1,881	65	39,220	41,100	41,100,410	16.99	1.30	953,205	31.78
2050	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2051	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2052	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2053	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2054	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2055	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2056	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2057	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2058	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2059	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2060	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2061	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2062	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2063	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2064	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2065	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2066	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2067	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2068	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2069	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78
2070	0	632,314	65	0	65	41,100	41,100	41,100,410	16.99	1.30	953,205	31.78

Red text means the volume decreased from the immediate previous year

Appendix B Landfill Leachate Production Study



TECHNICAL MEMORANDUM

DATE November 4, 2024

Project No. CA-WSP-131-22826-25

TO Darren Fry, A.Sc.T.
Project Director, Environmental Division
Walker Environmental Group Inc.

FROM Frank Barone, Ph.D., P.Eng.

EMAIL frank.barone@wsp.com

PREDICTED ANNUAL LEACHATE VOLUMES - PROPOSED SOUTH (PHASE II) LANDFILL

This Technical Memorandum provides initial predictions of annual leachate generation volumes for the proposed South (Phase II) Landfill at Walker Environmental Group's Thorold Campus. The leachate volumes are intended to inform the Environmental Assessment studies for the proposed landfill.

As shown in Figure 1 (attached), the initial conceptual design for the South (Phase II) Landfill has sixteen cells within a 63-hectare fill area. The cells will be landfilled over a fifteen-year period from Years 2030 to 2045, with final cover applied progressively as final waste fill contours are reached. Figure 1 and Table 1 show the progression of landfill cell development, filling and final cover placement (i.e., capping).

For each year of the landfilling period, the leachate volume generated from areas without final cover was estimated taking into consideration leachate volumes pumped from the existing South Landfill prior to the start of final cover construction in 2020. As shown in Table A.1 (Appendix A, attached), the leachate volume pumped each year from the South Landfill from the start of landfilling in Year 2010 to Year 2019, was divided by the corresponding waste fill area to obtain a leachate generation rate in millimeters per year (mm/y) for that year. The resulting leachate generation rates range from 400 to 450 mm/y for the first two years of the landfilling period and then follow a decreasing trend to a stable range between 200 and 300 mm/y after year six of operation (Figure A.1). The decreasing trend reflects moisture uptake by the waste fill as the average thickness of waste across the landfill increases. This trend was applied to the progression of cell development and capping for the proposed South (Phase II) landfill to estimate annual leachate volumes from waste fill areas without final cover. For areas with final cover, the leachate generation rate was estimated using the HELP Model considering climate change (Appendix B). The modelling gave a leachate generation rate of 188 mm/y to Year 2040 followed by an increasing trend to 232 mm/y at Year 2070. Year 2070 represents the end of the second period of climate change projections given in the Ministry of Natural Resources and Forestry Climate Change Research Report CCRR-44 (2015).

Based on the above approach, the predicted annual leachate volumes for the South (Phase II) from the start of landfilling in Year 2030 to Year 2070 are shown in Table 2 and Figure 2. The annual leachate volumes increase from approximately 30,000 m³ in Year 2030 to 131,000 m³ at the end of the operating period in Year 2045, followed by a decreasing trend to 128,000 m³ at completion of final cover construction in Year 2050. From Year 2050 to 2070, annual leachate volumes gradually increase due to climate change to 147,000 m³.

WSP Canada Inc.

DRAFT

Frank Barone, Ph.D., P.Eng.
Senior Geo-Environmental Engineer

FSB/al

- Attachments: Table 1: Progression of Landfill Cell Development, Filling and Capping – Proposed South (Phase II) Landfill
Table 2: Estimated Annual Leachate Generation Rates and Volumes – Proposed South (Phase II) Landfill
Figure 1: Cell Development Plan - Proposed South (Phase II) Landfill
Figure 2: Estimated Annual Leachate Volumes – Proposed South (Phase II) Landfill
Appendix A – Leachate Generation Rates from Uncapped Waste Fill Areas (Existing South Landfill)
Appendix B – HELP Modelling for Leachate Generation Rate from Capped Waste Fill Areas – Proposed South (Phase II) Landfill

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Table 1. Progression of Landfill Cell Development, Filling and Capping – Proposed South (Phase II) Landfill

Landfill Timing				
Year	Licence Surrender Year	Cell Construction (Spring Start)	Waste Placement (Jan 1st)	Capped
2028	Stage 1			
2029		Cell 1		
2030		Cell 2	Cell 1	
2031		Cell 3	Cell 2	
2032	Stage 2	Cell 4	Cell 3	
2033		Cell 5	Cell 4	
2034		Cell 6	Cell 5	
2035		Cell 7	Cell 6	Cell 1
2036	Stage 3	Cell 8	Cell 7	Cell 2
2037		Cell 9	Cell 8	Cell 3
2038		Cell 10	Cell 9	Cell 4
2039		Cell 11	Cell 10	Cell 5
2040	Stage 4	Cell 12	Cell 11	Cell 6
2041		Cell 13	Cell 12	Cell 7
2042		Cell 14	Cell 13	Cell 8
2043		Cell 15	Cell 14	Cell 9
2044		Cell 16	Cell 15	Cell 10
2045			Cell 16	Cell 11
2046				Cell 12
2047				Cell 13
2048				Cell 14
2049				Cell 15
2050				Cell 16

Stage 1

Stage 2

Stage 3

Stage 4

Table 2. Estimated Annual Leachate Generation Rates and Volumes – Proposed South (Phase II) Landfill

Year	Area Without Final Cover at Start of Year (m ²)	Area With Final Cover at Start of Year (m ²)	Leachate Generation from Area Without Final Cover		Leachate Generation from Area With Final Cover		Total Leachate Generation from Landfill (m ³)
			(mm/y)	m ³	(mm/y)	m ³	
2030	66,111		450	29,750			29,750
2031	125,110		420	52,546			52,546
2032	173,929		380	66,093			66,093
2033	227,198		340	77,247			77,247
2034	269,752		295	79,577			79,577
2035	235,358	66,111	250	58,840	188	12,429	71,268
2036	215,597	125,110	250	53,899	188	23,521	77,420
2037	202,992	173,929	250	50,748	188	32,699	83,447
2038	191,590	227,198	250	47,898	188	42,713	90,611
2039	189,673	269,752	250	47,418	188	50,713	98,132
2040	199,097	301,469	250	49,774	188	56,676	106,450
2041	183,477	340,707	250	45,869	189	64,553	110,422
2042	175,330	376,921	250	43,833	191	71,967	115,799
2043	158,786	418,788	250	39,697	192	80,575	120,271
2044	143,957	459,425	250	35,989	194	89,067	125,056
2045	131,748	500,566	250	32,937	195	97,777	130,714
2046	108,130	524,184	250	27,033	197	103,159	130,192
2047	80,063	552,251	250	20,016	198	109,493	129,509
2048	54,740	577,574	250	13,685	200	115,361	129,046
2049	28,932	603,382	250	7,233	201	121,400	128,633
2050	0	632,314	250	0	203	128,149	128,149
2051	0	632,314	250	0	204	129,076	129,076
2052	0	632,314	250	0	206	130,004	130,004
2053	0	632,314	250	0	207	130,931	130,931
2054	0	632,314	250	0	209	131,859	131,859
2055	0	632,314	250	0	210	132,786	132,786
2056	0	632,314	250	0	211	133,713	133,713
2057	0	632,314	250	0	213	134,641	134,641
2058	0	632,314	250	0	214	135,568	135,568
2059	0	632,314	250	0	216	136,496	136,496
2060	0	632,314	250	0	217	137,423	137,423
2061	0	632,314	250	0	219	138,350	138,350
2062	0	632,314	250	0	220	139,278	139,278
2063	0	632,314	250	0	222	140,205	140,205
2064	0	632,314	250	0	223	141,132	141,132
2065	0	632,314	250	0	225	142,060	142,060
2066	0	632,314	250	0	226	142,987	142,987
2067	0	632,314	250	0	228	143,915	143,915
2068	0	632,314	250	0	229	144,842	144,842
2069	0	632,314	250	0	231	145,769	145,769
2070	0	632,314	250	0	232	146,697	146,697

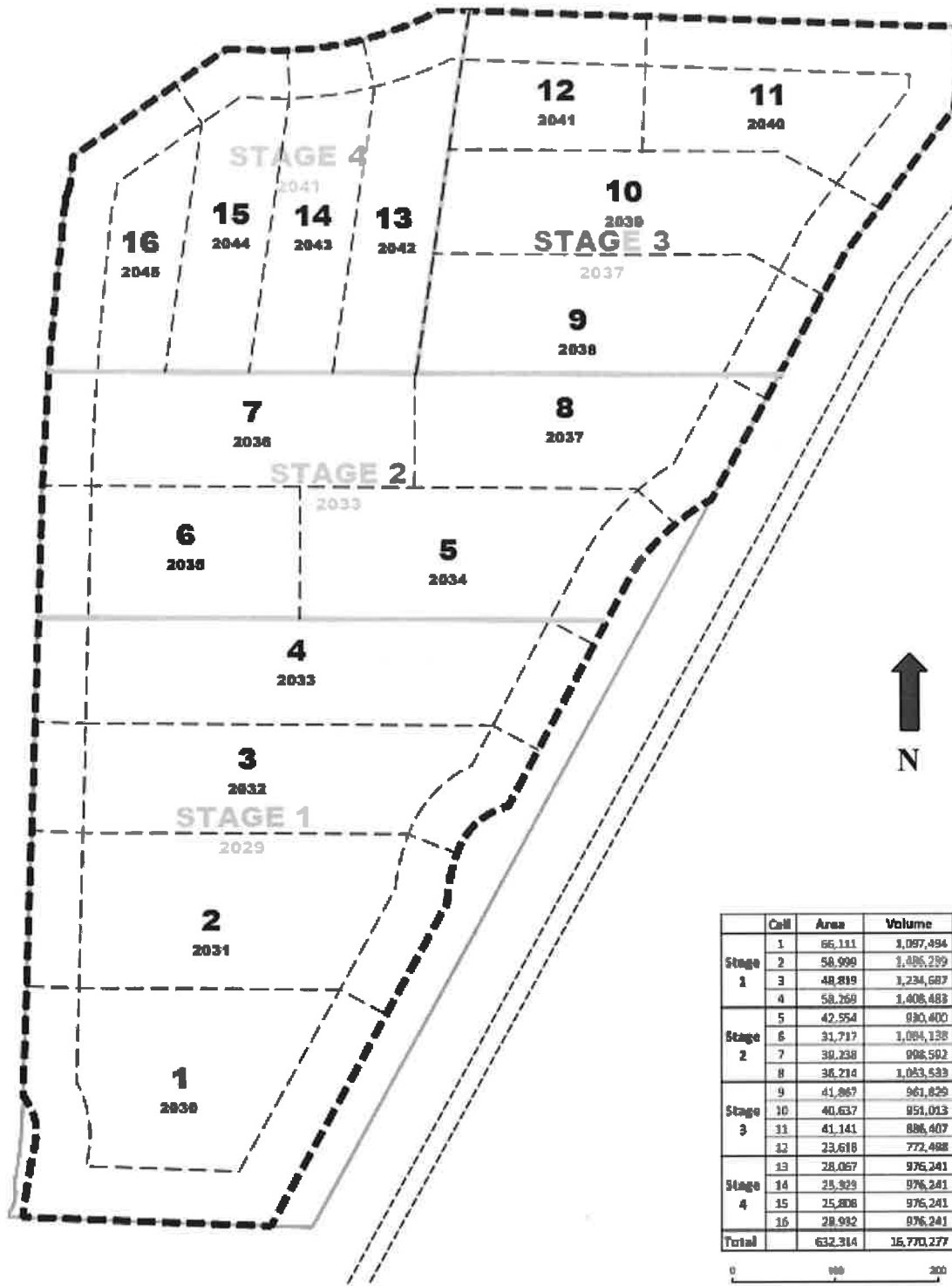


Figure 1. Cell Development Plan - Proposed South (Phase II) Landfill

Estimated Annual Leachate Volumes

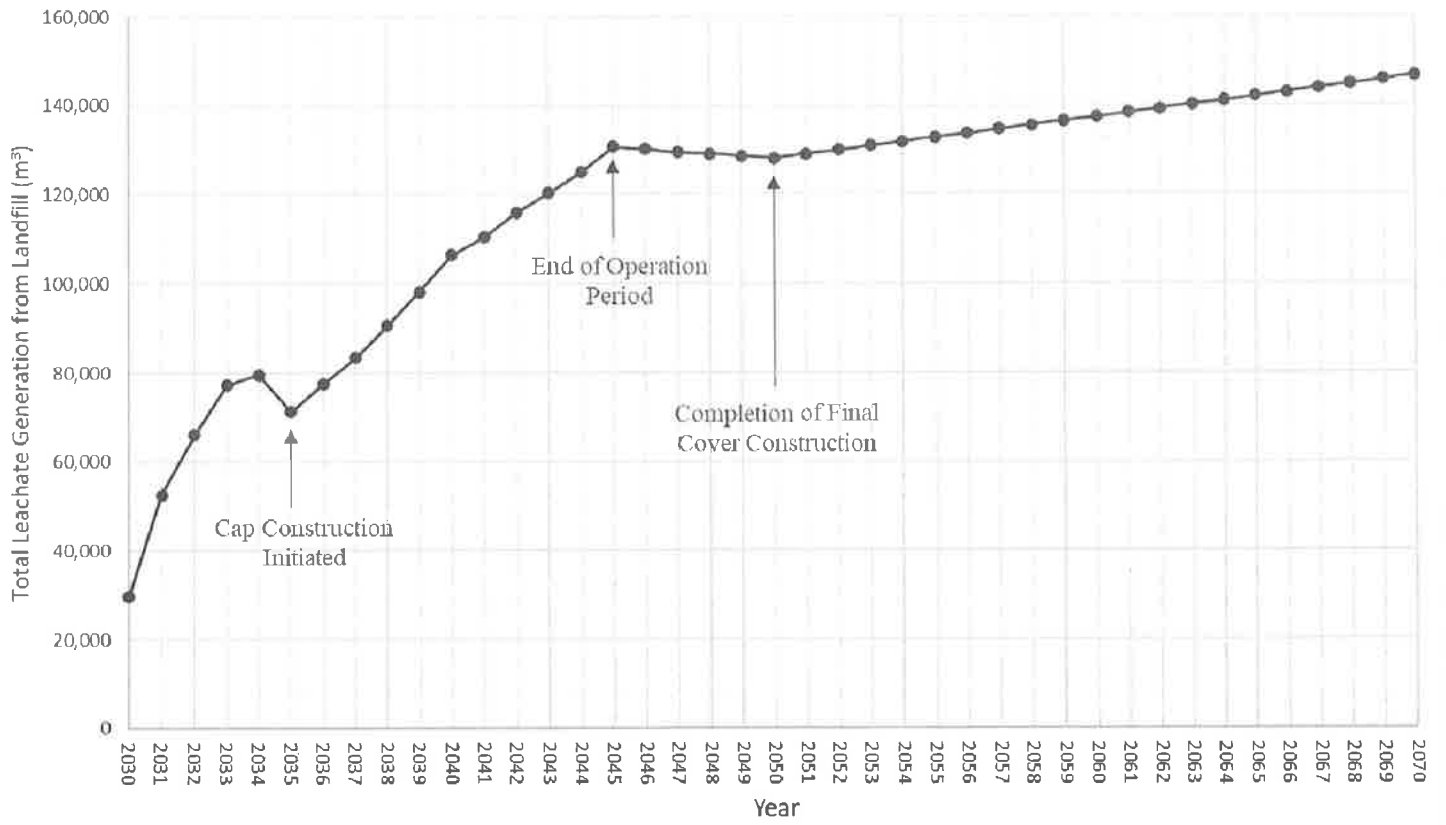


Figure 2. Estimated Annual Leachate Volumes – Proposed South (Phase II) Landfill

APPENDIX A

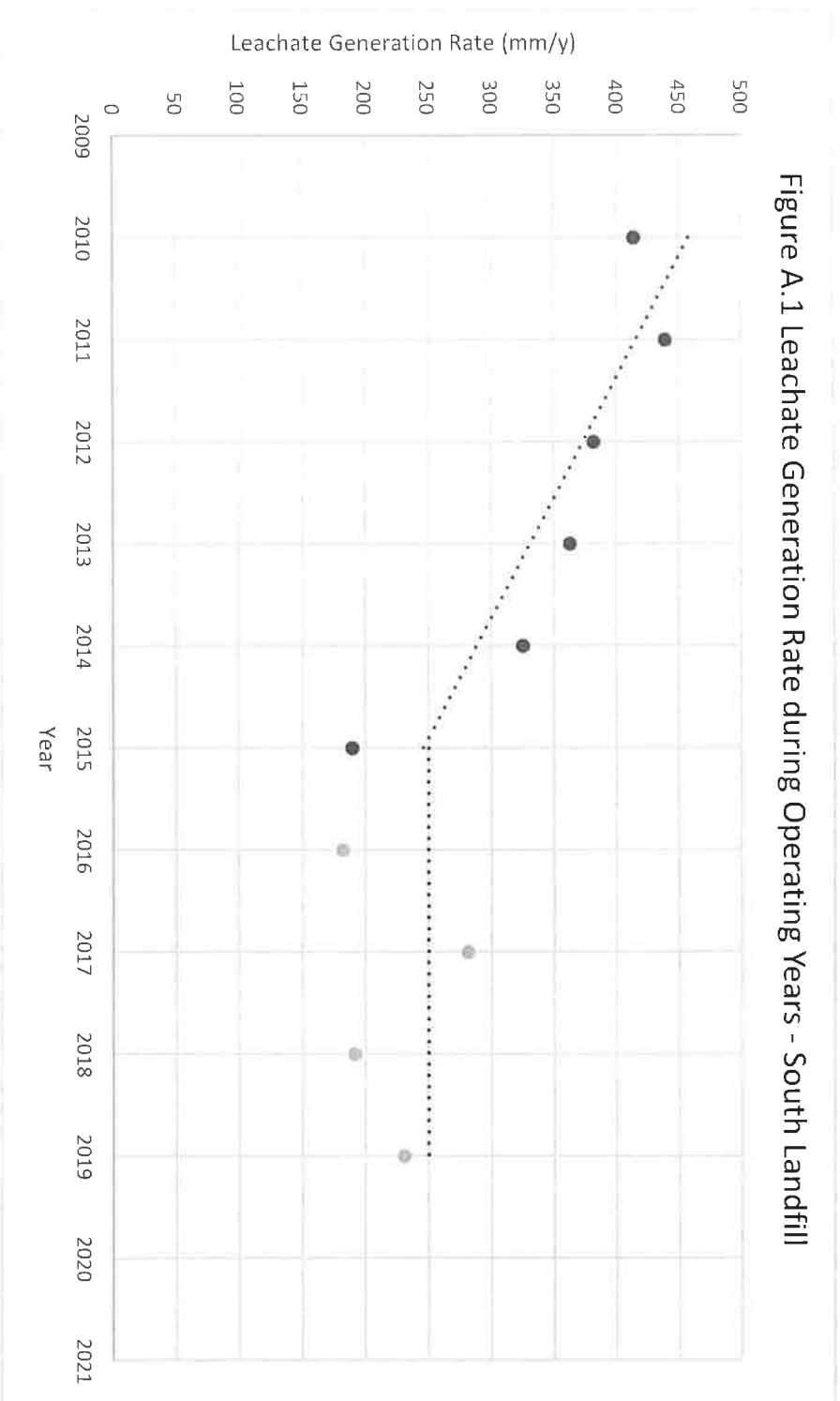
**Leachate Generation Rates from
Uncapped Waste Fill Areas
(Existing South Landfill)**

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Table A.1. South Landfill Measured Annual Leachate Pumping Volumes and Equivalent Leachate Generation Rate Without Final Cover

Year	Area of Waste Fill Placement (m²)	Total Annual Leachate Pumping Volume (m³)	Equivalent Leachate Generation Rate (mm/y)
2010	75,222	31,179	414.5
2011	121,075	53,205	439.4
2012	144,686	55,242	381.8
2013	184,032	66,722	362.6
2014	228,183	74,138	324.9
2015	262,118	49,661	189.5
2016	316,388	57,633	182.2
2017	360,294	101,355	281.3
2018	384,638	73,673	191.5
2019	384,638	88,828	230.9

Figure A.1 Leachate Generation Rate during Operating Years - South Landfill



APPENDIX B

HELP Modelling for Leachate
Generation Rate from Capped
Waste Fill Areas - Proposed South
(Phase II) Landfill

Calculation of Leachate Generation Rates for Areas with Final Cover, Proposed Walker South (Phase 2) Landfill, Thorold, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
Reviewed by: F. Barone

Date: November 2024

1.0 INTRODUCTION

The leachate generation rates due to atmospheric water infiltration through the final cover of the proposed South (Phase 2) Landfill at the Walker Environmental Group Thorold Campus was estimated using the Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07 (Ref.-1).

The HELP model is a quasi-two-dimensional water-balance model for water movement in the landfill (Ref-2.). The model accepts the weather data and landfill design data and uses solution techniques that account for the effect of different processes such as surface storage, snowmelt, runoff, infiltration, evapotranspiration, vegetation growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through liners (Ref-2. and Ref-3). The site-specific runoff, evapotranspiration, infiltration, drainage, leachate collection and liner leakage can be determined, as needed, using the HELP model.

2.0 CLIMATOLOGICAL INPUT PARAMETERS

Two different climatological scenarios were evaluated.

1. Without climate change; and
2. With climate change.

For the scenario without climate change, daily precipitation and temperature input data for the Site were synthetically generated using the HELP model (Ref. 1). This involved taking 30 years of continuous precipitation and temperature data for Buffalo, New York, USA (nearest reference station included in the HELP model database) and then adjusting the data with mean monthly precipitation and temperature values based on the average values for the St. Catherines Airport meteorological station as shown in the attached Table 1. Daily solar radiation data was synthetically generated using the HELP model by taking the Buffalo, New York solar radiation data (included in the HELP model database) and correcting the latitude for the Site. Average quarterly relative humidity and average annual wind speed for the Sarnia Airport meteorological station were used (refer to attached Table 2).

For the scenarios with climate change, the potential change in precipitation and temperature input data were based on Table 5 of Climate Change Research Report CCRR-44, Lake Erie Basin, reference periods 2011-2040 and 2040-2071 and representative concentration pathway (RCP) of 4.5 W/m² (Ref. - 4). The precipitation and temperature input in for the climate change scenarios are presented in attached Table 3.

Calculation of Leachate Generation Rates for Areas with Final Cover, Proposed Walker South (Phase 2) Landfill, Thorold, Ontario		
Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024

3.0 WASTE ONLY, DAILY COVER, AND FINAL COVER INPUT PARAMETERS

The HELP model input parameters for the final cover are summarized in Table 4. The values used in the HELP model for total porosity, field capacity, wilting point are according to the HELP model default values as shown in the attached Table 3. For the soil cover layers and waste fill the initial water content was taken as equal to or greater than the field capacity water content, which is the water content at which the soil can no longer absorb/retain additional moisture under free drainage. With respect to modelling the leachate generation rate, this is a conservative assumption as it reduces the time to reach peak leachate generation.

The model for the final cover was run with a final cover slope of 5% and runoff path length of 200 m based on the final contours for the landfill.

4.0 VEGETATION INPUT PARAMETERS

The HELP model requires input data for the type and extent of vegetation growing on the cover, as well as input data for the evaporative zone depth. The leaf area index is defined as the dimensionless ratio of the leaf area of actively transpiring vegetation to the nominal surface area of the final cover. For the final cover, a ground with good stand of grass with a maximum leaf are index of 4 was used.

The evaporative zone depth is defined as the maximum depth from which water may be removed by evapotranspiration. For the final cover an evaporative zone depth of 50 cm was assumed for the sandy loam topsoil / clayey cover soil with good stand of grass.

5.0 RESULTS

The leachate generation rates obtained from the HELP modelling are provided in Table 5. The average annual leachate generation rate for the scenario without climate change is 178 mm/y. For the climate change scenarios, average annual leachate generation rates of 188 mm/y for Reference Period 2011-2040 and 232 mm/y for Reference Period 2041-2070.

Calculation of Leachate Generation Rates for Areas with Final Cover, Proposed Walker South (Phase 2) Landfill, Thorold, Ontario

Project No.: CA-WSP-131-22826-27

Prepared by: S. Rimal
Reviewed by: F. Barone

Date: November 2024

REFERENCES

- Ref. 1 - The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07 (1 November 1997), Developed by Environmental Laboratory, USAE Waterways Experiment Station for U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, OH.
- Ref 2. – Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L. (1994). “The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3,” EPA/600/R-94/168b, September 1994, U.S. Environmental Protection Agency, Office of Research and Development, Washington DC.
- Ref 3. – Sharma, H.P. and Lewis, S.P. (1994). Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation, John Wiley and Sons, Inc. New York, 588p.
- Ref 4. - MNRF (2015). Climate Change Projects for Ontario: An Updated Synthesis for Policymakers and Planners, Ministry of Natural Resources and Forestry, Science and Research, Climate Change Research Report CCRR-44.

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024
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TABLE 1: NORMAL MEAN MONTHLY PRECIPITATION AND TEMPERATURE AT ST. CATHARINES AIRPORT METEOROLOGICAL STATION [1981-2010 DATA]

Climate ID: 6137287
 Elevation: 97.8 masl
 Latitude: 43°12'00.000" N
 Longitude: 79°10'00.000" W

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Precipitation	mm	65.2	54.9	61.7	77	76.8	85.9	77.8	70.3	90.6	67	81.6	71.5
Temperature	°C	-3.8	-2.9	1.1	7.4	13.7	19	21.9	20.8	16.6	10.4	4.6	-0.9

Source: Canadian Climate Normals 1981-2010 (Environment Canada).

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024
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TABLE 2: NORMAL RELATIVE HUMIDITY AND WINDSPEED AT ST. CATHARINES AIRPORT METEOROLOGICAL STATION [1981-2010 DATA]

Climate ID: 6137287
 Elevation: 97.8 masl
 Latitude: 43°12'00.000" N
 Longitude: 79°10'00.000" W

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative Humidity at 15:00	%	73	67.7	62.9	57.6	55.9	58.1	57.5	59	60.5	64.5	69.1	71.9
Average Quarterly Relative Humidity	%	67.9			57.2			59.0			68.5		
Windspeed*	km/h	21.1	19.2	18.5	17.3	14.5	13.9	13.2	12.4	13.6	15.4	18.2	19
Average Annual Windspeed	km/h	16.4											

Source: Canadian Climate Normals 1981-2010 (Environment Canada).
 *Wind Speed: Canadian Climate Normals 1971-2000 (Environment Canada).

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024
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TABLE 3: MEAN MONTHLY PRECIPITATION AND TEMPERATURE FOR CLIMATE CHANGE SCENARIOS

	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Reference Period 2011-2040													
Total Precipitation	mm	76.1	65.8	62.9	78.2	78.0	83.1	75.0	67.5	91.8	68.2	82.8	82.4
Temperature	°C	-1.7	-0.80	3.5	9.8	16.1	21.0	23.9	22.8	19.0	12.8	7.0	1.2
Reference Period 2041-2070													
Total Precipitation	mm	75.9	65.6	70.4	85.7	85.5	85.6	77.5	70.0	99.3	75.7	90.3	82.2
Temperature	°C	0.3	1.20	4.7	11.0	17.3	22.2	25.1	24.0	20.2	14.0	8.2	3.2

Source: Mean monthly precipitation and temperature was modified using Table 5 of Ref-4 to account for climate change.

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024
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TABLE 4: HELP MODEL INPUT PARAMETERS†

Input Parameters	Units	Waste	Final Cover	
			Topsoil	Cover Soil
HELP Model Soil Texture Class†	[-]	-	6	26
USDA Soil Texture Class / Description	[-]	MSW	Sandy Loam (SL)	Silty Clay (SICL) (Moderate)
Thickness	m	10 m	0.15	0.60
Total porosity	[-]	0.671	0.453	0.445
Field capacity	[-]	0.292	0.190	0.393
Wilting point	[-]	0.077	0.085	0.277
Initial volumetric water content	[-]	0.292	0.190	0.445
Hydraulic Conductivity*	cm/s	1.0 x 10 ⁻³	7.2 x 10 ⁻⁴	1.9 x 10 ⁻⁶

Notes: † HELP model default soil texture class were used together with model default parameters for total porosity, field capacity, wilting point and hydraulic conductivity. HELP model default parameters for total porosity, field capacity, wilting point and hydraulic conductivity are considered representative for the waste fill at the Site. Specified hydraulic conductivity was used for the final cover soil.
* Effective saturated hydraulic conductivity.

Calculation of Leachate Generation Rates for Areas with Final Cover, Walker South Landfill, Welland, Ontario

Project No.: CA-WSP-131-22826-27	Prepared by: S. Rimal Reviewed by: F. Barone	Date: November 2024
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TABLE 5: PREDICTED LEACHATE GENERATION RATES WITH FINAL COVER

Month	Without Climate Change		With Climate Change Reference Period (2011-2040)		With Climate Change Reference Period (2041-2070)	
	Avg. (mm)	Potential Peak (mm)	Avg. (mm)	Potential Peak (mm)	Avg. (mm)	Potential Peak (mm)
January	28	52	40	62	41	59
February	7	14	28	55	39	65
March	8	13	13	31	34	61
April	20	26	39	57	44	62
May	13	21	23	45	20	42
June	8	16	1	4	3	10
July	7	13	0	0	0	0
August	9	12	0	0	0	0
September	12	21	0	1	0	1
October	19	29	6	17	7	19
November	25	36	13	26	16	30
December	27	36	25	35	28	38
Annual Avg.	178		188		232	

Appendix C Hydraulic Modelling Results

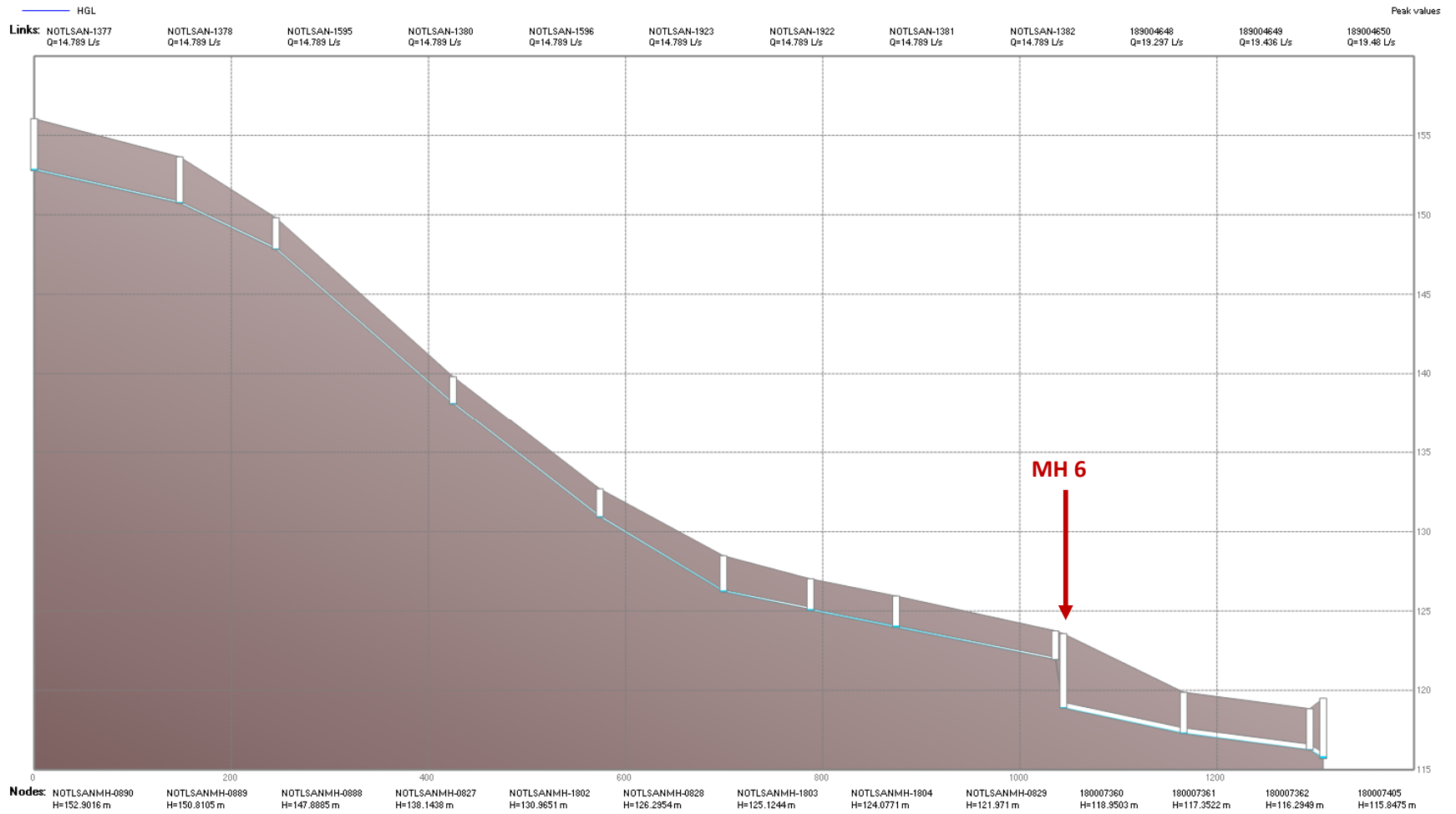


Figure C-1: Sewer performance of Walker Industries gravity sewer and Region Sewer to 162 Taylor Road with existing flow (10-year design storm)

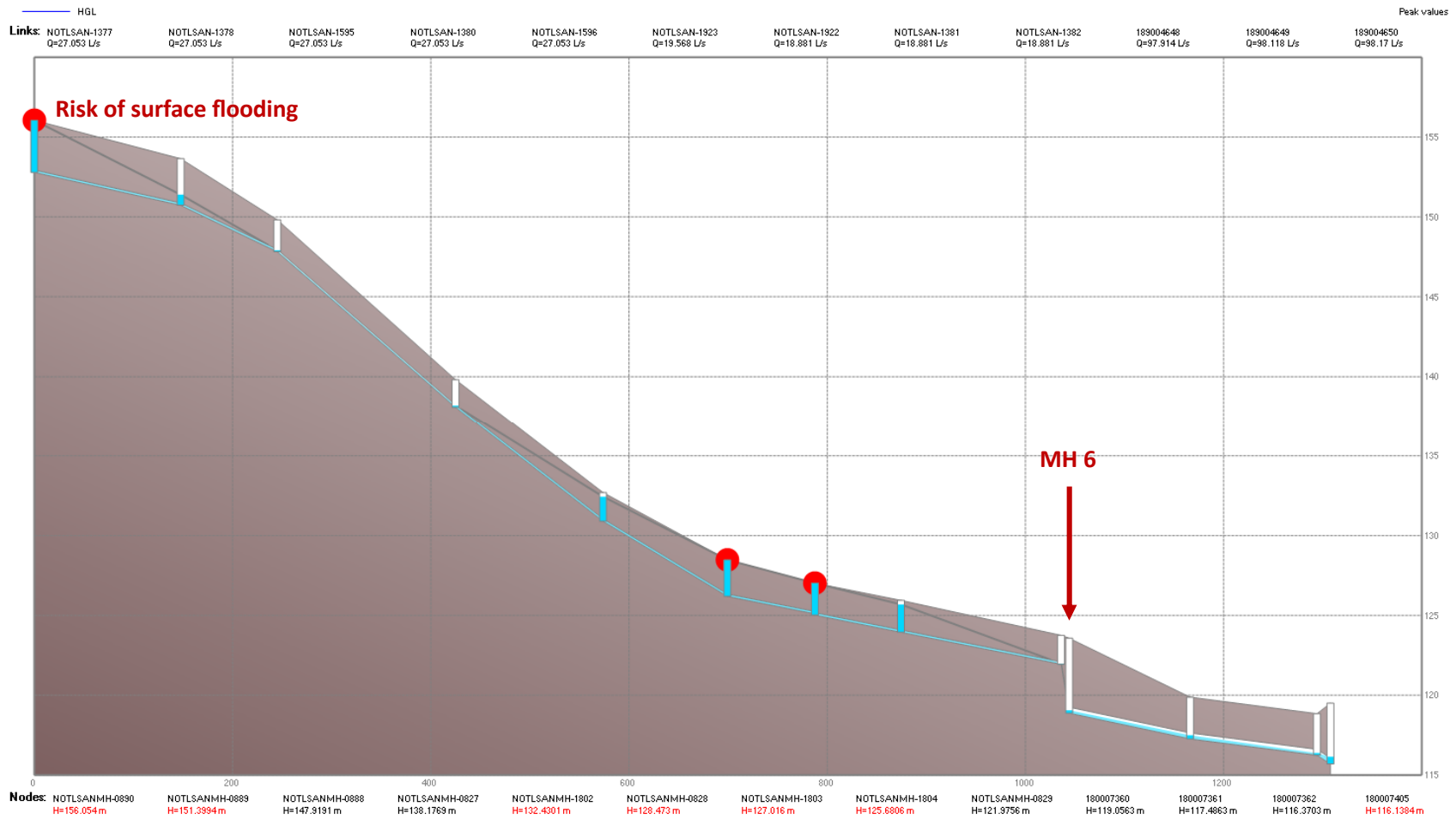


Figure C-2: Sewer performance of Walker Industries gravity sewer and Region Sewer to 162 Taylor Road with 2070 Leachate flows and High-Density Growth (“Future” 10-year design storm)

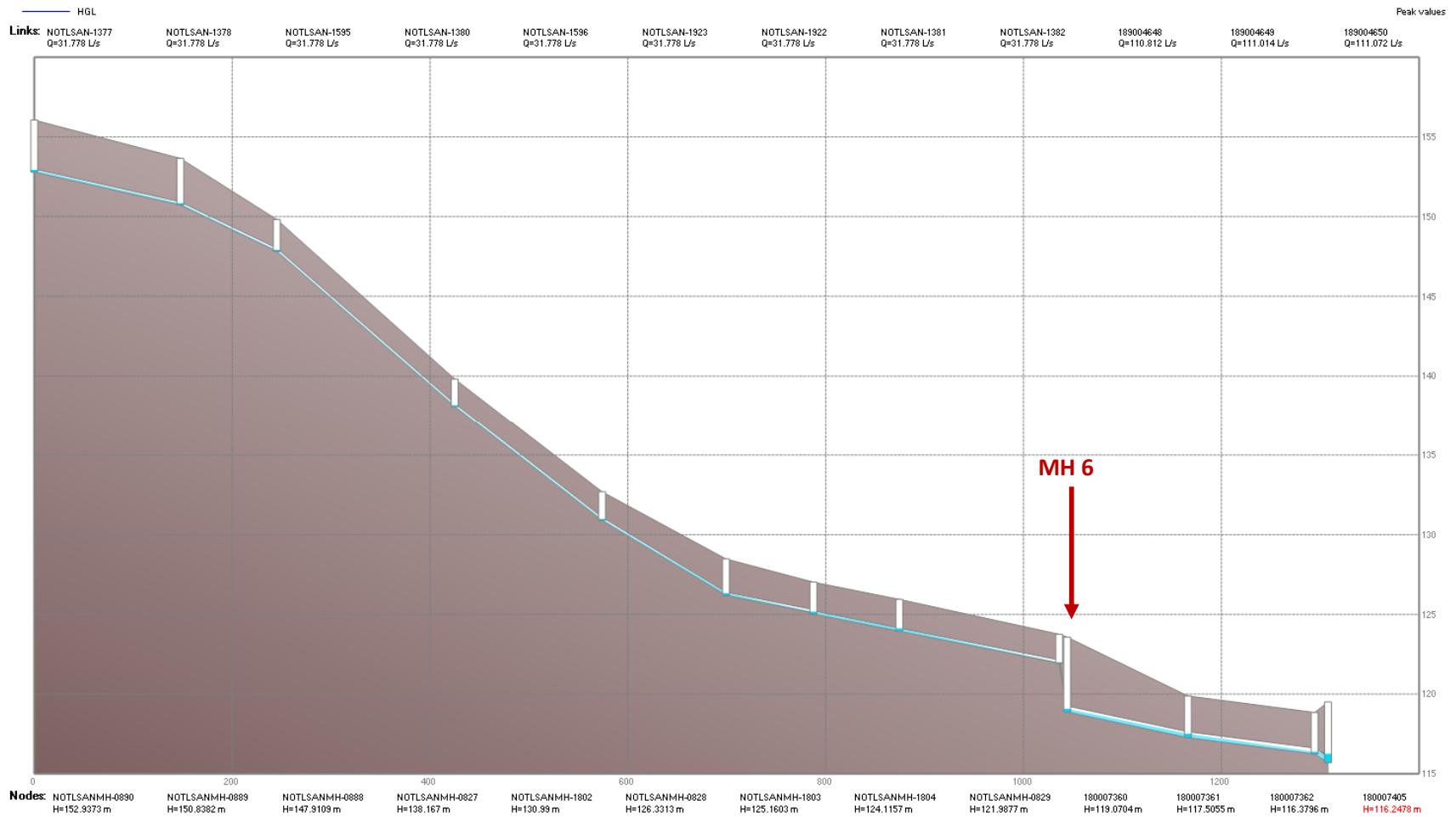


Figure C-3: Sewer performance of Walker Industries gravity sewer (upsized to 200mm) and Region Sewer to 162 Taylor Road with 2070 Leachate flows and High-Density Growth (“Future” 10-year design storm)

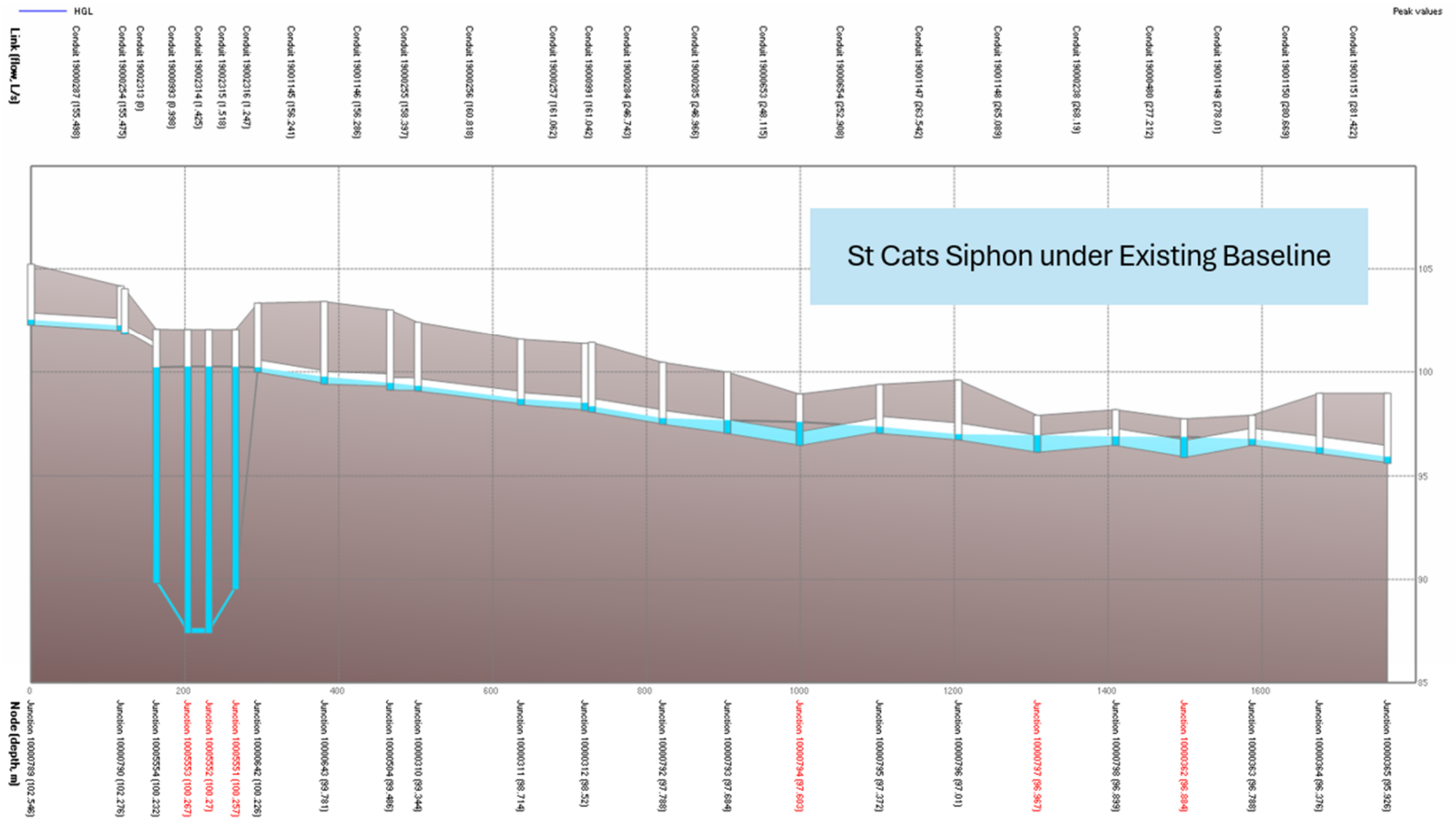


Figure C-4: St Catharine’s Siphon under Welland Canal performance under baseline existing conditions

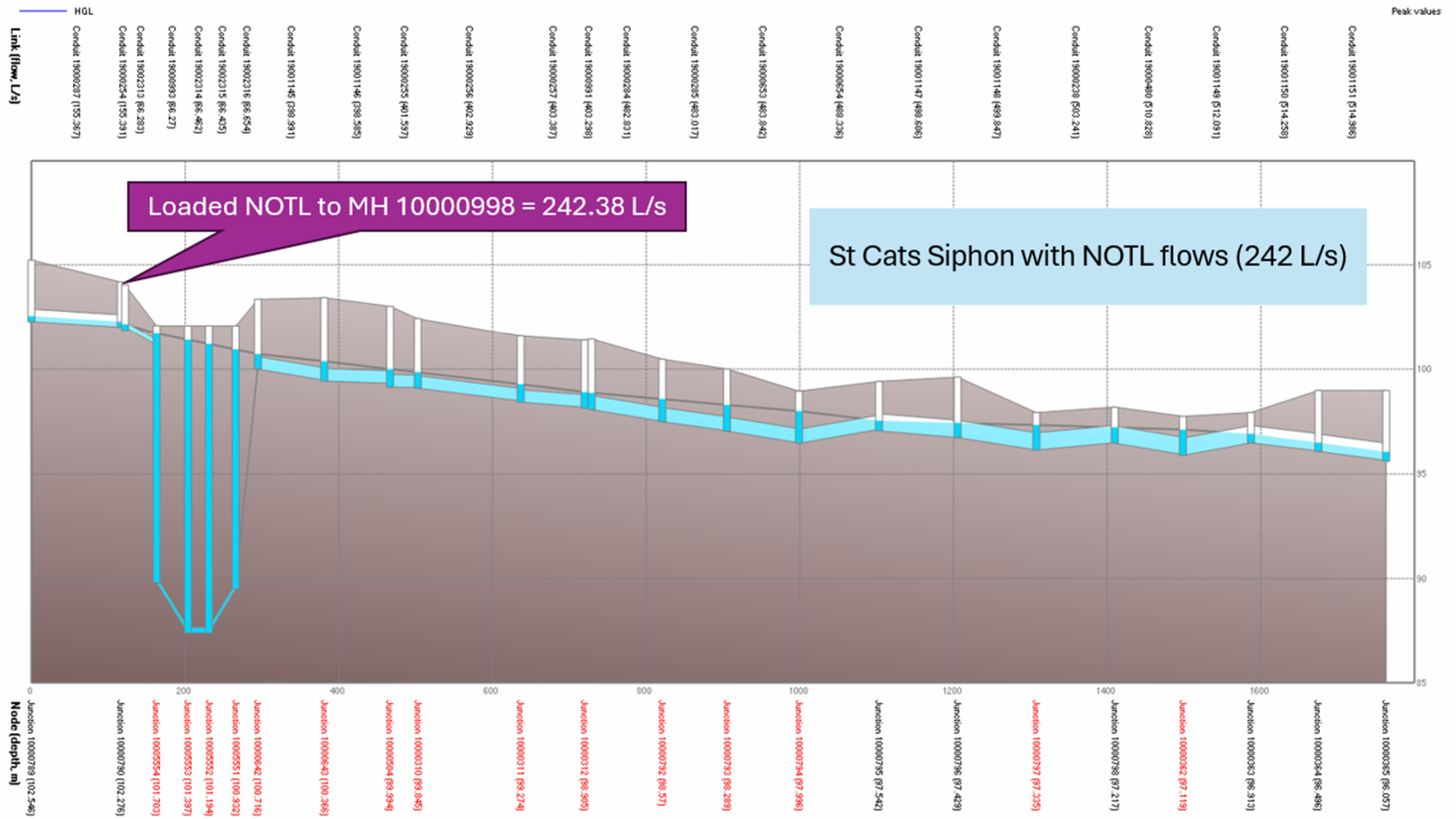


Figure C-5: St Catharine's Siphon under Welland Canal performance under High-Density Growth (2051 10-year design storm)

Appendix D Sanitary Sewer Discharge Quality

Parameters (mg/L unless otherwise noted)	Walker Leachate Lagoon Effluent Average 2022 - 2024	2024 Niagara Region Bylaw Limit	1996 Agreement between Walker and Region, Average (Maximum) Limit	1996 Agreement between Walker and Region, Sampling Frequency
Biochemical Oxygen Demand	62	300	100 (2,500)	Monthly
Total Suspended Solids	85	350	100 (500)	Monthly
pH (unitless)	7.98	Minimum 6 Maximum 11	--	Monthly
Chemical Oxygen Demand	27	600	--	Monthly
Sulphide	0.12	1	--	Monthly
Sulphate IC	212	1500	--	Monthly
Phosphorus	1.2	10	--	Monthly
Arsenic	0.028	1	--	Semi-annually
Cadmium	< 0.0009	0.7	--	Semi-annually
Chromium	0.098	3	--	Semi-annually
Cobalt	0.009	5	--	Semi-annually
Copper	0.005	3	--	Semi-annually
Lead	0.001	1	--	Semi-annually
Mercury	< 0.000001	0.01	--	Semi-annually
Molybdenum	0.005	5	--	Semi-annually
Nickel	0.047	2	--	Semi-annually
Selenium	< 0.02	1	--	Semi-annually
Antimony	0.005	5	--	Semi-annually
Zinc	0.02	3	--	Semi-annually
Phenols 4AAP	0.036	1	--	Semi-annually
Cyanide Total	0.125	1	--	Semi-annually
Total Kjeldahl Nitrogen	215	100	--	Semi-annually
Benzene	< 0.005	0.01	--	--
BEHP – Bis (2-ethylhexyl phthalate)		0.28	--	--
Chloroform	< 0.005	0.04	--	--
1,2-dichlorobenzene	< 0.01	0.05	--	--
1,4-dichlorobenzene	< 0.01	0.08	--	--
Ethylbenzene	< 0.005	0.16	--	--
Fluoride	1.8	10	--	--
Methylene Chloride	< 0.025	0.21	--	--
o-Xylene	< 0.005	0.52	--	--
PCBs	< 0.005	0.0001	--	--
Silver	< 0.0009	5	--	--

Parameters (mg/L unless otherwise noted)	Walker Leachate Lagoon Effluent Average 2022 - 2024	2024 Niagara Region Bylaw Limit	1996 Agreement between Walker and Region, Average (Maximum) Limit	1996 Agreement between Walker and Region, Sampling Frequency
Solvent Extractables animal or vegetable in origin	6.2	150	--	--
Solvent Extractables mineral or synthetic in origin	1.4	15	--	--
1,1,2,2 – Tetrachloroethane	< 0.01	0.04	--	--
Tetrachloroethylene	< 0.005	0.05	--	--
Tin	0.002	5	--	--
Toluene	< 0.01	0.2	--	--
Trichloroethylene	< 0.01	0.05	--	--
Xylenes	< 0.005	1.4	--	--
Ammonia	< 0.05	--	--	Semi-annually
Total Solids	--	--	--	Monthly
DOC	--	--	--	Monthly
TOC	--	--	--	Monthly
VOC (scan)	< RDL		--	Annually

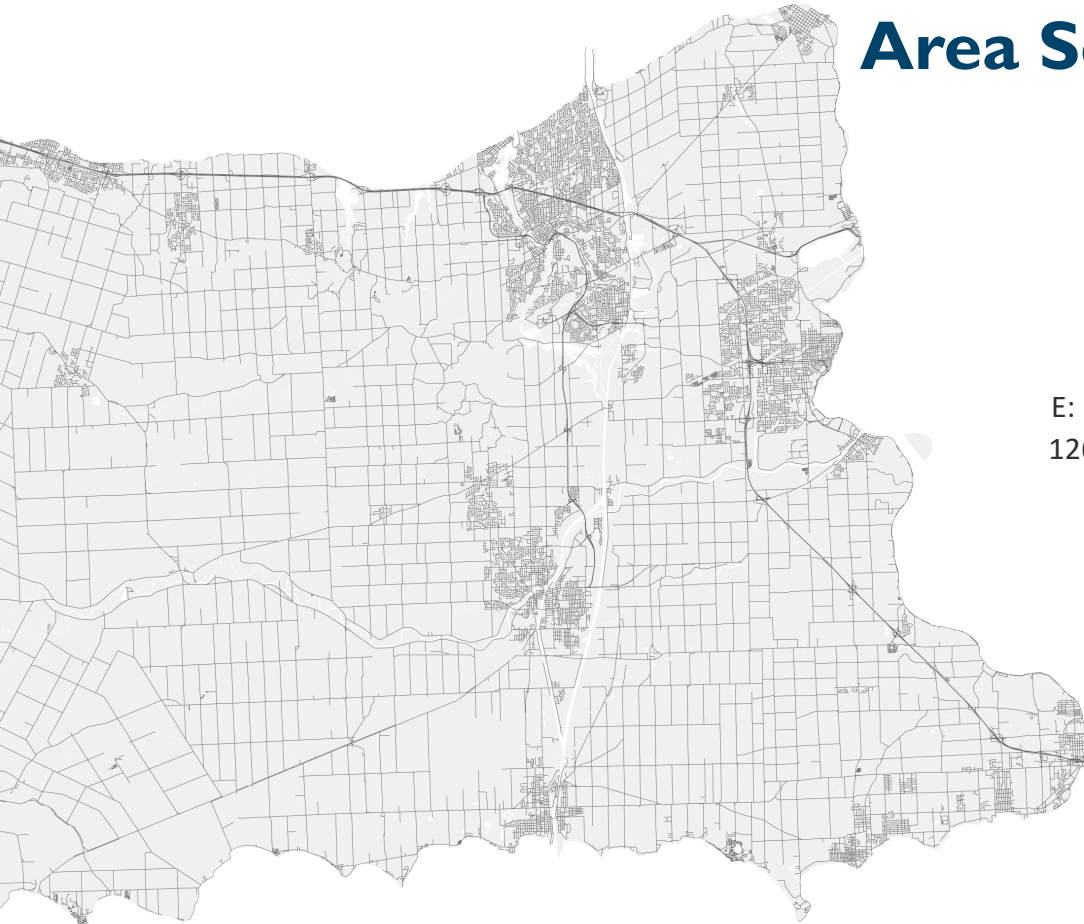
Appendix E Glendale Secondary Plan – Water, Wastewater and Stormwater Area Servicing Plan



Water, Wastewater and Stormwater Servicing

Glendale Secondary Plan Update Area Servicing Plan

August 28, 2024



Contact Person:

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August 28, 2024
GMBP File: 722013

The Planning Partnership
1255 Bay Street, Suite 500
Toronto, Ontario M5R 2A9

Attention: Donna Hinde BES, MLA, OALA, FCCLA
Project Manager / Partner

Re: Glendale Secondary Plan Update Area Servicing Plan

Dear Ms. Hinde,

GM BluePlan Engineering Limited is pleased to submit this Water, Wastewater and Stormwater Area Servicing Plan for Niagara Region's Glendale Secondary Plan Update. This draft is based on the preferred land use concept and builds on previous findings and recommendations presented to Niagara Region, the Town of Niagara-on-the-Lake, stakeholders, approval agencies, landowner groups, and the public, and comments received from Niagara Region.

If you have any questions, or require any additional information, please contact the undersigned.

Yours truly,

GM BLUEPLAN ENGINEERING LIMITED

A handwritten signature in black ink, appearing to read 'Matthew Fisher'.

Per: Matthew Fisher, P.Eng.
Project Manager

VERSION LOG

Version	Date	Author(s)	Description
1	November 6, 2023	Matthew Fisher	Draft for Review
2	March 28, 2024	Matthew Fisher	Draft with Revised Submission Package to Niagara Region
3	May 6, 2024	Matthew Fisher	Revised Draft for Submission for Stakeholders' Review
4	July 8, 2024	Matthew Fisher	Final Submission
5	August 28, 2024	Matthew Fisher	Revised Final with Updated Land Use Schedule

EXECUTIVE SUMMARY

The Glendale Study Area is located at the southwest limit of the Town of Niagara-on-the-Lake (NOTL). The area has been identified as a strategic growth area for Niagara Region with anticipated development into an integrated mixed-use community with higher densities than currently exist.

GM BluePlan (GMBP) was retained to complete a study to review the water, wastewater, and stormwater Area Servicing Plan (ASP) in support of the Glendale Secondary Plan Update that is being led by The Planning Partnership (TPP).

Ultimately, GMBP completed a servicing review and needs assessment to inform the development of a preferred servicing strategy to provide a comprehensive and cost-effective infrastructure phasing plan to accommodate development in the area. The proposed servicing strategies include the following key recommendations:

- Existing water and wastewater infrastructure can generally service the Glendale Study Area to build-out.
- New water and wastewater servicing extensions and connections can be designed and constructed as part of the proposed development application works with confirmation of depth/location and capacity of existing infrastructure.
- Existing stormwater infrastructure can service the southwest portion of the Study Area.
- New storm sewers and stormwater management facilities for development sites in the northeast portion of the Study Area can be designed and constructed as part of the proposed development application works.
- Provisional storm sewers may be required in the northeast to accommodate future high-density development, and can be constructed as part of future road improvements / urbanization projects.

The Glendale Study Area is serviced by the Decew Water Treatment Plant (WTP) and a transmission network comprised of Regional, Local, and Private watermains. Existing water servicing within the Study Area can accommodate growth within the Secondary Plan area.

A new trunk watermain to Virgil Elevated Tank and new elevated tank in Virgil are recommended for 2032 and 2043, respectively to address the storage issues in broader Niagara-on-the-Lake, and will support growth within the Secondary Plan area to buildout.

Fire flow in the Study Area can be provided by the existing trunk watermains. Local mains can supply fire flows to new developments with looping of proposed watermains to be encouraged as part of future development applications detailed engineering design.

Wastewater in the existing Glendale area is conveyed by a network of Regional, Local and Private sewers that ultimately discharge to the Port Weller WWTP in St. Catharines. Existing wastewater servicing within the Study Area and downstream have sufficient capacity to accommodate wastewater flows associated with the projected growth to build-out.

The capacity of the existing sewer siphon used to convey flows in the Queenston Road trunk sewer across the Welland Canal has been identified for additional review. The siphon may require upgrades at Secondary Plan build-out (post-2051) to accommodate flows if densities exceed the minimum targets established in the Secondary Plan. Monitoring should be conducted, and the capacity of the siphon is to be reviewed as part of future Region-wide MSP updates.

The Modero Estates residential subdivision development located at the northeast limit of the Study Area proposed a pumped solution to ultimately convey wastewater flows to the south, discharging to the existing Local sewer. The remainder of the Study Area can be serviced by gravity sewers; development will require extensions of local sewers and gravity connections to the existing downstream network.

The Glendale Study Area is located within three subwatersheds, draining to Six Mile Creek, Eight Mile Creek, and Welland Canal. The section of the Study Area southwest of QEW is serviced by Regional and Local storm sewers and a stormwater pond. The area northeast of QEW is primarily serviced by roadside ditches.

A separate Subwatershed Study has also been completed to support the Secondary Plan. It was determined that the existing infrastructure in southeast of QEW has sufficient capacity to service this portion of the Study Area. In the northeast portion of the Study Area, conceptual locations for stormwater management (SWM) facilities were identified. Storm sewers and SWM facilities can be designed and constructed as part of the proposed development application works. Potential future development in the area of Townline Road and York Road may require new storm sewers and SWM facilities – which can be included as part of future road improvements projects in the area.

Existing water, wastewater and stormwater infrastructure within the Glendale Secondary Plan area can service initial development with the flexibility to accommodate water demands and sanitary and storm flows from future development. Growth in the Secondary Plan area and resultants demands and flows are to be tracked with updated input and projections for the area feeding into future Region-wide MSPs. This will ensure timing of planned area capital projects reflects the best available information – and future MSPs and associated Development Charges programs are updated to meet the evolving requirements of the Glendale Secondary Plan area.

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Appendix A: Construction Cost Estimates

I.0 Introduction

GM BluePlan Engineering Limited (GMBP) has been retained to complete the water, wastewater, and stormwater Area Servicing Plan (ASP) in support of the Glendale Secondary Plan Update. GMBP are part of the project team led by The Planning Partnership (TPP) to develop the Secondary Plan Update for Niagara Region (Region).

The Water, Wastewater, and Stormwater ASP for the Glendale Secondary Plan Update identifies and evaluates water, wastewater, and stormwater servicing alternatives and recommends a servicing strategy for the preferred Secondary Plan land use option. The ASP will also utilize the background information, consultation, and input from the previously completed Glendale District Plan process.

The key objectives of this Water, Wastewater, and Stormwater ASP are to:

- Develop a comprehensive servicing strategy to meet the requirements of the Glendale Secondary Plan that can be cost-effectively constructed.
- Provide a defensible framework and implementation plan for servicing of the Glendale Secondary Plan Area.
- Provide justification and recommendations for timing and phasing of new Regional and Local infrastructure.
- Build on previous studies, including studies completed in support of the Glendale District Plan, to create a forward-looking document that aligns with infrastructure planning across Niagara Region.

I.1 Study Background

The Town of Niagara on the Lake's (Town, NOTL) original Glendale Secondary Plan was adopted in 2010 by the Town and approved in 2011 by the Region. The original Secondary Plan vision has not been realized and the policy framework is required to be updated based on the vision and key direction of the Region's Glendale District Plan. Through this project, the Region and Town have refined the Secondary Plan based on updated technical studies, including the Water, Wastewater and Stormwater Area Servicing Plan.

I.1.1 Study Area

The Glendale Secondary Plan Update study area is approximately 380 hectares (ha), generally bounded by Queenston Road to the north, Concession 7 Road to the east, the Niagara Escarpment to the south and Homer Road to the west. The Study Area is located entirely within the Region’s Glendale District Plan boundaries as the Secondary Plan will focus solely on the urban area of Glendale. The Queen Elizabeth Way (QEW) 400-series highway runs through the Study Area with an interchange at Glendale Avenue providing highway access to Glendale. The Glendale Avenue interchange is currently under construction. The Study Area is shown in Figure 1-1.



Figure 1-1: Glendale Secondary Plan Update Study Area

I.2 Approach

The water, wastewater, and stormwater servicing analysis builds on the Infrastructure Strategies identified in the Glendale District Plan. The Servicing Analysis includes the development and evaluation of servicing strategies, as well as the selection of a preferred servicing strategy to meet the needs of planned development, which aligns with the Vision and Community Design Principles established for the Study Area.

The preferred water, wastewater, and stormwater strategies for the area will provide the flexibility to be effectively incorporated into the Town and Region's current and ongoing master servicing plans (MSP).

Extensive collaboration with the Town and Region have been undertaken to understand planning and timing of water infrastructure to supply the Study Area as well as downstream infrastructure to receive wastewater flows from the Study Area.

The preferred servicing strategy is to provide a comprehensive and cost-effective infrastructure phasing plan to service the initial development through to build-out with a focus on meeting desired development timing and supporting the transition to design as part of future development applications.

1.3 Area Servicing Plan Terms of Reference

The ASP Report documents the comprehensive process undertaken to develop and recommend a proposed water and wastewater servicing strategy for the Glendale Secondary Plan Study Area. This Report is organized as follows:

- **Section 1 – Introduction**
An introduction to the study, description of study area, study purpose and objectives, and the report outline.
- **Section 2 – Background**
Provides the background plans, related studies, legislative and policy planning context, water and wastewater servicing principles and policies relevant to the Water, Wastewater, and Stormwater ASP being completed in support of the Glendale Secondary Plan Update.
- **Section 3 – Land Use and Planning Projections**
Outlines the existing land use and environmental conditions, future planned land use, and population and employment growth forecasts for the Secondary Plan area.
- **Section 4 – Existing Conditions**
Includes the baseline description of the existing water, wastewater, and stormwater systems, including water supply, wastewater and stormwater catchments and outlets, and available infrastructure capacities.
- **Section 5 – Service Policy Review**
Identifies the applicable water, wastewater, and stormwater service policies for the Secondary Plan Study Area and includes an approach for calculation of the water demand, wastewater flows, and stormwater flows.

- **Section 6 – Servicing Review and Needs Assessment**
Includes a review of the infrastructure needs for the area, including relevant constraints and the potential to reach the capacity of the servicing infrastructure prior to the build-out of the Secondary Plan area.
- **Section 7 – Proposed Servicing Strategy**
Documents the proposed water, wastewater, and stormwater servicing strategy to support the ultimate build-out of the Secondary Plan Area. The servicing strategy includes recommended phasing to meet development timing and cost estimates of capital projects to service the Glendale Secondary Plan Area which take into consideration the system-wide needs.
- **Section 8 - Conclusion**
Summarizes the servicing strategy recommended for the study area and lists the required capital upgrades and improvements.

2.0 Background

2.1 Relevant Documents and Studies

Several studies have been previously completed to detail planned growth within the Glendale Secondary Plan area, which are summarized below. The following key studies have also been referenced as part of the development of the water and wastewater servicing strategies for the Glendale Secondary Plan Update. Reference to the updated plans have been made to ensure the Secondary Plan aligns with the broader servicing strategy through implementation. The servicing strategies will be referenced to existing approved documents with identification of any changes as part of the ongoing studies.

2.1.1 Glendale District Plan

The Glendale District Plan was developed to set out a high-level framework for the land use planning, design, and development of the Glendale community. The District Plan was established for the 700 ha. Study Area, which is generally bound by Queenston Road to the north, the Niagara Escarpment to the south, Concession 7 Road to the east, and Welland Canal to the west. Ultimately the District Plan will be implemented through an amendment to the Niagara Region Official Plan, a review and update of the Glendale Secondary Plan, and continued Planning Act Approval application approvals by the Town and Region. The Glendale District Plan was endorsed by Regional Council on September 17, 2020. Further to this endorsement, the Region has approved Regional Official Plan Amendment 17 to implement the vision and policy direction of the District Plan in the Region's Official Plan.

The infrastructure review, capacity, and upgrades identified a build-out of approximately 21,500 population equivalent for the Glendale plan area and recommended that available servicing capacity be further investigated through detailed technical work and the creation of a phasing plan through the Secondary Plan Update. The District Plan also recommended consideration of a Community Benefit Charge Strategy and an area-specific development charge (DC) by-law by the Town.

2.1.2 Glendale Secondary Plan (2010)

The initial Glendale Secondary Plan was completed in 2010. The 2010 Secondary Plan noted that the Region had identified the potential for servicing issues as Glendale continues to develop, particularly related to sewer capacity. The Secondary Plan called for the initiation of a servicing study to identify problems and solutions, including consideration for a range of development scenarios, development of a preferred servicing strategy, and the costing and phasing of priority capital projects to be coordinated with recommended road improvements.

The sewer strategy was recommended to be coupled with an updated stormwater management strategy including design guidelines and implementation strategies to ensure future stormwater ponds were consolidated, located, and designed to maximize efficiencies and create open space features that enhanced development.

2.1.3 Niagara Region Water and Wastewater Master Plan Update

In 2016, Niagara Region completed a Water and Wastewater MSP that outlined the anticipated infrastructure needs to the year 2041, while maintaining levels of service. In 2021, the Region undertook a MSP Update to the plan to incorporate updated knowledge and current priorities to ensure the Region can accommodate further growth expected by 2051 and beyond, as per the amended Growth Plan for the Greater Golden Horseshoe.

The 2021 Study developed a comprehensive plan that incorporated all facets of the management, expansion, and funding of the water and wastewater systems for the urban service areas of the Region through to the year 2051 with consideration for post-2051 build-out.

Development of water and wastewater principles and policies are integral to providing guidelines and direction to the MSP Update process, as well as to the identification and evaluation of servicing strategies.

The Region's 2016 MSP established master planning policy, criteria, and principles; which were used as the basis for this memo. Updates to water and wastewater policy, criteria and principles were made using the best available data as of 2021, and through consultation with the Region.

In support of the 2021 Master Plan Update, the Region updated their water and wastewater models to incorporate recent trends and plan for growth to the 2051 planning horizon.

The Region's updated water model includes:

- An "all-pipe" network including all Region and Local Area Municipality (LAM) owned watermains and facilities;
- Existing demands based on water billing records and proposed demands based on the Region's Municipal Comprehensive Review (MCR) planned growth scenarios to 2051; and,
- Appropriate controls for all facilities to allow for extended period simulation system modelling under a greater range of demand conditions.

The water model has been updated to reflect the current water system including recent expansions, as well as new, updated, or decommissioned facilities (including capacities and controls), along with the proposed growth scenarios to 2051 and the associated capital projects that were recommended.

The Region's updated wastewater model includes:

- All existing and planned Regional facilities and downstream sewer networks (including all Region and LAM-owned sewer mains greater than 300mm diameter) up to the headworks of the wastewater treatment plants (WWTP);
- Existing domestic flows based on water billing records;
- Proposed demands based on Region Municipal Comprehensive Review (MCR) planned growth scenarios to 2051; and
- Calibrated wet weather flow scenarios.

Similarly, the wastewater model has been updated to reflect the current wastewater system including recent expansions, as well as new, updated, or decommissioned facilities (including capacities and controls), along with the proposed growth scenarios to 2051 and the associated capital projects that were recommended.

2.1.4 Town of Niagara on the Lake Pollution Prevention Control Plan

GMBP has been retained by the Town of Niagara-on-the-Lake (Town, NOTL) to complete the Town's Pollution Prevention Control Plan (PPCP), including hydraulic model update and analysis of existing and future conditions.

The PPCP will focus primarily on quantifying system capacity, identifying system hydraulic deficiencies, areas/systems with surplus capacity, quantifying system overflows, identifying areas of high Inflow & Infiltration (I&I), and MECF F-5-5 / F-5-1 analysis. The PPCP builds on the Town's existing 2012 Pollution Control Plan, including updates on implementation of approved recommendations, source validation, and quantification of impacts on the system and remaining/existing areas of concern.

The Town's wastewater model will be updated to reflect the current collection system and wastewater facilities, with SCADA and water billing data used to update existing demand conditions. A comprehensive flow-monitoring program is being undertaken to support calibration of the wastewater model update. The updated model will be utilized to develop the recommended capital program based on the Town's planned growth.

2.2 Development Applications Information

Current information on development applications has been provided by the Region and Town for review and incorporation into the Area Servicing Plan. Development applications' proposed water demands, wastewater flow, stormwater flows, and stormwater management facilities will be considered as part of the development of the ASP.

Development application information will be essential to informing anticipated phasing of development within the Study Area and required phasing of water and wastewater infrastructure to effectively meet the build-out of the area.

3.0 Land Use and Planning Projections

High-level land use and planning projections for the Study Area are available as part of the Region's MCR planned growth and have been utilized to inform the ongoing Region Water and Wastewater MSP Update.

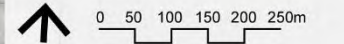
As noted in Section 2.1.2, the Glendale District Plan noted that the available capacity of the sanitary sewer system servicing the Glendale plan area (including Walker Industries and Airport Road areas) correlates to a build-out of approximately 21,500 population equivalents (including residential and employment).

3.1 Preferred Land Use Concept

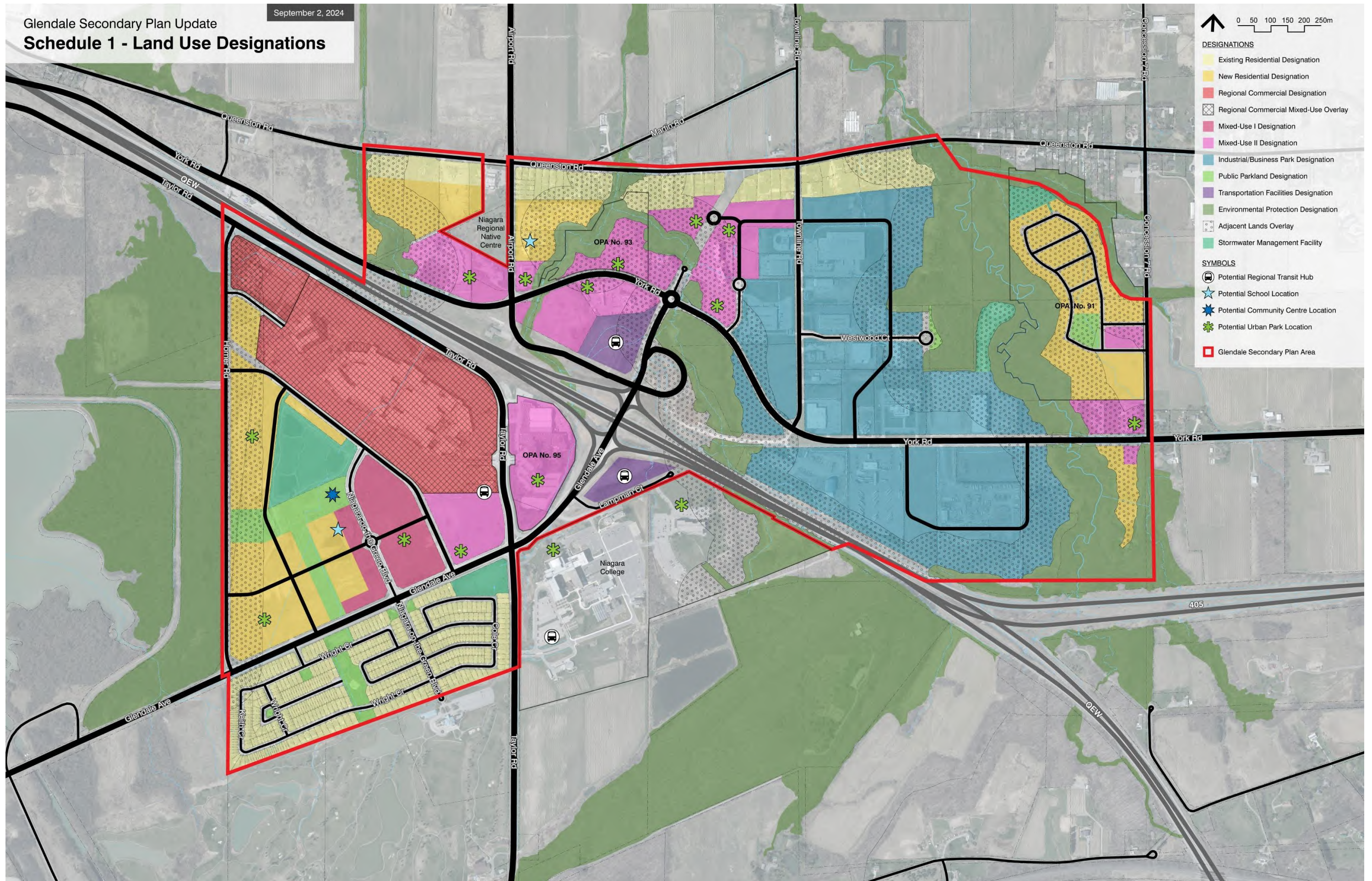
The preferred land use concept has been developed by The Planning Partnership through extensive consultation with the Region, Town, and key stakeholders, as documented in the associated TPP report. The preferred land use concept is shown in Figure 3-1.

Glendale Secondary Plan Update
Schedule 1 - Land Use Designations

September 2, 2024



- DESIGNATIONS**
- Existing Residential Designation
 - New Residential Designation
 - Regional Commercial Designation
 - Regional Commercial Mixed-Use Overlay
 - Mixed-Use I Designation
 - Mixed-Use II Designation
 - Industrial/Business Park Designation
 - Public Parkland Designation
 - Transportation Facilities Designation
 - Environmental Protection Designation
 - Adjacent Lands Overlay
 - Stormwater Management Facility
- SYMBOLS**
- Potential Regional Transit Hub
 - Potential School Location
 - Potential Community Centre Location
 - Potential Urban Park Location
 - Glendale Secondary Plan Area



The preferred land use considers two density scenarios:

- Scenario 1 – Higher Density Assumptions; and,
- Scenario 2 – Lower Density Assumptions

The Glendale Secondary Plan Area is anticipated to evolve beyond the time horizon of 2051 into an integrated mixed-use community, with higher densities than exist today. As noted in the Secondary Plan document, this ongoing evolution is anticipated to require an extended period of time to fully achieve. Overall, the Glendale Secondary Plan area is planned to accommodate the estimated population and employment yields as identified in Table 3-1.

Table 3-1: Estimated Population and Employment Yields for Glendale Secondary Plan Area

Scenario	Residential Population	Employment	Population + Jobs	Area	PPJ/ha
2051 Lower Density Assumptions	9,740	7,275	17,015	380 Ha.	~60 PPJ/ha
2051 Higher Density Assumptions	13,170	9,200	22,320		~80 PPJ/ha

As noted in the Secondary Plan, the population and employment projections included in this Plan are not to be considered as maximum build-out populations, or limitations on development, but rather minimum growth targets to be achieved to the year 2051. The Area Servicing Plan considers this and is based on the range of development – with infrastructure upgrade triggers that can be considered for increased (or decreased) densities/development.

The Region’s 2021 MSP Update included growth of 19,146 persons between 2021 and 2051 for the entire treatment plant catchment. As part of the analysis in support of the Secondary Plan, the updated densities were considered for additional infrastructure upgrade requirements.

It is recommended that the Glendale Secondary Plan continue to be identified as a strategic growth area for future Region-wide MSP updates, with consideration for increased densities. This recommendation is based on continued monitoring of the required timing for planned infrastructure upgrades and should consider additional infrastructure upgrades that may be required to meet development/growth beyond the minimum growth targets identified in the Secondary Plan.

4.0 Existing Conditions

4.1 Water

The Study Area is located within the Decew Water Treatment Plant (WTP) service area. The Decew WTP is located in St. Catharines and supplies NOTL through the St. Catharines transmission system. The Glendale Secondary Plan Study Area is located in Region Pressure Zones 161, 168, and 180. As noted in the 2016 MSP, the existing neighbourhoods within the Study Area experience a wide range in water pressure (50 to 100 psi) as a function of the varying elevation in the Study Area. There are existing pressure regulation valves installed on the Region transmission main within the area.

There is an existing distribution network throughout the Study Area. The existing water system for the Study Area is shown in Figure 4-1.

4.2 Wastewater

Flows from the Secondary Plan area will be received at the Port Weller Wastewater Treatment Plant (WWTP) located in St. Catharines via a Regional trunk sewer on Queenston Road that conveys flows across the Welland Canal and continues north (ultimately discharging to the Port Weller WWTP). There are no downstream sewage pumping stations (SPS) to the Port Weller WWTP, therefore sewers within the Glendale Secondary Plan drain entirely by gravity.

The existing sewers in the Study Area are shown in Figure 4-2.

4.3 Stormwater

The majority of the Study Area (east of Airport Road/Taylor Road) is located in the NOTL Six Mile Creek Subwatershed, with the area west of Airport Road/Taylor Road located in NOTL Eight Mile Creek Subwatershed; both of which drain to the noted creeks. A small portion along the west limit of the Study Area drains to the Welland Canal and is located in the Beaver Dam Schiner's Creek (BDSC) Welland Canal North Subwatershed. The Study Area is located within the jurisdiction of the Niagara Peninsula Conservation Authority (NPCA).

The section of the Secondary Plan Area located southwest of the QEW, and generally located within the Eight Mile Creek tributary, is generally well serviced by existing storm sewers, and a large pond stormwater management facility located west of Niagara on the Green Boulevard.

Northeast of the QEW, stormwater servicing is primarily by roadside ditch to various outlets to tributaries to Six Mile Creek. Various current development applications for the area propose on-site stormwater management facilities with quantity and quality control to service the individual development.

Existing storm sewers in the Study Area are shown in Figure 4-3.



Existing Water Infrastructure

- Pressure Regulation Valve
- Region Mains
- Local Mains
- Private

Water Pressure Zones (HGL)

- DeCew Falls WTP-161
- DeCew Falls WTP-168
- DeCew Falls WTP-180

Other Features

- Glendale Secondary Plan Area
- Municipal Boundaries
- Urban Area Boundary

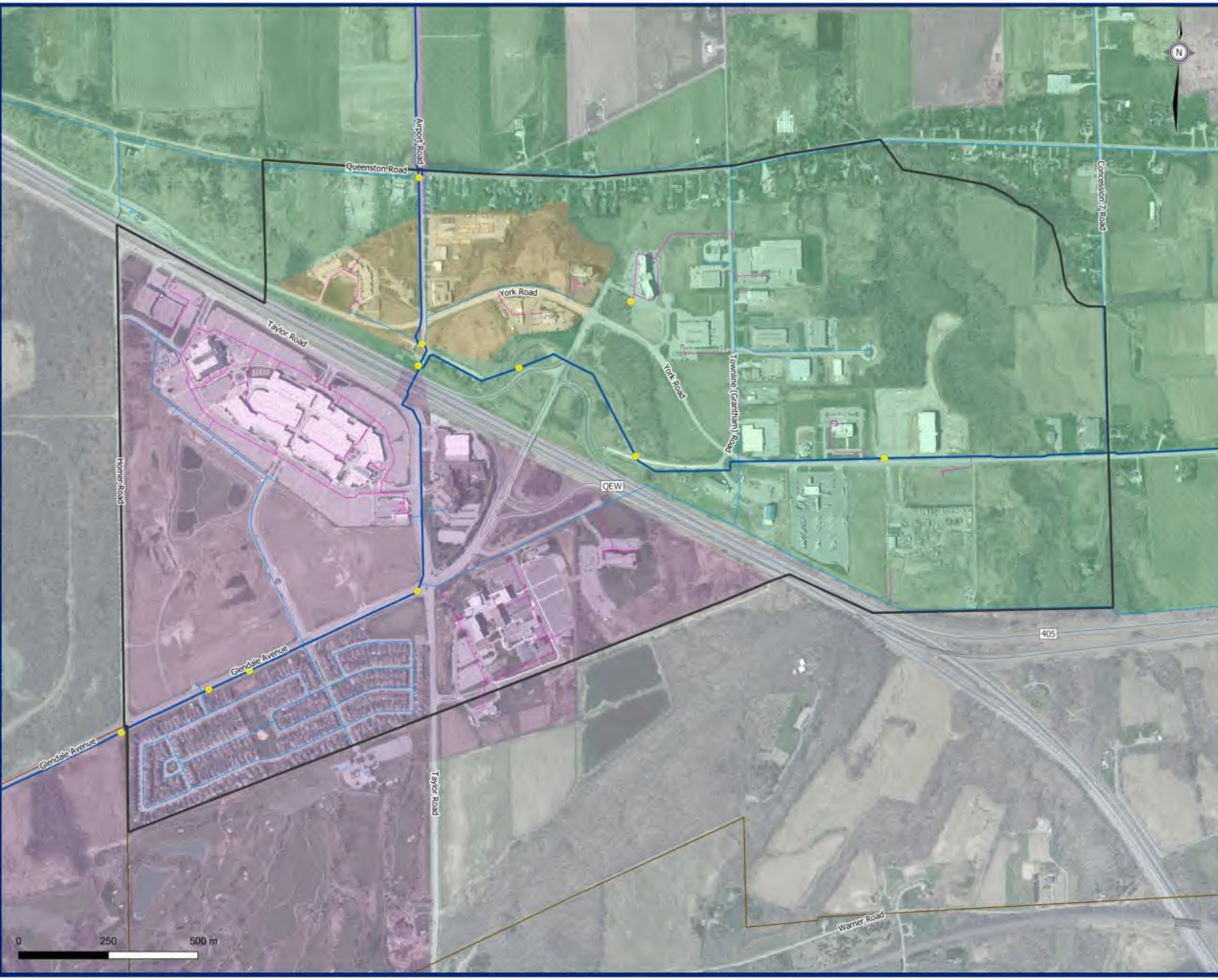


Figure 4-1
Existing Water System

Baseline System and Understanding



Existing Wastewater Infrastructure

- Sanitary Force Main
- ▶—▶—▶ Regional Gravity Main
- ▶—▶ Local Gravity Main
- Private

Sewer Catchment

- Port Weller WWTP

Other Features

- Glendale Secondary Plan Area
- Municipal Boundaries
- Urban Area Boundary

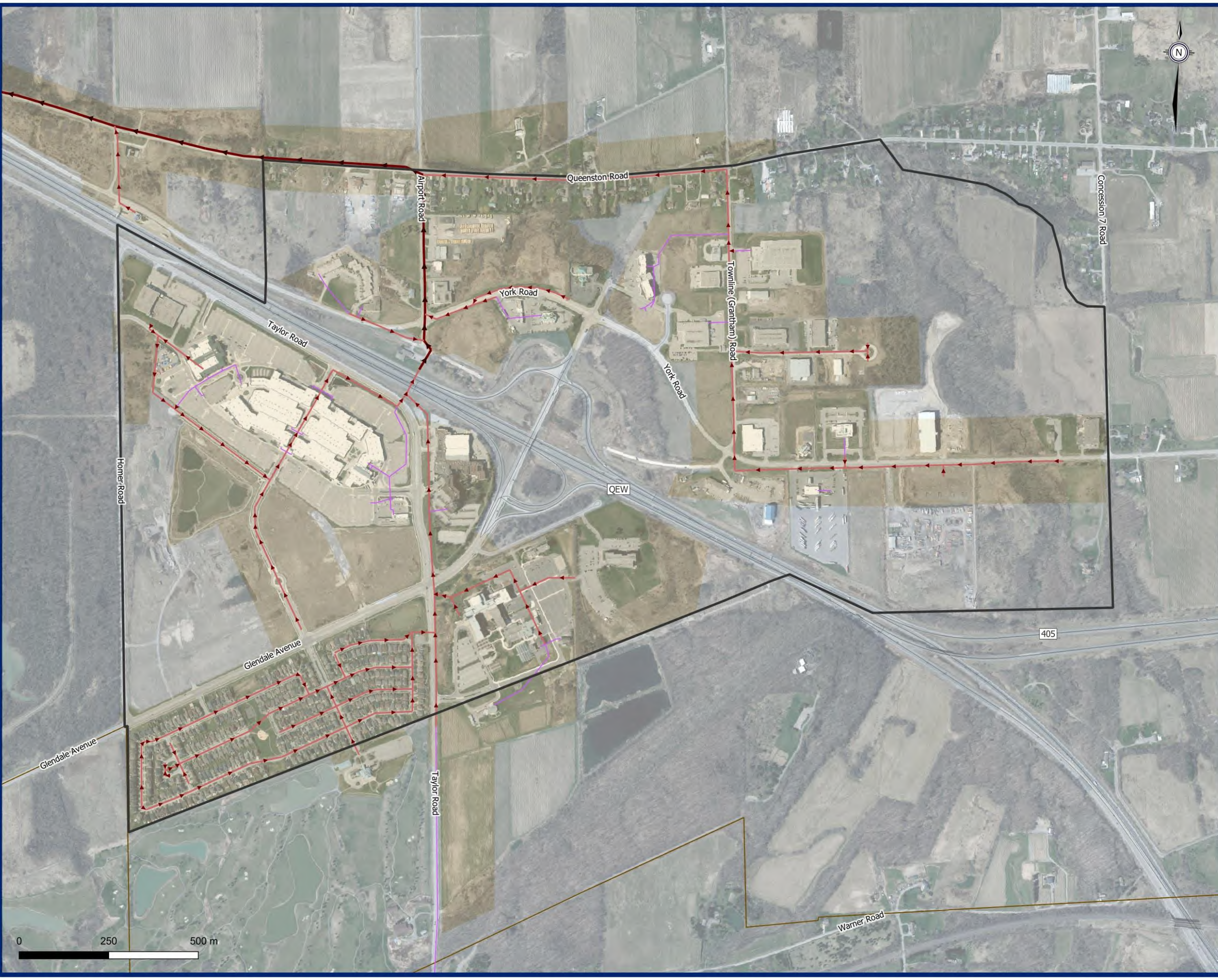


Figure 4-2
Existing Wastewater System

Baseline System and Understanding



Existing Stormwater Infrastructure

Regional

- Catchbasins
- Maintenance Holes
- Stormwater Main
- Stormwater Lead

Municipal

- Catchbasins
- Maintenance Holes
- Stormwater Pond
- Stormwater Main
- Stormwater Lead

Other Features

- ▭ Glendale Secondary Plan Area
- ▭ Municipal Boundaries
- ▭ Urban Area Boundary
- Watercourse

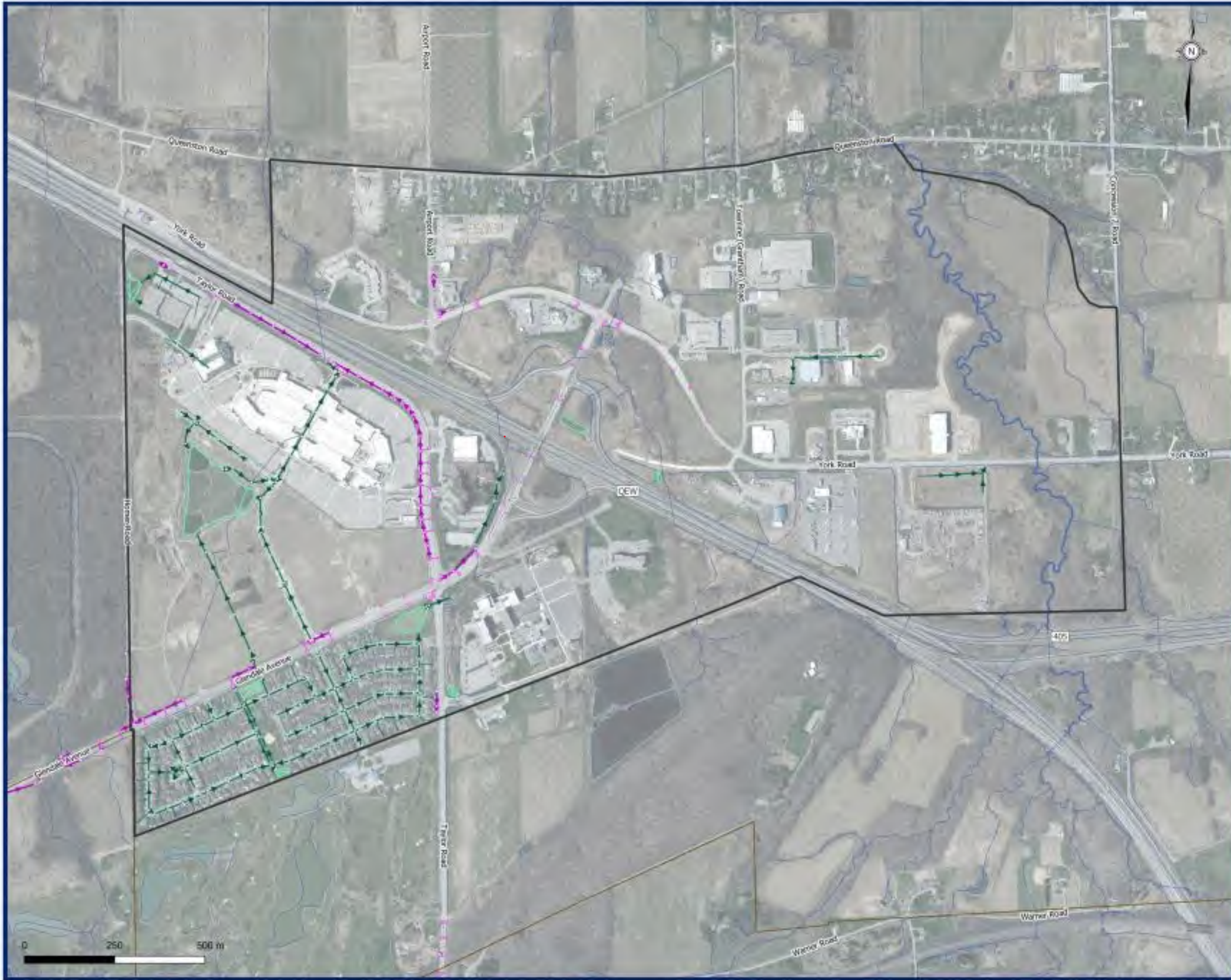


Figure 4-3
Existing Regional and Municipal
Stormwater System

Baseline System and Understanding

5.0 Service Policy Review

Development of the water and wastewater policies has been based on existing documentation and related sources, including primarily, the ongoing Region Water and Wastewater MSP Update. Water and wastewater policy was reviewed and updated as part of the ongoing MSP and is recommended to be carried forward for use as part of the ASP.

The objectives of the MSP Update Principles and Policy document include:

- Providing direction for planning and identifying water and wastewater servicing issues that may impact growth options;
- Providing direction for normal operation and maintenance of the water and wastewater systems;
- Providing direction for development and evaluation of servicing strategies for the Water and Wastewater MSP Update;
- Ensuring appropriate design and costing criteria are utilized for developing and evaluating servicing strategies for the Water and Wastewater Master Plan Update;
- Setting policies that are reasonably implemented; and,
- Setting policies that are robust and sustainable.

Policy is the overall guiding principle. Criteria is the practical implementation of policy.

5.1 Water

Water service policy for the Study Area will be based on the criteria developed as part of the Region's ongoing Water and Wastewater Master Plan Update. These criteria are included in the current Regional water and wastewater models which will be used for strategy evaluation purposes. Water service policy for the Study Area includes:

1. Water Demand Projection Methodology

- Utilize starting point methodology;
- Starting point based on local billing meter records from last 3 years of data; and
- Growth demands applied to starting point using design criteria.

2. Water System Criteria

- Maintain water system between 40 – 100 psi;
- Sizing water supply, transmission, and storage facilities for maximum day demand;
- Sizing water distribution system for peak hour flows and maximum day plus fire flow demands;
- Plant and facility planning process triggered at 80% capacity; and
- Plant and facility expansion process complete before 90% capacity achieved.

3. Water Consumption Criteria for Growth (from 2021 Water and Wastewater MSP Update)

- Residential criteria 240 L/cap/day;
- Employment criteria 270 L/emp/day;
- Maximum day factor based on rolling average from last 5 years of data; and
- Peak hour factor (residential and employment) is 1.5 times maximum day factor for MSPU purposes.
 - Local area municipalities (LAM) should use a maximum day factor of 2 and a peak hour demand factor of 3 in order to provide protection for local infrastructure sizing in the development review process.

4. Fire Flow Criteria

- Regional transmission mains to provide 250 L/s fire flow at 30 psi residual pressure; and
- Fire flow and duration for system storage calculation is based on Ministry of Environment, Conservation and Parks (MECP) recommendations and methodology.

Region and Town Engineering Design Guidelines will be referenced for the conceptual design of water servicing.

5.2 Wastewater

Wastewater service policy for the Study Area will be based on the criteria developed as part of the Region's ongoing Water and Wastewater Master Plan Update which are included in the Region's current water and wastewater models. Region and Town Engineering Design Guidelines will also be referenced for the conceptual design of wastewater servicing. Wastewater criteria developed in support of the Region MSP Update and wastewater model analysis includes:

1. Wastewater Demand Projection Methodology

- Utilize starting point methodology;
- Starting point based on local billing meter records from last 3 years of data; and
- Growth flows applied to starting point using design criteria.

2. Wastewater System Criteria

- Sizing treatment facilities for average day flows;
- Sizing of trunk sewer, pumping and collection system for peak wet weather flows;
- Firm capacity based on largest pump out of service;
- Plant and facility planning process triggered at 80% capacity;
- Plant and facility expansion process complete before 90% capacity achieved;
- System triggers as follows:

- Review if sewer flows are greater than 50% of pipe full (by depth) under peak dry weather flow;
- Review if sewer flows are greater than 90% of pipe full (by depth) under peak wet weather flow;
- Review if pumping station flows based on 2 times peak dry weather flows are greater than firm capacity;
- Review if peak wet weather flows are greater than sewer capacity and pumping station firm capacity;
- Review if sewer system hydraulic grade line is within 1.8m depth from surface under peak wet weather flow;
- Plan the system based on a 2-year design storm
- Under the 2-year design storm, allow for a maximum extraneous flow contribution from local catchment areas;
- Forcemain velocities should be maintained between 1 m/s to 2 m/s.

3. Wastewater Criteria for Growth (from 2021 Water and Wastewater MSP Update)

- Residential criteria 255 L/cap/day;
- Employment criteria 310 L/emp/day;
- Peaking factor based on Harmon formula with values between 2.0 and 4.0 with consideration to the catchment area performance; and
- Utilize extraneous flow rates of 0.286 L/s/ha as the wet weather level of service for triggering and sizing Regional wastewater infrastructure.

Region and Town Engineering Design Guidelines will be referenced for the conceptual design of wastewater servicing.

5.2.1 Sewage Pumping Stations and Forcemains Policy Proposed Policy Amendments

Niagara Region council has adopted a Sewage Pumping Stations and Forcemains Policy regarding upper-tier and lower-tier ownership and responsibilities. The Proposed Policy Amendments require the following key considerations for the recommendation of pumping station and forcemain infrastructure as part of the Secondary Plan Area Servicing Plan:

- Need for any new pumping station recommendations to be documented for approval by Niagara Region;
- Funding of new pumping stations to be identified for inclusion as part of the respective Region and/or Town DC Background Studies, if Regional DC criteria are met; and,
- Documentation of evaluation of pumping station recommendations compared against the option of servicing by gravity sewer (including life-cycle cost analysis for both options).

Region policy maintains that:

- Gravity sewers are the most reliable method of transferring sewage from the sanitary collection system to wastewater treatment facilities;
- There are limitations to the practical depth of gravity sewers such that new pumping stations will only be allowed where it can be shown that pumping is a more cost effective and feasible option than gravity sewers;
- The need for a new pumping station, as well as an assessment of capacity of the downstream infrastructure, must be documented in engineering and/or planning studies (including Area Servicing Plans); and,
- The cost for a new pumping station required to accommodate growth is to be included in the applicable Region/Town Development Charges (DC) by-law if Regional DC criteria are met.

5.3 Stormwater

5.3.1 Quantity

Phase 2 of the Secondary Plan Subwatershed Study (SWS) has been completed and includes hydrologic analyses to establish stormwater management criteria for future development within the Study Area. Sizing of conceptual stormwater management (SWM) facilities was completed to determine the required level of quantity control for the area, required on-site quantity controls, and required conveyance (storm sewers) measures.

The SWS work confirmed that SWM facilities providing quantity controls along the receiving watercourses can maintain the Town's standard stormwater quantity control requirement of post-development to pre-development peak flow control for design storms ranging from 1 in 2-year to 1 in 100-year.

The SWS also noted that over-control at the watercourses will be provided for more frequent storm events; which may provide opportunities to encourage the incorporation of Low Impact Development (LID) Best Management Practices (BMP) at the individual property level.

5.3.2 Quality

Phase 2 of the Subwatershed Study notes:

- The future development within the Glendale Secondary Plan area is anticipated to result in increased mass loadings of various water quality contaminants, including heavy metals, nutrients, and thermal enrichment. The stormwater management system within future development areas will be required to address Provincial standards for stormwater quality control to an Enhanced standard of treatment by adopting a treatment train approach per Provincial guidance, as well as measures to mitigate thermal enrichment of storm runoff.

The specific quality control measures to be used to achieve this criteria will need to be determined at the development application stage, as the site-specific details will need to be reviewed with respect to potential constraints, development form, site design, infrastructure connections, etc. However, there are various technologies available which can be designed to achieve a treatment train approach to SWM and achieve the required water quality and thermal mitigation measures, thereby providing flexibility at the future site plan design stage.

5.4 Infrastructure Oversizing

All new water, wastewater, and stormwater infrastructure proposed in support of development applications should be considered compared to the potential for the higher densities proposed as part of the Secondary Plan. There are recent examples of sanitary sewers installed across Niagara Region that have been required to be upgraded in advance of the end of life-cycle because they were sized too small to convey flows from new, higher density development. Proposed local sanitary sewer, sized only to convey flows from low-density development, may not have additional capacity to convey flows from high-density land use that may be approved for development in the future. There is the potential for extensive sections of recently installed sanitary sewer to require replacement to support the new development, which may be cost prohibitive as it will require removal of the existing sanitary sewer and installation within an existing street / right-of-way. Additionally, funding for the upgrade costs will need to be considered as there is the possibility that the first high-density development that triggers the need for additional capacity to be responsible for these costs. The removal of newly installed (but undersized) infrastructure does not represent best management practices for Town and Region assets.

5.4.1 Water

Local water infrastructure can be difficult to oversize from an operational perspective as it can result in water quality (water age) issues within infrastructure prior to the higher-density development coming online. This issue can become a permanent issue throughout the lifecycle of the watermain if the higher density development is not realized. Opportunities to loop watermain to support available fire flow is key to achieving best management of local water infrastructure across the Secondary Plan Area. Proposed watermain looping through developments will:

- Increase available fire flow (provision of flow from multiple connections to Region watermain);
- Provide system redundancy (maintenance of a secondary feed from the Region watermain in case of a watermain break); and,
- Improve water quality (mitigating water age concerns within single-feed “dead end” watermains).

5.4.2 Wastewater

Local sanitary infrastructure can be effectively over-sized to service an ultimate build-out population which will mitigate future upgrade requirements if higher-density development is achieved. Sanitary sewers can be oversized at minimal additional cost which is often primarily the additional material cost for upgraded PVC sewers as depth and construction trench dimensions for oversized sewers are typically similar. Installing sewers sized for ultimate build-out reduces the risk of future removal and upgrade to service higher density development flows. It is important to ensure that the design of oversized sewers maintains minimum cleansing velocities (0.6 m/s under full flow conditions).

5.4.3 Stormwater

Storm sewers installed within the right-of-way are designed to accommodate stormwater flows from development sites that are based on quantity controls of post-development to pre-development peak flow control. This does not typically change for development type and additional quantity controls (as well as stormwater quality controls) can be accommodated as part of site design. Oversizing of storm sewers for future higher-density development is not required or recommended. Increased conveyance capacity from oversized storm sewers can also negatively impact the downstream / end-of-pipe facilities under more intense storm events.

5.4.4 Development Charges

5.4.4.1 Regional

Updated growth projections for the Glendale Secondary Plan may have impacts on the Region's existing DC Program, as the higher growth numbers may trigger requirements for more significant water and wastewater upgrades and/or impact the required timing for planned upgrades. The required infrastructure upgrades compared to the Region's MSP Update Capital Program is detailed further in Section 6.0 - Servicing Review and Needs Assessment and Section 7.0 - Proposed Servicing Strategy, with recommendations on impacts to future DC Programs.

5.4.4.2 Local

The Glendale Secondary Plan identifies that to implement the required growth-related costs anticipated for the long-term development of the Secondary Plan Area, the Town may prepare a background study and enact an area-specific development charge by-law under the DC Act. Additional costs to accommodate strategic looping of local watermains and oversizing of sanitary sewers should be considered as part of required growth-related costs anticipated for the long-term development of the Secondary Plan Area. If an area-specific DC Background Study is to be completed, then the water, wastewater, and stormwater infrastructure costs associated with the long-term development of the Secondary Plan Area are to be included within the Study.

6.0 Servicing Review and Needs Assessment

6.1 Water

As outlined in Niagara Region's 2016 Master Servicing Plan (MSP) Update, the Decew WTP has surplus capacity within the 2041 planning horizon and treatment capacity is not anticipated to constrain development of the Secondary Plan area.

The Study Area experiences a wide range in water pressure (50 to 100 psi) as a function of the varying elevation across the Secondary Plan area.

In isolation, the NOTL system does not have sufficient storage capacity and relies on surplus conveyance capacity to support a portion of the storage deficiencies through transfers from the surplus storage from St. Catharines and Thorold. Increased intensification throughout St. Catharines will continue to limit the available surplus capacity to supplement peak flow transfers to the Niagara-on-the-Lake system.

New storage within NOTL and/or an increase from St. Catharines and Thorold (and/or Niagara Falls) is required to address future NOTL storage needs to 2041. Future MSP updates will incorporate the updated planning numbers for the Glendale Secondary Plan area.

The existing Region trunk watermain system across the Secondary Plan area can provide the Region's specified minimum fire flow requirement of 250 L/s at a minimum system pressure of 30 psi. Local distribution watermain within the area can supply sufficient available fire flow to proposed development with appropriate watermain looping.

Single watermain feeds to proposed developments with backflow prevention devices (typically as part of metered chambers and private watermains to condominiums) are to be avoided, where possible, to ensure the supply of sufficient available fire flow to meet long-term development densities within the Secondary Plan Area.

6.1.1 Planned System Improvements

A new trunk 600mm diameter feedermain from South NOTL to the Virgil Elevated Tank with a new pressure reducing valve (PRV) in NOTL is recommended as part of the Region's MP capital program to address the storage issues that will result from growth within the NOTL system (combined with growth within the "upstream" St. Catharines system) to 2032.

Additionally, a new elevated tank in Virgil to support additional build-out growth within NOTL is anticipated to be required to 2042.

The capital program projects recommended by the Region are summarized in Table 6-1.

Table 6-1: Region Planned System Improvements Impacting Glendale Secondary Plan Area

Master Plan ID	Name	Size / Capacity	Year in Service	Class EA Schedule	Estimated Cost (2022\$)
W-M-008	Trunk main from South Niagara-on-the-Lake to Virgil Elevated Tank	600 mm	2032 - 2041	A+	\$15.0M
W-S-008	New ET in Virgil to support 2051 and buildout growth	7.5 ML	2042 - 2051	B	\$17.5M
Total					\$32.5M

As part of the future MSP Updates and DC Background Study Updates, the required timing of both projects is to be considered incorporating the updated planning numbers for the Glendale Secondary Plan Area.

6.2 Wastewater

6.2.1 Treatment

The Region’s 2021 MSP Update has identified that the Port Weller WWTP has surplus capacity within the 2041 planning horizon; and treatment capacity is not anticipated to constrain development within the Secondary Plan area.

6.2.2 Planned System Improvements

The existing downstream St. Catharines trunk sewer infrastructure has sufficient capacity to support future design peak wet weather flows and development within the Study Area will be serviced through existing or new local sewers, outletting to the existing trunk sewer.

6.2.3 Existing Siphon Under Welland Canal (Downstream Queenston Road Trunk Sewer)

The MP Update also identifies that the existing downstream St. Catharines trunk sewer infrastructure has sufficient capacity to support future design peak wet weather flows. It is not anticipated that downstream sewer capacity will be a constraint to development within the Study Area. As noted in Section 3.0, the Region's MSP Update is based on planning projections developed as part of the Region's MCR. As part of previous servicing work supporting the District Plan, the existing downstream sewer siphon was identified for further capacity review (the District Plan considered the planned ultimate buildout population of 21,500 population equivalents). In 2018, Region Water and Wastewater Planning identified the hydraulic capacity range for the sanitary sewer system servicing the Glendale Secondary Plan area, as well as Walker Industries and the Airport Road SPS collected through the Siphon, inclusive of the Walker Landfill maximum agreed flow rate, can be considered to be at 300 L/s. Region Infrastructure Planning staff noted that this flow generation correlates to a build out of 21,714 population equivalents including residential and employment, existing and future.

Capacity of the existing siphon is to be reviewed as part of future MSP updates, incorporating updated and planned growth for the Glendale Secondary Plan Update.

6.2.4 Existing Niagara-on-the-Lake 450mm Diameter Sewer Crossing of QEW

Wastewater flows from growth areas southwest of the QEW within the Secondary Plan can continue to be conveyed to the Niagara-on-the-Lake sanitary sewers that ultimately discharge under the QEW, north of Taylor Road, via a Town-owned 450mm diameter sewer and outlet into the Region's 600mm diameter sewer that conveys flows north along Airport Road. The existing 450mm diameter sewer crossing has the capacity to convey flows to build-out and is anticipated to reach 70% full capacity at build-out. For the proposed development within the southwest portion of the Secondary Plan area that exceeds the minimum growth targets established as part of the Secondary Plan, consideration should be given to impacts on wastewater flows to the existing sewer crossing the QEW.

6.2.5 Pumped Solution for Modero Estates Development Lands

The recent development application for the Modero Estates Development (a 384-unit residential subdivision development located west of Concession 7 and south of Queenston Road, and east of Six Mile Creek) has proposed a pumping solution that complies with the Region's Sewage Pumping Stations and Forcemains Policy. Proposed townhomes at the north limit of the development convey flows to individual eOne sanitary pumping station units that pump sewage via a common forcemain to a gravity sewer that ultimately conveys flows to the south and discharges into the existing 375mm dia. Town sewer. The development application is currently under review by the Town.

Under the evolving land use plan for the Secondary Plan Area, it is unlikely that a pumping station would meet the Region policy criteria for this small area of development. As part of the Area Servicing Plan, it is assumed that the current proposed pumped solution will be approved, constructed, and maintained to the 2051 build-out timeline.

The remainder of the Secondary Plan Area can be serviced by proposed gravity sewers, with gravity connections to the existing downstream sanitary sewer network.

6.3 Stormwater

A separate Subwatershed Study is being completed in support of the Glendale Secondary Plan. Phase 1 (Subwatershed Characterization and Integration) and Phase 2 (Impact Assessment) of the Subwatershed Study have been completed. Phase 3 (Management, Implementation and Monitoring Plan) is being finalized.

The Phase 2 Report identified conceptual locations for stormwater management facilities. The existing storm sewer network for the area southwest of the QEW is sufficient to service the area. Northeast of the QEW, current development applications have proposed site-specific stormwater quantity and quality controls with outlets typically to the existing roadside ditches in the area. The conceptual stormwater management facility locations identified within the Subwatershed Study Phase 2 report have been located to service proposed developments. Considering the evolving land use of the Secondary Plan Area, storm sewers may be required in the area northeast of the QEW to service higher density buildout. There is an opportunity to construct storm sewers to service multiple higher-density developments - with outlets to conceptual SWM facilities sized for long-term land use within the Secondary Plan Area. This will be further detailed upon completion of Phase 3 of the Subwatershed Study.

7.0 Proposed Servicing Strategy

7.1 Water

The existing water servicing within the Glendale Secondary Plan Area is sufficient to service the proposed growth areas, including the low-density and high-density scenarios, as well as for densities higher than the minimum specified in the Secondary Plan.

Any distribution watermain proposed as part of development applications should be looped where the development allows for it (via subdivision roads, Town easements, etc.). This will ensure sufficient available fire flow to service long-term land use within the Secondary Plan Area.

7.1.1 Phasing of Servicing

Upgrades to the existing water system within the Glendale Secondary Plan Area are not required to service growth within the development area. Allocation of new development within the Secondary Plan area is to be monitored and compared to total development within the combined NOTL and “upstream” St. Catharines system to ensure that the planned trunk main from South Niagara on the Lake to the Virgil Elevated Tank, as well as the new elevated tank in Virgil to support 2051 and buildout growth, are planned (via Municipal Class EAs), budgeted for, designed, constructed and commissioned to meet the timing of anticipated growth. Future Region MSP Updates should directly reference growth within the Glendale Secondary Plan area, a strategic growth area, that may trigger need and drive timing for broader network improvements.

The transmission watermain along Airport Road, crossing the QEW, Taylor Road, and Glendale Avenue was constructed in the late 1970s and early 1980s, as well as the watermain on York Road, east of the QEW interchange. The Region’s transmission pipe may be nearing the end of its expected 75-year life-cycle around the anticipated 2051 build-out timeline for the Secondary Plan area. State-of-good-repair replacements can be considered and compared to servicing requirements for the ultimate build-out of the Secondary Plan area.

7.1.2 Cost Estimates

No upgrades to the existing Region and Town watermain within the Secondary Plan area are required. Extension of the local distribution network can be accomplished through development applications and direct developer construction of local watermains to service the respective developments.

7.2 Wastewater

The existing wastewater servicing within the Glendale Secondary Plan, and downstream has sufficient capacity to accommodate growth under both the low-density and high-density scenarios. Extensions of local sewers and connections to existing trunk sewers will be required as part of proposed developments but can be designed and constructed entirely as part of proposed development applications. An extension of the Glendale Avenue local sewer, southwest of Niagara on the Green Boulevard can be considered but may not be required if future development in areas west of the existing Niagara Outlet Mall are via a subdivision with sewers aligned with proposed internal roads.

Existing sewers have been confirmed to be designed at depths and profiles to effectively connect new local sewers to service area developments.

7.2.1 Provisional Upgrade of Siphon Under Welland Canal (Downstream Queenston Road Trunk Sewer)

If the 2051 high-density scenario can be fully achieved (and more than 22,000 PPJ within the Glendale Area), the downstream siphon may be required to be upgraded near build-out. Siphon capacity along with development progress and planned (and anticipated) densities for the Glendale Secondary Plan area should continue to be monitored with specific attention given to future Region-wide MSP Updates.

Incorporation of planned growth for Glendale into future MSP updates - along with consideration for development trends within the Study Area will inform potential upgrade timing for the existing downstream siphon. If a future MSP Updated identifies that the siphon will be required to be upgraded to meet growth flows for the area, then the project will need to be incorporated as part of future Region capital programs and associated DC Background Studies.

The existing siphon was installed in 1983 and there may be an opportunity to upgrade the siphon near the 2051 build-out timing to service both ultimate build-out of the Secondary Plan area as well as align with expected replacement timelines under the Region's State of Good Repair infrastructure replacement program. Linear PE / HDPE infrastructure is expected to have a 75-year lifespan before requiring replacement which would require the existing siphon be considered for replacement in the 2050s. Downstream wastewater upgrades have not been identified as part of the Area Servicing Plan and are to be monitored going forward.

7.2.2 Phasing of Servicing

Monitoring of development densities and wastewater flows for the area will continue to be important in order to plan flexible servicing solutions to meet the actual development densities that evolve over the lifecycle of the Secondary Plan area build-out.

As noted in Section 6.2.4, an upgraded sewer crossing of the QEW is not anticipated, but if a crossing is required to convey flows from developments at densities greater than the minimum specified, it will be costly infrastructure requiring substantial planning and design and construction budget. Allocation and planned long-term development within the southwest portion of the Secondary Plan are to be tracked and compared to the available capacity of the QEW crossing – with future MSP Updates (and associated capital programs and DC Background Study Updates) incorporating area development trends and updated planning numbers.

7.2.3 Cost Estimates

A cost estimate for the provisional proposed upgrade to the downstream Queenston siphon under the Welland Canal is shown in Table 7-1.

Table 7-1: Cost Estimate for Provisional Upgrade of the Queenston Road Siphon (under the Welland Canal)

Project	Anticipated Timing	Total Cost (2024\$)
Upgrade of Existing Queenston Road Siphon	2051 (or post 2051) Likely only required if higher than minimum target densities are achieved.	\$3.1M

Cost estimates have been prepared in accordance with Niagara Region guidelines and the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System and include 18% Engineering fees and 40% project contingency for a Class 4 (Feasibility Level) Estimate. The cost estimate for the provisional siphon upgrade (including the -10% and +30% accuracy range) is detailed further in Appendix A.

Upgrade of the siphon would be growth-driven and should be considered as a future DC eligible project under future MSP and DC Update programs.

7.3 Stormwater






The Subwatershed Study Phase 2 Report identified conceptual locations for stormwater management (SWM) facilities within the Glendale area. For most development sites, on-site storm sewers and SWM facilities can be designed and constructed as part of the development application works, potentially with connections to existing storm sewers. For potential future development in the area of Townline Road and York Road, the evolving land use that replaces current development application works with future higher density development may require new storm sewers, including:

- Proposed storm sewers running north along Townline Road (from north of York Road) to a proposed common stormwater management facility (to be located south of Queenston Road); and,
- Proposed storm sewers running east along York Road (from east of Townline Road) to a proposed common stormwater management facility located at Six Mile Creek.

Existing ditches for roads planned for urbanization will ultimately be required to be replaced by storm sewers. Storm sewer design and construction can be completed as part of future road improvements projects, and will incorporate existing as well as future flows for the area. Consideration for site specific controls and outlets to existing and future / provisional storm infrastructure is to be addressed as part of the development application and review process. Plans for the site controls and outlets are to prioritise flexibility for future connection solutions - with understanding that future road improvements may only be completed well after site development.

Proposed storm sewer infrastructure is shown in Figure 7-1.

Stormwater Infrastructure

-  Provisional Proposed Storm Sewer
-  Conceptual Quantity Control Facilities
-  Glendale Secondary Plan Area
-  Drainage Pathways
-  Roads

Proposed Subcatchments Boundaries

-  6 Mile Creek
-  8 Mile Creek

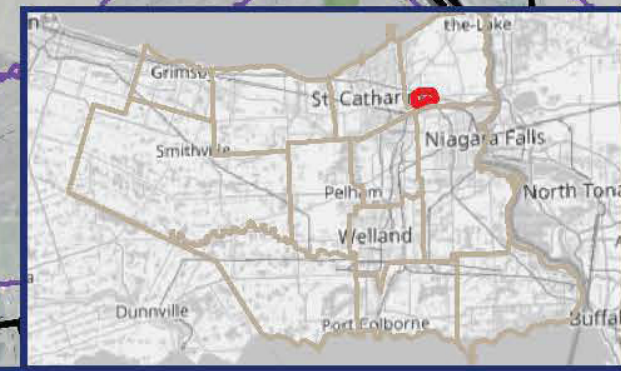
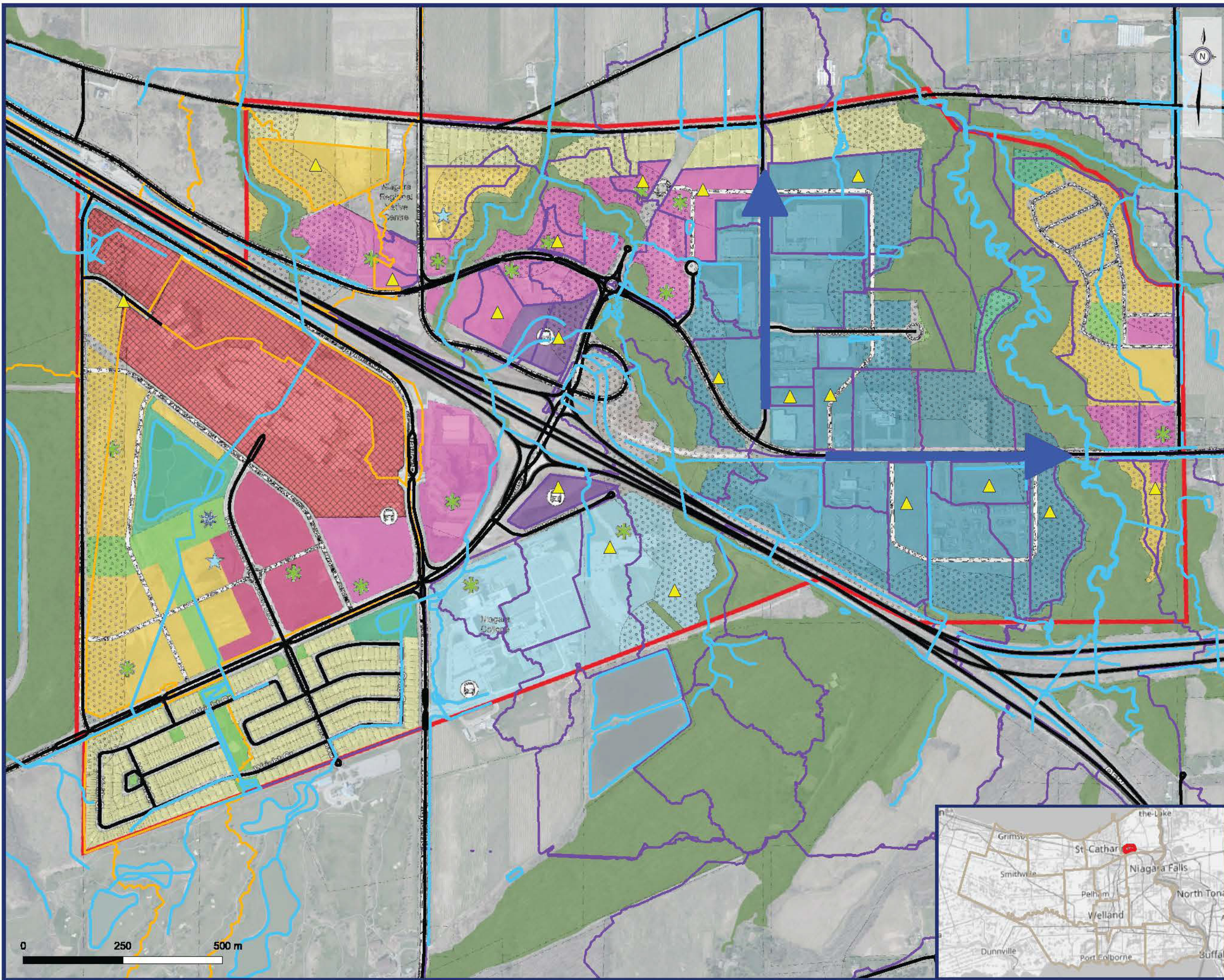
Landuse Designation

-  Existing Residential Designation
-  New Residential Designation
-  Regional Commercial Designation
-  Regional Commercial Mixed-Use Overlay
-  Mixed Use I Designation
-  Mixed Use II Designation
-  Industrial/Business Park Designation
-  Institutional Campus Designation
-  Public Parkland Designation
-  Transportation Facilities Designation
-  Environmental Protection Designation
-  Adjacent Lands Overlay
-  Stormwater Management Facility

Land Use shown based on Schedule 1 - Land Use Designations. Refer to Figure 3-1 for detailed designations and symbol definitions.

Figure 7-1

**Provisional Storm Sewers
Long-Term Growth Scenario**



7.3.1 Phasing of Servicing

Current development applications have generally proposed site-specific stormwater servicing and SWM facilities. Storm sewers to service evolving higher-density land uses to be developed in the future should be considered as part of any road upgrade projects to ensure available infrastructure ahead of new land use development.

7.3.2 Cost Estimates

Cost estimates for the provisional future storm sewers to be provisionally installed along Townline Road and York Road is shown in Table 7-2.

Table 7-2: Cost Estimate for Provisional Future Storm Sewer

Project	Anticipated Timing	Total Cost (2024\$)
1,000 metre length Townline Road Storm Sewer	Only to Support Evolving (Higher) Density within Northeast Area of Glendale	\$3.0M
850 metre length York Road Storm Sewer		\$2.5M
Total		\$5.5M

Cost estimates have been prepared in accordance with Niagara Region guidelines and the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System and include 18% Engineering fees and 40% project contingency for a Class 4 (Feasibility Level) Estimate. The cost estimate for the provisional storm sewer upgrades (including the -10% and +30% accuracy range) is detailed further in Appendix A.

8.0 Conclusion

It is anticipated that servicing of the Glendale Secondary Plan area can generally be achieved by utilizing the existing water, wastewater, and stormwater systems with localized infrastructure upgrades as required for new developments. Projected development within the study area is unlikely to trigger upgrades to the Region's water and wastewater systems, however it must be carefully monitored throughout the build-out of the Secondary Plan Area. If densities greater than the minimum densities specified as part of the Secondary Plan are achieved than potential upgrades to significant wastewater infrastructure may be required.

8.1 Water and Wastewater

It is recommended that as part of future Region Water and Wastewater MSP updates, the Region specifically consider the Glendale Secondary Plan study area to ensure timing for water servicing upgrades for the broader NOTL and "upstream" St. Catharines area is reflective of development progress and trends within the Glendale Secondary Plan study area. The Glendale Secondary Plan study area is anticipated to be a driver for larger system upgrades, albeit this growth will be balanced with St. Catharines' growth trends and development progress.

There is potential that the existing downstream Queenston Road / Welland Canal siphon upgrade is triggered if densities greater than the minimum specified in the Secondary Plan can be achieved. The upgrade would be required only at build-out of the Secondary Plan area, thereby allowing time to monitor and update future MSP Update and DC programs if necessary.

The existing sewer crossing of the QEW within the Secondary Plan also has sufficient capacity for low-density and high density build-out. If densities greater than minimum can be achieved in southwest portion of the Secondary Plan area, the crossing could reach full capacity.

Local water and wastewater infrastructure can be designed and constructed as part of development applications with existing infrastructure confirmed to be at sufficient depth/location with capacity for water demands and wastewater flows.

8.2 Stormwater

The existing storm sewer network southwest of QEW can provide sufficient service to build-out of the area. Provisional storm sewers along Townline Road and York Road may be required to service future higher density development over the evolving land use within Secondary Plan area (to be aligned with Phase 3 of the Subwatershed Study).

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A

Regional Municipality of Niagara

APPENDIX A

CONSTRUCTION COST ESTIMATES

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