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Interim Alternative Methods Report

December 2018

WASTE
CONNECTIONS
OF
CANADA

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December 3, 2018

Waste Connections of Canada
20262 Erieau Rd.
Blenheim, Ontario
N0P 1A0

Attention: Catherine Smith

Ridge Landfill EA – Interim Alternative Methods Report

Dear Cathy

Enclosed please find the Interim Alternative Methods Report. This report represents an important component of the environmental assessment process and includes the preliminary results of the evaluation of site development, leachate and landfill gas management alternatives. The information contained in this report forms the basis of the public consultation occurring this fall.

Sincerely,

DILLON CONSULTING LIMITED

Bill

Bill Allison, P. Eng.
Project Manager

Our file: 15-2456

Dillon Consulting
Limited

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Executive Summary

Waste Connections of Canada Inc. (Waste Connections) is undertaking an Environmental Assessment (EA) to expand its Ridge Landfill site in the Municipality of Chatham-Kent in accordance with the Amended Terms of Reference, approved by Ontario's Minister of the Environment and Climate Change on May 1, 2018.

The Ridge Landfill is situated near the communities of Blenheim, Charing Cross and Cedar Springs and has been in operation since 1966. The landfill, which is licensed to receive solid, non-hazardous waste, is an engineered facility with an excellent environmental performance record that has become an integral part of the economic and social fabric of the Municipality of Chatham-Kent. The Ridge Landfill employs 23 people and contributes approximately $14 million annually in a combination of direct financial contributions to Chatham-Kent and the purchase of local goods and services.

Waste Connections' operations contribute well over $200 million per year to the Ontario economy including third party suppliers of various goods and services and direct employment income for over 1,000 employees in the service area alone. The Ridge Landfill is a key component of the waste management system infrastructure Ontario and crucial to the Municipality of Chatham-Kent and will continue to be needed as the population and economy of southern and central Ontario continues to grow. More than 30,000 IC&I waste generators in southern and central Ontario constantly rely on Waste Connections to provide a comprehensive range of waste management services (collection, recycling, transportation and disposal) for their solid waste.

An expanded Ridge Landfill will continue to provide long-term disposal capacity to serve the growing population and economy in the province of Ontario. The expansion will see the Landfill Site Area increase from 262 ha to up to 340 ha (the total area of Waste Connections-owned lands at the Ridge Landfill), with no change to the annual waste disposal rate of 1.3 million tonnes.

This report has been compiled to document the technical work undertaken to date, as part of the first major component in the EA; that is, the assessment of alternative methods for site development, leachate and landfill gas management as outlined in Section 5.2 of the Approved Amended Terms of Reference (ToR).

As committed to in the ToR, the refinement of evaluation criteria and indicators used to undertake the evaluation herein was completed in consultation with agency stakeholders, indigenous communities, and members of the public. As per the MECP Code of Practice for Environmental Assessments the potential environmental effects for each alternative method were used as the basis to establish the relative advantages and disadvantages of each alternative method and identify a preferred alternative. Also per the Code of Practice the “do nothing” alternative is considered as it represents what is expected to happen if none of the alternatives being considered are carried out. It serves as a benchmark for comparing effects of the proposed expansion, and to highlight the advantages of proceeding with a particular undertaking.

The conclusion of this work is that the preferred method of expansion for the Ridge Landfill, subject to input received from Indigenous Communities, agencies and the public includes:

- A proposed lateral expansion of the a new fill area footprint and a vertical expansion of the old landfill within the existing property that would be no higher than the existing landfill
- Continuation of the methods currently used to manage leachate and gas at the site

The contents of this Interim Alternative Methods report, subject to further revisions, will ultimately be incorporated into the EA report.

1.0 Introduction

Waste Connections of Canada Inc. (Waste Connections) is seeking approval under the Ontario *Environmental Assessment Act* (the *Act*) for an expansion of its Ridge Landfill to continue to provide long-term, residual waste disposal capacity for the company's large Industrial, Commercial and Institutional (IC&I) customer base and as a regional and inter-regional waste management facility to serve the projected increase in population and economic growth in southern and central Ontario.

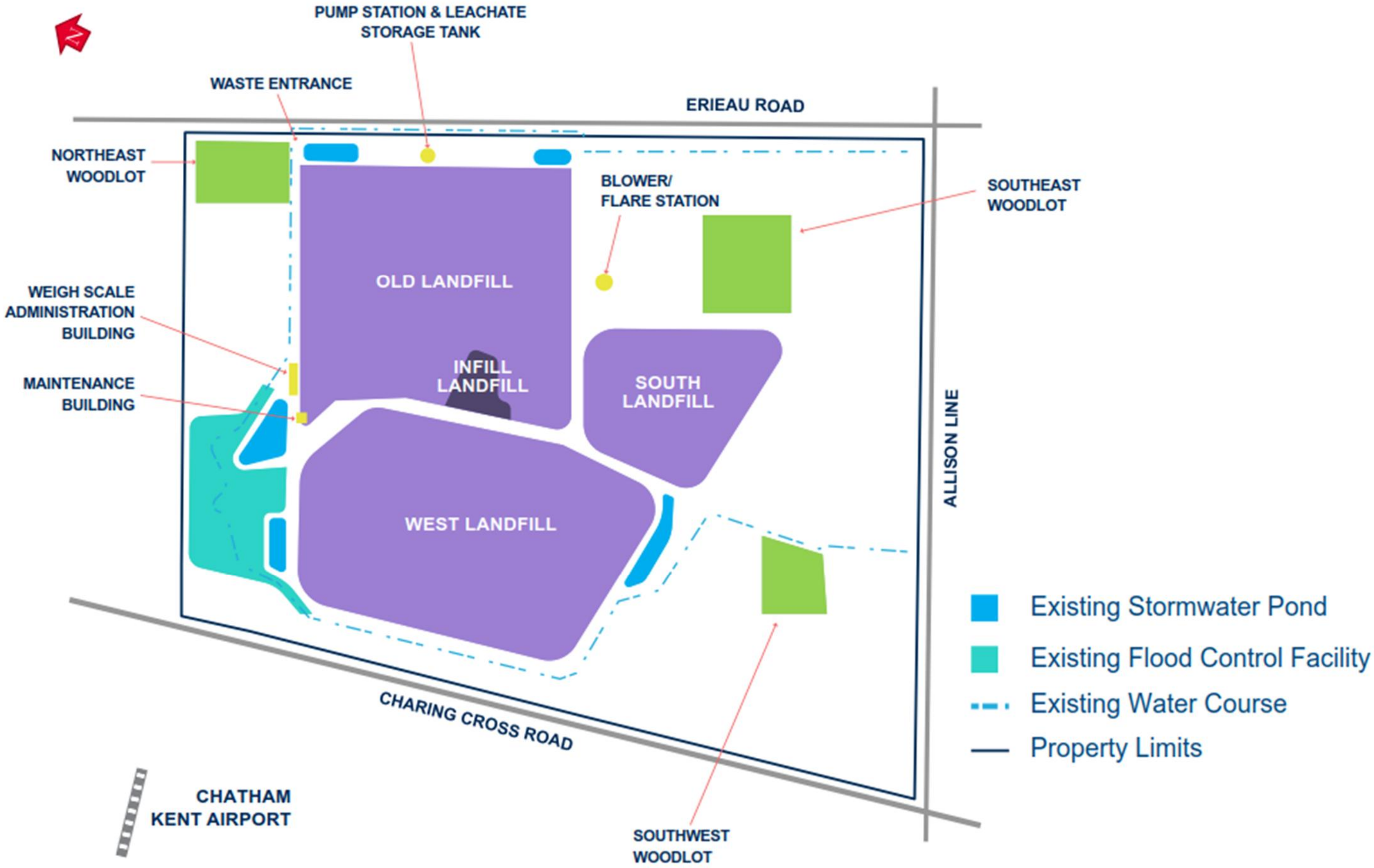
The Ridge Landfill is located at 20262 Erieau Road near Blenheim, Ontario in the Municipality of Chatham-Kent *(Figure 1-1)*, and is operated by Waste Connections*.* The site is currently approved to receive waste from the IC&I sectors in Ontario, and residential waste from the Municipality of Chatham-Kent and the surrounding Counties of Essex, Lambton, Middlesex and Elgin. The proposed expansion includes a revised service area to southern and central Ontario for IC&I waste and Chatham-Kent only for residential waste. The proposed expansion if granted would allow the site to continue to receive the same amount of waste annually (1.3 million tonnes) from 2022 to 2041.

Figure 1-1: Location of Ridge Landfill

The Ridge Landfill has been in operation since 1966 and was expanded in 1999. Waste Connections owns 340 hectares (ha) of land at the Ridge Landfill. The existing Landfill Site Area, which is approved under Environmental Compliance Approval (ECA) No. A021601 issued by the

Ministry of Environment, Conservation and Parks (MECP) for waste management and environmental work purposes, is 262 ha. The area within which waste disposal is permitted, called the Waste Fill Area, is 131 ha or half of the Landfill Site Area. As of December 2017, it is estimated that at the current fill rate (i.e., 1.3 million tonnes annually) the existing Waste Fill Area will provide waste disposal capacity until approximately 2021. *Figure 1-2* shows the current layout of the Ridge Landfill (a more detailed version of this figure is included in *Appendix A*).

Figure 1-2: Existing Layout of the Ridge Landfill

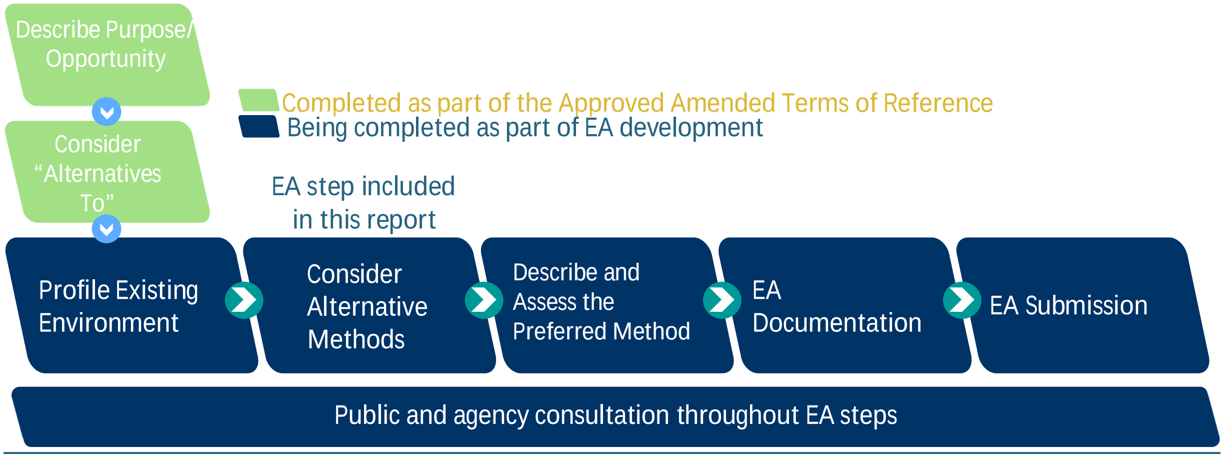


Waste Connections is undertaking an Environmental Assessment (EA) pursuant to the Act for the proposed expansion of the Ridge Landfill. The Approved Amended Terms of Reference (ToR) for the project was approved by the MECP in May 2018.

The ToR outlined the purpose of the undertaking, the opportunity for Waste Connections, work completed to consider "Alternatives to" the Undertaking, and work proposed to develop and evaluate Alternative Methods of carrying out the Undertaking and assessing potential effects on the broad environment defined in the *Act*.

This Interim Alternative Methods report documents the results of Waste Connections' assessment of alternative methods of carrying out the proposed landfill expansion, i.e. the different ways of expanding the landfill. *Figure 1-3* shows the EA process and the step in the process that is documented in this report.

Figure 1-3: EA Process Flow Chart



Alternative methods for the following are considered in this document:

- Site development alternatives - Site development alternatives consider different ways to expand existing fill areas or develop new fill areas to facilitate the continuation of the landfill from 2022 to 2041. Three (3) site development alternatives are being considered. One of the alternatives involves mining of the Old Landfill and recovery of air space that can be used for future landfilling. A detailed study on landfill mining was completed for the assessment of this alternative and it is contained in Appendix C. *Section 3.0* of this report identifies and evaluates these site development alternatives.
- Leachate treatment alternatives – Leachate is the liquid that is generated when precipitation (i.e., rain and snow) comes into contact with waste within the landfill. Leachate is currently collected from the existing landfill, and new waste cells would include an expanded leachate collection system that meets standards set out in Ontario Regulation (O.Reg.) 232/98 Landfilling Sites amended by 268/11, under the Environmental Protection Act, RSO 1990. Leachate from the Ridge Landfill is currently piped and treated at the Blenheim Waste Water Treatment Lagoons (BWTL). The continuing use of this facility has been reviewed with the Public Utilities Commission

(PUC) of the Municipality of Chatham-Kent, and it has been confirmed there will be sufficient capacity at the BWTL to receive leachate from the proposed expanded landfill. As noted in Section 5.2.1 of the ToR, Waste Connections committed to considering other reasonable long term leachate treatment alternatives. Three (3) alternatives are being considered representing combinations of different treatment locations and methods of leachate transport. *Section 4.0* of this report identifies and evaluates these leachate treatment alternatives.

- Landfill gas management alternatives – Landfill gas is collected at the Ridge Landfill and flared (i.e., destroyed by controlled burning). As noted in Section 5.2.1 of the ToR, Waste Connections is currently evaluating a potential project to utilize the existing landfill gas as a renewable natural gas (RNG). This is being undertaken separately from this EA. In the ToR, Waste Connections committed to an assessment of landfill gas treatment or utilization alternatives for the proposed expansion. Three (3) landfill gas management alternatives are being considered including flaring and different options for utilization. *Section 5.0* of this report identifies and evaluates the landfill gas management alternatives.

2.0 Overview of Evaluation Methodology

As originally documented in *Section 5.2* of the ToR, the following outlines the comparative evaluation methodology steps for each of the alternative methods:

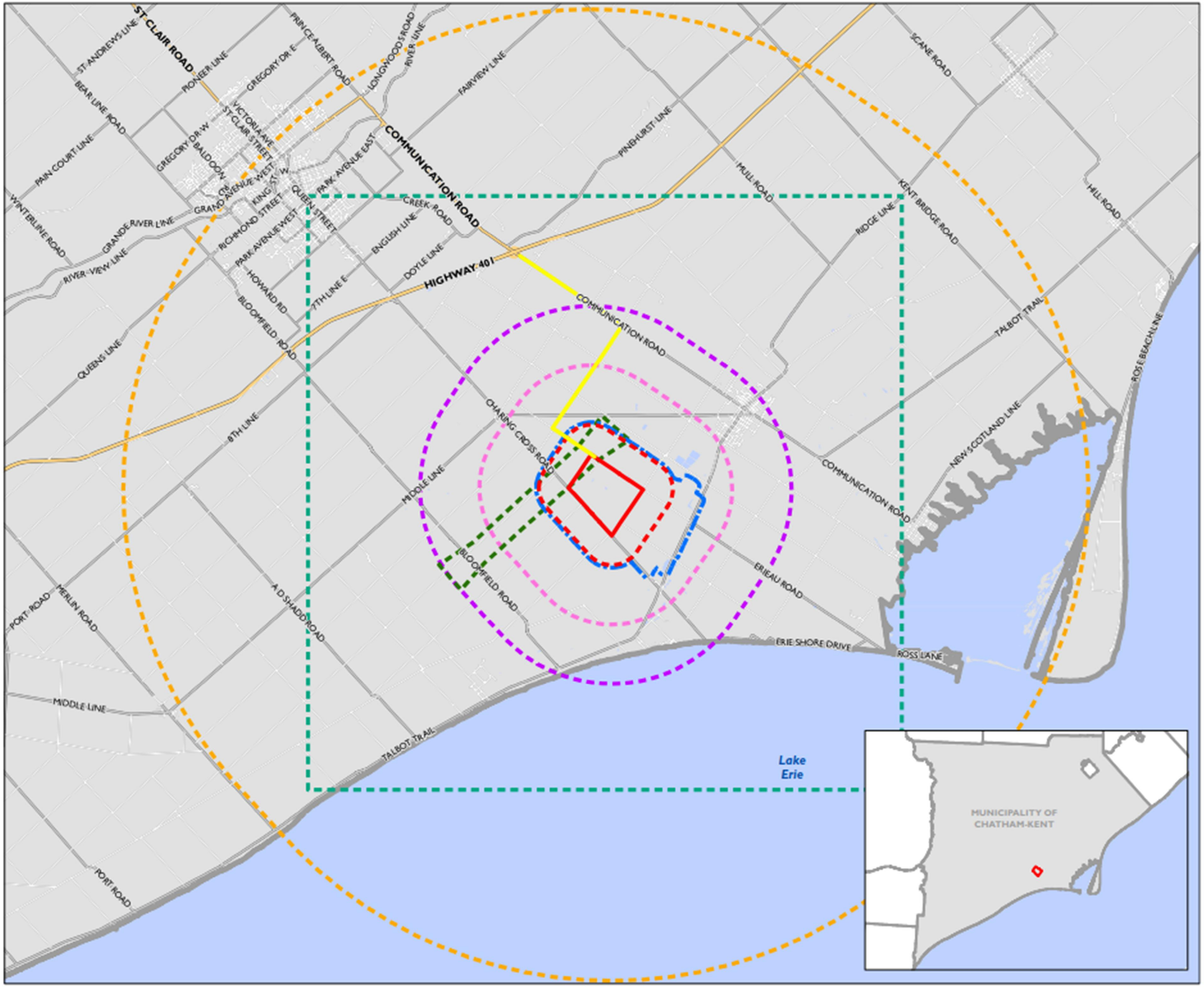
1. Characterize Baseline Conditions: Information on the existing environment has been gathered in sufficient detail to characterize baseline conditions. The characterization of existing environmental conditions entail gathering data from secondary sources as well as primary technical field work as required. This report includes an overview of existing conditions and a full description will be included in the EA document.
2. Develop Alternative Methods: Alternative Methods to expand the Ridge Landfill have been developed. Each includes a description and rationale. The Alternative Methods are described conceptually and in sufficient detail to allow for a comparative evaluation. The alternative methods for site development, leachate treatment and landfill gas management are included in this Interim Alternative Methods Report.
3. Predict Potential Environmental Effects for Each Alternative Method: For each alternative method, the potential for environmental effects has been identified, based on the broad definition of environment within the Act. This exercise involved the consideration of potential effects based on a set of evaluation criteria. Draft criteria were initially documented in the ToR. Upon approval, these criteria were further refined and indicators developed to specify how potential effects would be measured for the evaluation of site development, leachate treatment and landfill gas management alternatives. The criteria cover all components of the environment as follows:
    - Natural (Biological) Environment which includes Terrestrial Ecosystems & Aquatic Ecosystems;
    - Natural (Physical) Environment which includes Groundwater, Surface Water, Atmospheric, Climate Change;
    - Social Environment;
    - Economic Environment;
    - Cultural Environment; and,
    - Built Environment.

    Figure 2-1 depicts the study areas that were used for the assessment.

WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 2-1 STUDY AREAS



🟥 On Site Property Boundary:

- Archaeology and Heritage
- Biology
- Climate Change
- Hydrogeology
- Atmospheric
- Bird Hazard
- Surface Water
- Design and Operations
- Noise
- Socio-economic
- Transportation

― Haul Route (Study Area includes all adjacent properties):

- Climate Change
- Atmospheric
- Agriculture
- Surface Water
- Noise
- Socio-economic
- Transportation

▭ Off-Site Agriculture and Socio-economic Study Areas

▭ Off-Site Surface Water Study Area

▭ Off-Site Aviation Study Area

▭ Off-Site Visual Study Area

▭ Off-Site Hydrogeology Study Area

▭ Off-Site Atmospheric Study Area

▭ Off-Site Bird Hazard Study Area

1:125,000

0 1 2 4 km

N W E S

MAP DRAWING INFORMATION:
DATA OBTAINED FROM MNRF

MAP CREATED BY: GM
MAP CHECKED BY: MB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 152456

STATUS: DRAFT

DATE: 2018-11-30

As committed to in the ToR, the refinement of the evaluation criteria was completed in consultation with agency stakeholders, indigenous communities, and members of the public. In particular, public input on the criteria and indicators was solicited through a workshop in June 2018 and an open house in July 2018 and MECP and Walpole Island First Nation (WIFN) reviewed the evaluation criteria and indicators for all three (3) evaluations. Input received was incorporated where appropriate into the final list of criteria and indicators.

Mitigation measures to minimize potential effects were considered in this step. As such, the potential environmental effects represent net effects – or potential effects once mitigation measures are implemented.

4. Comparatively Evaluate the Alternative Methods to Identify a Preferred Alternative: The potential environmental effects for each alternative method were used as the basis to establish the relative Advantages and Disadvantages of each alternative method and identify a preferred alternative. The evaluation criteria/indicators, data sources and rationale for the evaluation of site development alternatives is included in *Appendix B*.

   To show relative difference, the alternatives were ranked as one of the following:

   - Major Advantage
   - Advantage
   - Neutral
   - Disadvantage
   - Major Disadvantage

   The qualitative evaluation methodology was applied through professional judgement as follows:

Ranking	Description
Major Advantage	Minimal impacts and clear benefit. Example: An alternative that would not require construction of additional infrastructure would be considered to have a major positive benefit when compared to an alternative that needs infrastructure development. It would have no or minimal impacts.

Ranking	Description
Advantage	Manageable impacts and in most cases a net positive benefit would result. Example: An alternative that would require a limited degree of infrastructure construction would be considered to have an advantage when compared to an alternative that requires significantly more construction of infrastructure.
Neutral	Absence of potential benefits (positive or negative) & absence of difference in impacts. Example: Alternatives being considered have similar infrastructure requirements, and differences cannot be identified.
Disadvantage	Some impacts and in most cases a net negative benefit would result. Example: Alternative would require construction of additional infrastructure compared to an alternative that requires less infrastructure development with lesser or minimal impacts.
Major Disadvantage	Significant impacts and would require extensive mitigation measures to reduce impacts. May not be technically feasible or commercially viable. Example: Alternative would require construction of significant infrastructure that may have significant negative environmental impacts, compared to an alternative that requires little to no additional infrastructure developed.

The rankings are recorded in a table for each of: site development, leachate treatment, and landfill gas management; and a preferred option identified for each of these three (3) components of the undertaking with a summation of the rankings.

Where possible, the following decision-making guidelines were applied in the summation process to determine an overall ranking:

- An Advantage would offset a Disadvantage within the same criteria and/or indicator.
- Major Disadvantage compared to an Advantage typically resulted in an overall Disadvantage.

- Multiple Advantages or Disadvantages did not constitute an overall Major Advantage or Major Disadvantage.

The preferred alternative for site development, leachate treatment and landfill gas management was then compared to a do-nothing scenario. This was to establish a benchmark to clearly articulate the consequences of implementing the alternative as per Section 4.4.2 of the Code of Practice for Preparing and Reviewing Environmental Assessments.

5. Impact Assessment of the Preferred Method: The preferred alternative methods for site development, leachate treatment and landfill gas management will be carried forward for a more detailed assessment of potential effects and the development/refinement of mitigation and monitoring measures. This step is not included in this Interim Alternative Methods Report and will be included in the EA document.

2.1 Consultation on the Alternative Methods

The following provides an overview on the consultation that has occurred since the Notice of EA Commencement in June 2018:

- Public – A by-invitation only workshop was held with Ridge Landfill neighbours to discuss the alternative methods and evaluation criteria on July 11th, 2018. An open house was held on July 25th, 2018 for the broader community to also solicited feedback on the alternative methods and evaluation criteria.
- Indigenous Communities
    - Walpole Island First Nation (WIFN) – Waste Connections met with WIFN on their territory on May 30th, 2018 to provide an overview of the project including the EA Study Areas, the evaluation criteria, the three (3) site development expansion alternatives, and upcoming work. In addition, WIFN provided a checklist to consider ways to accommodate the community's interests in the project. Waste Connections further conducted a tour for WIFN of the landfill site on September 13th, 2018. WIFN provided comments on the following: natural environment existing conditions report; work plans for various disciplines; evaluation criteria for the evaluation of site development alternatives: leachate treatment alternatives and landfill gas management alternatives; and study areas.
    - Chippewas of the Thames First Nation (COTTFN) – Waste Connections met with COTTFN on their territory on August 15th, 2018 to discuss the EA process and opportunities for COTTFN involvement in the project. COTTFN identified areas of

    interest in the project and related documents were provided for their consideration. Based on discussions COTTFN staff later met with their Environmental Committee and it was determined that a partnership would be developed with Waste Connections for the planting of between 3,000 - 5,000 trees at a location to be specified by them and that Waste Connections would partner with COTTFN to staff tree seedling maintenance.
    - Other First Nations[1] were provided notice about the EA Commencement and follow-up calls were made. No additional discussions have been held to date.
- Chatham-Kent Municipal Airport – Waste Connections met with representatives from the airport in March of 2018 to discuss the status of the EA and site development alternatives.
- Ministry of Transportation – The Ministry was provided the transportation work plan to review. Comments were noted and responses provided.
- Municipality of Chatham-Kent – Meetings have been held with various municipal departments: the PUC (leachate management), Waste and Recycling Services (alternative methods and waste diversion), Engineering and Transportation Services (follow-up from comments received at the Open House) and Planning Services (planning approvals).
- MECP has provided detailed comments on the following: discipline work plans; alternative methods for site development, leachate treatment and landfill gas; evaluation criteria for the evaluation of site development alternatives, leachate treatment alternatives and landfill gas management alternatives; and study areas.

At the public workshop and Open House in July 2018, comments and concerns raised included odour management, blowing litter and general site maintenance, groundwater impacts, traffic safety and road conditions along the designated haul route and the use by landfill trucks of roads that are not on the designated haul route. Following the meeting with Engineering and Transportation Services, additional directional signs for the designated haul route were installed and a road improvement schedule developed for the turning apron at the corner of Communication Road and Drury Line and re-paving along a portion of Drury Line.

Evaluation criteria were reviewed to confirm that where appropriate concerns and comments raised were considered in the evaluation of alternative methods. Input received resulted in the following key changes to the alternative methods evaluation criteria:

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[1] Other First Nations contacted: Caldwell, Aamjiwnaang, Kettle and Stony Point, Moravian of the Thames, Munsee Deleware, and Oneida Nation of the Thames

- Evaluation criteria were reorganized and reworded to capture potential effects during construction, operation and post-closure.
- Consideration of leachate contaminating lifespan and potential impact to drinking water were added to the evaluation criteria for comparing the site development alternatives.
- Modeling of the pre and post expansion flows was added to the surface water evaluation of site development alternatives.
- Cultural heritage was added as a criterion for the evaluation of site development alternatives.
- Area of Class 1-3 soils was added as a criterion for the evaluation of site development alternatives.

Consideration of impacts to aviation transportation infrastructure was added as a criterion for the evaluation of site development alternatives.

In addition to the above identified consultation, social-economic interviews were completed and are further discussed in *Section 3.2.3* of this report.

3.0 Site Development Alternatives

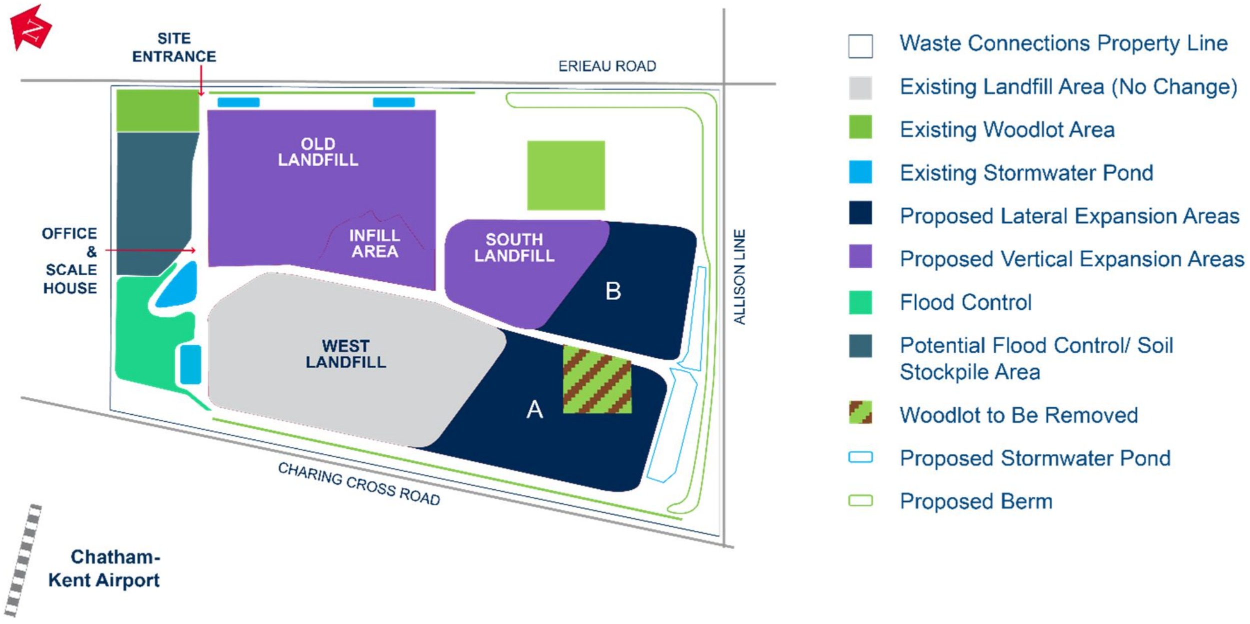
There are three (3) proposed landfill site development alternative methods to be evaluated for the Ridge Landfill EA. All three (3) alternatives provide the same disposal capacity (28.9 million cubic metres) over the EA planning period (2022 to 2041) and are further described as follows:

3.1 Description of Site Development Alternatives & Rationale

Each alternative method of how the landfill could be expanded within the site is described in *Table 3-1* below with the accompanying rationale. Please refer to *Figures 3-1 to 3-3* for the site development alternative methods and depiction of Areas: A, B, C, and Old Landfill. More detailed drawings of the site development alternatives are provided in *Appendix A*. The calculations used to achieve the disposal capacity of 28.9 million cubic meters for each of the three (3) alternatives are included in *Appendix C*.

3.1.1 Site Development Alternative 1

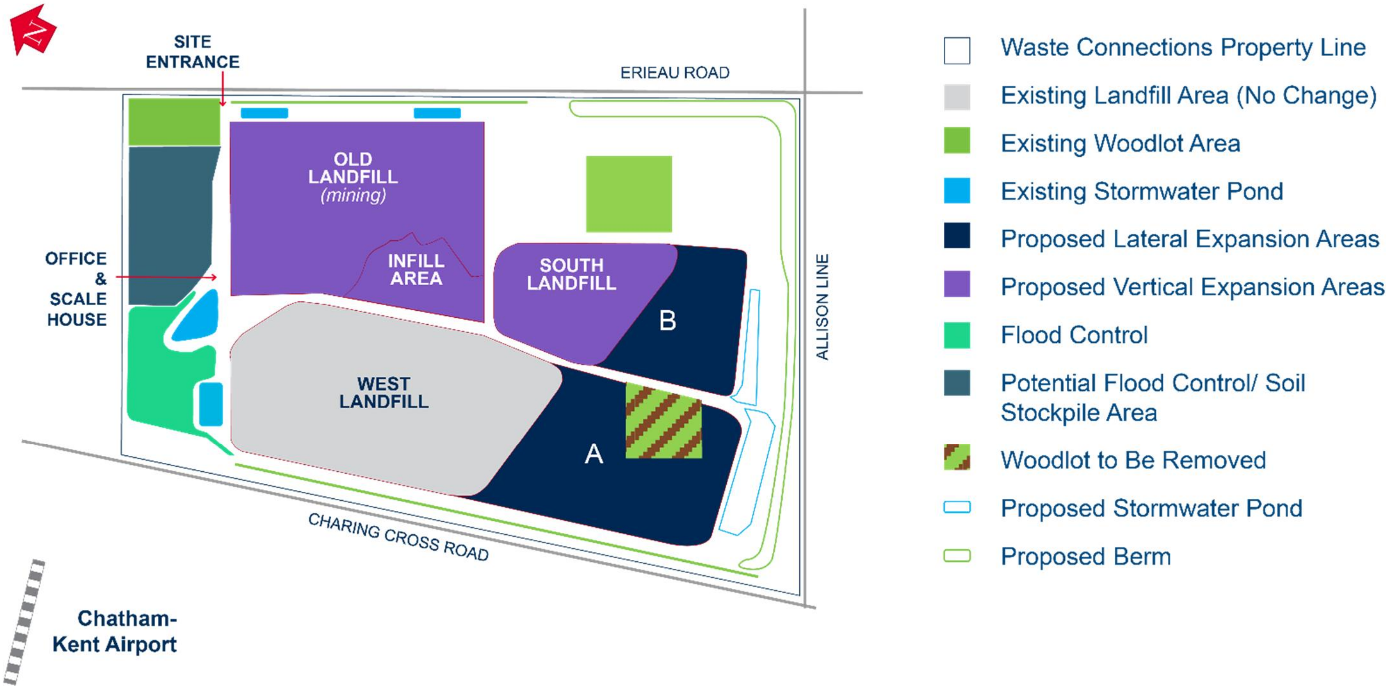
Figure 3- 1: Site Development Alternative 1



Site Development Alternative Method	Description	Rationale
Alternative 1 (*Figure 3-1*– Areas A, B, Old Landfill)	This alternative involves the following components: · Lateral expansion of the West Landfill (Fill Area A) This fill area expansion is approximately 36 ha providing approximately 13.2 million m^3 in capacity. It requires the removal of the southwest woodlot, the relocation of an existing pond, the expansion of another pond and the realignment of a section of the Howard Drain. This fill area would have a maximum elevation of 241 metres above sea level (masl) which is 0.3 metres below the maximum elevation allowed by the Chatham Airport Zoning Regulations. This expanded fill area accommodates the relocated pond and berm at the south edge of the property. · Lateral expansion of the South Landfill (Fill Area B) This fill area expansion is approximately 23 ha providing approximately 8.6 million m^3 in capacity. It involves a slight reshaping of the existing South Landfill and a minor vertical expansion of the South Landfill from its current height to the maximum elevation of 241 masl. This expanded fill area accommodates a new pond and berm at the south edge of the property. · Vertical expansion of the Old Landfill This vertical expansion provides approximately 7.2 million m^3 in capacity over an existing waste footprint of approximately 55 ha. It would result in a maximum elevation of 241 masl.	This alternative: · Provides capacity for the 20-year planning period · Makes use of the additional vertical space associated with the Old Landfill · Minimizes woodlot removal

3.1.2 Site Development Alternative **2**

Figure 3- 2: Site Development Alternative 2

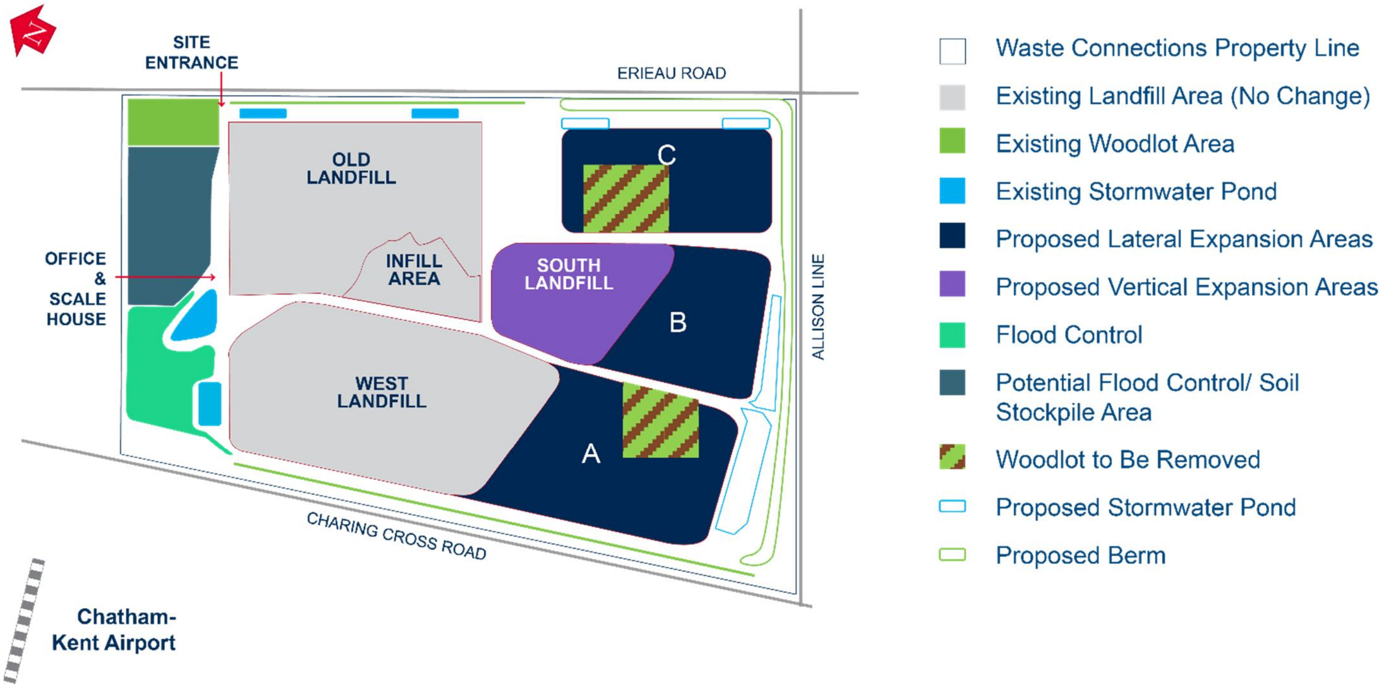


Site Development Alternative Method	Description	Rationale
Alternative 2 (*Figure 3-2* – Areas A, B, Old Landfill & Landfill Mining	This alternative involves the following components: · Lateral expansion of the West Landfill (Fill Area A) See description under Site Development Alternative 1 above. · Lateral expansion of the South Landfill (Fill Area B) For Site Development Alternative 2, the footprint of fill area B is smaller than it is for Site Development Alternative 1 as additional capacity is provided through landfill mining. This fill area expansion is approximately 17 ha providing approximately 6.4 million m^3 in capacity. It involves a slight reshaping of the existing South Landfill and a minor vertical expansion of the South Landfill from its current height to the	This alternative: • Provides capacity for the 20-year planning period • Makes use of the additional vertical space associated with the old landfill • Maximizes the capacity of the old landfill through landfill mining • Minimizes woodlot

Site Development Alternative Method	Description	Rationale
	maximum elevation of 241 masl. This expanded fill area accommodates a new pond and berm at the south edge of the property. · Landfill Mining This alternative includes mining of the Old Landfill. Landfill mining is a complex operation that requires excavating buried waste, screening, sorting and moving separated materials either on-site (i.e., new disposal cell) or off-site (i.e., another licensed disposal facility). The Old Landfill was developed in three (3) waste disposal areas, from Mound 1 to 3. Mound 3 was the latest waste disposal area developed and was closed in December 1999. Mining the three (3) mounds of the Old Landfill can obtain approximately 1.4 million m^3 in capacity. The assumed air space recovery from landfill mining is the basis for the footprint size of Fill Area B. Further information on landfill mining is included in *Appendix C*. An additional 0.8 million m^3 of space is created by removing soil from beneath the existing waste in the Old Landfill after it is mined. · Vertical expansion of the Old Landfill This vertical expansion provides approximately 7.2 million m^3 in capacity over an existing waste footprint of approximately 55 ha. It would result in a maximum elevation of 241 masl.	removal

3.1.3 Site Development Alternative 3

Figure 3- 3: Site Development Alternative 3



Site Development Alternative Method	Description	Rationale
Alternative 3 (Figure 3-3 – Areas A, B, C)	This alternative involves the following components: · Lateral expansion of the West Landfill (Fill Area A) See description under Site Development Alternative 1 above. · Lateral expansion of the South Landfill (Fill Area B) See description under Site Development Alternative 1 above. · New landform (Fill Area C) This fill area expansion is approximately 24 ha, providing approximately 7.1 million m3 in capacity. It requires the removal of the southeast woodlot and result in a maximum elevation of 241 masl.	This alternative: • Provides capacity for the 20-year planning period • Maintains the existing height of the old landfill • Requires the removal of two (2) woodlots

3.1.4 Common Characteristics

The following are common characteristics of the three (3) landfill site development alternatives:

- Capacity – All site development alternatives have been conceptually designed to provide the same disposal capacity (28.9 million cubic metres).
- Planning period – All site development alternatives have been conceptually designed for a 2022 to 2041 planning period.
- Type of waste – Non-hazardous solid waste is the only waste that will be accepted at the site and this will remain the case for all site development alternatives.
- Height - All expanded fill areas would be limited to the height restrictions imposed by the Chatham-Kent Municipal Airport Zoning Regulations (i.e., approximately 45 m above natural ground level).
- Howard Drain – Fill Area A is common to all site development alternatives and will require relocating the Howard Drain which was previously relocated in 1999.
- Site entrance and scale house – The site entrance off Erieau Road will not change and the scale house and office will remain in the same place.
- Berms – New berms will be constructed along the south and east property lines.
- Flood control – There is an existing flood control area at the north end of the site and available land held for a future flood control area if required for all three (3) alternatives. Ponds will be added to the site to accommodate runoff.
- Woodlots – The woodlot at the northeast of the site will remain regardless of the site development alternative.
- Hours of operation – The hours of operation would be the same for all site development alternatives and will be confirmed as the part of the EA.
- Diversion – The type of on-site diversion implemented would be consistent for all alternatives. It is anticipated that any on-site diversion activities could be located within available lands on the property. The specific location would depend on the site development alternative selected and operational constraints.

3.2 Evaluation of Site Development Alternatives

Each of the three (3) site development alternatives were assessed to determine the potential impacts on each of the six (6) environments (i.e., Natural [Biological and Physical], Social, Economic, And Cultural and Built Environments), as follows:

- Evaluation Criteria - As noted in *Section 2.0*, evaluation criteria and indicators were prepared for the evaluation of site development alternatives with input from the public, MECP and WIFN. The table of twenty-nine evaluation criteria/indicators, data sources and rationale for the evaluation of site development alternatives is included in *Appendix B*. The criteria and indicators for each environmental component are included in the write-up in this section.
- Existing Conditions – A brief overview of the existing conditions is provided for context.
- Assessment - An assessment of the potential impact each alternative might have on that environment assuming the application of standard, approved mitigation measures is documented. This assessment considers the potential for impact and ranks the alternative as Major Advantage, Advantage, Neutral, Disadvantage or Major Disadvantage (see definitions in *Section 2.0*). The assessment is documented in *Table 3-1* and summarized in the text in this report section.
- Environmental Component Conclusion - Based on the Advantages and Disadvantages noted in the text and *Table 3-1*, a conclusion on which of the alternatives is preferred for each of the six (6) environments is presented at the end of each subsection.

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: 🔵 Major Advantage ⚪ Advantage 🟢 Neutral 🟡 Disadvantage 🟠 Major Disadvantage

Environment/ Criteria	Indicators	Alternative 1 Vertical Expansion of Old Landfill, Addition of Footprint A + B	Alternative 2 Vertical Expansion of Old Landfill, Landfill Mining of Old Landfill, Addition of Footprint A + Reduced B	Alternative 3 No Vertical Expansion, Addition of Footprint A+B+C
NATURAL ENVIRONMENT - BIOLOGICAL				
Potential for effect on terrestrial systems from construction and operation.	· Area and type of terrestrial systems (e.g., significant woodlots, hedgerows, wetlands, etc.) to be removed on-site.	🟢 Neutral Removes approximately 3.7 ha of lower quality southwest woodlot. Alternatives 1 and 2 will result in minimal effects on terrestrial systems as compared to Alternative 3. Discussions are already underway regarding replanting the trees at a 2-to-1 ratio. Some trees will be planted adjoining an existing woodlot making it larger.	🟢 Neutral Removes approximately 3.7 ha of lower quality southwest woodlot. Alternatives 1 and 2 will result in minimal effects on terrestrial systems as compared to Alternative 3. Discussions are already underway regarding replanting the trees at a 2-to-1 ratio. Some trees will be planted adjoining an existing woodlot making it larger.	🟡 Disadvantage Removes approximately 3.7 ha of lower quality southwest woodlot plus 8 ha of higher quality southeast woodlot with SAR bat habitat. Discussions are already underway regarding replanting the trees at a 2-to-1 ratio. Some trees will be planted adjoining an existing woodlot making it larger. Alternative 3 has a greater potential effect on terrestrial features than Alternatives 1 and 2.
	· Area and type of terrestrial systems (e.g., significant woodlots, hedgerows, wetlands, etc.) potentially disrupted within 1 km.	🟢 Neutral No disruption from construction or operation off-site. There is no difference between the alternatives for this criterion/indicator.	🟢 Neutral No disruption from construction or operation off-site. There is no difference between the alternatives for this criterion/indicator.	🟢 Neutral No disruption from construction or operation off-site. There is no difference between the alternatives for this criterion/indicator.
Potential for effect on habitat of Endangered or Threatened Species during construction.	· Area of habitat for endangered or threatened species on-site.	🟢 Neutral No removal of significant habitat. Alternatives 1 and 2 will result in no impact on significant habitat.	🟢 Neutral No removal of significant habitat. Alternatives 1 and 2 will result in no impact on significant habitat.	🟡 Disadvantage Removes the SAR bat habitat associated with the 8 ha SE woodlot. Alternative 3 has more of an impact on significant habitat than Alternatives 1 and 2.
Potential effect on medicinal or other culturally sensitive species of importance to First Nations Groups during construction.	· Area and type of species of importance to be removed on-site.	🟢 Neutral No medicinal or culturally sensitive features identified. There is no difference between the alternatives for this criterion/indicator.	🟢 Neutral No medicinal or culturally sensitive features identified. There is no difference between the alternatives for this criterion/indicator.	🟢 Neutral No medicinal or culturally sensitive features identified. There is no difference between the alternatives for this criterion/indicator.
Potential for effect on aquatic systems during construction.	· Amount and type of aquatic systems (i.e., ponds, drains) that would be displaced on-site.	🟢 Neutral Requires relocation of Howard Drain and an existing pond. Aquatic habitat is of low sensitivity and it will be relocated. Effect is considered minimal. There difference between the alternatives for this criterion/indicator is minor and all are considered relatively equal.	🟢Neutral Requires relocation of Howard Drain and an existing pond. Aquatic habitat is of low sensitivity and it will be relocated. Effect is considered minimal. There difference between the alternatives for this criterion/indicator is minor and all are considered relatively equal.	🟢 Neutral Requires relocation of Howard Drain and an existing pond. Aquatic habitat is of low sensitivity and it will be relocated. Effect is considered minimal. There difference between the alternatives for this criterion/indicator is minor and all are considered relatively equal.

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/ Criteria	Indicators	Alternative 1 Vertical Expansion of Old Landfill, Addition of Footprint A + B	Alternative 2 Vertical Expansion of Old Landfill, Landfill Mining of Old Landfill, Addition of Footprint A + Reduced B	Alternative 3 No Vertical Expansion, Addition of Footprint A+B+C
NATURAL ENVIRONMENT – PHYSICAL				
Groundwater				
Potential impacts to groundwater quality during construction, operation and post closure.	· Qualitative assessment of ability of alternative to meet Reasonable Use Guideline.	● Neutral All alternatives are reasonably expected to meet Reasonable Use Guideline based on historical monitoring data and extensive natural protection supported by engineering controls. Predictive modelling will be run to confirm for the preferred site.	● Neutral All alternatives are reasonably expected to meet Reasonable Use Guideline based on historical monitoring data and extensive natural protection supported by engineering controls. Predictive modelling will be run to confirm for the preferred site.	● Neutral All alternatives are reasonably expected to meet Reasonable Use Guideline based on historical monitoring data and extensive natural protection supported by engineering controls. Predictive modelling will be run to confirm for the preferred site.
Leachate contaminating lifespan during construction, operation and post closure.	· Prediction based on tonnes of waste per hectare of footprint area and leachate generation rate.	● Neutral Leachate generation rate is similar for alternatives and the qualitative estimate of contaminating lifespan ranges from approximately 294-years to approximately 316-years.	● Neutral Leachate generation rate is similar for alternatives and the qualitative estimate of contaminating lifespan ranges from approximately 294-years to approximately 316-years.	● Neutral Leachate generation rate is similar for alternatives and the qualitative estimate of contaminating lifespan ranges from approximately 294-years to approximately 316 -years.
Potential impacts to groundwater quantity.	· Landfill footprint.	● Neutral All site development alternatives have relatively similar footprint sizes ranging from 185 ha to 214 ha. Landfill footprint serves as an indication of the extent of recharge area that will be removed.	● Neutral All site development alternatives have relatively similar footprint sizes ranging from 185 ha to 214 ha. Landfill footprint serves as an indication of the extent of recharge area that will be removed.	● Neutral All site development alternatives have relatively similar footprint sizes ranging from 185 ha to 214 ha. Landfill footprint serves as an indication of the extent of recharge area that will be removed.
Potential impacts to water supply wells.	· Extent of natural setting protection.	● Neutral All site development alternatives have over 30 metres of clay underneath which together with engineered systems will protect water supply. Residences and businesses on Erieau Road and Charing Cross are on municipal servicing.	● Neutral All site development alternatives have over 30 metres of clay underneath which together with engineered systems will protect water supply. Residences and businesses on Erieau Road and Charing Cross are on municipal servicing.	● Neutral All site development alternatives have over 30 metres of clay underneath which together with engineered systems will protect water supply. Residences and businesses on Erieau Road and Charing Cross are on municipal servicing.
Surface water				
Potential impacts to surface water quantity.	· Changes in peak flows pre- and post-expansion.	● Neutral Pre and post peak flows are maintained at or below the baseline condition for all three of the site development alternatives.	● Neutral Pre and post peak flows are maintained at or below the baseline condition for all three of the site development alternatives.	● Neutral Pre and post peak flows are maintained at or below the baseline condition for all three of the site development alternatives.
Potential impacts to surface water quality.	· Anticipated change in temperature, water quality, benthos and fish habitat.	● Neutral Change in temperature, water quality, benthos or fish habitat is anticipated to be minimal and not expected to significantly change from current.	● Neutral Change in temperature, water quality, benthos or fish habitat is anticipated to be minimal and not expected to significantly change from current.	● Neutral Change in temperature, water quality, benthos or fish habitat is anticipated to be minimal and not expected to significantly change from current.

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: 🔵 Major Advantage 🔵 Advantage 🟢 Neutral 🟡 Disadvantage 🟠 Major Disadvantage

Environment/ Criteria	Indicators	Alternative 1 Vertical Expansion of Old Landfill, Addition of Footprint A + B	Alternative 2 Vertical Expansion of Old Landfill, Landfill Mining of Old Landfill, Addition of Footprint A + Reduced B	Alternative 3 No Vertical Expansion, Addition of Footprint A+B+C
Atmospheric				
Potential for dust during construction and operation.	· Relative levels of material movement and vehicular activity as an indicator for dust and combustion emissions.	🟢 Neutral Landfill construction requires approximately 500-750 trucks per year, on average, to import material over the 20 year operation. During operation all three alternatives will receive the same number of waste trucks. Based on current operation it is demonstrated that dust from material movement for standard landfill operation can be mitigated and will be similar for all three alternatives. It is noted that Alternatives 1 and 3 are similar to the current condition and have the least potential for dust impact.	🟠 Major Disadvantage Landfill construction requires approximately 500-750 trucks per year, on average, to import material over the 20 year operation; mining of approximately 4.5 million m3 of material over a 5 to 10 year period; and approximately 90-180 trucks per year over this time to transport recovered material off-site. During operation all three alternatives will receive the same number of waste trucks. Based on current operation it is demonstrated that dust from material movement for standard landfill operation can be mitigated and will be similar for all three alternatives. Alternative 2 has a greater potential for dust impact as this alternative includes landfill mining which will result in dust from additional materials movement and vehicular activity.	🟢 Neutral Landfill construction requires approximately 500-750 trucks per year, on average, to import material over the 20 year operation. During operation all three alternatives will receive the same number of waste trucks. Based on current operation it is demonstrated that dust from material movement for standard landfill operation can be mitigated and will be similar for all three alternatives. It is noted that Alternatives 1 and 3 are similar to the current condition and have the least potential for dust impact.
Potential for impacts to air quality during construction and operation.	· Nitrogen Oxides, Sulphur Dioxide and Carbon Monoxide (together referred to as criteria air contaminants): relative levels of vehicular activity as an indicator for amount of fuel combusted. · Hydrogen Sulphide, Vinyl Chloride, Chloroform: anticipated difference in landfill gas emissions.	🟢 Neutral Vehicular activity associated with construction and operation similar to that experienced today will occur for this alternative. Proper vehicle maintenance will help minimize the potential for air quality impact as a result of vehicular activity. With similar waste quantities being landfilled and similar landfill gas capture and control in place all three alternatives will result in similar landfill gas emissions from the standard landfill operations.	🟡 Disadvantage With the addition of landfill mining, this alternative involves a significant increase in vehicular activity associated with construction when compared to Alternatives 1 and 3 and has a greater potential for air quality impact. Proper vehicle maintenance will help minimize the potential for air quality impact as a result of vehicular activity With similar waste quantities being landfilled and similar landfill gas capture and control in place all three alternatives will result in similar landfill gas emissions from standard landfill operations. This alternative also includes landfill mining which will result in a short term increase in the release of by-products of waste decomposition (e.g. hydrogen sulphide) because of the required exposure and handling of previously buried waste.	🟢 Neutral Vehicular activity associated with construction and operation similar to that experienced today will occur for this alternative. Proper vehicle maintenance will help minimize the potential for air quality impact as a result of vehicular activity With similar waste quantities being landfilled and similar landfill gas capture and control in place all three alternatives will result in similar landfill gas emissions from standard landfill operations.

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/ Criteria	Indicators	Alternative 1 Vertical Expansion of Old Landfill, Addition of Footprint A + B	Alternative 2 Vertical Expansion of Old Landfill, Landfill Mining of Old Landfill, Addition of Footprint A + Reduced B	Alternative 3 No Vertical Expansion, Addition of Footprint A+B+C
Climate change				
Potential for greenhouse gas emissions during construction and operation.	· Daily/annual waste volume landfilled. · Anticipated differences in on-site vehicular activity. · Extent of woodlot removal.	● Neutral All alternatives will receive 1.3 million tonnes of waste annually, the same as current site operations. On-site vehicular activity associated with standard landfill construction and operation will be relatively consistent with what occurs today. 3.7 ha of woodlot would be removed and replanted at a 2-to-1 ratio. For all alternatives landfill gas will be collected and managed and standard landfill operation is anticipated to result in similar greenhouse gas emissions to what occurs today.	● Disadvantage All alternatives will receive 1.3 million tonnes of waste annually, the same as current site operations. On-site vehicular activity associated with standard landfill construction and operation will be relatively consistent with what occurs today. 3.7 ha of woodlot would be removed and replanted at 2-to-1 ratio. Landfill mining would result in a short-term increase in greenhouse gases from an increase in vehicular activity during the 5-10 year period of mining. For all alternatives landfill gas will be collected and managed and standard landfill operation is anticipated to result in similar greenhouse gas emissions to what occurs today. Overall, the additional vehicle activity associated with landfill mining for Alternative 2 will result in a greater potential for greenhouse gas emissions than Alternatives 1 and 3.	● Neutral All alternatives will receive 1.3 million tonnes of waste annually, the same as current site operations. On-site vehicular activity associated with standard landfill construction and operation will be relatively consistent with what occurs today. 11.7 ha of woodlot would be removed and replanted at 2-to-1 ratio. For all alternatives landfill gas will be collected and managed and standard landfill operation is anticipated to result in similar greenhouse gas emissions to what occurs today.
Resilience of engineered systems.	· Qualitative assessment of the resiliency of proposed infrastructure.	● Neutral The expanded site will be designed with consideration of future changes in climate to allow for resilience of engineered systems.	● Neutral The expanded site will be designed with consideration of future changes in climate to allow for resilience of engineered systems.	● Neutral The expanded site will be designed with consideration of future changes in climate to allow for resilience of engineered systems.
SOCIAL ENVIRONMENT				
Potential for noise / vibration impacts on residents during site construction and site operation.	· Number of households in the study area who may experience noise/ vibration impacts.	● Neutral There are twenty-five households in the 1 km study area who may experience noise during construction and operation. The proposed changes for all alternatives generally moves the active fill areas south and east moving noise causing activities away from approximately seven (7) residences who are in proximity (within 500 m) of the West Landfill and closer	● Neutral There are twenty-five households in the 1 km study area who may experience noise during construction and operation. The proposed changes for all alternatives generally moves the active fill areas south and east moving noise causing activities away from approximately seven (7) residences who are in proximity (within 500 m) of the West Landfill and closer	● Neutral There are twenty-five households in the 1 km study area who may experience noise during construction and operation. The proposed changes for all alternatives generally moves the active fill areas south and east moving noise causing activities away from approximately seven (7) residences who are in proximity (within 500 m) of the West Landfill and closer

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

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		to approximately ten (10) residences who will be in proximity (within 500 m) of the new fill areas. Based on past noise assessment it is anticipated that noise at residences in the vicinity of the landfill will not exceed the MECP's criterion of 55dBA for landfills. Noise will be modelled for the preferred site development alternative and mitigation recommended if necessary. Based on the site's long operating history, the types of activities and the location of receptors, vibration is not anticipated.	to approximately ten (10) residences who will be in proximity (within 500 m) of the new fill areas. Based on past noise assessment it is anticipated that noise at residences in the vicinity of the landfill will not exceed the MECP's criterion of 55dBA for landfills. Noise will be modelled for the preferred site development alternative and mitigation recommended if necessary. Based on the site's long operating history, the types of activities and the location of recptors, vibration is not anticipated.	to approximately ten (10) residences who will be in proximity (within 500 m) of the new fill areas. Based on past noise assessment it is anticipated that noise at residences in the vicinity of the landfill will not exceed the MECP's criterion of 55dBA for landfills. Noise will be modelled for the preferred site development alternative and mitigation recommended if necessary. Based on the site's long operating history, the types of activities and the location of recptors, vibration is not anticipated.
Potential for odour during construction and operation.	· Number of potential odour sources, relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors.	● Neutral Primary odour sources for Alternative 1 and 3 include the open disposal face and fugitive landfill gas emissions. These are the same key odour sources as the current condition. It is noted that for all three alternatives landfill gas flares/management system would remain in place. The face of the landfill would move south and east for all alternatives. Generally the odour sources for Alternatives 1 and 3 are expected to be similar as today and result in less of an impact as compared to Alternative 2.	● Disadvantage Primary odour sources for Alternative 2 include the open disposal face, fugitive landfill gas emissions and the landfill mining area. The first 2 odour sources noted are the same key odour sources as the current condition. It is noted that for all three alternatives landfill gas flares/management system would remain in place. The landfill mining is a potentially more significant odour source that could occur over the 5 -10 years of landfill mining operation.	● Neutral Primary odour sources for Alternative 1 and 3 include the open disposal face and fugitive landfill gas emissions. These are the same key odour sources as the current condition. It is noted that for all three alternatives landfill gas flares/management system would remain in place. The face of the landfill would move south and east for all alternatives. Generally the odour sources for Alternatives 1 and 3 are expected to result in less of an impact as compared to Alternative 2.
Potential for visual impacts on residents during site construction and site operation.	· Percent change in view within study area.	● Disadvantage While the shape of the mound will differ between alternatives, the height of the proposed expansion will not exceed the restricted height of 241.3 m above sea level (masl) dictated by the Chatham Airport Zoning Regulation and will be built no higher than the current elevation of the existing landfill. The existing landfill is visible from approximately 27% of the land within the 3 km visual study area. The proposed expansion will be visible from approximately 43% of the land within this study area for all three alternatives.	● Disadvantage While the shape of the mound will differ between alternatives, the height of the proposed expansion will not exceed the restricted height of 241.3 m above sea level (masl) dictated by the Chatham Airport Zoning Regulation and will be built no higher than the current elevation of the existing landfill. The existing landfill is visible from approximately 27% of the land within the 3 km visual study area. The proposed expansion will be visible from approximately 43% of the land within this study area for all three alternatives.	● Disadvantage While the shape of the mound will differ between alternatives, the height of the proposed expansion will not exceed the restricted height of 241.3 m above sea level (masl) dictated by the Chatham Airport Zoning Regulation and will be built no higher than the current elevation of the existing landfill. The existing landfill is visible from approximately 27% of the land within the 3 km visual study area. The proposed expansion will be visible from approximately 43% of the land within this study area for all three alternatives.

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: 🔵 Major Advantage ⚪ Advantage 🟢 Neutral 🟡 Disadvantage 🟠 Major Disadvantage

Environment/ Criteria	Indicators	Alternative 1 Vertical Expansion of Old Landfill, Addition of Footprint A + B	Alternative 2 Vertical Expansion of Old Landfill, Landfill Mining of Old Landfill, Addition of Footprint A + Reduced B	Alternative 3 No Vertical Expansion, Addition of Footprint A+B+C
Potential for landfill traffic effect on residents during construction and operation.	· Number of waste trucks during operation. · Number of trucks for soil import/export for construction.	🟢 Neutral All alternatives include approximately 200 waste trucks on the designated haul route per day during operation. All alternatives include approximately 500-750 additional construction material trucks per year, on average, using the designated haul route over the 20-year operation of the proposed expansion.	🟢 Neutral All alternatives include approximately 200 waste trucks on the designated haul route per day during operation. All alternatives include approximately 500-750 additional construction material trucks per year, on average, using the designated haul route over the 20-year operation of the proposed expansion.	🟢 Neutral All alternatives include approximately 200 waste trucks on the designated haul route per day during operation. All alternatives include approximately 500-750 additional construction material trucks per year, on average, using the designated haul route over the 20-year operation of the proposed expansion.
Potential for effect on worker safety during construction and operation.	· Likelihood of safety concerns with alternative.	🟢 Neutral Operation similar to current with known and manageable safety risks.	🟡 Disadvantage Landfill mining component poses a higher potential high safety risk for workers as the Old Landfill dates back to the 1960s and Waste Connections has no records on materials deposited in the landfill prior to 1982.	🟢 Neutral Operation similar to current with known and manageable safety risks.
ECONOMIC ENVIRONMENT				
Potential for effect on businesses during construction and operation.	· Number of businesses (e.g., agricultural operations) in the study area who may experience disruption (e.g., as a result of continued soil haulage during operations).	🟢 Neutral There are two (2) retail businesses in the 1 km study area (farm market/agricultural operation and small equipment dealer) plus farming operations. All alternatives include a berm around the perimeter of the site which will minimize impact on businesses in the vicinity.	🟡 Disadvantage There are two (2) retail businesses in the 1 km study area (farm market/agricultural operation and small equipment dealer) plus farming operations. All alternatives include a berm around the perimeter of the site which will minimize impact on businesses in the vicinity. The landfill mining associated with Alternative 2 has a greater potential to result in nuisance impacts that could impact businesses and it is ranked as having a disadvantage compared to Alternatives 1 and 2.	🟢 Neutral There are two (2) retail businesses in the 1 km study area (farm market/agricultural operation and small equipment dealer) plus farm operation. All alternatives include a berm around the perimeter of the site which will minimize impact on businesses in the vicinity.
Potential for landfill traffic effect on businesses during construction and operation.	· Number of waste trucks during operation. · Number of trucks for soil import/export for construction.	🟢 Neutral All alternatives include approximately 200 waste trucks on the designated haul route per day during operation. All alternatives include approximately 500-750 additional construction material trucks per year, on average, using the designated haul route over the 20-year operation of the proposed expansion.	🟢 Neutral All alternatives include approximately 200 waste trucks on the designated haul route per day during operation. All alternatives include approximately 500-750 additional construction material trucks per year, on average, using the designated haul route over the 20-year operation of the proposed expansion.	🟢 Neutral All alternatives include approximately 200 waste trucks on the designated haul route per day during operation. All alternatives include approximately 500-750 additional construction material trucks per year, on average, using the designated haul route over the 20-year operation of the proposed expansion.
Potential for effect on agriculture during construction.	· Area of on-site crop production lost. · Area of Class 1-3 soils lost.	🟡 Disadvantage All three site development alternatives will require the displacement of agricultural uses on the site. For all alternatives it can be assumed that the full site will be used for landfilling activities for the 20-year	🟡 Disadvantage All three site development alternatives will require the displacement of agricultural uses on the site. For all alternatives it can be assumed that the full site will be used for landfilling activities for the 20-year	🟡 Disadvantage All three site development alternatives will require the displacement of agricultural uses on the site. For all alternatives it can be assumed that the full site will be used for landfilling activities for the 20-year

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

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		lifespan of the site; however farming operations will be permitted until those lands are required. This Alternative includes landfilling over approximately 59 ha of Class 2 soils. It is noted that landfills can return to some form of agricultural use, as has been done at other locations in Ontario.	lifespan of the site; however farming operations will be permitted until those lands are required. This alternative includes landfilling over approximately 54 ha of Class 2 soils. It is noted that landfills can return to some form of agricultural use, as has been done at other locations in Ontario.	lifespan of the site; however farming operations will be permitted until those lands are required. This alternative includes landfilling over approximately 83 ha of Class 2 soils. It is noted that landfills can return to some form of agricultural use, as has been done at other locations in Ontario.
Cost of facility.	· Approximate cost of site development alternative.	● Neutral Represents standard landfill construction with an order of magnitude capital cost of approximately $60 million.	● Major Disadvantage Represents standard landfill construction with the addition of a landfill mining component. Alternative 3 has an order of magnitude capital cost of approximately $165 million.	● Disadvantage Represents standard landfill construction with an order of magnitude capital cost of approximately $80 million.
CULTURAL ENVIRONMENT				
Potential effects to archaeological resources as a result of construction.	· Area of undisturbed land affected by the expansion alternative.	● Neutral Approximately 59 ha of undisturbed land may be affected by the proposed expansion. Some of this land has been cleared of archaeological potential based on a Stage 1 Archaeological Assessment. A Stage-2 Archaeological Assessment will be completed and any resources found will be documented and removed.	● Neutral Approximately 54 ha of undisturbed land may be affected by the undertaking. . Some of this land has been cleared of archaeological potential based on a Stage 1 Archaeological Assessment. A Stage-2 Archaeological Assessment will be completed and any resources found will be documented and removed.	● Neutral Approximately 83 ha of undisturbed land may be affected by the undertaking. . Some of this land has been cleared of archaeological potential based on a Stage 1 Archaeological Assessment. A Stage-2 Archaeological Assessment will be completed and any resources found will be documented and removed.
Potential effects to cultural heritage resources as a result of construction.	· Number and type of cultural heritage resources affected by expansion alternative.	● Neutral On-site cultural resources (residence, barn, and a farmscape) will be removed. The features will be documented prior to removal/demolition if shown to be warranted.	● Neutral On-site cultural resources (residence, barn, and a farmscape) will be removed. The features will be documented prior to removal/demolition if shown to be warranted.	● Neutral On-site cultural resources (residence, barn, and a farmscape) will be removed. The features will be documented prior to removal/demolition if shown to be warranted.
BUILT ENVIRONMENT				
Effects on land use as a result of construction.	· Size of landfill footprint.	● Neutral Approximately 190 ha footprint for this alternative. Lands in the southeast corner of site will have a more flexible use upon closure. The difference between Alternatives 1 and 2 was not considered significant and they were ranked the same as they both leave some lands available for flexible future use.	● Neutral Smallest footprint at approximately 185 ha. Lands in the southeast corner of site will have a more flexible use upon closure. The difference between Alternatives 1 and 2 was not considered significant and they were ranked the same as they both leave some lands available for flexible future use.	● Disadvantage Largest footprint size at approximately 214 ha. This alternative uses the full property and limits the flexibility of use upon closure. Alternative 3 was considered to have a greater negative impact on land use than Alternatives 1 and 2.

TABLE 3-1 – SITE DEVELOPMENT EVALUATION & RANKING

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Potential effects on existing transportation infrastructure and transportation operation.	· Number of waste trucks during operation. · Number of trucks for soil import/export for construction. · Anticipated impact on the Chatham-Kent Airport.	● Neutral All of the alternatives would continue the approximately 200 waste trucks/ day for the 20-year operation of the facility. Soil movement to remain on-site. Waste Connections provides funds to the Municipality of Chatham-Kent for upkeep of the designated haul route so no change in impact to the this transportation infrastructure is anticipated. All alternatives will be within the height restriction dictated by the airport, so no change in effect on the airport is anticipated.	● Neutral All of the alternatives would continue the approximately 200 waste trucks/ day for the 20-year operation of the facility. Soil movement to remain on-site. Waste Connections provides funds to the Municipality of Chatham-Kent for upkeep of the designated haul route so no change in impact to the this transportation infrastructure is anticipated. All alternatives will be within the height restriction dictated by the airport, so no change in effect on the airport is anticipated.	● Neutral All of the alternatives would continue the approximately 200 waste trucks/day for the 20-year operation of the facility. Soil movement to remain on-site. Waste Connections provides funds to the Municipality of Chatham-Kent for upkeep of the designated haul route so no change in impact to the this transportation infrastructure is anticipated. All alternatives will be within the height restriction dictated by the airport, so no change in effect on the airport is anticipated.
Ease to implement/construct and maintain/operate.	· Anticipated complexity of construction and operation.	● Neutral Construction processes similar to that at existing landfill. Operational processes similar to the existing landfill.	● Disadvantage Construction more complex than at existing landfill due to landfill mining. Operational processes similar to the existing landfill.	● Neutral Construction processes similar to that at existing landfill. Operational processes similar to the existing landfill.
Potential for effects on existing landfill infrastructure as a result of construction.	· Extent and type of change required to existing site facilities.	● Neutral Existing berms, stock pile and flood control facilities to the north, entrance, scale house, office remain the same for all alternatives.	● Neutral Existing berms, stock pile and flood control facilities to the north, entrance, scale house, office remain the same for all alternatives.	● Neutral Existing berms, stock pile and flood control facilities to the north, entrance, scale house, office remain the same for all alternatives.

3.2.1 Natural Environment – Biology

Biology Evaluation Criteria

The following criteria and indicators were used to assess the site development alternatives relative to the natural environment from a biology perspective.

Criteria	Indicators
Terrestrial	
Potential for effect on terrestrial systems from construction and operation.	· Area and type of terrestrial systems (e.g., significant woodlots, hedgerows, wetlands, etc.) to be removed on-site. · Area and type of terrestrial systems (e.g., significant woodlots, hedgerows, wetlands, etc.) potentially disrupted within 1 km.
Potential for effect on habitat of Endangered or Threatened species during construction.	· Area of habitat for endangered or threatened species on-site.
Potential effect on medicinal or other culturally sensitive species of importance to First Nations Groups during construction.	· Area and type of species of importance to be removed on-site.
Aquatic	
Potential for effect on aquatic systems during construction.	· Amount and type of aquatic systems (i.e., ponds, drains) that would be displaced on-site.

Overview of Biology Existing Conditions

Key existing environmental features on the Ridge Landfill property include three (3) woodlots (i.e., northeast, southeast and southwest woodlots). All three (3) are identified in the Chatham-Kent Official Plan as *Significant Woodlands* (i.e., greater than two [2] ha).

Based on the field investigation results completed in support of the EA, 1.46 ha (or 39%) of the 3.76 ha southwest woodlot identified in Chatham-Kent's Official Plan was associated with a deciduous thicket. In addition, no species at risk (SAR), species of conservation concern (SCC) and/or significant wildlife habitat (SWH) were identified in association with the southwest woodlot. As a result, and in consideration of the adjacent land uses, the southwest woodlot was identified as having limited ecological function. Field investigation results confirmed the presence of SAR, SCC and SWH in association with the 8 ha southeast woodlot as well as a 1.60 ha deciduous swamp inclusion. Given that preservation of the northeast woodlot was identified early in the EA process, field investigations were limited to ecological land classification (ELC) and botanical inventories for this feature. Based on the field investigation results, the 5.16 ha northeast woodlot includes 1.65 ha of deciduous swamp, candidate SWH for bat maternity colonies and has the potential to provide habitat for SAR.

Natural heritage features adjacent to the landfill are limited; however, they include a woodlot east of Erieau Road as well as west of Charing Cross Road.

Existing watercourses that cross the site or are in immediate proximity include the Howard Drain, Duke Drain, Scott Drain, Lewis Drain and Gales Drain. These drains are classified as intermittent or ephemeral (Duke, Gales and Howard Drains) or are unclassified (Lewis and Scott Drains). All these drains are classified as warm water systems. *Figure 3-4* shows these biological features.

I:\GIS\141382 - Ridge Landfill\Mapping\Interim Alternative Methods Report\Figure 3_4 Natural and Surfacewater Features at the Ridge Landfill.mxd

WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 3-4 EXISTING NATURAL ENVIRONMENT AND SURFACE WATER FEATURES AT THE RIDGE LANDFILL

▭	Property Boundary (Study Area)
- · -	Existing Watercourse
🟦	Existing Pond
▭	Existing Flood Control Facility
🟩	Significant Woodlot

1:12,000

0 100 200 400 m

MAP DRAWING INFORMATION:
IMAGERY PROVIDED BY DIGITAL GLOBE/
DATA OBTAINED FROM MNRF

MAP CREATED BY: LK
MAP CHECKED BY: DB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 152456
STATUS: DRAFT
DATE: 2018-11-30

Biology Assessment

The following commentary describes the alternatives with respect to each of the evaluation criteria/indicators.

Terrestrial systems - The key Disadvantage of the site development alternatives and difference between alternatives from a terrestrial perspective relates to the potential for construction impacts on the on-site woodlots. The northeast woodlot will not be impacted by the proposed expansion. Construction of any of the three (3) site development alternatives will require removal of the smaller southwest woodlot which is approximately 3.7 ha in size. Construction of Alternatives 1 or 2 would enable the maintenance of the approximately 8 ha southeast woodlot with a confirmed presence of SAR, SCC and SWH, whereas Alternative 3 would require the removal of this woodlot. Compensation for woodlot removal would be provided at a 2-to-1 ratio, planting two (2) trees for every tree removed. Waste Connections owns property on Erieau Road across from the Ridge Landfill where some trees could be planted. Discussions are also being held with the Lower Thames Valley Conservation Authority (LTVC) and First Nations regarding other locations for tree planting. Given the tree compensation being discussed, the net effect of the woodlot removal for Alternatives 1 and 2 is considered minimal and ranked as Neutral. The removal of the southeast woodlot with Alternative 3 is considered to be a Disadvantage compared to Alternatives 1 and 2 as it has a greater potential for impact on the terrestrial environment given the quality of the woodlot and the associated habitat.

Site operation is not anticipated to negatively impact on-site terrestrial features that remain after construction and there is no disruption to off-site features noted above anticipated from site construction or operation of the proposed expansion.

Endangered species habitat - As noted, the only habitat for endangered or threatened species identified on-site is the potential SAR bat habitat in the 8 ha southeast woodlot. Alternative 3 requires removal of this habitat and is therefore considered to be Disadvantaged over the other alternatives for this criterion. Alternative 3 would require an Overall Benefit Permit under Section 17(2) c of the ESA for removal of the southeast woodlot.

Culturally valued species – No medicinal or culturally sensitive species of importance were identified by WIFN who reviewed the Natural Environment Existing Conditions Report and have visited the site.

Aquatic systems – Municipal drains are common in Chatham-Kent and drains in this area have been in place for many decades. The on-site drains were successfully moved in 1999 to accommodate the landfill expansion at that time. Drains that are currently within the area of the site development alternatives are considered to have limited potential for fish habitat. All three (3) site development alternatives will require the relocation of approximately 1,260 m of the Howard Drain. The Howard Drain would be directed to the south and west of the expansion Fill Area A and would join up with the Scott Drain. Based on the work completed, the sensitivity to fish habitat is considered to be low and the impact of moving drains will be minimal. All three (3) site development alternatives would also remove one (1) existing pond at the south edge of the West Landfill. This pond would be relocated to the southern edge of expansion Fill Area A. No turtles were observed in this pond during field work and potential impact association with moving the storm water management pond is anticipated to be minimal.

Summary of Ranking Preference – Biology Natural Environment

Biology Natural Environment	Alternative 1	Alternative 2	Alternative 3
Terrestrial Systems Ranking	Neutral	Neutral	Disadvantage
Endangered Species Habitat Ranking	Neutral	Neutral	Disadvantage
Culturally Sensitive Species Ranking	Neutral	Neutral	Neutral
Aquatic Systems Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Neutral	Disadvantage

Conclusion

Based on the above assessments, Alternative 1 and 2 are preferred over Alternative 3 relative to the natural environment from a biology perspective.

3.2.2 Natural Environment – Physical

The following criteria and indicators were used to assess the site development alternatives relative to the natural environment from a groundwater, surface water, and air quality and climate change perspective.

Groundwater Evaluation Criteria

Criteria	Indicators
Potential impacts to groundwater quality during construction, operation and post closure.	· Qualitative assessment of ability of alternative to meet Reasonable Use Guideline.
Leachate contaminating lifespan during construction, operation and post closure.	· Prediction based on tonnes of waste per hectare of footprint area and leachate generation rate.

Criteria	Indicators
Potential impacts to groundwater quantity.	- Landfill footprint.
Potential impacts to water supply wells.	- Extent of natural setting protection.

Overview of Groundwater Existing Conditions

The Ridge Landfill has a 30 m thick layer of natural clays underlying the site. These low permeability clay soils result in very low rates of groundwater movement, and provide a natural barrier to protect groundwater from potential impacts from the existing landfill. In addition, prior landfill development at the site has included leachate collection systems consisting of granular drainage layers, geosynthetics and a network of leachate collection pipes and pump stations. Landfill leachate is currently collected and directed off-site for treatment at the BWTL. Since the early 1980s a groundwater monitoring program has been in place at the Ridge Landfill to monitor the effectiveness of existing controls to protect groundwater. Based on monitoring results it has been demonstrated that the landfill is not impacting groundwater resources. For the proposed landfill expansion, extension of the site's leachate collection system will continue to enable leachate collection and treatment. Groundwater monitoring will also continue to evaluate the effectiveness of environmental controls. It is noted that residences along Erieau Road and Charing Cross Road are supplied by municipal water. The on-site residences may be on well water and these leases will be terminated should the expansion be approved regardless of the site development alternative selected. There are currently nineteen residential wells monitored on an annual basis and wells are added to the program at the request of neighbouring residents.

Groundwater Assessment

The following commentary describes the alternatives from a groundwater perspective with respect to each of the evaluation criteria/indicators.

Groundwater quality - To determine the significance of an impact on groundwater quality, the MECP developed Guideline B 7, The Incorporation of the Reasonable Use Concept into MECP Groundwater Management Activities (RUG). The essence of this guideline is to establish site specific groundwater quality criteria based on criteria established for the "reasonable use" of the groundwater and background concentrations. These criteria are typically applicable at the landfill boundary.

The “reasonable use” for groundwater at the Ridge Landfill site is drinking water. The RUG specifies that the maximum concentration of a particular contaminant that would be acceptable in groundwater beneath an adjacent property is a fraction of the Ontario Drinking Water Objectives (25% increase over background levels for health related parameters and 50%

increase for non-health related parameters). Historical monitoring activity has shown that the Ridge Landfill site consistently meets the RUG. O.Reg. 232/98 (Table 3-1) specifies the water quality parameters that should be assessed as part of the hydrogeological assessment.

Given the protection provided by the natural setting and the supporting long-term historical monitoring data, groundwater impacts related to the construction of the new proposed fill areas prior to solid waste deposition are not considered significant. Also due to the natural setting and supported by appropriate engineering controls, all three (3) alternatives are expected to continue to meet reasonable use during landfill operation. To confirm this, a predictive impact assessment will be completed for the preferred site development alternative using contaminant transport computer modelling to assess the suitability of the site, specifically the compliance with the RUG.

- Leachate contaminating lifespan – Leachate is the liquid produced in a landfill from the waste material degradation and any water from precipitation that infiltrates into it. Leachate is produced at a landfill over the operating life of the site and after the site is closed. Contaminating lifespan is the time required for leachate concentrations to reduce within the landfill. Understanding the site's leachate contaminating lifespan will help determine the ongoing mitigation and contingency measures needed to protect the environment into the future. A qualitative assessment of the contaminating life span was completed for the three (3) site development alternatives. The qualitative contaminating lifespan was calculated using a formula that relates leachate concentrations to the total mass of waste, the tonnes of waste per hectare and anticipated leachate generation rate. The contaminating lifespan was determined based on the time for chloride concentrations in the leachate to reduce to the level allowed under the RUG (187.5 mg/L).

  Overall, when considering the total landfill, the three (3) alternatives have calculated contaminating lifespans of 308 years (Alternative 1), 316 years (Alternative 2) and 294 years (Alternative 3). The nominal difference (7% or less) between the three (3) site developments alternatives is not considered to be significant. It is noted that the contaminating lifespan for the preferred site development alternative is expected to be significantly less than these rates as the calculations did not take into consideration landfill design details and engineering controls (i.e., leachate collection systems) combined with the effects of the natural setting.

- Groundwater quantity – The site is situated on a thick deposit on low permeability clay till soil and recharge through the till is very low. In addition, recharge to the bedrock aquifer from the fill footprint areas is eliminated while the leachate collection system is active. Therefore the total footprint area of the design alternative can be used to evaluate this indicator.

- Alternative 1 - 190 ha
- Alternative 2 - 185 ha
- Alternative 3 - 214 ha

(Note - the footprint area includes the existing landfill areas as well as the horizontal expansion)

Alternative 1 and 2 are nearly the same and Alternative 3 has a 15% greater footprint area. However, given the limited amount of recharge through the thick clay soils at the site, all three (3) site development alternatives are considered to have similar potential to influence recharge at the site.

Water supply wells - All three (3) site development alternatives overlay more than 30 m of natural clay. In addition, engineered protection would also include a leachate collection system. Based on the natural setting and site features it is anticipated that there would be no difference between the three (3) site development alternatives from the perspective of potential to impact water supply wells. As noted, some of the residences and businesses are municipally serviced, nineteen private residential wells are currently monitored on an annual basis and further work as part of the EA will confirm if there are additional private wells that need to be tested.

Surface Water Evaluation Criteria

Criteria	Indicators
Potential impacts to surface water quantity.	· Changes in peak flows pre- and post-expansion.
Potential impacts to surface water quality.	· Anticipated change in temperature, water quality, benthos and fish habitat.

Overview of Surface Water Existing Conditions

Existing surface water features on the site include the Howard Drain which runs approximately through the middle of the site, the Scott Drain along the east edge and the Duke Drain along the west edge. The site also includes five (5) stormwater ponds and a flood control facility at the northern edge of the landfill. These features are shown on *Figure 3-4.* Surface water runoff from the covered fill areas generally travels toward the perimeter of the fill areas where flows are intercepted and conveyed by ditches to stormwater management ponds which outlet to the Howard or Duke Drains.

Surface Water Assessment

The following commentary describes the alternatives from a surface water perspective with respect to each of the evaluation criteria/indicators.

- Surface water quantity - It will be important to demonstrate whether the construction of any of the alternatives would impact the quantity of flow to the drains. Changes between pre and post expansion peak flows will represent the most significant potential impact to surface water quantity for each site development alternative. It is noted that for all site development alternatives, stormwater management infrastructure will be constructed as landfill cells are developed to ensure effective surface water management throughout the construction and operation of the site. The results of the hydrologic analysis indicates that peak flows are maintained at or below the baseline condition for all three (3) of the site development alternatives under the full suite of storm events (2 to 250 years). In addition, the runoff volumes were maintained at or below the baseline condition for Site Development Alternatives 1 and 2, while there were minor increases (in the order of 1-3%) for Site Development Alternative 3. Further information on the surface water quantity assessment is included in *Appendix F*.
- Surface water quality - A surface water quality monitoring program has been ongoing at the Ridge Landfill since 1995 and a 12-month program was initiated in May 2017 to collect baseline water quality data for the proposed expansion project. Benthic community sampling was also completed in June 2017. Based on current conditions, which reflect the operation of a landfill, the following can be anticipated for all three (3) site development alternatives:
  - Temperature: Surface water temperatures measured over the 12-month monitoring program in 2017-2018 generally showed that temperatures were slightly cooler in the watercourses upstream of the landfill site during the summer months; however, the measured temperatures were relatively comparable over the remaining portion of the monitoring period (i.e., fall, winter, and spring months). Significant increases in surface water temperatures are not anticipated for any of the proposed landfill expansion alternatives, once appropriate mitigation measures are implemented.
  - Water quality and benthos: The 12-month surface water quality monitoring program in 2017 involved the collection of samples at four (4) locations, three (3) upstream and one (1) downstream of the Ridge Landfill. The objective was to determine if the landfill was impacting water quality by comparing upstream and downstream sampling results. Samples were collected over nine (9) sampling events, which were analyzed for a suite of parameters (general chemistry, metals, and inorganics). The analytical results show exceedances to the corresponding Provincial Water Quality Objectives for several

parameters at the three (3) sampling locations located upstream of the landfill, and the one (1) downstream location. Similarly, the results of the benthic assessment indicate that invertebrate diversity and richness were low upstream and downstream of the landfill, which is likely related to poor water quality (elevated phosphorus concentrations were identified as a stressor of particular significance). As poor surface water quality was observed at all sampling locations upstream and downstream of the landfill, it is concluded that other land uses (e.g., agricultural) in the watershed are contributing substantially to the elevated contaminant levels (particularly phosphorus).

- Surface water quality downstream of the site is similar to that observed upstream of the landfill, demonstrating the landfill engineering controls are effective in preventing surface water quality impacts. The proposed expansion would include further engineering controls to ensure that there continues to be no impacts on water quality in comparison with baseline conditions.
- Fish habitat: The Howard, Scott and Duke Drains are warm water intermittent drains and based on field work have limited fish habitat potential. The ongoing operation of the site is not anticipated to significantly change quality of fish habitat over the long term.

Air Quality Evaluation Criteria

Criteria	Indicators
Potential for dust during construction and operation.	· Relative levels of material movement and vehicular activity as an indicator for dust and combustion emissions.
Potential for impacts to air quality during construction and operation.	· Nitrogen Oxides, Sulphur Dioxide and Carbon Monoxide (together referred to as criteria air contaminants): relative levels of vehicular activity as an indicator for amount of fuel combusted. · Hydrogen Sulphide, Vinyl Chloride, Chloroform: anticipated difference in landfill gas emissions.

Overview of Air Quality Existing Conditions

The Ridge Landfill is currently an active landfill where approximately 1.3 million tonnes of waste are disposed of annually. As required by Condition 9.8 of MECP ECA (Waste Disposal Site) Number A021601, air quality monitoring of particulates and organic compounds was completed at the Ridge Landfill site in 2014. To identify the preferred locations for monitoring equipment, a site visit was carried out with a representative from MECP on May 23, 2014. Sampling locations were identified with MECP based on predominant wind direction across the site, access to locations, availability of electricity and security of location. Three (3) final monitoring locations were selected: two (2) downwind locations north and northeast of the Ridge Landfill property and one (1) upwind location southwest of the site.

The results of the monitoring program showed that the Ridge Landfill site was operating in compliance with MECP air quality criteria.

Air Quality Assessment

The following commentary describes the alternatives from an air quality perspective with respect to each of the evaluation criteria/indicators.

- Dust - Construction, vehicular movement on unpaved roads and landfill mining have the potential to generate dust. Relative levels of material movement and vehicular activity are indicators of dust and criteria air contaminant emissions. Standard mitigation practices are put in place to manage emissions at the site including effective vehicle maintenance and the management of fugitive dust through the site's dust management plan. The construction and operation of Site Development Alternatives 1, 2 and 3 involve material movement and vehicular activity associated with cell construction and closure and ongoing waste receipt and deposition in the landfill. During operation each of the three (3) alternatives would receive the same amount of waste and as such the same number of waste trucks. The following identifies the key construction related activities that could result in dust for each alternative:
    - Alternative 1 requires approximately 500 trucks per year, on average, to import landfill construction materials over the 20-year operation of the landfill.
    - Alternative 2 requires approximately 600 trucks per year, on average, to import landfill construction materials over the 20-year operation of the landfill. This alternative involves the mining of approximately 4.5 million m^3 of material on-site over a 5 to 10 year period. Approximately 1,800 trucks to transport recovered material from landfill mining off-site will also be required (90 to 180 trucks per year over the 5 to 10 year mining period). This is based upon a recovery rate of recyclable material of 2%.
    - Alternative 3 requires approximately 750 trucks per year, on average, to import landfill construction materials over the 20-year operation of the landfill.

  Standard dust mitigation measure such as reduced vehicle speeds and the use of dust suppressants would continue to be used to manage dust as they are done today. Alternative 1 has the least activity and potential for dust and is ranked as Neutral. Alternative 2 is ranked as a Major Disadvantage due to the inclusion of landfill mining.

Alternative 3 has a comparable number of trucks to Alternative 1 when considered over the 20-year time span and is ranked as Neutral.

- Air Quality – Construction and landfilling of waste have the potential to result in impacts to air quality. The level of vehicular activity for each alternative will act as an indicator for the amount of fuel combusted and the resulting potential for nitrogen oxides, sulphur dioxide and carbon monoxide. Levels of material movement and associated vehicular activity associated with construction and landfilling of waste for Alternatives 1 and 3 are comparable (i.e., 500 to 750 trucks per year for construction materials). Proper vehicle maintenance helps to minimize the air quality impact of vehicular activity. Site Development Alternative 2 includes the addition of landfill mining which would involve a significant increase in material movement, processing and vehicular activity.

The anticipated landfill gas emissions for each of the site development alternative will be used to indicate the potential for Hydrogen Sulphide, Vinyl Chloride, and Chloroform from the site. During operation, all alternatives will have waste deposited at the same rate as is currently and for the same duration into the future, resulting in similar annual emissions generation as current activities. The term “contaminating lifespan” typically refers to the period of time over which landfill gas, if released to the natural environment would have an adverse effect. It is expected that most gas generation will occur within 60 years of completion of the expansion for all alternatives and would be down to low levels of generation by the year 2100. Given the very thick clay layer under the landfill and the engineered controls, the potential for migration to occur and cause an adverse effect is negligible. In this regard, the three (3) landfill alternatives are equally ranked.

The landfill mining included as part of Site Development Alternative 2 will result in an increase in the release of by-products of waste decomposition (e.g., hydrogen sulphide) because of the required exposure and handling of previously buried waste. Alternative 2 has a greater potential for air quality impacts during mining activities and has been ranked Disadvantaged for this criterion/indicator due to the inclusion of landfill mining.

Climate Change Evaluation Criteria

Criteria	Indicators
Potential for greenhouse gas emissions during construction and operation.	· Daily/annual waste volume landfilled · Anticipated differences in on-site vehicular activity · Extent of woodlot removal
Resilience of engineered systems.	· Qualitative assessment of the resiliency of proposed infrastructure.

Climate Change Assessment

Landfilling waste has the potential to release greenhouse gases (GHG), primarily methane, which can contribute to climate change. Landfill systems also need to take climate change into consideration by meeting design standards that ensures system resilience. The following commentary describes the alternatives from a climate change perspective with respect to each of the evaluation criteria/indicators.

- Greenhouse gas - The same amount of waste will be accepted for all three (3) site development alternatives. All three (3) site development alternatives will have waste deposited over the proposed 20-year planning life at the same rate as is done currently. This will result in similar annual landfill gas generation rates and total potential emissions over the lifetime for all alternatives. Landfill gas collection will occur regardless of the site development alternative selected and at a minimum, landfill gas will be treated through active flaring to destroy the methane and thereby significantly reduce potential GHG emissions. Site Development Alternatives 1 and 2 involve the removal of one (1) woodlot with Alternative 3 removing a second woodlot. Trees will be replanted within Ecoregion 7E, the same ecoregion as the Ridge Landfill at a 2-to-1 ratio to compensate for the loss. Given the replanting of trees will be at a higher ratio, the potential for climate change impacts from on-site woodlot removal is less and ranked Neutral. The landfill mining included in Alternative 2 will result in an increase in vehicular activity over historical operations during the period of mining, resulting in an increase in GHG from vehicle emissions. In addition, exposing and processing previously landfilled waste will increase GHG through the release of by-products of waste decomposition representing a Disadvantage ranking for Alternative 2.
- Resiliency of landfill systems - Landfill systems will be designed in accordance with current regulations and design standards that take climate change into consideration. The preferred alternative will be assessed, through completion of a climate change risk assessment, to allow for resiliency to be incorporated into the impact assessment of the preferred alternative. All alternatives have similar ability to incorporate climate resilient designs and therefore, all alternatives have been ranked as Neutral under a climate resiliency assessment.

Summary of Ranking Preference - Physical Natural Environment

Physical Natural Environment	Alternative 1	Alternative 2	Alternative 3
Groundwater Quality Ranking	Neutral	Neutral	Neutral
Leachate Contaminating Lifespan Ranking	Neutral	Neutral	Neutral
Groundwater Quantity Ranking	Neutral	Neutral	Neutral
Water Supply Wells Ranking	Neutral	Neutral	Neutral
Surface Water Quantity Ranking	Neutral	Neutral	Neutral
Surface Water Quality Ranking	Neutral	Neutral	Neutral
Dust Ranking	Neutral	Major Disadvantage	Neutral
Air Quality Ranking	Neutral	Disadvantage	Neutral
Climate Change: Greenhouse Gas Emissions Ranking	Neutral	Disadvantage	Neutral
Climate Change: Systems Resilience Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Disadvantage	Neutral

Conclusion

Based on the above assessments, Alternative 1 and 3 are preferred over Alternative 2 relative to the natural environment from a groundwater, surface water, air quality and climate change perspective.

3.2.3 Social Environment

Social Evaluation Criteria

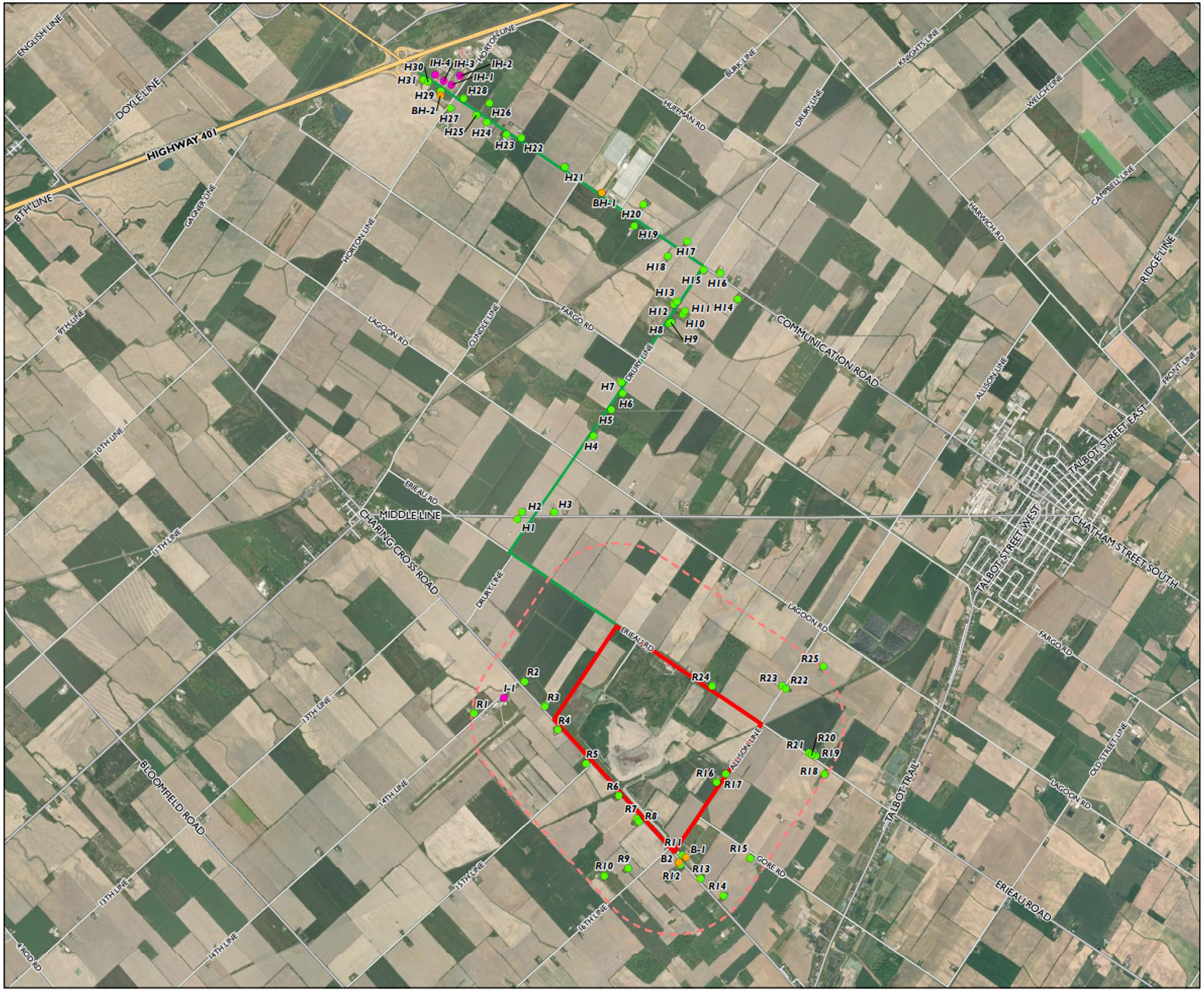
Criteria	Indicator
Potential for noise/vibration impacts on residents during site construction and site operation.	· Number of households in the study area who may experience noise/vibration impacts.

Criteria	Indicator
Potential for odour during construction and operation.	- Number of potential odour sources, relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors.
Potential for visual impacts on residents during site construction and site operation.	- Percent change in view within the study area.
Potential for landfill traffic effect on residents during construction and operation.	- Number of waste trucks during operation. - Number of trucks for soil import/export for construction.
Potential for effect on worker safety during construction and operation.	- Likelihood of safety concerns with alternative.

Overview of Existing Social Conditions

There are twenty-five residences within 1 km of the Ridge landfill and thirty-one residences fronting on the designated haul route which includes Erieau Road, Drury Line and Communication Road. There are also two (2) leased residences on-site and these leases will be terminated should the expansion be approved regardless of the site development alternative selected. The locations of existing residences in the site vicinity and along the designated haul route are shown on *Figures 3-5*.

The landfill has been in operation since the 1960s and many site neighbours are long-time residents and are familiar with the landfill and its operation. Residents in the vicinity of the site and along the designated haul route who might experience impacts from landfill operations are encouraged to contact Waste Connections to discuss concerns and resolve any issues. Waste Connections continues to work proactively to minimize and mitigate any potential off-site impacts through employing recognized landfill best management practices and mitigation measures. All complaints are investigated by landfill staff, mitigated as required and discussed with the complainant.



WASTE CONNECTIONS of CANADA

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 3-5
EXISTING RESIDENCES, BUSINESSES AND INSTITUTIONS IN THE SOCIO-ECONOMIC STUDY AREA AND ALONG THE HAUL ROUTE

- ● Business
- ● Institution
- ● Residence
- ▭ On Site Property Boundary
- ⬚ Socio-Economic Study Area
- — Haul Route

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MAP DRAWING INFORMATION:
IMAGERY PROVIDED BY DIGITAL GLOBE/
DATA OBTAINED FROM MNRF

MAP CREATED BY: GM
MAP CHECKED BY: MB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 152456
STATUS: DRAFT
DATE: 2018-12-03

Social Assessment

The following commentary describes the alternatives from a social perspective with respect to each of the evaluation criteria/indicators.

- Noise and vibration – Ambient noise levels for the residents in the landfill vicinity include noises of nature, traffic, agricultural activities, the existing airport and the existing landfill operation. In 2010 to 2011 a noise impact assessment for the current landfill was undertaken in support of an application to adjust the annual fill rate. The results of the 2010 to 2011 noise assessment indicated that the predicted receptor sound levels at residences in the vicinity of the landfill were below the MECP's criterion of 55 dBA for landfills.

  Each of the proposed alternatives generally moves the active fill areas south and east. This will result in noise causing activities moving away from approximately seven (7) residences that are within 500 m proximity of the West Landfill, and closer to approximately ten (10) residences that are within 500 m proximity of the new proposed fill areas.

  The construction of berms along the north, south and east sides of the site will help to mitigate potential noise impacts. Given that past noise assessment work did not identify significant off-site noise impacts from the current landfill operations, it is reasonable to assume that this will be the case for the proposed expansion given no changes are proposed to the landfilling activities and annual disposal rate. This will be confirmed through the noise assessment of the preferred site development alternative and any mitigation needed to meet MECP noise criterion will be put into place as part of the expansion design.

  This site has a long operating history and vibration has not been raised as a concern by the nearby receptors to date. Based on the location of existing receptors and the types of activities at the landfill, a vibration assessment is not warranted for the proposed changes.

  All alternatives have been ranked as Neutral for noise as they have a similar and minimal potential for noise impacts.

- Odour – The proposed expansion will continue to use similar landfilling practices as done today, with the landfill tipping face and fugitive landfill gas emissions being the main potential odour sources. The active tipping face will move south and east as the new fill areas are developed. As noted above the shift of landfill activity will move the site further away from approximately seven (7) residences at the northern end of the site, and closer to approximately ten (10) residents (within 500 m) at the southern and eastern site boundary. As noted above, odour complaints have occurred over the operational life of the Ridge Landfill. Waste Connections have historically addressed odour through employing recognized operational practices such as minimizing the size of the working face, the application of daily and intermediate cover material, expansion of the landfill gas collection system and destruction of the landfill gas (flaring), and installing and operating odour neutralizing systems. These practices will continue and be expanded as required during the future operation of the landfill. With mitigation efforts it is anticipated that the odour impacts associated with all site development alternatives will be minimized and Alternatives 1 and 3 are ranked as Neutral.

However, landfill mining, which is a component of Alternative 2, would be a new operation, over a period of 5 to 10 years that could be a significant widespread potential odour source. In the immediate proximity of the mining operation would be two (2) residential receptors on Erieau Road east of the existing Old Landfill. The potential nature of odour from landfill mining results in this alternative being ranked as a Disadvantage with respect to potential odour impact.

- Visual - Residents in the vicinity of the site may have different views of the landfill based on the site development alternatives. The height of development of any of the three (3) alternatives will not exceed the restricted height of 241.3 m above sea level (masl) dictated by the Chatham Airport Zoning Regulation and will be built no higher than the current elevation of the existing landfill. Based on the analysis undertaken, all three (3) alternatives may be visible from approximately 43% of the land within 3 km of the site, compared to current visibility at approximately 27% of the land. As all three (3) alternatives have same impact and the expanded landfill will be seen from a higher percentage of the study area than current, all three (3) are ranked as disadvantaged.
- Traffic –As noted there are thirty-one residences on the existing designated haul route to and from the Highway 401 interchange to the site, and approximately 200 waste trucks/ day[2] (this includes a combination of tractor trailers and collection vehicles) currently access the Ridge Landfill. The annual tonnage and the designated haul route will remain unchanged for the three (3) proposed site development alternatives. As a result, no significant change is anticipated in the number of waste trucks that will access the site on an annual basis for any of the alternatives.

  Concerns have been raised at consultation events relating to trucks not staying on the designated haul route and fugitive litter from trucks going to the landfill. Waste Connections has put in place a protocol to ensure trucks use the designated haul route, and all loads are properly covered/tarped. Waste Connections encourages residents along the designated

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[2] The number of trucks is based on Ridge Landfill scale data for a typical waste receiving month (October 2018).

haul route to report any litter concerns that need to be addressed. Following the summer consultations for the EA, Waste Connections met with the Municipality of Chatham-Kent to discuss additional signs to remind drivers to stay on the designated haul route and these signs have since been installed.

All three (3) alternatives will require the import of material for the construction of cells in the new fill areas. As previously noted, the number of trucks required to transport construction materials to the site for all three (3) alternatives are comparable and between 500 and 750 per year over the 20-year operation of the landfill. Alternatives 1, 2 and 3 are ranked equally as Neutral.

- Worker Safety – Waste Connections' #1 core operating value is safety. "*We strive to assure complete safety of our employees, our customers and the public in all of our operations. Protection from accident or injury is paramount in all we do*." Precautions are taken to make the landfill site a safe work place. All alternatives involve the construction of cells and the landfilling of solid non-hazardous waste of which Waste Connections has significant experience. Landfill mining which is included in Alternative 2, adds an increased level of risk to workers from elevated levels of dust and odours generated during the extended period that landfill mining would occur. In addition, landfill mining is a complex operation that involves the movement and operation of heavy equipment and material for a period of 5 to 10 years. Alternative 2 is ranked as a Disadvantage for this criterion/indicator.

Summary of Ranking Preference - Social Environment

Social Environment	Alternative 1	Alternative 2	Alternative 3
Noise Ranking	Neutral	Neutral	Neutral
Odour Ranking	Neutral	Disadvantage	Neutral
Visual Ranking	Disadvantage	Disadvantage	Disadvantage
Traffic Ranking	Neutral	Neutral	Neutral
Worker Health and Safety Ranking	Neutral	Disadvantage	Neutral
Overall Ranking	Neutral	Disadvantage	Neutral

Conclusion

Based on the above assessments, Alternative 1 and 3 are preferred over Alternative 2 relative to the social environment.

3.2.4 Economic Environment

Economic Evaluation Criteria

Criteria	Indicator
Potential for effect on businesses during construction and operation.	· Number of businesses (e.g., agricultural operations) in the study area who may experience disruption (e.g., as a result of continued soil haulage during operations).
Potential for landfill traffic effect on businesses during construction and operation.	· Number of waste trucks during operation. · Number of trucks for soil import/export for construction.
Potential for effect on agriculture during construction.	· Area of on-site crop production lost. · Area of Class 1-3 soils lost.
Cost of facility.	· Approximate cost of site development alternative.

Overview of Economic Existing Conditions

Businesses operating near the site include a small equipment dealer on Charing Cross Road near Allison Line (Southwest Small Engines and Service) and a year round market (Thompson's Orchards), as well as one (1) institutional use (Chatham-Kent Airport). The area is an agricultural area and there are agricultural operations surrounding the Ridge Landfill. There are two (2) businesses and four (4) institutions along the current designated haul route. Existing businesses are shown on *Figure 3-5*. The agricultural character of the area has not changed significantly over the past 20-years, with corn, soybeans, and winter wheat as the main crops harvested. The area on-site that is not used for landfilling is currently leased to local tenant farmer operators.

Economic Assessment

The following commentary describes the alternatives from an economic perspective with respect to each of the evaluation criteria/indicators.

- Construction and operation effect on businesses – As noted above, construction and operation of all site development alternatives will shift the working area of the Ridge Landfill to the south and east. This will result in landfill activities moving closer to some businesses and further from others. For all three (3) alternatives the material excavated during cell construction will be stored in predesignated areas on the site for future use in a way that will minimize material handling and movement. The construction of a berm around the perimeter of the site will help separate the landfill from agricultural operations and other businesses in the vicinity. Mitigation measures to reduce noise, dust, litter and odour impacts will also be in place. These same mitigation measures have been employed to date and along with regular communications with neighbours have successfully minimized disruption. It stands to reason that continuing to employ these practices with the proposed expansion will continue to minimize disruption. This particularly holds true for Alternatives 1 and 3, and so these are considered to be Neutral, however the landfill mining component of Alternative 2 brings a greater potential for impacts (e.g., dust and odour) and was subsequently ranked as a Disadvantaged.

- Traffic effect businesses – Businesses including agricultural operations located along the designated haul route use the route for access to their business for employees and customers, shipping and receiving goods and services, and in the case of agricultural operations the haul route is used by agricultural machinery and for the movement of agricultural product.

  Currently, there are approximately 200 waste trucks/day that access the Ridge Landfill. These trucks have some potential to cause traffic nuisance impacts for the businesses and farmers along the designated haul route. The annual tonnage and designated haul route for a future expanded site will not change and as such, there is no proposed change in the approximate number of waste trucks accessing the site and no difference between the site development alternatives in this regard.

  Soil movement during cell construction for any of the site development alternatives will occur on-site, however all three (3) alternatives require the transport of stone and granular material to the site for the development of the new cells (approximately 500 to 750 truckloads per year, on average). All three (3) alternatives are similar and ranked as Neutral.

- Removal of agricultural lands - The portion of the Ridge Landfill that is proposed for the expansion is currently being leased to tenant farm operators with soybean (58.34 ha), corn (24.77 ha) and winter wheat (3.99 ha) being grown in 2017. A 6.52 ha apple orchard is located on the north side of the on-site lands east of the landfill entrance. A review of Canada Land Inventory mapping indicates the soils in the on-site area are Class 2 with a limitation of excess water (i.e., land that typically experiences flooding in the spring or after storm events throughout the summer). However, a network of tile drains has enabled many operations to grow common field crops.

All three (3) site development alternatives will require the displacement of some agricultural uses on the site however farming operations will still be permitted until those lands are required for landfilling or soil storage. Farming operations would progressively be displaced as movement increases toward the southwest portion of the site and therefore some operations could remain in place several years into the expansion. In some cases operations might be able to continue throughout the expansion period and this will be determined with the detailed design of the preferred alternative. The alternative that poses the greatest potential displacement of agricultural use is Alternative 3. Regardless, all three (3) alternatives have been ranked as Disadvantaged from an agricultural perspective as most of the agricultural activity on the site will be displaced by the expansion. It is noted that landfills can be returned to some form of agricultural use, as has been done at other locations in Ontario.

- Facility cost – For comparison purposes, a per hectare cost for an expansion of a landfill such as the Ridge Landfill could be assumed to be in the order of $1 million per hectare based on historical costs at this and other landfills. Using this per hectare unit cost, Alternative 1 would cost in the order of $60 million and Alternative 3 would cost approximately $80 million. The cost for landfill mining is in the order of $25 per cubic meter and would add approximately $112 million to the total cost. Alternative 2, including the landfill mining would likely cost in the order of $165 million. The operating cost will be similar for all site development alternatives as the same amount of waste will be landfilled, except for leachate treatment for Alternative 3 that would be about 15% higher than Alternatives 1 and 2 due to the larger overall area of the alternative.

Summary of Ranking Preference - Economic Environment

Economic Environment	Alternative 1	Alternative 2	Alternative 3
Effect on Businesses Ranking	Neutral	Disadvantage	Neutral
Traffic Ranking	Neutral	Neutral	Neutral
Agricultural Ranking	Disadvantage	Disadvantage	Disadvantage
Cost Ranking	Neutral	Major Disadvantage	Disadvantage
Overall Ranking	Neutral	Major Disadvantage	Disadvantage

Conclusion

Based on the above assessments, Alternative 1 is preferred over Alternative 2 and 3 relative to the economic environment from an impact on businesses, traffic, agricultural and project cost perspective.

3.2.5 Cultural Environment

Cultural Evaluation Criteria

Criteria	Indicator
Potential effects to archaeological resources as a result of construction.	- Area of undisturbed land affected by the expansion alternative.
Potential effects to cultural heritage resources as a result of construction.	- Number and type of cultural heritage resources affected by expansion alternative.

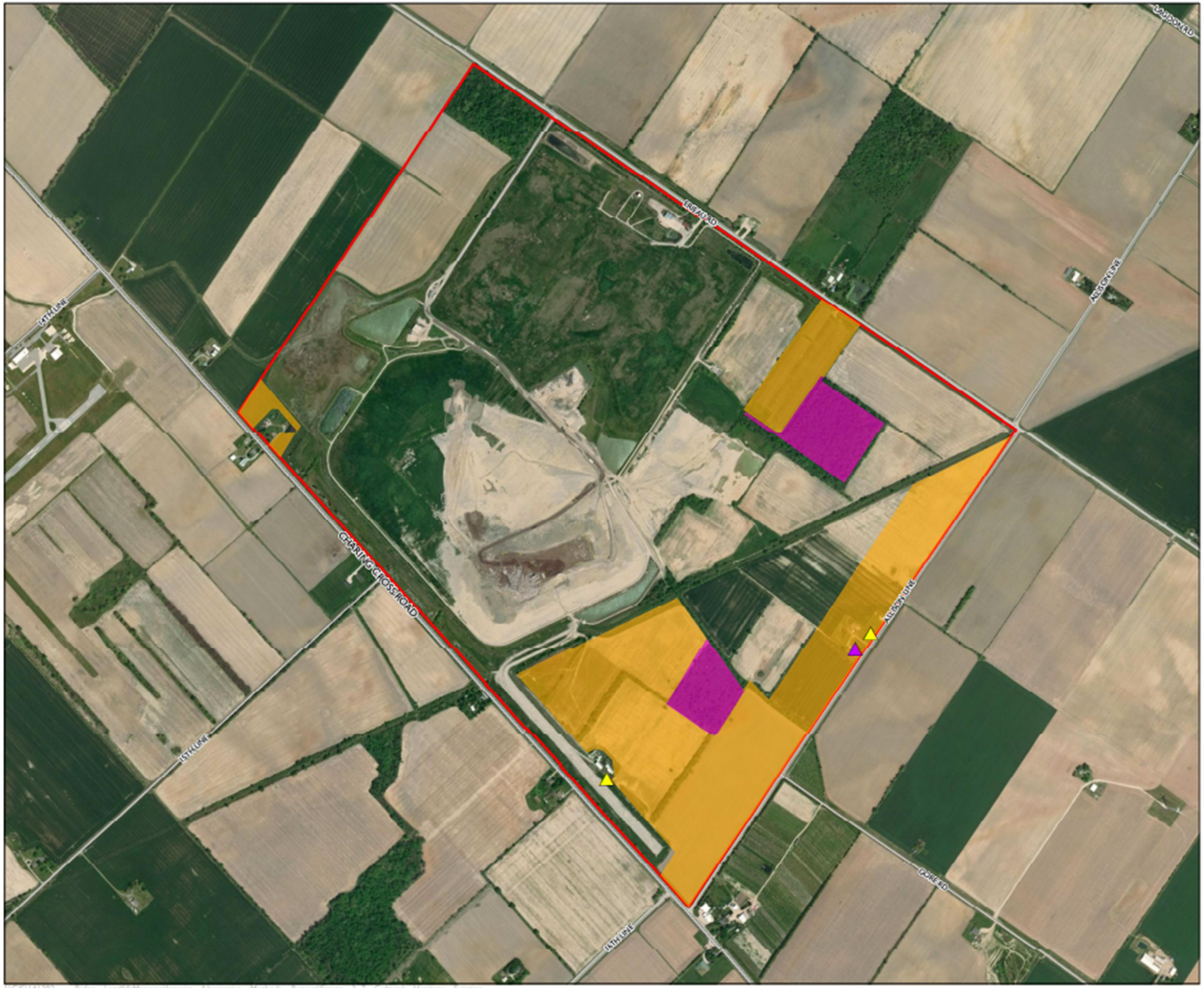
Overview of Archaeology/Cultural Heritage Existing Conditions

A Stage-1 Archaeological Assessment was completed for the Ridge Landfill in May 2017. This assessment identified that much of the Ridge Landfill property has no archaeological potential. Lands in the southern portion of the proposed expansion primarily south of the former rail line do have archaeological potential requiring a Stage-2 assessment. Any archaeological resources identified during the Stage-2 or additional future assessment will be catalogued and removed.

Within the area identified for the site development alternatives the two (2) rented houses on Allison Line represent a built heritage resource and cultural resource landscape. There are also remnants of a farm complex that used to be on Charing Cross Road that is considered to be a built heritage resource. These resources were identified as contributing to the agricultural and rural nature of the area. They are not included in Municipal Heritage Register for the Municipality of Chatham-Kent. A property specific Heritage Impact Assessment will be undertaken prior to removal of these features and will include an evaluation of the resource based on the criteria set out in Ontario Regulation 9/06. Should it be warranted based on the Heritage Impact Assessment a Cultural Heritage Documentation Report may be identified as a mitigation action. The cultural heritage existing conditions are shown on *Figure 3-6.*

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 3-6 CULTURAL HERITAGE EXISTING CONDITIONS



- ▲ Built Heritage Resource
- ▲ Cultural Heritage Resource
- 🟧 Archaeological Potential - Requires Stage 2 Pedestrian Survey
- 🟪 Archaeological Potential - Requires Stage 2 Test Pit Survey
- ☐ Property Boundary (Study Area)

1:12,000

0 100 200 400 m

MAP DRAWING INFORMATION:
IMAGERY PROVIDED BY DIGITAL GLOBE/
DATA OBTAINED FROM MNRF

MAP CREATED BY: LK
MAP CHECKED BY: DB
MAP PROJECTION: NAD 1983 UTM Zone 17N

PROJECT: 152456

STATUS: DRAFT

DATE: 2018-11-30

I:\GIS\141382 - Ridge Landfill\Mapping\Interim Alternative Methods Report\Figure 3_7 Cultural Heritage Existing Conditions.mxd

Cultural Heritage Assessment

The following commentary describes the alternatives from a cultural heritage perspective with respect to each of the evaluation criteria/indicators.

- Archaeological resources – Alternative 2 has the least amount of land with archaeological potential (all of Fill Area A). Alternative 1 adds a small area at the southern edge of Fill Area B where there is archaeological potential. Alternative 3 has the greatest amount of land with archaeological potential (all of Fill Area A, the southern edge of Fill Area B, and approximately half of Fill Area C). Given that any archaeological resources (if identified) will be removed prior to the construction of any expansion, no archaeological impact is anticipated and all three (3) site development alternatives are ranked as Neutral for this criterion.
- Cultural features – All three (3) site development alternatives will result in the removal/demolition of the residence, barn and farmscape identified as cultural resources. As noted, a Heritage Impact Assessment will be completed prior to removal/demolition which could involve documentation of the feature in a Cultural Heritage Documentation Report. No impact is anticipated and all three (3) site development alternatives are ranked as Neutral for this criterion.

Summary of Ranking Preference – Cultural Environment

Cultural Environment	Alternative 1	Alternative 2	Alternative 3
Archaeology Ranking	Neutral	Neutral	Neutral
Cultural Resources Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Neutral	Neutral

Conclusion

Based on the above assessments, all three (3) alternatives are equal relative to the cultural environment from an archeological and cultural perspective.

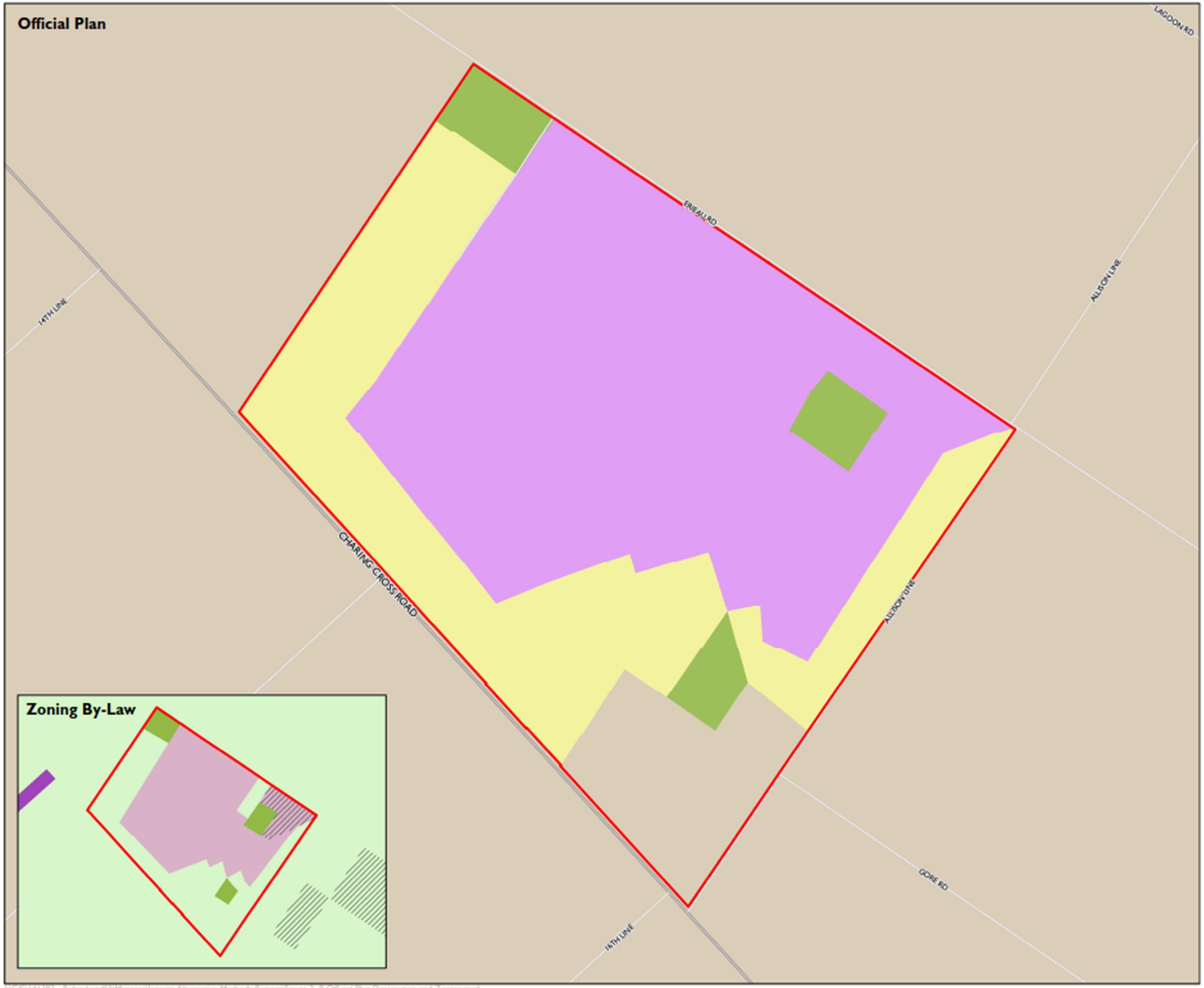
3.2.6 Built Environment

Built Evaluation Criteria

Criteria	Indicator
Effects on land use as a result of construction.	· Size of landfill footprint.
Potential effects on existing transportation infrastructure and transportation operation.	· Number of waste trucks during operation. · Number of trucks for soil import/export for construction. · Anticipated impact on the Chatham-Kent airport.
Potential for effects on existing landfill infrastructure as a result of construction.	· Extent and type of change required to existing site facilities.
Ease to implement/construct and maintain/operate.	· Anticipated complexity of construction and operation.

Overview of Built Existing Conditions

The Ridge Landfill site is identified in the Chatham-Kent Official Plan and is zoned for waste management. *Figure 3-7* shows the current Official Plan designation and site zoning. As an operating landfill it has an existing agreement with the municipality for the maintenance of the designated haul route. As shown on *Figure 1-2* and in *Appendix A*, the site has existing infrastructure that includes a site entrance, access roads, two (2) weigh scales, scale house, office, equipment maintenance building, stormwater management facilities, landfill gas blowers/flares, and a leachate storage tank.



I:\GIS\141382 - Ridge Landfill\Mapping\Interim Alternative Methods Report\Figure 3_8 Official Plan Designation and Zoning.mxd

Waste Connections of Canada

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 3-7
EXISTING OFFICIAL PLAN AND ZONING BY-LAW DESIGNATIONS

🟥 Property Boundary (Study Area)

Existing Official Plan

- 🟫 Agricultural
- 🟨 Agricultural Buffer
- 🟩 Open Space/Conservation Lands
- 🟪 Waste Management Site

Zoning By-Law (See Inset)

- ▨ Holding-Agricultural
- 🟩 Agricultural
- 🟪 Airport
- ▨ Holding-Landfill
- 🟪 Landfill
- 🟩 Open Space Recreational

1:12,000

0 100 200 400 m

MAP DRAWING INFORMATION:
IMAGERY PROVIDED BY DIGITAL GLOBE/
DATA OBTAINED FROM MNRF

MAP CREATED BY: LK
MAP CHECKED BY: DB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 152456
STATUS: DRAFT
DATE: 2018-11-30

Built Assessment

The following commentary describes the alternatives from a built environment perspective with respect to each of the evaluation criteria/indicators.

- Land use –The three (3) proposed site development alternatives have different landfill footprints that provide different opportunities for the long term development and use of the land. For example, a smaller landfill footprint results in less land used for landfilling of waste, leaving some land flexible for a greater variety of uses during the 20-year expansion period and upon-site closure. Amendments to the Chatham-Kent Official Plan and Zoning By-law will be needed for all site development alternatives. Discussions to date with planning staff at the Municipality of Chatham-Kent have identified that a simplified site zoning that would provide flexibility for the landfill operation may be appropriate and that the Official Plan Amendment and Zoning By-law Amendment should identify steps to be taken once landfill operation ceases. Alternatives 1 and 2 have the smallest footprint and would result in the greatest flexibility for future use in the southeast corner of the property once the site is permanently closed and so are ranked Neutral. Alternative 3 has a Disadvantage as its larger footprint makes full use of the property limiting the land use flexibility in the future.
- Transportation infrastructure and operation - As previously noted, the designated haul route to the site and the annual tonnage being hauled to the site will remain the same. Currently, approximately 200 waste trucks/day are traveling between the landfill and Highway 401 interchange via Erieau Road, Drury Line and Communication Road (CR 11). As noted, construction truck traffic will remain on-site for cell construction; however, there will be an increase in haul traffic for Alternative 2 as recovered materials from landfill mining are moved off-site. Concerns were raised by a few residents through recent consultation regarding trucks not adhering to the designated haul route. Other residents were concerned about damage to the roads. Waste Connections has since met with Chatham-Kent who have added additional road signs to reinforce to drivers the appropriate route to take to-and-from the landfill. Waste Connections also provides funding to Chatham-Kent for road maintenance along the designated haul route. Recent discussions with Chatham-Kent have resulted in plans for upgrades to both the turning apron at the corner of Communication Road and Drury Line and a portion of Drury Line. This practice would be continued with the expansion. Given that Waste Connections provides funding to address the impact that landfill trucks have on road infrastructure the net effect to transportation infrastructure is anticipated to be minimal and all three (3) site development alternatives are ranked Neutral for this criterion/indicator.

Transportation infrastructure includes the Chatham-Kent Municipal Airport. Waste Connections works closely with the airport to control wildlife and birds so that the danger to air traffic is minimized. Programs that are currently in place would continue with the proposed expansion include:

§ Habitat Management – This involves making the landfill site as uninviting as possible to wildlife by keeping the active working face small, applying cover daily, minimizing loafing/resting areas (bare areas), and keeping unused areas thickly vegetated where possible, eliminating temporary ponding, and monitoring of stormwater management ponds.

§ Predator Bird Services – This is a daily practice that includes the use of falcons and hawks to control birds as well as a range of active controls including pyrotechnics, distress calls, and lethal control if necessary.

The Chatham Airport Zoning Regulations define that within the regulation area (which includes the proposed landfill expansion) construction of anything permanent taller than 45 meters above the Airport Reference Point elevation of 196.3 m masl is prohibited, i.e. above 241.3 masl. This regulation is what dictates the maximum height of the landfill. All site development alternatives will result in the active landfilling area moving further from the airport. As a result no additional impact to the airport is expected for any of the proposed site development alternatives since the height of each alternative of 241 masl is within the regulated height limitation. There is also no ground traffic interference between the landfill and airport users as the airport is not located on the designated haul route.

- Landfill infrastructure - Existing landfill infrastructure includes the site entrance, access roads, two (2) weigh scales, scale house, office, equipment maintenance building, stormwater management facilities, landfill gas blowers/flares and a leachate storage tank. While some relocation/expansion of stormwater ponds will be required other infrastructure will remain as is. All three (3) site development alternatives are ranked Neutral for their impact to key site infrastructure. Leachate collection and landfill gas collection infrastructure is described in Chapters 4 and 5 respectively.
- Ease of construction and operation –All three (3) alternatives represent a continuation of current landfilling operations and practices employed by Waste Connections. Alternative 2 however also includes a landfill mining component which is a more specialized and complicated undertaking and is considered to be Disadvantaged compared to Alternatives 1 and 3 for this criterion.

Summary of Ranking Preference – Built Environment

Built Environment	Alternative 1	Alternative 2	Alternative 3
Land Use Ranking	Neutral	Neutral	Disadvantage
Transportation Infrastructure Ranking	Neutral	Neutral	Neutral
Ease of Construction and Operation Ranking	Neutral	Disadvantage	Neutral
Landfill Infrastructure Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Disadvantage	Disadvantage

Conclusion

Based on the above assessments, Alternative 1 is preferred over Alternative 2 and 3 relative to the built environment from a land use, transportation, ease of construction and operation and landfill infrastructure perspective.

3.2.7 Comparative Evaluation of Site Development Alternatives

Table 3-2 shows the relative ranking for the six (6) environments based on the advantages and Disadvantages described for each of the criteria and indicators in *Section 3.2* and *Table 3-1*. As shown, Alternative 1 is the preferred option over the other site development alternatives for all but one of the environments considered, and is therefore considered the preferred overall. This preliminary conclusion is subject to consultation with agencies and the public and will be confirmed in the EA document.

Table 3- 2: Comparative Evaluation of Site Development Alternatives

Environment	Alternative 1	Alternative 2	Alternative 3
Natural Environment (Biological) Ranking	Neutral	Neutral	Disadvantage
Natural Environment (Physical) Ranking	Neutral	Disadvantage	Neutral
Social Environment Ranking	Neutral	Disadvantage	Neutral
Economic Environment Ranking	Neutral	Major Disadvantage	Disadvantage
Cultural Environment Ranking	Neutral	Neutral	Neutral
Built Environment Ranking	Neutral	Disadvantage	Disadvantage
	Preferred Alternative		

3.2.8 Considering the "Do-Nothing" Alternative

As per the MECP Code of Practice for Environmental Assessment, the "do nothing" alternative represents what is expected to happen if none of the alternatives being considered are carried out. It serves as a benchmark for comparing effects of the proposed expansion, and to highlight the advantages of proceeding with a particular undertaking.

In a "do-nothing" scenario, the Ridge Landfill would close in 2021 and would no longer accept the 1.3 million tonnes annually of non-hazardous solid waste from its IC&I customers in Ontario and would no longer accept municipal waste from the Municipality of Chatham-Kent. This would mean that waste currently taken to the Ridge Landfill for disposal would have to be diverted to other approved waste disposal facilities. Landfill capacity in Ontario is already limited and will not be able to absorb an additional 1.3 million tonnes of waste annually. Consequently this waste will likely have to be transported out of Province and/or Country, putting additional stress on the waste management system and have other unintended consequences. This is outlined in detail in the Needs Assessment Study completed as part of the EA TOR.

The majority of IC&I waste that comes to the Ridge Landfill is from the southern and central Ontario area, and transporting out of province would result in additional hauling distances for many customers and an associated increase in costs and GHG emissions. The Municipality of Chatham-Kent would need to find an alternate disposal facility for its residential waste. An alternate location will be further than the Ridge Landfill and would result in significant additional costs to the municipality through required negotiation of transfer station capacity/construction, hauling contract(s) and disposal capacity.

In addition, the Ridge Landfill employs twenty three people and contributes approximately $14 million annually in a combination of direct financial contributions to Municipality of Chatham-Kent, the Trust Fund, and purchase of local goods and services. This direct and indirect funding includes compensation provided to the landfill neighbours as well as the Ridge Community Trust Fund which together provides in the order of $1 million annually directly to the communities of Charing Cross, Cedar Springs and Blenheim. These monies support numerous sports teams, breakfast programs, the senior's centre, youth centre and local schools on an annual basis as well as one time purchases for specific community needs. Examples include the recent purchase of the Jaws of Life for the Blenheim Fire Department and a new mobility van for the senior's centre. The closure of the landfill would bring these contributions to an end and would result in a significant negative impact to the local economy.

As committed to in the ToR, Waste Connections must consider the do-nothing alternative as a baseline. *Table 3-3* highlights key elements of the preliminary preferred site development alternative (Alternative 1) and the do-nothing alternative for the six (6) environmental components considered. Standard mitigation is assumed for the preliminary preferred alternative. The purpose of this comparison is to confirm whether proceeding with the proposed site development alternative is appropriate given the potential for impact on the environment. As is demonstrated in *Table 3-3*, the potential impacts associated with the preliminary preferred site development alternative are relatively minimal and can for the most part be addressed through mitigation.

Table 3-3: Preliminary Preferred Site Development Alternative Compared to the Do-Nothing Alternative

Environmental Component	Site Development Alternative 1	Do-Nothing Alternative
Natural Environment - Biology	Site Development Alternative 1 will remove the 3.7 ha southwest woodlot and replant the woodlot at a 2:1 ratio.	The southwest woodlot would remain.
Natural Environment – Physical (Groundwater)	The protection afforded by the natural setting Site Development Alternative 1 is expected to meet Reasonable Use Guideline.	Historical monitoring activity has shown that the Ridge landfill site consistently meets the Reasonable Use Guideline.
Natural Environment – Physical (Surface Water)	Temporary disruption to surface water from the relocation of some drains will not impact overall quality or quantity. Site Development Alternative 1 would have minimal to no impact on surface water.	The existing site would continue to have minimal to no impact on surface water.
Natural Environment – Physical (Air Quality)	Landfill gas emissions would continue to be managed by flaring or utilization. Traffic related dust and air quality would likely occur until landfill closure.	Landfill gas emissions would continue to be managed by flaring or utilization. Traffic related dust would diminish and air quality would improve once site is no longer operational.
Natural Environment – Physical (Climate Change)	Landfill gas emissions and associated greenhouse gas (GHG) emissions would continue to be managed by flaring or utilization.	Landfill gas emissions and associated GHG emissions would continue to be managed by flaring or utilization.

Environmental Component	Site Development Alternative 1	Do-Nothing Alternative
Social Environment	Site Development Alternative 1 will continue to generate landfill gas and have the potential for odour as well as minor noise impacts to residents over the next 20-years. The visibility of the site will change; however, the overall height will not increase. Truck traffic over the next 20-years is expected to be similar to that experienced today i.e. approximately 200 waste trucks/day.	Upon closure disruption from noise and truck traffic would be reduced. The landfill will continue to generate landfill gas and have the potential for odours. The site will remain visible from some surrounding residences/businesses.
Economic Environment	Site Development Alternative 1 will result in minor disruption associated with site operation and truck traffic over the next 20-years. There will be some loss of Class 2 lands currently used for agriculture.	Upon closure, disruption impacts such as noise and truck traffic would be reduced. The on-site lands that are currently leased for farming could continue to be farmed. The Municipality of Chatham-Kent would have to find an alternative disposal facility. There would be a significant negative local economic impact to the community.
Cultural Environment	Any identified archaeological resources and the barns, residence and farmscape cultural features identified on-site will be documented and removed as appropriate.	Any archaeological resources will remain undiscovered and on-site cultural features may remain, subject to property owner wishes and/or the site closure plan.
Built Environment	Waste Connections will continue to liaise with Chatham-Kent to provide funding for upkeep of the designated haul route.	The designated haul route would not be required and Waste Connections would no longer pay for its maintenance and upkeep.

4.0 Leachate Treatment Alternatives

There are three (3) leachate treatment alternative methods being evaluated for the Ridge Landfill EA. All three (3) alternatives provide responsible handling of leachate produced on-site over the EA planning period (2022 to 2041) and are further described within this Section.

4.1 Description of Leachate Treatment Alternatives

Each alternative method of how leachate can be treated at the Ridge Landfill is outlined below with the accompanying rationale.

The existing leachate collection system consists of under-drains and perimeter collection drains, with leachate flow by gravity to low points around the waste mounds, which is pumped to a central storage tank, and then pumped via underground forcemain to the BWTL. Installation of the underground forcemain was completed as part of a 1997 Host Community Agreement with the Municipality of Chatham-Kent. The current agreement requires the BWTL to reserve capacity for leachate generated from the Ridge Landfill for a 100 year period and for a specified daily maximum of 340,000 litres/day.

The proposed undertaking would be designed with a similar leachate collection system concept in accordance with applicable regulations and subject to MECP review and approval prior to installation.

As specified in a memo dated June 29th, 2018 entitled *Ridge Landfill EA - Leachate Management Alternatives* provided to MECP (see *Appendix D*) neither full-treatment on-site with discharge to Lake Erie nor leachate evaporation would be evaluated as alternative methods. These are not considered feasible alternatives as follows:

- If the treated effluent were to be discharged to Lake Erie it would require land acquisitions, permits, Federal, Provincial and Municipal approvals, and construction of an outfall into Lake Erie and a transmission forcemain that would be more than six (6) kilometers in length.
- Natural evaporation is not feasible due to the large volume of leachate anticipated.

Leachate Treatment Alternative Method	Description	Rationale
Alternative 1 Direct Discharge to Sanitary Sewer	Leachate that is collected at the site is conveyed to the area east of the Old Landfill and is pumped via the existing underground forcemain to the BWTL. This alternative requires an agreement with the Chatham-Kent PUC to discharge untreated leachate to the BWTL. This agreement is currently in place for leachate from the existing landfill. Leachate is and would continue to be conveyed to the BWTL via the existing forcemain. No change is required. The Chatham-Kent PUC has confirmed that the BWTL have sufficient capacity to treat the quantity of leachate expected over the EA planning period. A letter from the PUC is included in *Appendix D* that provides further detail on the treatment of leachate. In the event that the BWTL are unable to continue to receive the leachate for treatment, it will be transported by truck to a licensed wastewater treatment plant off-site. The closest facility other than BWTL is the Chatham Wastewater Treatment plant. The PUC has indicated that the Chatham facility is licensed to receive untreated leachate and has facilities for off-loading of trucks. Receiving leachate by truck is the preferred method at the Chatham Wastewater Treatment plant as it allows discharge to holding tanks that enables the operators to meter leachate into the plant. A pipeline from the Ridge Landfill to the Chatham plant is not feasible or supported by the Chatham-Kent PUC.	Maintains the current practice and allows for a contingency.
Alternative 2 On-site Pre- treatment Prior to Discharge to Sanitary Sewer	This alternative would require the construction of a pre-treatment facility on the Ridge Landfill property. This facility would be located either where the current leachate storage tank is located east of the Old Landfill or in available space in the southeast segment of the property. The pre-treatment system would be designed to meet one or more specific parameters in the event that the BWTL could not treat for these specific parameters. An example could be that if the BWTL could not effectively remove a specific metal from the leachate and this was impacting its effluent quality then a pre-	Pre-treats the leachate for specific parameters to levels that render it acceptable for final treatment at BWTL and allows for a contingency.

Leachate Treatment Alternative Method	Description	Rationale
	treatment system could be installed at the landfill to address this. The pre-treated leachate would be conveyed via the existing forcemain to the BWTL. In the unlikely event that the BWTL is unable to receive the pre-treated leachate for final treatment, it will be transported by truck to an alternative licensed wastewater treatment facility off-site as described in Alternative 1 above.	
Alternative 3 On-Site Full Treatment Prior to Discharge to Surface Water	On-site full treatment involves treating the leachate to meet surface water discharge criteria and discharging the effluent directly to the environment. In the event that the leachate cannot be treated to meet surface water discharge criteria the effluent would then be discharged via the existing forcemain to the BWTL, or alternatively transported by truck to an alternative licensed wastewater treatment facility off-site (as described in Alternative 1 above). A full treatment facility could involve the construction of complex on-site facilities, including: - Physical and chemical pre-treatment - Biological treatment removal of ammonia, Total Kjeldahl Nitrogen (TKN), biological oxygen demand (BOD), and some volatile organic compounds (VOCs), and phenolic compounds. - Reverse osmosis (RO), a water purification technology that uses a semi-permeable membrane to remove ions, molecules and larger particles (i.e. sodium, potassium, chloride, and trace contaminants) from effluent. - Activated carbon, treatment and ultraviolet (UV) disinfection of effluent prior to discharge to the environment. A treatment plant would likely be located in the southeast section of the property and would require significant electrical and natural gas energy to operate the facility. Some off-site trucking will be required to remove liquid waste separated from the leachate through the reverse osmosis process for off-	Treats leachate to meet surface water discharge criteria which allows direct discharge to environment and allows for a contingency.

Leachate Treatment Alternative Method	Description	Rationale
	site disposal.	

4.1.1 Common Characteristics

The following are common characteristics of the three (3) leachate treatment alternatives:

- Leachate Capacity – A review by Chatham-Kent PUC indicated that the average daily quantity during the highest discharge month in 2018 for the Ridge Landfill equated to 597.32 m^3/day of leachate. This number varies depending upon a number of factors one of which includes rainfall received in the area.

  For the purpose of assessing the leachate treatment alternatives it has been assumed that the leachate collected from the current and expanded landfill would result in a doubling of the current quantities being collected.

- Quality of Leachate – Only non-hazardous solid waste will be accepted at the site regardless of the alternative selected. This is reflective of what happens currently so the quality of leachate is expected to remain relatively unchanged from what is currently discharged.
- Treatment Contingency - There are no other existing wastewater treatment facilities sufficiently close to the Ridge Landfill to feasibly construct another transmission forcemain. However, the Chatham-Kent PUC, (a public entity) has indicated that if Waste Connections needs to discharge leachate at the Chatham Wastewater Treatment Plant (an existing public facility licensed to accept landfill leachate), the facility is setup to off-load trucks for discharge to the holding tanks which allows plant operators to meter leachate into the system at their discretion. It currently receives leachate by truckload from others on a daily basis. There are also other privately-owned wastewater treatment facilities in the Province of Ontario that hold the appropriate licenses to accept leachate that Waste Connections could potentially consider as a disposal receiver.
- Contingency Haul Route –The trucks would adhere to roads that are designated for truck use.

4.1.2 Review of Existing Leachate Management System

As committed to in the ToR, Waste Connections has reviewed the existing leachate management system, including the BWTL and the associated municipal forcemain, in order to confirm whether there is sufficient capacity for leachate management from an expanded landfill. This review included a review of the Chatham-Kent Wastewater Master Plan (2012 updated in 2018), and a meeting with the Chatham-Kent PUC on July 25th, 2018. A letter was also received from the Chatham-Kent PUC and is included in *Appendix D*.

The ECA for the BWTL indicates that "Average daily flow of leachate into the Blenheim Lagoons shall not exceed 4,045 m^3/day, and peak flow shall not exceed 12,046 m^3/day." A review by Chatham-Kent PUC indicated that the highest discharge month in 2018 for the Ridge Landfill equated to 597.32 m^3/day.

Based on this information and confirmed in the letter from Chatham-Kent PUC, the BWTL have adequate capacity now and into the future to treat the quality and quantity of leachate expected from the existing Ridge Landfill operation and from the proposed undertaking. There is adequate capacity in the existing leachate transmission forcemain to convey the leachate. The review of the existing leachate treatment system confirms that there is no need to consider trucking of the leachate to the BWTL, except as an emergency contingency measure.

4.2 Evaluation of Leachate Treatment Alternatives

This evaluation considers the potential for impact on the environment of each of the three (3) leachate treatment alternatives. The evaluation assumes the application of standard, approved mitigation measures, considers the potential for impact, and ranks the alternative as Major Advantage, Advantage, Neutral, Disadvantage or Major Disadvantage (see definitions in *Section 2.0*). The evaluation criteria used to compare the leachate treatment alternatives cover all components of the environment (i.e. natural – biological, natural – physical, social, economic, cultural and built). The table of evaluation criteria, indicators, data sources and rationale for the evaluation of leachate treatment alternatives is included in *Appendix D* The criteria and indicators for each environmental component are included in the write-up in this section.

The evaluation is documented in *Table 4-1* which follows and summarized in the text in this report section. The subsections that follow, are divided into the components of the environment, and summarize the net effects evaluation and ranking preference for each of the leachate alternatives. Based on the Advantages and Disadvantages noted in the text and *Table 4-1*, a conclusion on which of the alternatives is preferred for each of the six (6) environments is presented at the end of each subsection.

4.2.1 Natural Environment - Biology

Biology Evaluation Criteria

The following criteria and indicators were used to assess the leachate alternatives relative to biological aspects of the natural environment.

Criteria	Indicators
Aquatic	
Potential for effect on aquatic systems during construction and operation.	- Potential for accidental spill or leakage to on-site watercourses.

Biological Assessment

Aquatic - The on-site surface water drains that make up part of the municipal drainage network are considered to have limited potential for fish habitat. Notwithstanding, Alternatives 1 and 2 have the potential to impact this limited aquatic environment as a result of a leakage or spill. Alternative 3 has the potential for greater impacts resulting from operational upset and the potential discharge of untreated leachate to surface water.

Alternative 3 has the added risk for aquatic impact resulting from potential treatment malfunction and the accidental release of either raw or partially treated leachate to the environment.

Leachate treatment Alternative 1 is similar to the system currently in place, and the Alternative 2 would entail pre-treatment in an enclosed and contained area. Alternative 3 would have a full treatment facility in an enclosed and contained area, but with discharge directly to a local surface water drain. Alternatives 1 and 2 are ranked equally as Neutral. Alternative 3 is ranked as Major Disadvantage based on the potential risk of either untreated or partially treated leachate being released to the environment.

TABLE 4-1 – LEACHATE SUMMARY EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/Criteria	Indicators	Alternative 1 DIRECT DISCHARGE TO SANITARY SEWER	Alternative 2 ON-SITE PRE-TREATMENT AND DISCHARGE TO SANITARY SEWER	Alternative 3 ON-SITE FULL TREATMENT AND DISCHARGE TO SURFACE WATER
NATURAL ENVIRONMENT – BIOLOGICAL				
Potential for effect on aquatic systems during construction and operation.	· Potential for accidental spill or leakage to on-site watercourses.	● Neutral This alternative has minimal potential for an on-site spill or leakage from leachate storage tank or underground pipe. There is minimal on-site habitat and it is of low sensitivity.	● Neutral This alternative has minimal potential for an on-site spill or leakage from the pre-treatment facility which would be constructed with containment features. There is minimal aquatic habitat on-site and it is of low sensitivity.	● Major Disadvantage This alternative has the greatest potential for accidental discharge of untreated leachate into on-site surface waters. Aquatic habitat on-site is of low sensitivity.
NATURAL ENVIRONMENT – PHYSICAL				
Groundwater				
Potential impacts to groundwater quality during construction, operation and post closure.	· Potential for spill or leakage of leachate, that may potentially affect groundwater.	● Neutral There is more than 30 metres of natural clay under the site which would protect groundwater from the potential impact of an operational upset, spill or leakage. Should an operational upset, spill or leak occur, leachate pumps can be cycled off and the landfill can contain leachate for a significant period of time to allow for effective clean up and repair.	● Neutral There is more than 30 meters of natural clay under the site which would protect groundwater from the potential impact of an operational upset, spill or leakage. Should an operational upset, spill or leak occur, leachate pumps can be cycled off and the landfill can contain leachate for a significant period of time to allow for effective clean up and repair.	● Neutral There is more than 30 meters of natural clay under the site which would protect groundwater from the potential impact of an operational upset, spill or leakage. Should an operational upset, spill or leak occur, leachate pumps can be cycled off and the landfill can contain leachate for a significant period of time to allow for effective clean up and repair.
Surface Water				
Potential impacts to surface water quantity and quality.	· Potential for spill or leakage of leachate to on-site watercourses.	● Neutral Alternative 1 and 2 would have similar potential for spill or leakage. All facilities will be contained and the landfill can act as a leachate storage facility if necessary.	● Neutral Alternatives1 and 2 would have similar potential for spill or leakage. All facilities will be contained and the landfill can act as a leachate storage facility if necessary.	● Major Disadvantage Alternative 3 has potential for an accidental discharge of untreated leachate into on-site surface waters should a treatment malfunction occur.
Atmospheric				
Potential impacts to air quality during construction and operation.	· Nitrogen Oxides, Sulphur Dioxide and Carbon Monoxide (together referred to as criteria air contaminants): relative levels of construction as an indicator. · Relative amount of energy required to operate facility.	● Neutral This alternative involves no construction to impact air quality. The energy required to operate the infrastructure for Alternatives 1 and 2 will be relatively minimal.	● Neutral Construction for Alternatives 2 and 3 will be short term without significant impact on air quality. The energy required to operate the infrastructure for Alternatives 1 and 2 will be relatively minimal.	● Disadvantage Construction for Alternatives 2 and 3 will be short term without significant impact on air quality. Significantly more electrical or natural energy is required to operate a full treatment scenario.

TABLE 4-1 – LEACHATE SUMMARY EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/Criteria	Indicators	Alternative 1 DIRECT DISCHARGE TO SANITARY SEWER	Alternative 2 ON-SITE PRE-TREATMENT AND DISCHARGE TO SANITARY SEWER	Alternative 3 ON-SITE FULL TREATMENT AND DISCHARGE TO SURFACE WATER
Climate Change				
Potential for greenhouse gas emissions during construction and operation.	· Qualitative assessment of the potential for greenhouse gas (GHG) emissions as a result of leachate alternatives.	● Neutral GHG emissions similar to what occurs today will be extended over time.	● Neutral GHG emissions similar to what occurs today will be extended over time.	● Disadvantage Full treatment of leachate on-site involves a longer construction period and significant energy which has higher GHG emissions.
SOCIAL				
Potential for noise/vibration impacts on residents during construction and operation.	· Number of households in the study area who may experience noise/vibration impacts as a result of leachate treatment facility construction and operation.	● Neutral There are twenty-five residences within 1 km of the property boundary. No households will experience noise and/or vibration impacts as a result of facility construction. Operational noise is expected to be minimal and all alternatives have the same number of existing households who could potentially be impacted by operational noise.	● Disadvantage There are twenty-five residences within 1 km of the property boundary. Potential for some noise and/or vibration impacts as a result of construction of pre-treatment infrastructure. Operational noise is expected to be minimal and all alternatives have the same number of existing households who could potentially be impacted by operational noise.	● Major Disadvantage There are twenty-five residences within 1 km of the property boundary. Greatest amount of infrastructure to be constructed and the longest construction period gives this alternative the highest potential for noise and/or vibration impacts as a result of full treatment facility construction. Operational noise is expected to be minimal and all alternatives have the same number of existing households who could potentially be impacted by operational noise.
Potential for odour during construction and operation.	· Number of potential odour sources from leachate treatment facility construction and operation; relative significance of odour sources and relative distance of odour sources to sensitive receptors.	● Neutral Odour is not anticipated during construction of any of the alternatives. This alternative does not add any new odour sources. No change to existing conditions for operating lifespan of proposed expansion.	● Disadvantage Odour is not anticipated during construction of any of the alternatives. The pre-treatment facility has the potential to be a source of odour under upset conditions.	● Major Disadvantage Odour is not anticipated during construction of any of the alternatives. The on-site full treatment facility has the potential to be a greater source of odour under upset conditions due to the complexity of treatment that would occur on-site.
Potential for landfill traffic effect on residents during construction and operation.	· Number of leachate trucks during operation as a result of leachate production.	● Neutral Trucking of leachate is only a contingency for all three alternatives. Should the contingency be necessary it would result in approximately 14 tanker truck trips/day.	● Neutral Trucking of leachate is only a contingency for all three alternatives. Should the contingency be necessary it would result in approximately 14 tanker truck trips/day.	● Neutral Trucking of leachate is only a contingency for all three alternatives. Should the contingency be necessary it would result in approximately 14 tanker truck trips/day.
ECONOMIC				
Potential for effect on businesses during construction and operation.	· Number of potential odour sources and relative significance of odour sources. · Extent of trucking.	● Neutral No change to the number of odour sources at the site during operation. Odour is not anticipated for any of the alternatives during construction. No truck traffic associated with Alternative 1.	● Disadvantage Alternatives 2 and 3 have some potential for odour during upset conditions. Odour is not anticipated for any of the alternatives during construction. On-site facility construction will result in some construction trucks as well as ongoing delivery of treatment products.	● Disadvantage Alternatives 2 and 3 have some potential for odour during upset conditions. Odour is not anticipated for any of the alternatives during construction. On-site facility construction will result in

TABLE 4-1 – LEACHATE SUMMARY EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/Criteria	Indicators	Alternative 1 DIRECT DISCHARGE TO SANITARY SEWER	Alternative 2 ON-SITE PRE-TREATMENT AND DISCHARGE TO SANITARY SEWER	Alternative 3 ON-SITE FULL TREATMENT AND DISCHARGE TO SURFACE WATER
		Trucking of leachate is a contingency measure for all alternatives.	Trucking of leachate is a contingency measure for all alternatives.	some construction trucks as well as ongoing delivery of treatment products. Trucking of leachate is a contingency measure for all alternatives.
Cost of facility.	· Approximate cost of leachate treatment facility alternative.	● Major Advantage No facility construction; no construction cost.	● Disadvantage Approximately $3-5 Million for construction of a pre-treatment facility plus the addition of some operations staff.	● Major Disadvantage Approximate range of $15-20 Million for construction of a full-treatment facility and associated infrastructure, plus a full time staff compliment.
CULTURAL				
Potential effects to archaeological resources as a result of construction.	· Area of undisturbed land affected by the on-site component of the leachate treatment alternative.	● Neutral The lands in the vicinity of the current leachate storage and pump location have been identified as having no archaeological potential.	● Neutral A pre-treatment facility would be constructed in an area that has been cleared of archaeological potential.	● Neutral A full treatment facility would be constructed in an area that has been cleard of archaeological potential.
BUILT				
Potential effects on existing transportation infrastructure and transportation operation.	· Anticipated number of trucks required.	● Neutral No trucking is required for standard operation of this alternative. Trucking of leachate is only a contingency for all three alternatives. Should the contingency be necessary it would result in approximately 14 tanker truck trips/day.	● Neutral This alternative would involve nominal trucking associated with delivery of treatment chemicals (i.e. 2-3 trucks per week) and some short duration trucking during construction. Overall the extent of trucking required is considered minimal. Trucking of leachate is only a contingency for all three alternatives. Should the contingency be necessary it would result in approximately 14 tanker truck trips/day.	● Neutral This alternative would involve nominal trucking associated with delivery of treatment chemicals (i.e. 2-3 trucks per week) and some short duration trucking during construction. Overall the extent of trucking required is considered minimal. Trucking of leachate is only a contingency for all three alternatives. Should the contingency be necessary it would result in approximately 14 tanker truck trips/day.
Ease to implement/construct and maintain/operate.	· Anticipated complexity of construction and operation.	● Major Advantage No facility construction; alternative similar to existing and is straightforward to implementation and operation.	● Disadvantage Pre-treatment facility construction requires somewhat specialized construction, and licensed operator to maintain/operate.	● Major Disadvantage Full treatment facility construction extremely complex and requires full staff complement licensed operators to maintain/operate. In addition, the regulatory requirements associated with securing permits and approvals to discharge treated effluent to the environment would severely limit the proponent's ability to manage leachate from the site

It is noted that in a contingency situation for all alternatives, where leachate is trucked to another licensed treatment facility there is some potential for an accidental spill. To mitigate the potential for impact on the aquatic environment, only MECP licensed/approved and regulated liquid waste haulers would be used to transport the leachate and best practices for transportation would be used.

Summary of Ranking Preference – Biological Natural Environment

Biological Natural Environment	Alternative 1	Alternative 2	Alternative 3
Aquatic Ranking	Neutral	Neutral	Major Disadvantage
Overall Ranking	Neutral	Neutral	Major Disadvantage

Conclusion

Based on the above assessments, Alternative 1 and 2 are preferred over Alternative 3 relative to the natural environment from a biology perspective.

4.2.2 Natural Environment - Physical

Physical Evaluation Criteria

The following criteria and indicators were used to assess the leachate alternatives relative to the natural physical environment.

Criteria	Indicators
Groundwater	
Potential impacts to groundwater quality during construction, operation and post closure.	· Potential for spill or leakage of leachate, that may potentially affect groundwater.
Surface Water	
Potential impacts to surface water quantity and quality.	· Potential for spill or leakage of leachate to on-site watercourses.
Atmospheric	
Potential impacts to air quality during construction and operation.	· Nitrogen Oxides, Sulphur Dioxide and Carbon Monoxide (together referred to as criteria air contaminants): relative levels of construction as an indicator. · Relative amount of energy required to operate facility.

Criteria	Indicators
Climate Change	
Potential for GHG emissions during construction and operation.	· Qualitative assessment of the potential for GHG emissions as a result of leachate alternatives.

Physical Assessment

Groundwater - For all alternatives, should an operational upset occur, leachate pumps can be cycled off and the landfill can contain leachate for a significant period of time to allow for effective clean up and repair. There is 30 metres of natural clay under the site which would protect the groundwater from the potential impact of operational upset, spill or leakage, therefore Alternatives 1, 2 and 3 are ranked equally as Neutral with respect to groundwater quality.

All three (3) alternatives involve the same contingency of trucking the leachate to another licensed facility which has some potential to result in a spill. As noted above, the use of licensed haulers and appropriate best practices will minimize the potential for impacts to groundwater.

Surface Water - From a surface water quality and quantity perspective, the key difference between alternatives relates to the potential for an operational upset resulting in potential discharge of leachate to on-site watercourses. There would be no difference between Alternatives 1 and 2 both of which would have some potential for a spill or leakage. However, Alternative 3, because it involves full treatment prior to direct surface water discharge, has a significantly greater risk of environmental impact should a treatment malfunction occur. As noted above, for all alternatives, the landfill can act as short term containment for leachate. For surface water, Alternatives 1 and 2 are ranked Neutral, while Alternative 3 is ranked as Major Disadvantage. All three (3) alternatives involve the same contingency of trucking the leachate to another licensed facility which has some potential to result in a spill. As noted above, the use of licensed/approved haulers and appropriate best practices will minimize the potential for impacts on surface water.

Atmospheric - With respect to potential impacts to air quality, the key difference between the alternatives is the need for electrical and natural gas energy. Alternatives 1 and 2 require energy for pumping leachate to the BWTL. Alternative 3 requires a much greater amount of electrical and natural gas energy to treat the leachate in a complex wastewater treatment facility. It is noted that Alternatives 2 and 3 also require construction activity; however, this activity is short term and will not result in significant difference in air quality. Alternatives 1 and 2 are ranked as Neutral with Alternative 3 ranked as Disadvantaged for this criterion.

Climate Change - Alternative 1 and 2 use minimal energy and thus have minimal potential to generate GHG emissions and are ranked as Neutral. For Alternative 3, significant energy is required to operate a full treatment facility on-site resulting in a higher potential for GHG emissions. Alternatives 2 and 3 both require construction although it is not anticipated that the short term nature of the construction associated with Alternative 2 will contribute significantly to GHG emissions. Alternative 3 will require a much longer construction period which is typical for a complex treatment facility and outfall to a local drain. Alternative 3 will therefore result in a higher potential for GHG emissions than Alternative 1 or 2. As such, Alternative 1 and 2 are ranked as Neutral and Alternative 3 is ranked as a Disadvantaged for this criterion.

Summary of Ranking Preference - Physical Natural Environment

Physical Natural Environment	Alternative 1	Alternative 2	Alternative 3
Groundwater Ranking	Neutral	Neutral	Neutral
Surface Water Ranking	Neutral	Neutral	Major Disadvantage
Atmospheric Change Ranking	Neutral	Neutral	Disadvantage
Climate Change Ranking	Neutral	Neutral	Disadvantage
Overall Ranking	Neutral	Neutral	Disadvantage

Conclusion

Based on the above assessments, Alternative 1 and 2 are preferred over Alternative 3 relative to the natural environment from a physical (i.e., surface water, atmospheric and climate change) perspective.

4.2.3 Social Environment

Social Evaluation Criteria

The following criteria and indicators were used to assess the leachate alternatives relative to the social environment.

Criteria	Indicators
Social	
Potential for noise / vibration impacts on residents during construction and operation.	· Number of households in the study area who may experience noise/vibration impacts as a result of leachate treatment facility construction and operation.

Criteria	Indicators
Potential for odour during construction and operation.	- Number of potential odour sources from leachate treatment facility construction and operation; relative significance of odour sources and relative distance of odour sources to sensitive receptors.
Potential for landfill traffic effect on residents during construction and operation.	- Number of leachate trucks during operation as a result of leachate production.

Social Assessment

There are twenty-five residences within 1 km of the Ridge landfill property, primarily on Charing Cross Road, Erieau Road and Allison Line. These residents are already familiar with the landfill operations. It is noted there are also 2 leased residences on-site and these leases will be terminated should the expansion be approved. The following provides an overview of the potential impacts that different leachate treatment alternatives could have on landfill neighbours:

Noise –Alternative 1 involves no change in the leachate treatment system so there would be no additional noise sources with this alternative and so this alternative is deemed Neutral. Alternative 2 involves construction of the pre-treatment facility which could result in temporary construction noise, and is ranked as Disadvantaged. Alternative 3 would require significant on-site construction to build a full treatment plant, and would have a longer duration of potential noise/vibration impacts associated with construction activity. Alternative 3 is ranked as having a Major Disadvantage. Limited noise is anticipated for any of the alternatives during operation.

Odour – Odour is not anticipated during construction of either of the facilities required for Alternatives 2 and 3. There is potential for a difference in odour generation during operation between the three (3) alternatives. Alternative 1 represents no change to the current operation and based on operating experience, does not result in any significant odour, and is ranked as Neutral. The operation of the on-site pre-treatment or full treatment facility has the potential to generate odours if the plant is not working properly or if there are climatic or changed conditions during operation. Alternative 2 is ranked as Disadvantaged due to the limited amount of treatment at the site whereas Alternative 3 is ranked as a Major Disadvantage because of the more complex on-site treatment system required and higher likelihood of odours being generated.

Traffic – All three (3) alternatives include a contingency to truck leachate to another licensed wastewater facility should it be required for short periods of time. For the current operation of the landfill, approximately 7 trucks would be required per day to haul leachate offsite. As the landfill continues to operate over the expansion period, the number of trucks could increase to approximately 14.the route would depend on the destination but it can be assumed that designated truck routes and roads designed for truck use would be used. All three (3) alternatives are ranked as Neutral.

Summary of Ranking Preference – Social Environment

Social Environment	Alternative 1	Alternative 2	Alternative 3
Noise Ranking	Neutral	Disadvantage	Major Disadvantage
Odour Ranking	Neutral	Disadvantage	Major Disadvantage
Traffic Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Disadvantage	Major Disadvantage

Conclusion

Based on the above assessments, Alternative 1 is preferred over Alternative 2 and 3 relative to the social environment from a noise, odour and traffic perspective.

4.2.4 Economic Environment

Economic Evaluation Criteria

The following criteria and indicators were used to assess the leachate alternatives relative to the economic environment.

Criteria	Indicators
Economic	
Potential for effect on businesses during construction and operation.	· Number of potential odour sources and relative significance of odour sources. · Extent of trucking.
Cost of facility.	· Approximate cost of leachate treatment facility alternative.

Economic Assessment

Construction and operation effect on businesses - Businesses operating within the study area include an equipment dealer, a farm market and numerous farmed parcels that are part of agricultural operations. Odour is not anticipated during the construction of any of the alternatives. There is a difference between the alternatives in the potential for odour impacts that businesses may experience during operation. Alternative 1 represents no change to the current operation and based on operating experience does not result in any significant odour, and is ranked Neutral. The operation of an on-site pre-treatment facility (Alternative 2) has some potential for odour and the operation of a full treatment facility (Alternative 3) has the greatest potential for odour due to plant operation. With respect to truck traffic, Alternatives 2 and 3 will require on-site construction and require on-going delivery of treatment products and the disposal of treatment residue. As a result both will have a greater number of trucks than Alternative 1. Leachate will only be transported by truck as a contingency and the same contingency and number of trucks would apply to all alternatives. Alternatives 2 and 3 have a greater potential to disrupt businesses and are ranked Disadvantage; whereas Alternative 1 has minimal impacts and is ranked Neutral.

Cost of facility - Alternative 1 has no additional expenditures and is ranked as having a Major Advantage. Alternative 2 requires expenditure for a pre-treatment facility (estimated in $3 to $5 million range) and some operating staff and is ranked as Disadvantaged. Alternative 3 would require significant expenditures for construction of a full wastewater treatment plant and associated infrastructure (estimated in $15 to $20 million range) and a full time staff compliment and is ranked as having a Major Disadvantage.

Summary of Ranking Preference – Economic Environment

Economic Environment	Alternative 1	Alternative 2	Alternative 3
Effect on Business Ranking	Neutral	Disadvantage	Disadvantage
Cost of Facility Ranking	Major Advantage	Disadvantage	Major Disadvantage
Overall Ranking	Major Advantage	Disadvantage	Major Disadvantage

Conclusion

Based on the above assessments, Alternative 1 is preferred over Alternative 2 and 3 relative to the economic environment from a traffic and facility cost perspective.

4.2.5 Cultural Environment

Cultural Environment Evaluation Criteria

The following criteria and indicators were used to assess the leachate treatment alternatives relative to the cultural environment.

Criteria	Indicators
Cultural	
Potential effects to archaeological resources as a result of construction.	· Area of undisturbed land affected by the on-site component of the leachate treatment alternative.

Cultural Environment Assessment

Within the Ridge Landfill property any infrastructure required (Alternatives 2 and 3) would be located in an area that has been found to exhibit no archaeological potential based on the completed Stage 1 Archaeology Assessment or future Stage 2 work. Given that any archaeological resources will be removed prior to the construction of any expansion no archaeological impact is anticipated and all three (3) site development alternatives are ranked as Neutral for this criterion.

Summary of Ranking Preference – Cultural Environment

Cultural Environment	Alternative 1	Alternative 2	Alternative 3
Archaeological Potential Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Neutral	Neutral

Conclusion

Based on the above assessment, all Alternatives are considered equal relative to the cultural environment from an archeological perspective.

4.2.6 Built Environment

Built Environment Evaluation Criteria

The following criteria and indicators were used to assess the leachate alternatives relative to the built environment.

Criteria	Indicators
Built	
Potential effects on existing transportation infrastructure and transportation operation.	· Anticipated number of trucks required.
Ease to implement/construct and maintain/operate.	· Anticipated complexity of construction and operation.

Built Environment Assessment

Transportation infrastructure - Alternative 1 would have no impact to existing transportation operations or infrastructure and is ranked as Neutral. Alternatives 2 and 3 require some delivery of treatment chemicals and some disposal of treatment waste e.g. liquid waste. The number of trucks utilizing the transportation network for that however would be nominal (i.e., approximately 2-to-3 trucks per week). There would be additional traffic (constructors, contractors, building materials etc.) associated with facility construction, some for Alternative 2 and more significantly for Alternative 3 however these would be for relatively short duration. In terms of overall impact to transportation infrastructure and operations all three (3) alternatives are deemed to be Neutral.

Ease of Implementation - Alternative 1 is the 'status quo' and as such will be easily implemented, maintained and operated and is ranked as having a Major Advantage. Alternative 2 is expected to be more complex than Alternative 1, as it requires construction of a pre-treatment facility, some additional operating staff and related training and so is ranked as Disadvantaged. It should be noted that since there are currently no parameters in the leachate from the Ridge Landfill that the BWTL cannot treat, there is no technical reason to install a pre-treatment system at the landfill at this time.

Alternative 3 would include the construction of a complex full leachate treatment facility and an outfall to a local drain, a full staff compliment and extensive training to operate the facility. The full staff complement would be required to operate the facility, handle chemicals required for treatment and manage the waste streams from the treatment. It should also be noted that it is anticipated that the regulatory requirements associated with securing permits and approvals to discharge treated effluent to the environment would severely limit the proponent's ability to manage leachate from the site. For example, leachate needs to be managed throughout the year from the landfill. Year round discharge to a local drain, an important resource for local agricultural operations, would be an issue given the quality of the surface water in the drains and local climatic conditions (dry in the summer and frozen part of the winter). Alternative 3 is therefore ranked as having a Major Disadvantage.

Summary of Ranking Preference – Built Environment

Built Environment	Alternative 1	Alternative 2	Alternative 3
Transportation Infrastructure Ranking	Neutral	Neutral	Neutral
Complexity Ranking	Major Advantage	Disadvantage	Major Disadvantage
Overall Ranking	Major Advantage	Disadvantage	Major Disadvantage

Conclusion

Based on the above assessment, Alternative 1 is preferred over Alternative 2 and 3 relative to the built environment from a transportation and project complexity perspective.

4.2.7 Comparative Evaluation of Leachate Alternatives

Based on the net effects outlined above assuming appropriate mitigation measures, the alternatives were identified as having a Major Advantage, Advantage, Neutral, Disadvantage, or Major Disadvantage ranking for each of the valid evaluation criteria. *Table 4-2* below summarizes the ranking results for each of the components of the environment. These rankings were used as a means to identify a preference for one of the alternatives. Alternative 1 was clearly ranked as Advantage overall and is considered the preferred alternative for leachate treatment.

Table 4- 2: Comparative Evaluation Overall Ranking of Leachate Alternatives

Environment	Alternative 1	Alternative 2	Alternative 3
Natural Environment Biological Ranking	Neutral	Neutral	Major Disadvantage
Natural Environment Physical Ranking	Neutral	Neutral	Disadvantage
Social Ranking	Neutral	Disadvantage	Major Disadvantage
Economic Ranking	Major Advantage	Disadvantage	Major Disadvantage
Cultural Ranking	Neutral	Neutral	Neutral
Built Environment Ranking	Major Advantage	Disadvantage	Major Disadvantage
Overall Leachate Ranking	Preferred Leachate Treatment Alternative		

4.2.8 Considering the "Do Nothing" Alternative

As per the MECP Code of Practice for Environmental Assessment, the "do nothing" alternative represents what is expected to happen if none of the alternatives being considered are carried out. It serves as a benchmark for comparing effects of the proposed expansion, and to highlight the advantages of proceeding with a particular undertaking.

With respect to the existing leachate treatment system the "do nothing" alternative requires the continued pumping of leachate to the BWTL. At landfill closing, the leachate quantity is expected to initially remain the same, and then decrease gradually over the time period 2022 to 2041. Leachate quality would be expected to remain the same initially but becoming more dilute over time.

To confirm whether proceeding with the preferred leachate treatment alternative is appropriate given the potential for impact on the environment, *Table 4-3* below provides a more specific comparison with the do-nothing alternative. Appropriate mitigation measures are assumed for the preferred leachate treatment alternative. As is demonstrated in the table below the potential impacts associated with the preliminary preferred leachate treatment alternative are relatively minimal.

Table 4-3: Preliminary Preferred Leachate Treatment vs Do Nothing

Environmental Component	Preferred Leachate Treatment	Do Nothing
Natural Environment - Biology	The preferred alternative has some potential to disrupt the limited aquatic environment by leakage or spill incident; however, mitigation can effectively contain any spill.	Even upon closure the site continues to generate leachate that would have the same potential for spills/leaks as the preferred leachate treatment alternative.
Natural Environment – Physical	The preferred leachate treatment system would continue to have minimal to no impact on ground water, surface water and climate change.	Following site closure, the existing leachate treatment system would continue to have minimal to no impact on ground water, surface water and climate change.
Social Environment	The preferred leachate treatment system would have minimal odour, noise and traffic impacts on residents.	The current leachate treatment system would continue to operate and would continue to have minimal odour, noise and traffic impacts on residents.
Economic Environment	The preferred leachate treatment system would have minimal odour and truck traffic impact on businesses. There would be no costs for this alternative as the infrastructure is in place. Sewer use income would continue to grow for BWTL as leachate volume increases.	The current leachate treatment system would continue to have minimal odour and truck traffic impact on businesses. There would be no construction cost for the "do-nothing" scenario. Sewer use income for BWTL would decline as leachate volumes decline following closure.
Cultural Environment	There will be no disturbance to lands of archaeological potential.	There will be no disturbance to lands of archaeological potential.
Built Environment	There are no trucks required to transport leachate except in a contingency situation. The preferred leachate treatment system is straightforward to operate.	There are no trucks required to transport leachate except in a contingency situation. The "do nothing" scenario is straightforward to operate.

5.0 Landfill Gas Management Alternatives

There are three (3) landfill gas management alternative methods being evaluated for the Ridge Landfill EA. All three (3) alternatives provide responsible management of the landfill gas produced on-site over the EA planning period (2022 to 2041) and are further described within this Section.

Landfill gas is produced as organic waste biodegrades, typically increasing throughout the operational period of landfill development, and peaking upon closure. The landfill gas production rate slowly declines over the years after the landfill is closed, until the waste has finished decomposing[3]. The existing landfill gas collection system at the Ridge Landfill consists of vertical extraction wells installed in the waste mound of landfill cells that have reached final approved waste grades. Landfill gas is also collected in the perimeter of the leachate collection system mainly for odour abatement purposes.

The existing landfill gas collection system consists of perforated or slotted pipe installed vertically in the waste (i.e., extraction wells) and connected to a series of landfill gas collection pipes and a header system that conveys the landfill gas to the on-site landfill gas flares for destruction by combustion. Blowers provide a vacuum on the extraction system (i.e., wells and collection pipe) to actively extract the landfill gas from the landfill cells. Future expansion of the on-site landfill gas collection system would be an extension of the existing network of landfill gas wells and collection system into the proposed new cells. The collection system would continue to be designed in accordance with Provincial regulations and be subject to MECP review and approval.

Another approach to manage landfill gas would be passive venting, whereby collection wells, also referred to as vent stacks, are installed to collect landfill gas and release it to the atmosphere where it is dispersed. Similar to an active landfill gas collection system, passive venting wells are constructed from perforated or slotted pipe and installed vertically throughout the sections of the landfill that have been closed. Passive venting is typically installed at smaller landfills were landfill gas volumes do not warrant expensive active landfill gas extraction systems. In addition, a passive venting system provides a release of landfill gas and prevents lateral migration of landfill gas from a landfill.

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[3] See Appendix D Technical Memo – Ridge Landfill Expansion EA: Landfill Gas Contaminating Life Span & Subsurface Migration, Golder & Associates, 2018.

Ontario Regulation 232/98 (O.Reg.232/98) and O.Reg.347 (General Waste Management) as amended in June 2008 under the Environmental Protection Act (EPA), requires that new, expanding, and operating landfills with capacity larger than 1.5 million m^3 must actively collect and flare (burn), or recover and use, landfill gas. The Ridge Landfill has a capacity greater than 1.5 million m^3 and would not be permitted to use passive venting for landfill gas management. Passive venting is therefore not a feasible alternative to consider for the purposes of alternative methods assessment and is not carried through the evaluation.

In the past, Waste Connections investigated the opportunity to utilize landfill gas from the existing landfill to generate electricity and feed it to the provincial electricity grid, but there was insufficient capacity in the electrical grid to accept the generated electricity at that time. It is noted that currently there are no programs available that would allow a connection to supply electricity generated from landfill gas to the grid. However, Waste Connections is currently in discussions with a natural gas pipeline company who are interested in conveying gas from the existing landfill to an off-site location where it would be treated before injecting it into the gas distribution system. These discussions are being held outside the scope of the EA and are on-going. The decision to proceed with this potential opportunity or indeed any landfill gas utilization project will be based on an available third party and commercial viability and therefore should not affect the course of the EA.

5.1 Description of Landfill Gas Management Alternatives

Each alternative method of how landfill gas from the proposed Ridge Landfill expansion can be managed is outlined below with the accompanying rationale.

Landfill Gas Management Alternative Method	Description	Rationale
Alternative 1 Flaring	Involves the active collection of landfill gas through a network of vertical wells and pipes, and its conveyance to a flare (a facility designed to combust landfill gas under high temperatures and controlled conditions). This process destroys the methane and trace organic compounds in landfill gas. The expanded Ridge Landfill is predicted to have a peak gas generation rate of up to 14,000 standard cubic feet per minute [scfm] (23,800 m^3/hour or 570,000 m^3/day)[4] in approximately the year 2042. There are currently two (2) flares in operation at the Ridge Landfill, for the expansion, additional flares will be required.	A widely accepted landfill gas management method at large landfills and is currently used at Ridge Landfill. Significantly reduces the level of landfill gas, and GHG emissions. In Ontario, flaring is mandatory for a landfill the size of Ridge.
Alternative 2 Energy Recovery – Renewable Natural Gas (RNG)	Through the application of technology, energy can be recovered from landfill gas. Based on the energy needs at the landfill a standalone RNG project is not warranted. The opportunity for a RNG project is therefore dependent on being able to develop a commercially viable project with a 3rd party who can either use or market the energy. Potential off-site uses could be either at an industrial facility that would use the gas as an alternate fuel source in its operations, or the landfill gas could be treated and injected into the wider natural gas distribution system as a RNG. As previously stated Waste Connections is in discussions with a 3rd party to contract the supply of its existing landfill gas for use as RNG. If such an undertaking is determined to be economically viable and moves forward, landfill gas collected in the future from the expansion areas could also be provided to this 3rd party. Since there is no existing 3rd party agreement or confirmed RNG project at this time, for the purposes of this	Similar GHG reduction as flaring at local scale. On a larger scale, beneficial use of the gas offsets use of traditional fuels.

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[4] See Appendix D for technical information relating to landfill gas generation.

Landfill Gas Management Alternative Method	Description	Rationale
	assessment, the evaluation of the identified criteria will need to be qualitative and general in nature. In the event that a project is developed, a back-up flare system (Alternative 1) would likely still be required.	
Alternative 3 Energy Recovery – Electricity	Electrical energy could also be generated from landfill gas. As there is a limited amount of electricity needed at the landfill, external uses for the electricity would need to be identified and assessed. Producing energy from the landfill gas would require the construction of infrastructure to convert landfill gas to electricity and transmission lines to feed it into the local electricity grid. In the event that a landfill gas-to-electricity project with a 3rd party becomes viable, possible locations for the necessary infrastructure could be on-site and/or off-site. Previously, Waste Connections pursued and secured an ECA approval to construct and operate electric power generators on the site. However, a landfill-gas-to-electricity project was never developed because an economically viable project could not be identified because of electricity grid access constraints. An assessment of the feasibility to deliver electricity off-site in the future would need to be undertaken as project specific opportunities arise in response to changes in the electricity market and regulations. In the event that a project is developed, a back-up flare system (Alternative 1) would likely still be required.	Similar GHG reduction as flaring at local scale. On a larger scale, beneficial use of the gas offsets use of traditional fuels.

Of the three (3) landfill gas alternatives, Alternative 1, flaring, is the only management method confirmed and identified as an on-site option that is solely within the control of Waste Connections. For the other two (2) alternatives which can only be based on commercial market driven opportunities, the facility required could either be on-site or off-site, depending on the opportunity.

In the event that an RNG facility is built off-site to accept gas from the existing landfill, there would be minimal impacts to area residents and businesses from landfill gas subsequently supplied from the expansion.

Similarly, there are currently no opportunities identified for electricity generation and so an assessment of impacts to residents and businesses is not possible. In the event that a utilization project is identified, the necessary approvals will be pursued as required at that time.

5.1.1 Common Characteristics

The following are common characteristics of the three (3) landfill gas management alternatives:

- Landfill Gas Capacity – The current predicted average daily quantity of landfill gas produced at the Ridge Landfill once the currently approved landfill is fully built out and the final gas collection system installed will be approximately 7,000 scfm (12,000 m^3/hour or 300,000 m^3/day) [see *Figure 5-1* below and Technical Memo in *Appendix E*]. This number is influenced by a number of factors including rainfall received in the area and climatic conditions.[5].

  It is expected that additional landfill gas will be generated in the proposed expansion areas at a rate similar to that from the existing landfill. The evaluation for landfill gas management alternatives has been completed based on an estimate that a maximum of approximately 14,000 scfm (570,000 m^3/day)[5] of landfill gas will be produced by the existing and future landfill expansion areas.

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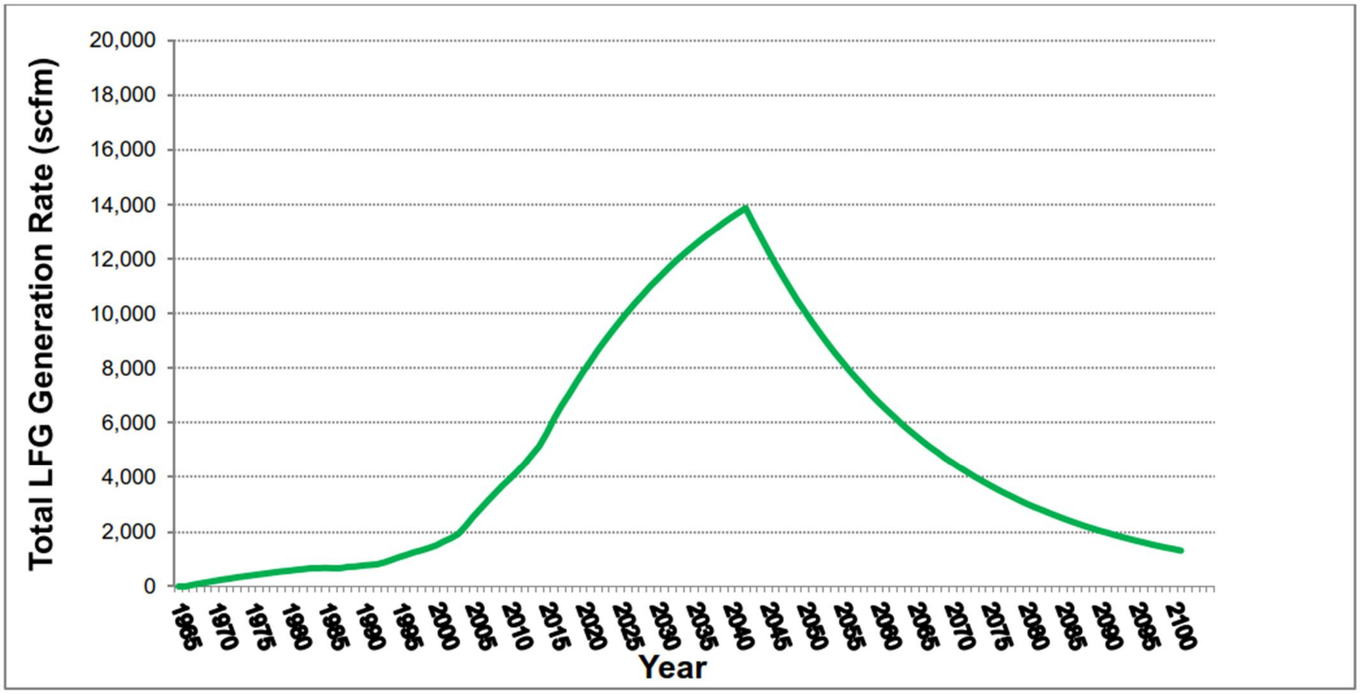
[5] See Appendix D for technical information relating to landfill gas generation.

Figure 5- 1: Landfill Gas Generation Rate (Except from Technical Memo - see Appendix E)



- Quality of Landfill Gas – Only non-hazardous solid waste predominately from IC&I customers will be accepted at the site regardless of the development alternative preferred. This is reflective of what happens currently so the quality of landfill gas is expected to remain relatively unchanged from what is currently flared. The past six (6) year average methane concentration in the landfill gas at the Ridge Landfill is approximately 53%.
- Existing Landfill Gas Collection and Flaring System –The existing system was commissioned in late 2009 and initially consisted of twenty-nine vertical landfill gas extraction wells installed on the final slopes in the north half of the West Mound of the landfill, including nine (9) connections to capture landfill gas from the leachate collection system. These extraction wells are connected by a network of lateral and header piping that connects to a series of blowers and two (2) flares located south of the old landfill. The current system design and approval includes a third blower and flare, to be constructed once the landfill gas extraction volumes reaches the required design parameters.

Between 2011 and 2016 the landfill gas collection system was expanded to portions of the West Mound with the installation of an additional sixty-three vertical landfill gas extraction wells. With completion of the West Mound in late 2017, an additional twenty-three landfill gas extraction wells were installed in the fall of 2018. In the future, additional wells will be installed in the West and South Mounds of the Landfill, as required, to optimize landfill gas capture and odour mitigation. The subsurface migration of landfill gas is highly unlikely given the underlying geologic conditions and site engineering features. However, as a safety precaution, combustible gas alarms are installed at all on-site buildings in compliance with provincial regulations.

5.2 Evaluation of Landfill Gas Management Alternatives

This evaluation considers the potential for impact on the environment for each of the landfill gas management alternatives. The evaluation assumes the application of standard, approved mitigation measures, considers the potential for impact, and ranks the alternative as Major Advantage, Advantage, Neutral, Disadvantage or Major Disadvantage (see definitions in *Section 2.0*). The evaluation criteria used to compare the landfill gas management alternatives cover all components of the environment (i.e. natural, social, economic, cultural, and built). The table of evaluation criteria, indicators, data sources and rationale for the evaluation of landfill gas management alternatives is included in *Appendix B*. The criteria and indicators for each environmental component are included in the write-up in this section.

The evaluation is documented in *Table 5-1* which follows and summarized in the text in this report section. The subsections that follow, are divided into the components of the environment, and summarize the net effects evaluation and ranking preference for each of the landfill gas alternatives. Based on the Advantages and Disadvantages noted in *Table 5-1* and in the following text, a conclusion on which of the alternatives is preferred for each of the six (6) environments is presented at the end of each subsection.

5.2.1 Natural Environment - Physical

Physical Natural Environment - Evaluation Criteria

The following criteria and indicators were used to assess the landfill gas alternatives relative to the natural environment from a physical perspective.

Criteria	Indicators
Atmospheric	
Potential impacts to air quality during construction and operation.	· Relative levels of construction as an indicator of the generation of air contaminants from equipment exhaust (nitrogen oxides, sulphur dioxide and carbon monoxide). · Relative amount of energy required to operate facility.
Climate Change	
Potential for reduction of greenhouse gas (GHG) emissions during construction and operation.	· Qualitative assessment of the potential for GHG emissions reduction as a result of landfill gas alternatives.

Physical Natural – Alternative Methods Environment Assessment

Atmospheric - With respect to potential impacts to air quality during construction and operation of the landfill gas management alternatives, the relative levels of construction and the relative amount of energy required to operate the infrastructure as indicators, have differences as follows: The first alternative consists of flares on-site so maintaining the status quo and no change with regard to air quality. The flares are effective at removing GHG's, and are ranked as Neutral. The second alternative requires minimal construction to convey the gas off-site for use as "RNG"), which would have no impacts on air quality. However, it will have similar GHG removal efficiency as flaring, so it is also ranked as Neutral. The third alternative requires construction of a facility, either off-site or on-site, to convert the gas to electricity which would have minimal impacts on air quality and a similar efficiency for GHG removal. Alternative 3 is also ranked Neutral. Flaring requires minimal energy to operate while the energy requirements of Alternatives 2 and 3 are unknown.

TABLE 5-1 – LANDFILL GAS MANAGEMENT SUMMARY EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/Criteria	Indicators	Alternative 1 FLARING	Alternative 2 ENERGY RECOVERY – RNG	Alternative 3 ENERGY RECOVERY - Electricity
NATURAL ENVIRONMENT - PHYSICAL				
Atmospheric				
Potential for impacts to air quality during construction and operation.	· Relative levels of construction as an indicator of the generation of air contaminants from equipment exhaust (nitrogen oxides, sulphur dioxide and carbon monoxide). · Relative amount of energy required to operate facility.	● Neutral Two (2) flares are already operational. Minor construction may be required should additional flares be needed to manage the quantity of landfill gas associated with the proposed expansion. No change to air quality is expected from this construction. Operation of this alternative does not require a significant amount of energy.	● Neutral Any on-site construction would be minimal involving pumping gas to an off-site facility. Minimal to no impacts to air quality anticipated. The extent of energy required for operation of Alternatives 2 and 3 will depend on the specific facility, which is undefined at this time.	● Neutral Converting gas to electricity requires some construction which may or may not be on-site. Minimal to no impacts to air quality anticipated. The extent of energy required for operation of Alternatives 2 and 3 will depend on the specific facility, which is undefined at this time.
Climate Change				
Potential for reduction of greenhouse gas (GHG) emissions during construction and operation.	· Qualitative assessment of the potential for GHG emissions reduction as a result of landfill gas alternatives.	● Neutral Minimal greenhouse gas (GHG) emissions remain after flaring.	● Advantage Minimal greenhouse gas (GHG) emissions remain after flaring. This alternative has the potential for a positive impact on climate change from the offset of the use of traditional fuels.	● Advantage Minimal greenhouse gas (GHG) emissions remain after flaring. This alternative has the potential for a positive impact on climate change from the offset of the use of traditional fuels.
SOCIAL				
Potential for noise as a result of landfill gas management facility construction and operation.	· Number of occupied households in the study area who may experience noise or other disturbance.	● Neutral There are twenty-five residences within 1 km of the property boundary. With limited construction, none of these households will experience noise or other disturbance different than existing conditions. No operational noise is anticipated with any of the alternatives.	● Disadvantage There are twenty-five residences within 1 km of the property boundary. While specific projects for Alternatives 2 and 3 have not been defined, the level of construction is anticipated to be beyond what would be required for Alternative 1 and it is reasonable to assume that some households could potentially experience noise or other disturbance during construction. No operational noise is anticipated with any of the alternatives.	● Disadvantage There are twenty-five residences within 1 km of the property boundary. While specific projects for Alternatives 2 and 3 have not been defined, the level of construction is anticipated to be beyond what would be required for Alternative 1 and it is reasonable to assume that some households could potentially experience noise or other disturbance during construction. No operational noise is anticipated with any of the alternatives.

TABLE 5-1 – LANDFILL GAS MANAGEMENT SUMMARY EVALUATION & RANKING

Alternative Preference Ranking Key: ● Major Advantage ● Advantage ● Neutral ● Disadvantage ● Major Disadvantage

Environment/Criteria	Indicators	Alternative 1 FLARING	Alternative 2 ENERGY RECOVERY – RNG	Alternative 3 ENERGY RECOVERY - Electricity
Potential for odour during construction and operation.	· Number of potential odour sources; relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors.	● Neutral This alternative does not add any new odour sources. Backup and contingency plans would be in place to deal with any upset condition to prevent or mitigate the escape of fugitive landfill gas	● Neutral This alternative does not add any new odour sources. Backup and contingency plans would be in place to deal with any upset condition to prevent or mitigate the escape of fugitive landfill gas.	● Neutral This alternative does not add any new odour sources. Backup and contingency plans would be in place to deal with any upset condition to prevent or mitigate the escape of fugitive landfill gas
ECONOMIC				
Potential for effect on businesses during construction and operation.	· Number of potential odour sources and relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors. · Qualitative assessment of noise potential of on-site landfill gas management equipment.	● Neutral No change to the number of odour sources or to the potential for noise.	● Neutral Minimal potential for change to the number of odour sources or to the potential for noise.	● Neutral Minimal potential for change to the number of odour sources or to the potential for noise.
Cost of facility.	· Approximate cost of landfill gas recovery facility.	● Advantage Additional expenditures associated with an expanded flare system will be minimal an can be readily estimated.	● Disadvantage Alternatives 2 and 3 would require significant expenditures for construction of the required infrastructure for projects that are undefined. Until a project to implement Alternatives 2 or 3 is defined, the assumption is that these Alternatives are economically unattractive and therefore ranked as a Disadvantaged.	● Disadvantage Alternatives 2 and 3 would require significant expenditures for construction of the required infrastructure for projects that are undefined. Until a project to implement Alternatives 2 or 3 is defined, the assumption is that these Alternatives are economically unattractive and therefore ranked as a Disadvantaged.
CULTURAL				
Potential effects to archaeological resources as a result of construction.	· Area of undisturbed land affected by the on-site component of landfill gas management alternative.	● Neutral The lands in the vicinity of the existing flares have been identified as having no archaeological potential.	● Neutral The impacts of Alternatives 2 and 3 cannot be determined outside the context of a defined commercially driven project, which is independent of the proposed expansion.	● Neutral The impacts of Alternatives 2 and 3 cannot be determined outside the context of a defined commercially driven project, which is independent of the proposed expansion.
BUILT				
Ease to implement/construct and maintain/operate.	· Anticipated complexity of construction and operation.	● Advantage Alternative is easy to implement and maintain/operate.	● Disadvantage Landfill gas utilization is more complex than flaring as it involves more specialize equipment and coordination with a third party. Specific projects are not defined at this time.	● Disadvantage Landfill gas utilization is more complex than flaring as it involves more specialize equipment and coordination with a third party. Specific projects are not defined at this time.

Climate Change - The key difference between landfill gas alternatives from a reduction of GHG perspective concerns the ability to offset emissions from traditional carbon based fuels. Alternative 1 is expected to remain similar to existing conditions with regard to GHG emission levels, and is ranked as Neutral. For Alternatives 2 and 3, with the energy recovery from gas, there is potential for a positive impact on climate change from the offset of the use of traditional fuels. Energy application alternatives are both ranked as Advantage.

Summary of Ranking Preference - Physical Natural Environment

Physical Natural Environment	Alternative 1	Alternative 2	Alternative 3
Atmospheric Change Ranking	Neutral	Neutral	Neutral
Climate Change Ranking	Neutral	Advantage	Advantage
Overall Ranking	Neutral	Advantage	Advantage

Conclusion

Based on the above assessments, Alternative 2 and 3 are preferred over Alternative 1 relative to the natural environment from a physical perspective.

5.2.2 Social Environment

Social Environment - Evaluation Criteria

The following criteria and indicators were used to assess the landfill gas alternatives relative to the social environment.

Criteria	Indicators
Social	
Potential for noise as a result of landfill gas management facility construction and operation.	· Number of occupied households in the study area who may experience noise or other disturbance.
Potential for odour during construction and operation.	· Number of potential odour sources, relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors.

Social Environment - Alternative Methods Assessment

For all three (3) landfill gas alternatives, there are twenty-five residences within 1 km of the Ridge landfill property, primarily on Charing Cross Road, Erieau Road and Allison Line.

Individual residents' experience may differ depending on their proximity to the different environmental components on-site. The following outlines the potential for noise, odour related to landfill gas management activities on-site. It is noted there are also two (2) leased residences on-site and these leases will be terminated should the expansion be approved regardless of the site development alternative selected.

Noise – One of the differences between landfill gas alternatives from a social environment perspective relates to the number of occupied households in the study area who may potentially experience noise or other disturbance during landfill gas facility construction and operation. Alternative 1, flaring, has not historically and would not likely disturb occupied households, and is therefore ranked Neutral. Very little to no change to noise is expected as a result of operation of any of the landfill gas management alternatives after noise mitigation measures have been employed. Because projects for Alternatives 2 and 3 have not been identified and are dependent on 3rd party participation, the level of construction that might occur on-site, beyond what would be required as back-up flare capacity (same as Alternative 1) is not known and so the degree of noise associated with any additional construction activity is not known. There is however likelihood that some households may experience noise or other disturbance during construction as it would occur for Alternatives 2 and 3 and therefore they are ranked as Disadvantaged.

Odour - None of the three (3) landfill gas management alternatives would have much potential to generate odours and are ranked as Neutral. Backup and contingency plans would be in place to deal with any upset condition to prevent or mitigate the escape of fugitive landfill gas in the design of the system.

Summary of Ranking Preference – Social Environment

Social Environment	Alternative 1	Alternative 2	Alternative 3
Noise Ranking	Neutral	Disadvantage	Disadvantage
Odour Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Disadvantage	Disadvantage

Conclusion

Based on the above assessments, Alternative 1 is preferred over Alternatives 2 and 3 relative to the social environment from a noise and odour perspective.

5.2.3 Economic Environment

Economic Environment - Evaluation Criteria

The following criteria and indicators were used to assess the landfill gas alternatives relative to the economic environment.

Criteria	Indicators
Economic	
Potential for effect on businesses during construction and operation.	· Number of potential odour sources and relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors. · Qualitative assessment for noise potential of on-site landfill gas management equipment.
Cost of facility.	· Approximate cost of landfill gas recovery facility.

Economic Environment - Alternative Methods Assessment

Businesses operating within the study area include an equipment dealer, a farm market and numerous farmed parcels that are part of agricultural operations.

Effect on businesses - There are no significant odour or noise sources associated with Alternative 1 and it is ranked as Neutral. Alternatives 2 and 3 would potentially add a minimal amount of noise during construction for a short period of time, but operationally would not change any odour or noise sources, so are also ranked as Neutral.

Cost of facility - While Alternative 1 has additional expenditures associated with an expanded flare system, those costs can be readily estimated and is therefore ranked as Advantaged. Alternatives 2 and 3 would require significant expenditures for construction of the required infrastructure for projects that are undefined beyond the construction of any additional flares required as back-up (similar to Alternative 1). The economic Advantages and Disadvantages of Alternatives 2 and 3 cannot be determined outside the parameters of a defined project, which would be commercial in nature. Until a project to implement Alternatives 2 or 3 is defined, the assumption is that these Alternatives are economically unattractive and therefore ranked as a Disadvantaged.

Summary of Ranking Preference – Economic Environment

Economic Environment	Alternative 1	Alternative 2	Alternative 3
Effects on Businesses	Neutral	Neutral	Neutral
Cost of Facility Ranking	Advantage	Disadvantage	Disadvantage
Overall Ranking	Neutral	Disadvantage	Disadvantage

Conclusion

Based on the above assessments, Alternative 1 is preferred over Alternative 2 and 3 relative to the economic environment from an effect on businesses and facility cost perspective.

5.2.4 Cultural Environment

Cultural Environment – Evaluation Criteria

The following criteria and indicators were used to assess the landfill gas alternatives relative to the cultural environment.

Criteria	Indicators
Cultural	
Potential effects to archaeological resources as a result of construction.	· Area of undisturbed land affected by the on-site component of landfill gas management alternative.

Cultural Environment Alternative Methods Assessment

From a cultural perspective none of the landfill gas alternatives would involve activity in areas identified as having archaeological potential in the Stage-1 Archaeological Assessment, so all three (3) are ranked as Neutral. All alternatives require that additional flares be constructed on-site. Unlike Alternative 1 which will have very defined criteria by which the additional flares will be added, the impacts of Alternatives 2 and 3 cannot be determined outside the context of a defined commercially driven project, which is independent of the proposed expansion.

Summary of Ranking Preference – Cultural Environment

Cultural Environment	Alternative 1	Alternative 2	Alternative 3
Archaeological Potential Ranking	Neutral	Neutral	Neutral
Overall Ranking	Neutral	Neutral	Neutral

Conclusion

Based on the above assessment, all three (3) alternatives are equal relative to the cultural environment.

5.2.5 Built Environment

Built Environment - Evaluation Criteria

The following criteria and indicators were used to assess the landfill gas alternatives relative to the built environment.

Criteria	Indicators
Built	
Ease to implement/construct and maintain/operate.	· Anticipated complexity of construction and operation.

Built Environment Alternative Methods Assessment

From a built environment perspective relate to the anticipated complexity of construction and operation. Alternative 1 is easy to implement and maintain/operate reflecting what occurs today, so it is ranked as Advantage. Determining the design parameters for Alternative 1 will be technical and regulatory based. Alternatives 2 and 3 involving the recovery of energy are more complex than Alternative 1 due to the fact that they are not defined and will require 3rd party agreements, specialized technology and equipment. In addition to engineering design and regulation, Alternatives 2 and 3 will be commercially driven and so are ranked as Disadvantaged without an agreed project being defined.

Summary of Ranking Preference – Built Environment

Built Environment	Alternative 1	Alternative 2	Alternative 3
Complexity Ranking	Advantage	Disadvantage	Disadvantage
Overall Ranking	Advantage	Disadvantage	Disadvantage

Conclusion

Based on the above assessment, Alternative 1 is preferred over Alternative 2 and 3 relative to the built environment from a complexity perspective.

5.2.6 Comparative Evaluation

Based on the net effects outlined above and assuming appropriate mitigation measures, the alternatives were identified as having a Major Advantage, Advantage, Neutral, Disadvantage, or Major Disadvantage ranking for each of the valid evaluation criteria. *Table 5-2* below summarizes the ranking results. As shown by the summary table below, Alternative 1 is the preferred landfill gas management alternative.

Table 5- 2: Comparative Evaluation Overall Ranking of Landfill Gas Alternatives

Environment	Alternative 1 - Flaring	Alternative 2 – Energy Recovery (RNG)	Alternative 3 – Energy Recovery (Electricity)
Natural Environment Physical Ranking	Neutral	Advantage	Advantage
Social Ranking	Neutral	Disadvantage	Disadvantage
Economic Ranking	Neutral	Disadvantage	Disadvantage
Cultural Environment	Neutral	Neutral	Neutral
Built Environment Ranking	Advantage	Disadvantage	Disadvantage
Overall Landfill Gas Management Ranking	Preferred		

The identified flaring and energy recovery applications are all very good alternatives for the management of collected landfill gas for the proposed Ridge Landfill expansion. Flaring of the landfill gas destroys GHG emissions, is readily implementable and is a reliable and proven technology.

An energy recovery project provides the benefit of reducing GHG emissions by offsetting the traditional use of carbon based fuel. However, for an energy recovery project to go forward there must be a market or user for the energy. Waste Connections does not have an agreement to utilize the landfill gas from the existing landfill. Waste Connections proposes to manage landfill gas through flaring in accordance with O.Reg.232/98. Waste Connections are investigating opportunities for commercially viable energy recovery projects at the Ridge Landfill.

For the purposes of this EA, the preferred alternative for landfill gas management is Alternative 1, Flaring.

5.2.7 Considering the "Do Nothing" Alternative

As per the MECP Code of Practice for Environmental Assessment, the "do nothing" alternative represents what is expected to happen if none of the alternatives being considered are carried out. It serves as a benchmark for comparing effects of the proposed expansion, and to highlight the advantages of proceeding with a particular undertaking.

With respect to the landfill gas management at the site, the "do nothing" alternative would involve the continued collection and flaring of landfill gas from the existing landfill. The well field, blowers and flares would continue to be monitored and maintained as it is today until the site closes and then during the post-closure care period.

Following closure of the landfill, gas generation would be expected to remain the same initially but would decrease gradually over the time period 2022 to 2041 and beyond. Landfill gas quality would be expected to remain the same.

The preferred landfill gas management alternative is compared to the "do-nothing" alternative in *Table 5-3* below. For the purposes of this assessment the preferred alternative to be used will be flaring (Alternative 1) to provide the most conservative comparison. Appropriate mitigation measures are assumed for the preferred landfill gas management alternative.

The purpose of this comparison is to confirm whether proceeding with the proposed landfill gas management alternative is appropriate given the potential for impact on the environment. As demonstrated in *Table 5-3* the potential impacts associated with the preliminary preferred landfill gas management alternative are relatively minimal.

Table 5- 3: Preliminary Preferred Landfill Gas Management vs Do Nothing

Environmental Component	Preferred Landfill Gas Management	Do Nothing
Natural Environment – Physical	Continued flaring of landfill gas is an effective method to manage GHG emissions. The flare system would be expanded as required to manage the additional gas over the expansion period. The site would continue to have minimal to no impact on the atmosphere or climate change.	Following site closure, flaring would continue until the gas in the existing landfill is exhausted as an effective way to manage GHG emissions. The site would continue to have minimal to no impact on atmospheric and climate change.

Environmental Component	Preferred Landfill Gas Management	Do Nothing
Social Environment	There is limited potential for noise and odour impact to residents associated with continued flaring of landfill gas.	After landfill closure, flaring would continue resulting in limited potential for noise and odour impacts to residents.
Economic Environment	There is limited potential for noise and odour impact to businesses associated with continued flaring of landfill gas.	After landfill closure, flaring would continue resulting in limited potential for noise and odour impacts to businesses.
Cultural Environment	Continuation of flaring for the expansion does not impact the cultural environment.	Flaring following closure of the landfill does not impact the cultural environment.
Built Environment	Continued flaring is easy to implement and maintain/operate.	Flaring following closure of the landfill is easy to implement and maintain/operate.

6.0 Summary

6.1 Preferred Alternatives

In accordance with the ToR, a range of alternative methods were evaluated using the methodology developed and recorded in *Section 2.0*. The following preferred alternatives for site development, leachate treatment, and landfill gas management are presented in the following summary table.

Alternative Method	Description	Preferred Method(s)
Site Development	Different ways the landfill could be developed on the site to accommodate a disposal capacity of 28.9 million m^3.	Lateral expansion of the South and West Landfill Areas A & B, and Vertical expansion of the Old Landfill.
Leachate Treatment	Different ways of treating leachate on-site.	Continuation and expansion of current leachate collection system and discharge to underground forcemain to the BWTL.
Landfill Gas Management	Different ways of managing landfill gas on-site.	Continuation and expansion of current landfill gas collections and flaring system. Continue to explore commercially viable energy utilization projects.

6.2 Next Steps

The detailed impact assessment of the preferred alternatives is the next major step in the EA process. The three (3) preferred alternatives of site development, leachate treatment, and landfill gas management, are combined as the proposed facility characteristics to be carried forward for detailed EA.

7.0 Acronyms, Abbreviations, Definitions

An abbreviation and an acronym are both shortened versions of something else. Both can often be represented as a series of letters. Many people are unable to tell the difference between an abbreviation and an acronym.

– A –

Alternatives to, The Environmental Assessment Act (the "Act") requires that Undertakings being reviewed within the framework of the Act consider "alternatives to" the Undertaking, or functionally different ways of addressing the problem statement (in this case, managing waste). This is also known as an "Alternative to the Undertaking".

Alternative Daily Cover, cover material other than earthen material placed on the surface of the active face of a landfill at the end of each operating day to control odours, blowing litter, scavenging, etc. (California Department of Resources, 2016)

Alternative Methods, Various ways of carrying out the preferred undertaking that are technically feasible and economically viable[6].

– B –

Baseline, Term refers to environment conditions that exist before the proposed undertaking begins, against which subsequent changes can be referenced or measured i.e. landfilling is actively occurring at the site.

Baseline Studies, refers to "a range of pre-EA studies carried out to:

- *Identify environmental features that may influence alternative selection, site layout, etc.*
- *Identify areas or receptors that may require mitigation or compensation*
- *Provide data to enable prediction models if required*
- *Provide a baseline from which the results of future monitoring programs can be compared."[7]*

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[6] Ministry of the Environment, January 2014b, Section 4.2.2

[7] Based on definition from United Nations University GTP

Berm, refers to an elevated earthen ridge in a landfill site.

Buffer Area, refers to the areas of a landfill site that are not used for landfilling of waste.

– C –

Consultation – *Two-way communication with persons interested in the Ridge landfill and the EA.*

Commitment – Represents a course of action agreed to by Waste Connections to be implemented during the EA.

Cut-off Wall, is a term used in geotechnical engineering, and refers to a vertical clay barrier used to control the spread of contaminants.

Cumulative Effects, is the concentration of a contaminant in air which results from the discharges from multiple emitters in a given geographic or local area. It applies to emitters of contaminants governed by section 9 of the Environmental Protection Act[8].

-D –

Designated Haul Route, refers to Communication Road, Drury Line, and Erieau Road which are identified and used as the designated route for trucks entering and exiting the Ridge landfill from Highway 401.

Do–Nothing, An alternative that is typically included in the evaluation of alternative method that identifies the implications of doing nothing to address the problem or opportunity.

– E –

EA, Environmental Assessment, means an environmental assessment process described in Part II of the EAA and/or report submitted pursuant to subsection 5(1) of the EAA[9].

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[8] MECP

[9] Environmental Assessment Act

Effluent, refers to a liquid waste discharged from the site to the forcemain.

Environment, defined in the EA Act includes: natural environment (air, land, water, plant and animal life including humans), built environment (building, structure, machine), social, economic, cultural conditions and the interrelationships between them.

Evaluation, refers to the determination of the value, nature, character, or quality of something[10]*.*

– F –

Flaring, refers to the high temperature destruction (burning) of landfill gas generated by waste in the landfill and collected through a network of wells and pipes.

Fugitive Landfill Gas Emissions, refers to landfill gas that is not collected as part of an engineered landfill gas collection system.

– H –

Haul Route Study Area, The residences and businesses abutting the Designated haul route.

– I –

IC&I, refers to Industrial, Commercial and Institutional waste stream.

Impact Management Measures - Measures which can lesson potential negative environmental effects, or enhance positive effects including mitigation, compensation or community enhancement.

Indigenous Communities, The First Nations and Métis communities identified by the Ministry of Environment, Conservation and Parks that have potential to be interested in, or impacted by the Undertaking. These groups include the Caldwell First Nation, WIFN, Kettle and Stoney Point First Nation, Chiefs of Ontario, COTTFN, Moravian of the Thames, Munsee-Delaware Nation, Oneida of the Thames, Métis Nation of Ontario and the Aamjiwnaang First Nation.

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[10] Merriam-Webster Dictionary

Infill Area, refers to the approved waste cell located in the southwest corner of the Old Landfill. The Infill Area has not been developed yet.

– L –

Landfill, refers to an approved, engineered site used for the long-term disposal of waste.

Landfill Mining, refers to the process of excavating previously landfilled waste to recover valuable recyclable materials and/or space. This is a complicated process and its economic feasibility is based on the expected content of the landfill. It creates a high risk of contaminants escaping to the environment.

Landfill Site Area, This term encompasses the 262 ha area identified by the MECP which includes the fill areas and associated environmental works, and facilities required for the ancillary waste management activities.

Leachate, refers to the liquid produced when water passes through waste material.

Leachate Collection System, refers to the on-site system of pipes and drainage aggregate beneath or around a landfill mound that is designed to capture and move leachate to the forcemain and ultimately to the Blenheim Wastewater Treatment Lagoons.

– M –

MECP, Ministry of the Environment, Conservation and Parks.

Mitigation – Measures which can lesson potential negative environmental effects.

– N –

Net Effects, environmental effects, positive or negative that will remain after mitigation and impact management measures have been applied

– O –

Off-Site Study Area, The area within one (1) km of the maximum expanded fill area of the landfill.

Organics, refers to the biodegradable component of waste received at a landfill. Also referred to as green bin waste, originating from plants and animals, it includes: food, garden, yard, animal and plant based materials.

Old Landfill, This refers to the three (3) waste cells located at the northeast corner of the Landfill Site, adjacent to the entrance driveway. The Old Landfill was closed in 1999.

On-Site Study Area, The Ridge Landfill property including the Landfill Site Area, plus the proposed expansion areas.

– R –

Recovered Resources, This refers to recyclable materials that can be re-used.

Renewable Natural Gas, or RNG, is a low-carbon fuel that does not add new carbon to the atmosphere. It is a conventional natural gas replacement. Methane that is released from landfill waste can be recovered, cleaned and can be directly substituted for conventional natural gas[11]*.*

Resource Recovery, refers to materials or energy that can be taken from waste and used.

Ridge Landfill, Property that encompasses existing Landfill Site Area and proposed expansion. The site is owned by Ridge Limited Partnership. Ridge (Chatham) Holdings G. Inc., is the general partner and Waste Connections of Canada Ltd. is the limited partner.

– S –

Sensitive Receptors, refers to hospitals, schools, daycare facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse environmental effects.

Side Slope Liner, refers to the geomembrane or soil or both used as a liner on the sides of landfill cells.

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[11] Ministry of the Environment and Climate Change, May 2016

South Landfill, This refers to the waste cells located south of the Old Landfill. Development of the South Landfill began in August 2016.

Stakeholders, refers to 'interested persons' as defined in the "Code of Practice: Preparing and Reviewing Terms of Reference for Environmental Assessments in Ontario" (Ministry of the Environment, 2014b) (January2014).

Standard Cubic Feet per Minute (scfm), refers to the molar flow rate of a gas corrected to "standardized" conditions of temperature and pressure thus representing a fixed number of moles of gas regardless of composition and actual flow conditions.

– T –

Transfer Station (TS), refers to a facility where garbage (waste) is transferred from garbage collection trucks and consolidated into larger waste hauling trucks for transportation to waste processing, diversion, or disposal site.

– U –

Undertaking, The proposed expansion of the Ridge Landfill (also described herein as the "Project").

Upset, A condition at the on-site wastewater treatment facility that would cause the effluent quality to be out of compliance with the facility's MECP approval.

– W –

Waste Connections of Canada Inc., or "Waste Connections", is the proponent for this Undertaking. Waste Connections was formerly Progressive Waste Solutions Canada Inc. Progressive Waste Solutions and Waste Connections merged in an all-stock transaction as of June 1, 2016.

Waste Fill Area, This term encompasses the 131 ha area that is presently approved for the disposal of waste. The Waste Fill Area includes the Old Landfill, South Landfill, West Landfill and Infill Area.

Wastewater, refers to water containing dissolved or suspended solids, discharged from various land uses such as commercial, agricultural, industrial, and residential establishments.

West Landfill, refers to the waste cells located west of the Old Landfill. The West Landfill is currently accepting waste.

Acronyms

BWTL – Blenheim Wastewater Treatment Lagoons

COTTFN – Chippewas of the Thames First Nation

EA – Environmental Assessment

EAA, EA Act or the Act – The Environmental Assessment Act

ECA – Environmental Compliance Approval

ELC – Ecological Land Classification

GHG – Greenhouse Gas

IC&I – Industrial, Commercial and Institutional

LFG – Landfill Gas

LTVCA – Lower Thames Valley Conservation Authority

MECP – Ministry of Environment, Conservation and Parks

MNRF – Ministry of Natural Resources and Forestry

MRF – Materials Recovery Facility

PUC – Public Utilities Commission

RNG – Renewable Natural Gas

SAR – Species at Risk

SCC – Species of Conservation Concern

SCFM – Standard Cubic Feet per Minute

SWH – Significant Wildlife Habitat

ToR – Ridge Landfill Expansion Environmental Assessment Approved Amended Terms of Reference (May 2018)

WIFN – Walpole Island First Nation

References

California Department of Resources. (2016). CalRecycle Basics Alternative Daily Cover. Retrieved from: http://www.calrecycle.ca.gov/lgcentral/basics/adcbasic.htm

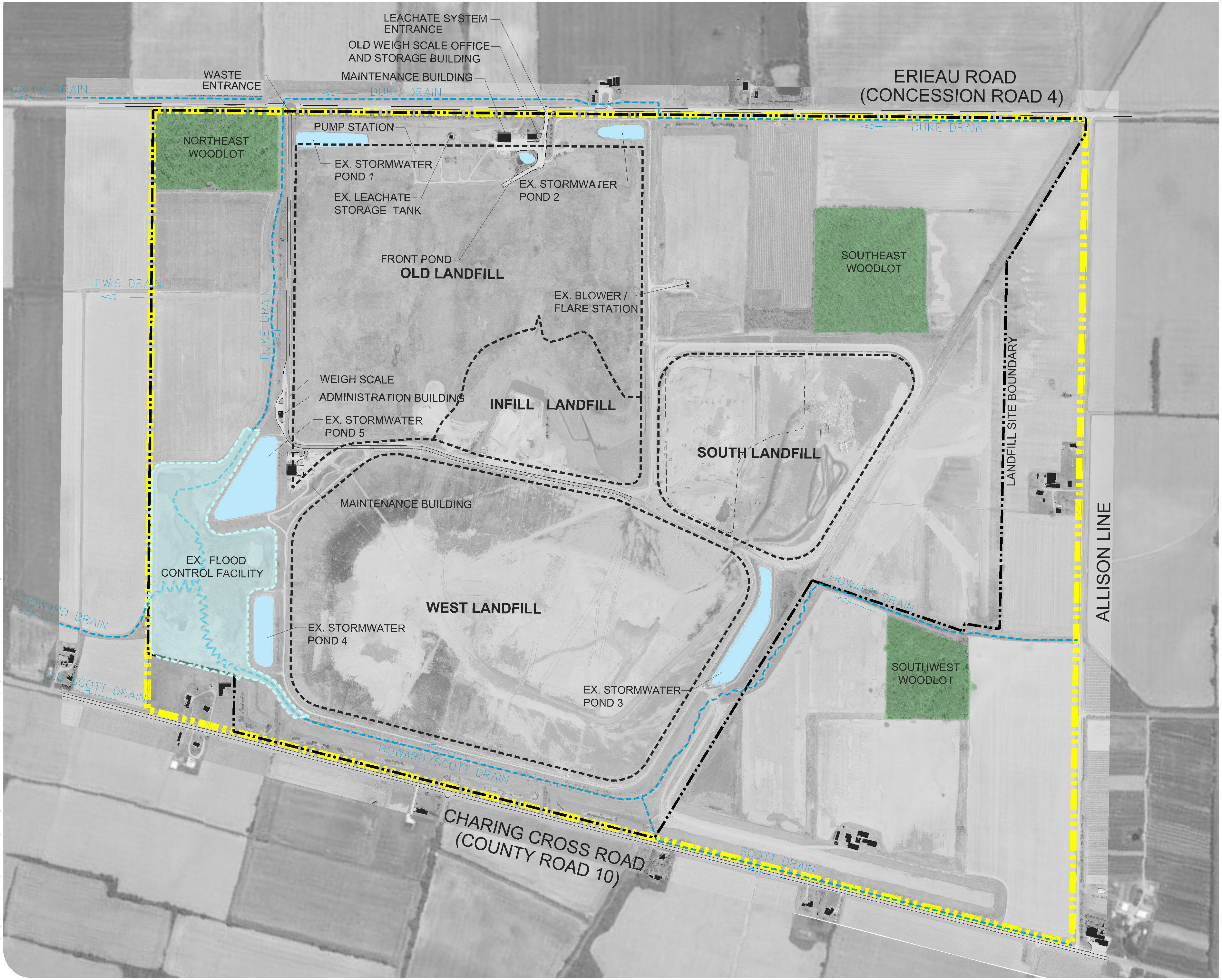
Dillon Consulting. (2017). Site Development, Operations and Monitoring 2018 Annual Report.

Dillon Consulting. (2015). Ridge Landfill 2014 Air Monitoring Report, BFI Canada, Inc.

Minister of the Environment. (2014b). Code of Practice for Preparing and Reviewing Environmental Assessments. Queen’s Printer for Ontario. Retrieved from: https://www.ontario.ca/document/preparing-and-reviewing-environmental-assessments-ontario-0

Appendix A

Site Figures



WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL
ENVIRONMENTAL ASSESSMENT

EXISTING SITE CONDITIONS AND CURRENTLY APPROVED WASTE LIMITS

FIGURE 1

- PROPERTY LIMITS
- EXISTING LANDFILL SITE BOUNDARY
- EXISTING WATER COURSE
- APPROVED WASTE LIMIT
- EXISTING POND
- EXISTING WOODLOT

0 100 200 400m

TRUE NORTH

PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
CHECKED BY: CO
DESIGNED BY: FG

DILLON CONSULTING

PROJECT: 14 1382
STATUS: FINAL
DATE: 03/29/16

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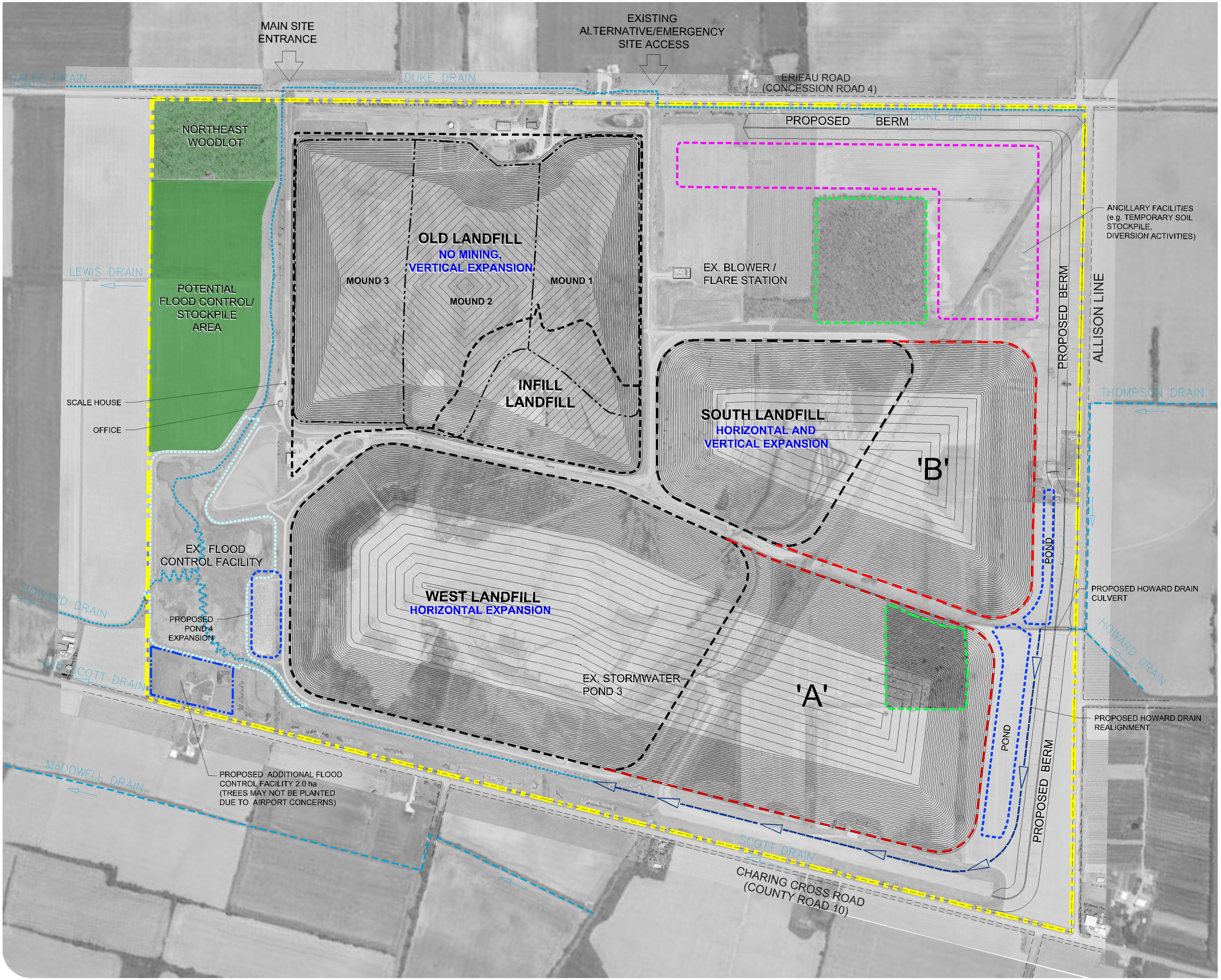

WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL
ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS
FIGURE 2
ALTERNATIVE 1
(HORIZONTAL AND VERTICAL EXPANSION)

- PROPERTY LIMITS
- APPROVED WASTE LIMIT
- OLD LANDFILL EXISTING WASTE LIMIT
- EXISTING WATER COURSE
- PROPOSED WASTE LIMIT FOR EXPANSION AREAS
- PROPOSED STORMWATER POND
- PROPOSED WATERCOURSE
- PROPOSED ROAD
- EXISTING WOODLOT AREAS

0 100 200 400m

TRUE NORTH

PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
CHECKED BY: CO
DESIGNED BY: FG

DILLON CONSULTING

PROJECT: 15 2456
STATUS: DRAFT
DATE: 05/31/17

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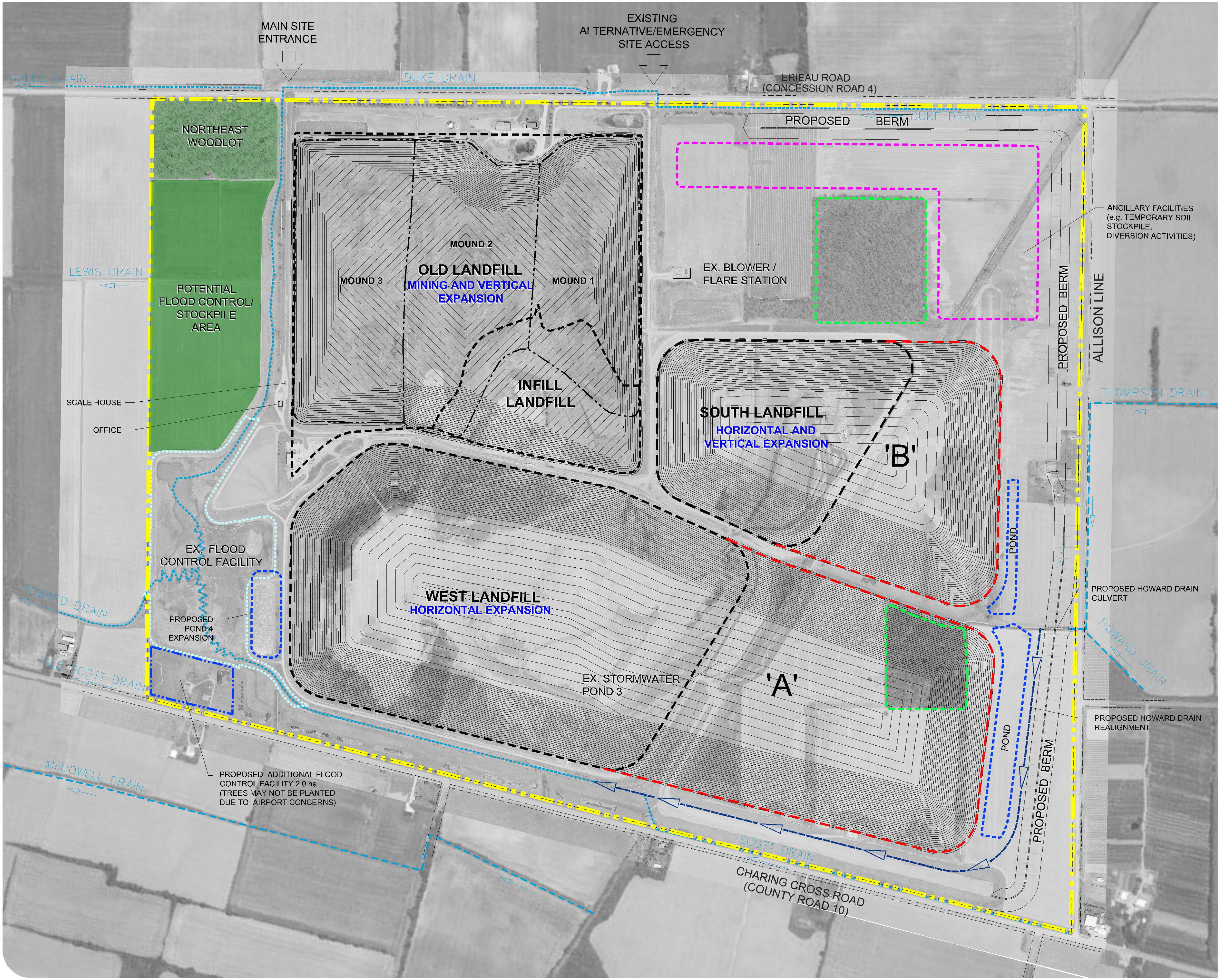

WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL
ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS
FIGURE 3
ALTERNATIVE 2
(HORIZONTAL AND VERTICAL EXPANSION PLUS LANDFILL MINING)

🟨	PROPERTY LIMITS
⬚	APPROVED WASTE LIMIT
▭	OLD LANDFILL EXISTING WASTE LIMIT
⇠	EXISTING WATER COURSE
🟥	PROPOSED WASTE LIMIT FOR EXPANSION AREAS
⬚	PROPOSED STORMWATER POND
⇠	PROPOSED WATERCOURSE
—	PROPOSED ROAD
🟩	EXISTING WOODLOT AREAS

0 100 200 400m

TRUE NORTH

PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
CHECKED BY: CO
DESIGNED BY: FG

DILLON CONSULTING

PROJECT: 15 2456
STATUS: DRAFT
DATE: 05/31/17

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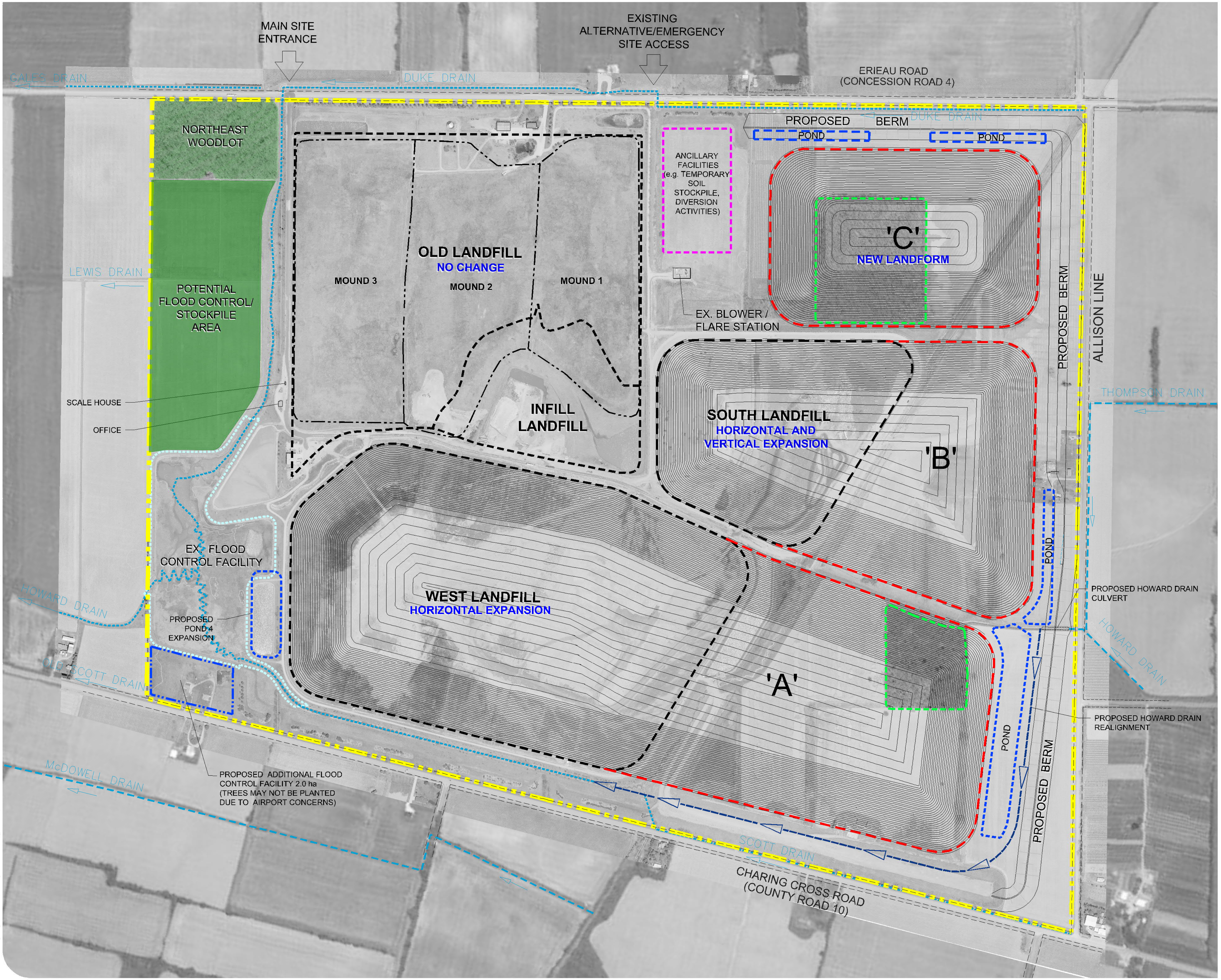

WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL
ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS

FIGURE 4
ALTERNATIVE 3
(HORIZONTAL EXPANSION)

- 🟨 PROPERTY LIMITS
- ⬚ APPROVED WASTE LIMIT
- ⬚ OLD LANDFILL EXISTING WASTE LIMIT
- ◁- - EXISTING WATER COURSE
- 🟥 PROPOSED WASTE LIMIT FOR EXPANSION AREAS
- ⬚ PROPOSED STORMWATER POND
- ◁- - PROPOSED WATERCOURSE
- ▬ PROPOSED ROAD
- ⬚ EXISTING WOODLOT AREAS

0 100 200 400m

TRUE NORTH

PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
CHECKED BY: CO
DESIGNED BY: FG

DILLON CONSULTING

PROJECT: 15 2456
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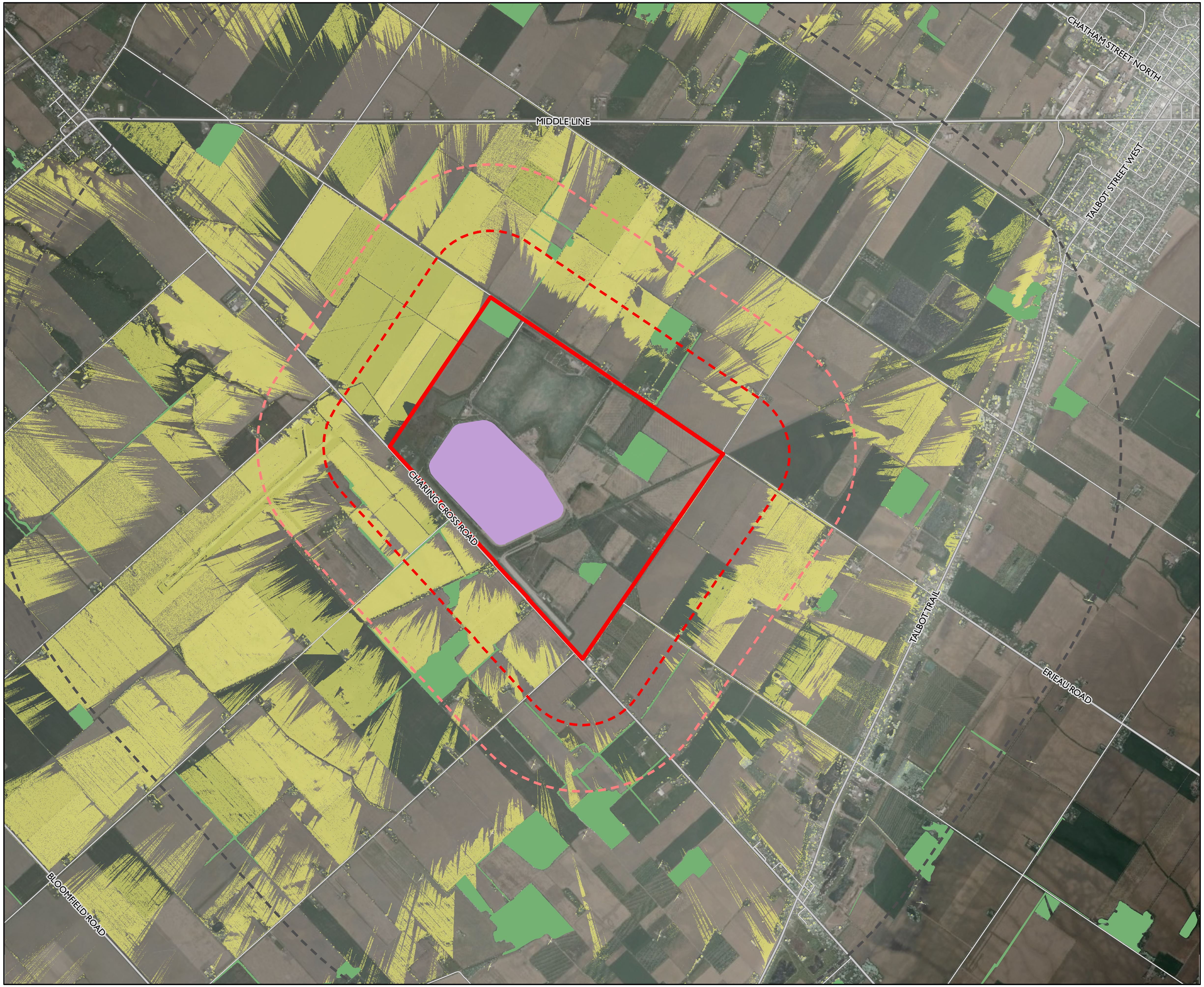


WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 5
EXISTING VIEWSHED

- 🟥 On Site Property Boundary
- 🟪 Existing Fill Area
- ▭ 500 m Property Boundary Setback
- ▭ 1 km Property Boundary Setback
- ▭ 3 km Property Boundary Setback
- 🟩 Woodlot
- 🟨 Visible Area

1:28,000

0 0.5 1 2 km

N E S W

MAP DRAWING INFORMATION:
DATA OBTAINED FROM MNRF

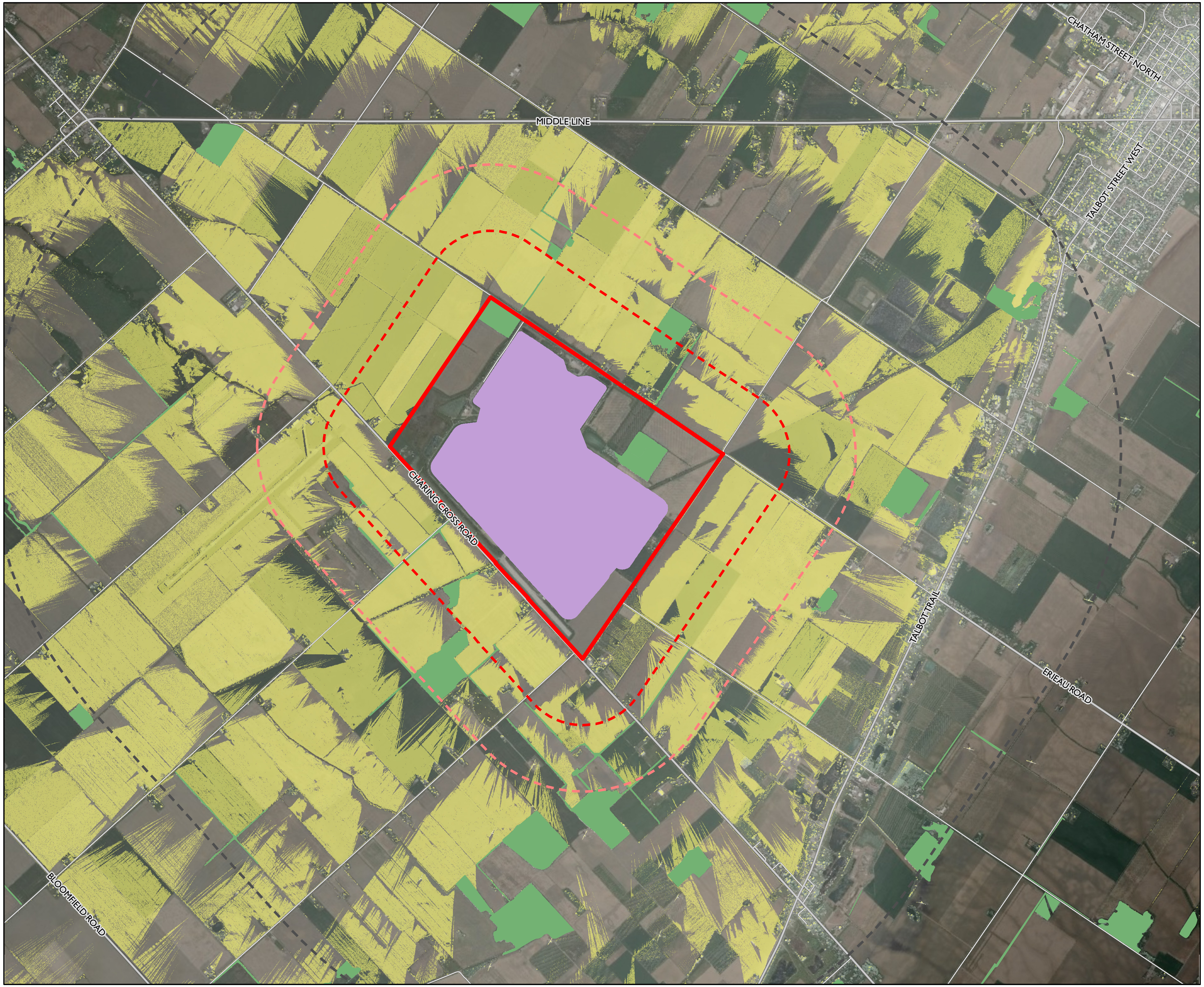
MAP CREATED BY: GM
MAP CHECKED BY: MB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON CONSULTING

PROJECT: 152456

STATUS: DRAFT

DATE: 2018-12-03



WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 6
ALTERNATIVE 1 VIEWSHED

🟥 On Site Property Boundary
🟪 Alternative 1 Fill Area
▭ 500 m Property Boundary Setback
▭ 1 km Property Boundary Setback
▭ 3 km Property Boundary Setback
🟩 Woodlot
🟨 Visible Area

1:28,000
0 0.5 1 2 km

N
W E
S

MAP DRAWING INFORMATION:
DATA OBTAINED FROM MNRF

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DILLON CONSULTING

PROJECT: 152456
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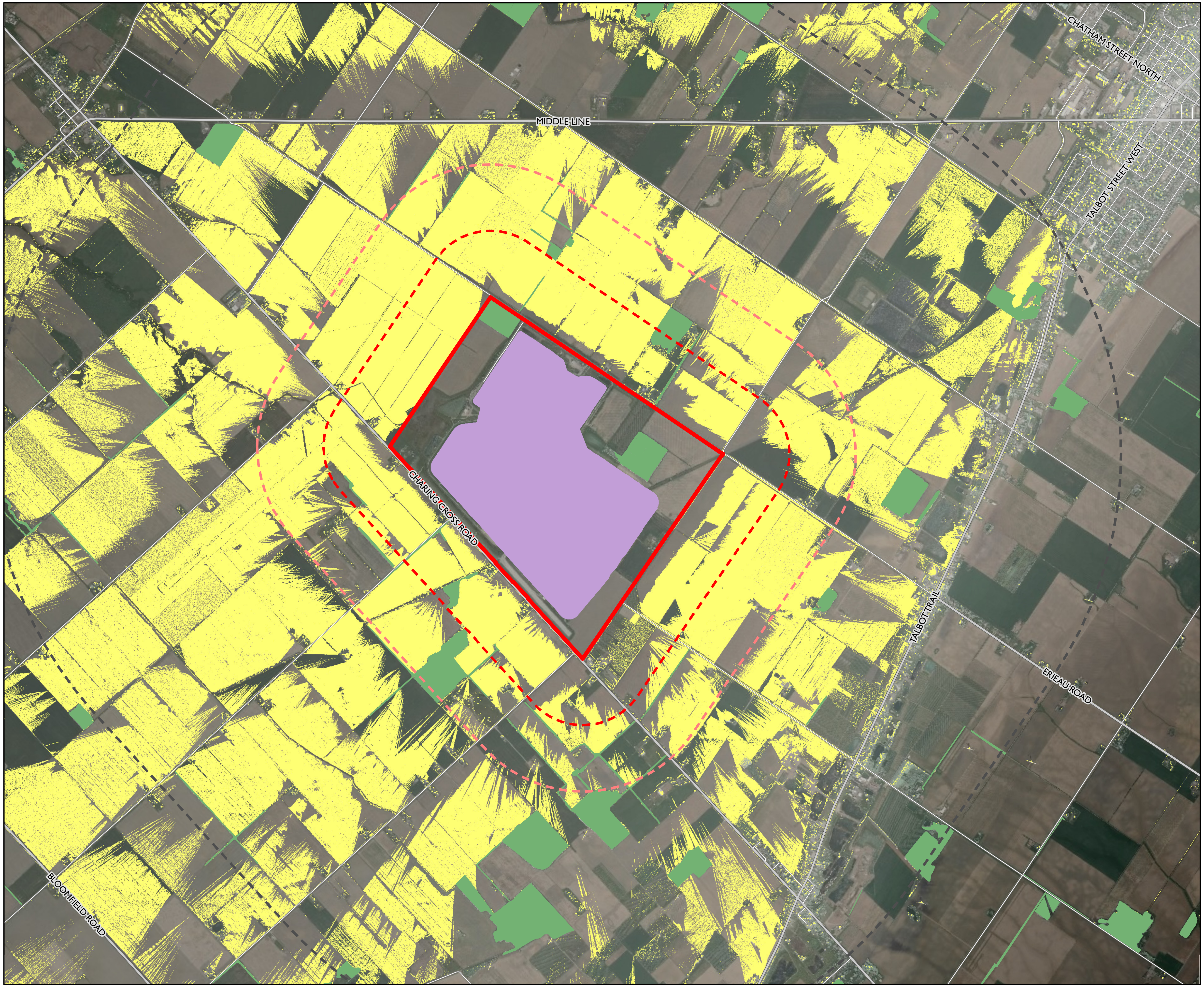


WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL ENVIRONMENTAL ASSESSMENT

FIGURE 7
ALTERNATIVE 2 VIEWSHED

🟥 On Site Property Boundary
🟪 Alternative 2 Fill Area
▭ 500 m Property Boundary Setback
▭ 1 km Property Boundary Setback
▭ 3 km Property Boundary Setback
🟩 Woodlot
🟨 Visible Area

1:28,000
0 0.5 1 2 km

N
W E
S

MAP DRAWING INFORMATION:
DATA OBTAINED FROM MNRF

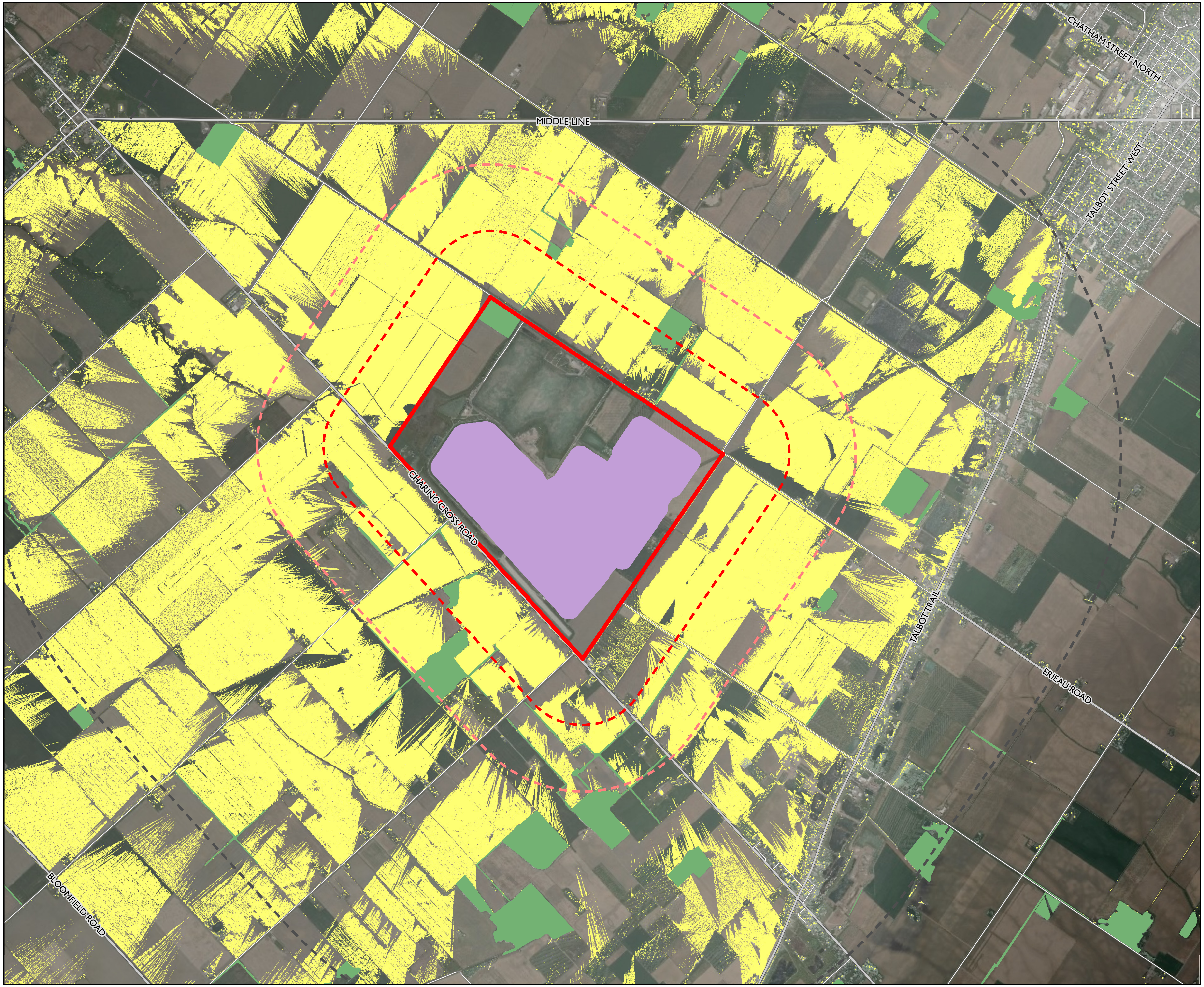
MAP CREATED BY: GM
MAP CHECKED BY: MB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON
CONSULTING

PROJECT: 152456

STATUS: DRAFT

DATE: 2018-12-03



Waste
Connections
of
Canada

RIDGE LANDFILL
ENVIRONMENTAL ASSESSMENT

FIGURE 8
ALTERNATIVE 3 VIEWSHED

🟥 On Site Property Boundary
🟪 Alternative 3 Fill Area
▭ 500 m Property Boundary Setback
▭ 1 km Property Boundary Setback
▭ 3 km Property Boundary Setback
🟩 Woodlot
🟨 Visible Area

1:28,000
0 0.5 1 2 km

N
W E
S

MAP DRAWING INFORMATION:
DATA OBTAINED FROM MNRF

MAP CREATED BY: GM
MAP CHECKED BY: MB
MAP PROJECTION: NAD 1983 UTM Zone 17N

DILLON
CONSULTING

PROJECT: 152456
STATUS: DRAFT
DATE: 2018-12-03

Appendix B

Evaluation Criteria Tables

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Draft criteria for the evaluation of site development alternatives were included in the Approved Amended Terms of Reference (May 2018). The criteria and indicators have since been revised based on input from the Ministry of the Environment, Walpole Island First Nation and as a result of discussion with the community at a workshop and open house in the spring/summer of 2018.

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Natural Biological – Terrestrial Ecosystems	1	• Potential for effect on terrestrial systems from construction and operation.	• Area and type of terrestrial systems (e.g., significant woodlands, hedgerows, wetlands, etc.) to be removed on-site. • Area and type of terrestrial systems (e.g., significant woodlands, hedgerows, wetlands, etc.) potentially disrupted within 1 km.	• Existing and proposed facility characteristics • Natural Environment Existing Conditions Report • Aerial photography & GIS mapping • ELC mapping • Official Plan mapping • Communication with agencies (e.g., MNRF) and knowledgeable citizens	There are minimal features on-site as it is an active landfill property. However, the existing woodlots in particular are important to some people in the community.
	2	• Potential for effect on habitat of Endangered or Threatened species during construction.	• Area of habitat for endangered or threatened species on-site.	• ELC mapping • Natural Environment Existing Conditions Report	This criterion was added as a result of feedback received from Indigenous Communities.
	3	• Potential effect on medicinal or other culturally sensitive species of importance to First Nations Groups during construction.	• Area and type of species of importance to be removed on-site.	• Natural Environment Existing Conditions Report • First Nations input	This criterion was added as a result of feedback received from Indigenous Communities.
Natural Biological – Aquatic Ecosystems	4	• Potential for effect on aquatic systems during construction	• Amount and type of aquatic systems (i.e., ponds, drains) that would be displaced on-site.	• Natural Environment Existing Conditions Report Existing and proposed facility characteristics • Communication with MNRF and LTVCA	There are drains on-site that may need to be moved for the site development alternatives.

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Natural Physical – Ground Water	5	• Potential impacts to groundwater quality during construction, operation and post closure.	• Qualitative assessment of ability of alternative to meet Reasonable Use Guideline.	• Site data collected through intrusive investigations. • Leachate characteristics taken from Table 1, Section 10 of O.Reg 232/98. • Landfill design input	Differences in site development footprints and heights may result in different abilities to meet reasonable use guidelines.
	6	• Leachate contaminating lifespan during construction, operation and post closure.	• Prediction based on tonnes of waste per hectare of footprint area and leachate generation rate.	• Leachate characteristics taken from Table 1, Section 10 of O.Reg 232/98. • Estimation from the method used by Rowe et.al (2004)	Differences in site development alternative footprints and heights may result in different contaminating lifespans. This criterion was added based on feedback from MECP at the ToR approval stage.
	7	• Potential impacts to groundwater quantity.	• Landfill footprint.	• Existing and proposed facility characteristics	The size of the footprint represents the area removed from infiltration.
	8	• Potential impacts to water supply wells.	• Extent of natural setting protection.	• Location of municipal water supply • Existing and proposed facility characteristics	Local residents have expressed concerns about drinking water.

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Natural Physical – Surface Water	9	• Potential impacts to surface water quantity.	• Changes in peak flows pre- and post-expansion.	• Topographic mapping and aerial imagery • Climate data • Soils and land use mapping • Previous drainage studies • Existing and proposed facility characteristics • Field observations • Aerial photography & GIS mapping • Past monitoring reports • Surface water modelling results	Differences in site development alternative footprints and heights may result in different quantities of runoff.
	10	• Potential impacts to surface water quality.	• Anticipated change in temperature, water quality, benthos and fish habitat.	• MECP published water quality data • Water quality monitoring data • Surface water quality program • Benthic community inventory • Fish habitat survey	Differences in site development alternatives footprints and heights may result in different levels of runoff that could impact surface water quality.
Natural Physical - Atmospheric	11	• Potential for dust during construction and operation.	• Relative levels of material movement and vehicular activity as an indicator for dust and combustion emissions.	• Existing and proposed facility characteristics and operational parameters	Construction, landfilling waste and landfill mining has the potential to cause some dust.
	12	• Potential for impacts to air quality during construction and operation.	• Nitrogen oxides, sulphur dioxide and carbon monoxide (together referred to as criteria air contaminants): relative levels of vehicular activity as	• Existing and proposed facility characteristics and operational parameters	Construction, landfilling waste and landfill mining has the potential to result in impact to air quality.

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
			an indicator for amount of fuel combusted. • Hydrogen sulphide, vinyl chloride, chloroform: anticipated difference in landfill gas emissions.		
Natural Physical – Climate Change	13	• Potential for greenhouse gas emissions during construction and operation.	• Daily/annual waste volume landfilled • Anticipated differences in on-site vehicular activity • Extent of woodlot removal	• Existing and proposed facility characteristics	Landfilling waste has the potential to release greenhouse gases that can contribute to climate change.
	14	• Resilience of engineered systems.	• Qualitative assessment of the resiliency of proposed infrastructure.	• Existing and proposed facility characteristics	Climate change results in less predictable weather patterns and storms that are larger and more violent. These storms could effects landfill infrastructure which could result in a negative impact on the environment.
Social	15	• Potential for noise/vibration impacts on residents during site construction and site operation.	• Number of households in the study area who may experience noise/vibration impacts.	• GIS mapping • Survey input from local residents as available • Existing and future facility characteristics • Public consultation	Residents in the vicinity of the site may experience noise impacts that are already familiar, from the current and continued operation of the landfill. This experience may differ depending on the characteristics of the site development alternatives.

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
	16	• Potential for odour during construction and operation.	• Number of potential odour sources, relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors.	• Existing and proposed facility characteristics • GIS mapping • Survey input from local residents as available • Public consultation	Landfilling waste has the potential to cause some odour. Landfill mining is a component included in the site development alternatives which has an even greater potential to result in odour.
	17	• Potential for visual impacts on residents during site construction and site operation.	• Number of households in the study area who may experience a change in view.	• GIS mapping • Existing and future facility characteristics • Public consultation • Survey input from local residents as available	Residents in the vicinity of the site may have different views of the landfill based on the site development alternatives.
	18	• Potential for landfill traffic effect on residents during construction and operation.	• Number of waste trucks during operation • Number of trucks for soil import/export for construction.	• Existing and proposed facility characteristics • Survey input from local residents as available • Public consultation	The annual tonnage and the haul route for a future expanded site will be the same as it is currently. There may be potential for minor additional truck traffic during construction for soil import/export.
	19	• Potential for effect on worker safety during construction and operation.	• Likelihood of safety concerns with alternative.	• Existing and proposed facility characteristics	The safety of workers is important to Waste Connections. The difference in site development alternatives footprints and heights may result in different potential safety concerns.

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Economic	20	• Potential for effect on businesses during construction and operation.	• Number of businesses (e.g., agricultural operations) in the study area who may experience disruption (e.g., as a result of continued soil haulage during operations).	• GIS mapping • Survey input from local businesses as available • Existing and proposed facility characteristics • Public consultation activities	There are limited businesses in the vicinity of the landfill (three in the study area) that may experience different nuisance effects depending on the site development alternatives.
	21	• Potential for landfill traffic effect on businesses during construction and operation.	• Number of waste trucks during operation. • Number of trucks for soil import/export for construction.	• Existing and proposed facility characteristics • Survey input from local businesses as available	The annual tonnage for a future expanded site will be the same as it is currently. There may be potential for minor additional truck traffic during construction for soil import/export.
	22	• Potential for effect on agriculture during construction.	• Area of on-site crop production lost. • Area of Class 1-3 soils lost.	• GIS mapping • Personal communication • Soils mapping of Ontario • Canada Land Inventory • Official Plan mapping	The area around the site is primarily agriculture. The characteristics of the different development alternatives may have minor effect on farmers and farm operations.
	23	• Cost of facility.	• Approximate cost of site development alternative.	• Cost estimate	The site development alternative characteristics may result in differing capital and operating costs.
Cultural	24	• Potential effects to archaeological	• Area of undisturbed land affected by the expansion alternative.	• Stage 1 archaeological assessment • Existing and proposed facility characteristics	There is undisturbed land remaining on-site that

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
		resources as a result of construction.			could have archaeological resources.
	25	• Potential effects to cultural resources as a result of construction.	• Number and type of cultural resources that may be affected by expansion alternative.	• Cultural Heritage Resource Assessment • Existing and proposed facility characteristics	There are identified cultural heritage resources on-site that could be impacted by alternatives.
Built	26	• Effects on land use as a result of construction.	• Size of landfill footprint.	• Existing and proposed facility characteristics	The site development alternatives involve different footprints resulting in differences in the use of land.
	27	• Potential effects on existing transportation infrastructure and transportation operation.	• Number of waste trucks during operation. • Number of trucks for soil import/export for construction. • Anticipated impact on the Chatham-Kent Airport.	• Existing and proposed facility characteristics • Annual tonnage	The annual tonnage to the site will not change so the number of landfill trucks will remain approximately the same as they are today. There may be potential for minor additional truck traffic during construction for soil import/export. Continued landfill truck traffic also has the potential to impact safety. It is noted that the airfield in the vicinity of the site equally dictates the height of landfilling for all alternatives and thus is not included in the

Table B-1: Criteria for the Evaluation of Site Development Alternatives (Master List)

Criteria for the Evaluation of Site Development Alternatives					
Environment		**Criteria**	**Indicators**	**Data Sources**	**Rationale**
	28				comparative evaluation criteria.
	28	- Potential for effects on existing landfill infrastructure as a result of construction.	- Extent and type of change required to existing site facilities.	- Existing and proposed facility characteristics	Site development alternative may result in different needs to adjust existing features on-site.
	29	- Ease to implement/construct and maintain/operate.	- Anticipated complexity of construction and operation.	- Existing and proposed facility characteristics	The alternatives will have different levels of complexity for Waste Connections staff to construct and operate.

Table B-2: Criteria for the Evaluation of Leachate Treatment Alternatives

The table below includes the criteria relevant to the leachate treatment evaluation with associated indicators, data sources and rationale which were reviewed by MECP and WIFN. Where criteria from the master list were not used, an explanation is provided below the table. Master list refers to Table B-1 that was used as the starting point for the development of criteria for the evaluation of leachate treatment alternatives.

Criteria for the Evaluation of Leachate Treatment Alternatives				
Environment	**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Natural Biological	• Potential for effect on aquatic systems during construction and operation.	• Potential for accidental spill or leakage to on-site watercourses.	• Existing and proposed facility characteristics	Different leachate treatment systems may have different potential to discharge untreated leachate to on-site watercourses.
Natural Physical	• Potential impacts to groundwater quality during construction, operation and post closure.	• Potential for spill or leakage of leachate, that may potentially affect groundwater.	• Existing and proposed facility characteristics	Different ways of leachate treatment may have different impacts on ground water.
	• Potential impacts to surface water quantity and quality.	• Potential for spill or leakage of leachate to on-site watercourses.	• Existing and proposed facility characteristics	Different ways of leachate treatment may have different impacts on surface water.
	• Potential impacts to air quality during construction and operation.	• Nitrogen Oxides, Sulphur Dioxide and Carbon Monoxide (together referred to as criteria air contaminants): relative levels of construction as an indicator. • Relative amount of energy required to operate facility.	• Existing and proposed facility characteristics	Different ways of leachate treatment may have different impacts on air quality.
	• Potential for greenhouse gas (GHG) emissions	• Qualitative assessment of the potential for greenhouse gas (GHG) emissions as a result of leachate alternatives.	• Existing and proposed facility characteristics	Some leachate treatment methods involve trucking which results in GHG.

Table B-2: Criteria for the Evaluation of Leachate Treatment Alternatives

Criteria for the Evaluation of Leachate Treatment Alternatives				
Environment	**Criteria**	**Indicators**	**Data Sources**	**Rationale**
	during construction and operation.			
Social	• Potential for noise/vibration impacts on residents during construction and operation.	• Number of households in the study area who may experience noise/vibration impacts as a result of leachate treatment facility construction and operation.	• GIS mapping • Existing and proposed facility characteristics	Different ways to treat leachate may have different impacts on residents around the landfill during construction.
	• Potential for odour during construction and operation.	• Number of potential odour sources from leachate treatment facility construction and operation; relative significance of odour sources and relative distance of odour sources to sensitive receptors.	• Feedback from neighbours.	Different ways to treat leachate may have different odour impacts on residents around the landfill during operation.
	• Potential for landfill traffic effect on residents during construction and operation.	• Number of leachate trucks during operation as a result of leachate production.	• Existing and proposed facility characteristics	Different ways to treat leachate may have different traffic impacts on residents around the landfill and along the haul route.
Economic	• Potential for effect on businesses during construction and operation.	• Number of potential odour sources and relative significance of odour sources. • Extent of trucking.	• GIS mapping • Existing and proposed facility characteristics	Different ways to treat leachate may have different impacts on businesses around the landfill.
	• Cost of facility.	• Approximate cost of the leachate treatment facility alternative.	• Existing and proposed facility characteristics	Different leachate treatment methods may have different costs.

Table B-2: Criteria for the Evaluation of Leachate Treatment Alternatives

Criteria for the Evaluation of Leachate Treatment Alternatives				
Environment	**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Cultural	• Potential effects to archaeological resources as a result of construction.	• Area of undisturbed land affected by the on-site component of the leachate treatment alternative.	• Stage 1 archaeological assessment • Existing and proposed facility characteristics	There is undisturbed land remaining on-site that could have archaeological resources.
Built	• Potential effects on existing transportation infrastructure and transportation operations.	• Anticipated number of trucks required.	• Existing and proposed facility characteristics	Some leachate treatment methods involve trucking which could have transportation impacts.
	• Ease to implement/construct and maintain/operate.	• Anticipated complexity of construction and operation.	• Existing and proposed facility characteristics	The alternatives will have different levels of complexity to construct and operate.

The following provides an explanation on why some criteria from the master list were not included in the evaluation of leachate treatment alternatives:

- **Potential for effect on terrestrial systems from construction and operation** – Leachate treatment would not have any effect on the woodlot which is the main terrestrial feature.
- **Potential for effect on habitat of endangered/threatened species during construction -** Leachate treatment would not have any effect on the woodlot which is the main terrestrial feature.
- **Potential effect on medicinal or other culturally sensitive species of importance to First Nations groups during construction -** Leachate treatment would not have any effect on the woodlot which is the main terrestrial feature.
- **Leachate contaminating lifespan –** Leachate contaminating lifespan is the time required for leachate concentrations to reduce within the landfill. It is not related to where or how leachate is treated.

Table B-2: Criteria for the Evaluation of Leachate Treatment Alternatives

- **Potential impact to groundwater quantity** – This criterion considers the size of the footprint and the resulting reduction in recharge area. Given the relatively small size of the leachate treatment facilities these will have no discernable impact on recharge.
- **Potential impacts to water supply wells –** The location and type of leachate treatment is not related to water supply wells.
- **Potential for dust during construction** – Construction activity associated with leachate treatment is minimal relative to the landfill construction activity; there will be no discernable impact on dust from leachate treatment.
- **Resilience of an engineered systems** – All leachate treatment alternatives will be designed to be resilient to changing climate.
- **Potential for visual impacts on residents during site construction and site operation** – All leachate treatment facilities would be behind berms and not noticeable to the community.
- **Potential for effect on worker safety** – Operation of all three alternatives must meet workplace health & safety regulations.
- **Potential for landfill traffic on existing businesses during** – All 3 alternatives include conveying treated leachate/effluent via the existing pipe. Any trucking of leachate/effluent is for contingency only and will be the same for all three alternatives.
- **Potential for effect on agriculture during construction** – None of the alternatives would result in disruption/loss of agricultural land beyond the impact for the landfill itself.
- **Potential effects on cultural resources** – None of the alternatives would result in loss of cultural resources.
- **Potential for effects on existing landfill infrastructure** – None of the alternatives would result in significant impact on existing infrastructure.

Table B-3: Criteria for the Evaluation of Landfill Gas Management Alternatives

The table below includes the criteria relevant to the landfill gas management evaluation with associated indicators, data sources and rationale which were reviewed by MECP and WIFN. Where criteria from the master list were not used, an explanation is provided below the table. Master list refers to Table B-1 that was used as the starting point for the development of criteria for the evaluation of landfill gas management alternatives.

Criteria for the Evaluation of Landfill Gas Management Alternatives				
Environment	**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Natural Physical	• Potential for impacts to air quality during construction and operation.	• Relative levels of construction as an indicator of the generation of air contaminants from equipment exhaust (nitrogen oxides, sulphur dioxide and carbon monoxide). • Relative amount of energy required to operate facility.	• Existing and proposed facility characteristics	Different ways that landfill gas management may have different impacts on air quality.
	• Potential for greenhouse gas (GHG) emissions during construction and operation.	• Qualitative assessment of the potential for greenhouse gas (GHG) emissions reduction as a result of landfill gas alternatives.	• Existing and proposed facility characteristics	Landfills release greenhouse gases (GHG) that contribute to climate change. Collecting this gas reduces GHGs and additionally the use of landfill gas can also displace the use of conventional fuels, further offsetting GHGs. Different methods to manage landfill gas could have different impacts to GHGs.
Social	• Potential for noise as a result of landfill gas management facility construction and operation.	• Number of occupied households in the study area who may experience noise or other disturbance.	• GIS mapping • Existing and proposed facility characteristics	The landfill gas management alternatives represent two difference scenarios – maintaining the status quo or actively using the gas. These scenarios will have different degrees of construction and thus different construction

Table B-3: Criteria for the Evaluation of Landfill Gas Management Alternatives

Criteria for the Evaluation of Landfill Gas Management Alternatives				
Environment	**Criteria**	**Indicators**	**Data Sources**	**Rationale**
				impacts on-site, and in the study area.
	• Potential for odour during construction and operation.	• Number of potential odour sources, relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors.	• GIS mapping • Feedback from neighbours. • Existing and proposed facility characteristics	Different ways to manage landfill gas may have different impacts.
Economic	• Potential for effect on businesses during construction and operation	• Number of potential odour sources and relative significance of odour sources (if characterization is possible), distance of odour sources to sensitive receptors. • Qualitative assessment for noise potential of on-site landfill gas management equipment.	• GIS mapping • Existing and proposed facility characteristics	Different ways to manage landfill gas have the potential to result in different odour and/or noise impacts which is the main disruption effect to local businesses.
	• Cost of facility.	• Approximate cost of landfill gas recovery facility.	• Cost estimate	Different LF gas management alternatives may result in differing capital and operating costs.
Cultural	• Potential effects to archaeological resources as a result of construction.	• Area of undisturbed land affected by the on-site component of landfill gas management alternative.	• Stage 1 archaeological assessment • Existing and proposed facility characteristics	There is undisturbed land remaining on site that could have archaeological resources.

Table B-3: Criteria for the Evaluation of Landfill Gas Management Alternatives

Criteria for the Evaluation of Landfill Gas Management Alternatives				
Environment	**Criteria**	**Indicators**	**Data Sources**	**Rationale**
Built	• Ease to implement/construct and maintain/operate.	• Anticipated complexity of construction and operation.	• Existing and proposed facility characteristics	The alternatives will have different levels of complexity to construct and operate.

The following provides an explanation on why some environmental components/criteria from the master list were not included in the evaluation of landfill gas alternatives:

- **Natural Environment Biological – Terrestrial Ecosystems** – Landfill gas management would not have any effect on the woodlot which is the main terrestrial feature.
- **Natural Environment Biological – Aquatic Ecosystems** – There is no potential impact on aquatic systems from landfill gas management.
- **Natural Environment Physical - Groundwater**– Landfill gas management will not impact groundwater quality at the site.
- **Natural Environment Physical – Surface Water** – Landfill gas management will not impact surface water quantity or quality.
- **Potential for dust during construction** – Construction activity associated with landfill gas management is minimal relative to the landfill construction activity; there will be no discernable impact on dust from this on-site construction.
- **Atmospheric, relative levels of landfill gas as a potential indicator for dust**- As no dust is created as a result of landfill gas management, this criteria is removed from further study, based on consultation with stakeholders and the MECP.
- **Resilience of an engineered systems -** No discernable differences are anticipated to the resiliency of the proposed infrastructure between the three landfill gas alternatives.
- **Potential for landfill traffic effect on residents off-site and along the haul route** - Landfill gas is collected and managed on-site and no traffic effects occur from landfill gas management on-site.
- **Potential for visual impacts on residents during site construction and site operation -** No differences will exist between alternatives with respect to landfill gas alternatives.
- **Potential for worker health and safety during construction and operation** - Operation of all alternatives must meet workplace health & safety regulations.

Table B-3: Criteria for the Evaluation of Landfill Gas Management Alternatives

- **Potential for effect on agricultural during construction -** No loss of agriculture would result from any landfill gas facility alternative constructed on-site.
- **Potential for landfill traffic effect on businesses during construction and operation –** Minor onsite construction would occur with limited trucking and there would be no discernable difference between alternatives.
- **Potential effects to cultural resources as a result of construction -** None of the alternatives would result in loss of cultural resources.

- **Effects on land use as a result of construction –** None of the alternatives involve significant footprint size to identify a difference in future land use flexibility.
- **Potential effects on existing transportation infrastructure -** Minor onsite construction would occur with limited trucking and there would be no discernable difference between alternatives.

Appendix C

Site Alternative Supporting Documents

Ridge Landfill Expansion
Capacity Summary
Table 1

Alternative ID	Figure No.	Composition	A (A1 + A2) (Mm3)	B (Mm3)	Reduced B (Mm3)	C (Mm3)	Mound 1 Mining (Mm3)	Mound 2 Mining (Mm3)	Mound 2 Excavation (Mm3)	Mound 3 Mining (Mm3)	Vertical Expansion of the Old Landfill (Mm3)	Disposal Capacity (Mm3)	Meets 28.9 Mm3 Needs? (Yes/No)
		Available Capacity (Mm3)	*13.2*	*8.6*	*6.5*	*7.1*	*0.4*	*0.5*	*0.8*	*0.5*	*7.2*		
1	1	Lateral expansions of West Landfill (Area A) and South Landfill (Area B), South Landfill (Area B) and Old Landfill vertical expansions	13.2	8.6							7.2	28.9	Yes
2	2	Lateral expansions of West Landfill (Area A) and South Landfill (Area "Reduced" B)*, South Landfill and Old Landfill vertical expansions. Landfill mining of Old Landfill	13.2		6.4		0.4	0.5	0.8	0.5	7.2	28.9	Yes
3	3	Lateral expansions of the West Landfill (Area A) and the South Landfill (Area B). Vertical expansion of the South Landfill and creation of new landform C	13.2	8.6		7.1						28.9	Yes

* For Alternative 2, the size of area B is reduced from Alternatives 1 and 3 because of the capacity gained through landfill mining activity.
All calculations rounded to the nearsest 0.1 Mm3
Volume of vertical expansion of West and South Landfills included in Area A and B calculations.

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CONSULTING

WASTE CONNECTIONS OF CANADA

Landfill Mining Assessment Report

Ridge Landfill Expansion EA

June 2018 – 15-2456

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Executive Summary

Waste Connections of Canada Inc. (WCC) is proposing to expand the Ridge Landfill and one of the contemplated options is to mine the existing portion of the site known as the Old Landfill to gain additional landfill capacity. Landfill mining (or landfill reclamation) consists of excavating existing disposed waste and cover material, attempt to recover typically 1-2% by volume of recyclables, separate earthen material or “fines”, and return the waste to an engineered disposal area.

The purpose of this report is to assess the site-specific advantages and disadvantages associated with landfill mining. To support this mining assessment report, we reviewed available background documents, completed a literature review and interviews with landfill managers that have completed mining projects, conducted a site investigation at the Old Landfill (i.e. drilled boreholes, observed the type of waste materials and measured leachate levels).

Landfill mining has been completed in Ontario and elsewhere in North America under favourable conditions when combined with significant drivers such as remediating groundwater impacts, gaining landfill capacity or accessing soil for future needs.

As discussed in this report, the Old Landfill does not have favourable conditions for landfill mining and none of the typical main drivers apply. Therefore, the potential advantages associated with landfill mining are limited and are by far outweighed by the various challenges and concerns specific to the Old Landfill.

The Ridge Landfill future capacity needs can be achieved by expanding the waste footprint horizontally and vertically expanding the Old Landfill without the contemplated mining component.

1.0 Introduction

1.1 Purpose of Report

Waste Connections of Canada (WCC) is currently undertaking an Environmental Assessment (EA) to expand the Ridge Landfill to fulfill a need for additional waste disposal capacity in Ontario. The proposed expansion would maintain the annual fill rate and extend the operating life of the facility for an additional 20 years. The EA will consider site development alternatives to physically expand the waste disposal capacity of the site. The primary purpose of this report is to examine the technical and economic feasibility, benefits and challenges related to undertaking landfill mining activities at the Old Landfill as a way to gain landfill capacity. Landfill mining has been discussed with the Ministry of the Environment and Climate Change (MOECC) and was described as a potential component of a site development alternative in the Terms of Reference (ToR) for the EA.

This report documents a desktop assessment for the potential to mine a portion of the Ridge Landfill. In preparing this report, we reviewed background documents available in our files for the Ridge Landfill, conducted interviews with WCC personnel, reviewed notes of previous site visits at the City of Barrie Landfill in Ontario and Ocean County Landfill mining project in New Jersey, interviewed landfill operators that have completed or are completing other mining (reclamation) projects in Ontario, and completed a literature review for landfill mining projects in Ontario and the USA.

2.0 Background

The Ridge Landfill started operations at the area currently known as the Old Landfill. The Old Landfill started operations in 1963 (Garter Lee, 1981) and received a Certificate of Approval (now called Environmental Compliance Approval) No. A021601, which was dated July 25, 1983.

The Waste Certificate of Approval changed its name to Environmental Compliance Approval No. A021601 (Waste ECA) and was consolidated in May 1, 2013. The Old Landfill is referred to in the consolidated Waste ECA as the Existing Fill Area with a 48.2 hectare waste fill area.

The Old Landfill did not have a weigh scale until 1992. Prior to 1992, waste records were tracked using truck load counts or ground survey methods.

Maps, aerial photos and plans are available from 1981 (Dillon, 1981 and Garter Lee, 1981).

The Old Landfill has 3 Mounds as shown on *Figure 1*. The landfill operations first started in Mound 2 and subsequently Mounds 1 and 3 were developed. The Old Landfill operated until December 31, 1999 and has not received waste since then.

3.0 Old Landfill Design

The development of the Old Landfill started in Mound 2 in 1963 (Garter Lee, 1981). A dozer was the only equipment on-site to excavate trenches, spread the waste and fill (trench and fill method) at Mound 2. The majority of Mound 2 was developed using the trench and fill method. According to Tim Kozlof (former Landfill Manager), the Mound 2 trenches had depths between 3 and 4.5 m (10 and 15 ft.) below the original ground. The filling method changed at later stages of Mound 2 with the introduction of a cell filling method (i.e. excavation of a wide area with rectangular or square shape excavated below the ground surface and filled to a final grade above the ground level) with base excavations up to 8.2 m (27 ft.) below original ground (Dillon, 1981).

Mound 1 was developed using a cell landfilling method. Dillon prepared excavation plans for Mound 1 from 1981, which consisted of generally rectangular cells up to 120 m long and with variable widths. Each individual cell was designed with a sloped base, a low point/sump to allow temporary pumping as needed, cut-off ditches at the edges, separation berms and access roads (Dillon, 1981). *Figure 2* illustrates a general representation of the base of Mound 1 without identification of individual cells.

An excavation plan was prepared for Mound 3 in 1985 (Dillon, 1985a). The base excavation of Mound 3 was initiated in 1985 and its filling started in 1992 and continued until the end of 1999. The cross-sections shown on *Figure 2* provide a visualization of the Mound 3 base. Note that the base of Mound 2 is not shown on *Figure 2* because we could not find records to confirm its depth.

The Old Landfill had an original approved capacity of 4,483,000 m^3 (5,864,000 yd^3) for waste and daily/intermediate cover (Dillon, 1985a, pg. C-8). An additional 689,000 m^3 of landfill capacity was approved as part of the late 1990s EA to horizontally expand the Old Landfill footprint. The approved horizontal expansion is located west of Mounds 1 and 2 in the area identified as Infill (shown on *Figure 1*).

Six leachate wells were drilled at the Old Landfill in January 2017 (refer to *Appendix A* – Leachate Well Borehole Logs and *Appendix B* – Leachate Well Photographs). The key information found in the borehole logs was added to *Figures 1* and *2*. The base depths determined in the drilling program and shown on the borehole logs suggest a reasonable correlation with the base design for Mounds 1 and 3.

Figure 2 indicates that waste was buried at Mound 2 at 3.2 m below original ground (M2W1 - from elevation 194.8 to 198 m above sea level) and 9.8 m (M2W2 - from elevation 188.2 to 198 m above sea level). The shallow landfill base at M2W1 location confirms the trench and fill method used at the majority of Mound 2 of the Old Landfill. The deeper base at M2W2 location confirms the cell fill method applied at later stages of the Mound 2 development.

3.1 Leachate Management System at the Old Landfill

During the operational period of the Old Landfill, a series of leachate collection ditches at the edges of the active cells of Mounds 1 and 3 were drained by gravity to low points/sumps. Leachate was pumped from the low points/sumps to leachate recharge trenches in the landfill waste cells. This leachate recharge practice was used from 1988 until the closure of the Old Landfill in 1999, i.e. for approximately 11 years.

Mounds 1 to 3 have a perimeter leachate collection system (toe drain). The perimeter leachate collection system was approved by MOECC in 1994 (Dillon, 1995, pg. 15&16) and constructed in three phases:

- Phase 1 - Mounds 1 and 2 perimeter completed in 1995.
- Phase 2 – Mound 3 perimeter initial phase completed in 1997.
- Phase 3 – Mound 3 perimeter final phase completed in 2000.

Leachate is collected at the perimeter of the Old Landfill by perforated pipes with finger drains spaced 60 m apart and drained by gravity to manholes and pumping stations, which pump to an above ground storage tank with a capacity of 600 m^3 (160,000 U.S. gallons). Leachate is pumped from the above ground storage tank through an off-site forcemain to the Blenheim Sewage Treatment Plant for treatment.

There is a low permeability wall (recompacted clay cut-off wall) constructed with native clay soil at the perimeter of the Old Landfill and outside the perimeter toe drain to enhance horizontal containment.

4.0 Old Landfill Operations

4.1 Filling Sequence

The available reports were reviewed to define the filling sequence determined by the location of the active landfilling area.

Table 1 below provides the annual location of the active landfilling area for the Old Landfill relative to each Mound.

Table 1: Location of Active Landfilling Area

Year	Mound		
	1	2	3
Initial Operations of Mound 2		ü	
Later Operations of Mound 2/Initial Operations of Mound 1	ü	ü	
1981	ü	ü	
1982	ü	ü	
1983	ü	ü	
1984	ü	ü	
1985	ü	ü	
1986	ü	Not filled	
1987	ü	Not filled	
1988	ü	Not filled	
1989	ü	ü	
1990	ü	ü	
1991	Closed	ü	
1992	Closed	ü	ü
1993	Closed	Not filled	ü
1994	Closed	Not filled	ü
1995	Closed	Not filled	ü
1997	Closed	Not filled	ü
1998	Closed	Not filled	ü
1999	Closed	ü	ü

Notes:

- The 1981 Dillon and Gartner Lee reports show aerial photographs and maps with the majority of the waste footprint on Mound 2 and a small waste footprint area on Mound 1. Since there are no records prior to 1981, the exact year when operations started in Mound 1 is unknown.
- The 1996 annual report was not available at the time of this report preparation.

In general, the filling operations proceeded in the following fashion:

- Mound 2 operations first started in 1963;
- Mound 1 operations started before 1981 (historical maps show small areas filled in Mound 1 in 1980);
- Mound 1 closed in 1991;
- Mound 3 landfilling started in 1992;
- Mound 2 operations resumed in 1999 to fill localized settlement areas before closure in 1999; and
- Mound 3 closed in December 31, 1999.

The filling sequence is relevant to the mining assessment because it gives an indication of the age of the waste.

4.2 Filling Method

The majority of Mound 2 was developed using the trench and fill method with depths between 3 and 4.5 m (10 and 15 ft.) below original ground, while Mounds 1 and 3 were developed using a cell filling method with deep cell excavations. Mound 2 therefore has soils between the trenches that were completed at earlier stages of Mound 2 operation, which could increase airspace gain if waste is excavated or mined. Further excavation can potentially be completed at soils under the trenches of Mound 2 to gain additional airspace.

4.3 Types and Quantities of Waste

From November 1972 to September 1981, the Ridge Landfill received approximately 1,400,000 m³ of municipal waste from the City of Chatham, the Town of Blenheim and the Town of Tilbury, approximately 580,000 m³ of industrial, commercial and institutional (IC&I) solid waste, and approximately 74,000 m³ (20,000,000 gal) of liquid industrial waste (which included municipal and industrial sludge). The municipal and IC&I sector wastes included grit from wastewater treatment facilities, wastes from street cleaning and other municipal activities, sludge from municipal sewage works, sludge from industrial wastewater treatment facilities and demolition debris (Dillon, 1981).

Based on the 1981 Design and Operations Report, on average, about 4,500 tonnes (5,000 tons) of waste per month was received at the site and it was anticipated that this amount would increase to 18,100 tonnes (20,000 tons) per month by 1991 (Dillon, 1981). The Old Landfill operated until December 31, 1999. During the operational period, the maximum annual tonnage received was 261,800 tonnes in 1999 (Dillon, 2000).

The following wastes were prohibited from 1981 (Dillon, 1981):

- Pathological wastes from hospitals or laboratories;
- Industrial liquid wastes;
- Hazardous or toxic substances;
- Radioactive wastes; and
- Septic tank pumpings.

Sludges from municipal sewage works and industrial wastewater treatment facilities continued to be accepted at the Old Landfill (Dillon, 1981).

There used to be a liquid waste lagoon at the east corner of Mound 1 with an interceptor trench in between the lagoon and the adjacent property (Dillon As-Built Drawing, Drawing 9 - Interceptor Trench, December 9, 1983). The liquid waste lagoon was later excavated, had its contents removed and was filled with clean soil (Dillon, 1987, Drawings 1 and 9, August, 1985).

The Existing Site Conditions map (Dillon, 1983, Drawing 1) shows that at different locations in Mounds 1 and 2 there were areas where liquid wastes had been co-disposed with solid waste and in Mound 2 there were also locations of industrial sludge and municipal sewage sludge co-disposed with solid waste in 1983.

The available reports indicate that Mounds 1 and 2 received sludge and liquid wastes. The available borehole logs and photographs (Appendix A and B) indicate the presence of sludges with strong odours. Mining wet wastes or sludges is not practical and is usually avoided based on our literature review.

4.4 Daily Cover

Based on the background information reviewed, a 4:1 waste to daily/intermediate soil cover was estimated, which equates to 20% by volume. Since no alternative daily cover was used at the Old Landfill, approximately 20% of the Old Landfill volume is comprised of local soils that were used as daily/intermediate cover and buried with waste.

The local soils, used as daily cover, are cohesive due to high clay content. Since cohesive soils holds moisture and tends to attach to waste, the mining process in this case would be less efficient, would possibly require additional equipment and as a consequence it would be more time consuming, which in turn would increase the potential for odour concerns.

4.5 Landfill Densities

Landfill densities are reviewed in this report to assist with the assessment of potential air space gain if landfill mining was done in the Old Landfill. Landfill mining is often conducted on closed landfill sites that have low compaction rates because the airspace gained through the mining operations offsets some or all of the mining costs.

Waste records were kept at the Ridge Landfill until February 1992 by volume. A weigh scale was installed in February 1992, with waste tonnages being recorded since then. Since tonnage information prior to 1992 is not available, density calculations were not completed for that period of time. For 1983 and 1984, the uncompacted and compacted waste densities were assumed to be 267 kg/m^3 (450 lb/yd^3) and 593 kg/m^3 (1000 lb/yd^3), respectively (Dillon, 1984, pg. 4; Dillon, 1985b, pg. 5).

From 1992 to 1999, waste/soil volume, waste weight, and apparent density were reported every year in annual reports, which are summarized on *Table 2* below.

Table 2: Annual Waste Tonnage, Depleted Capacity and Density

Reporting Period	Waste Weight (Jan – Dec) (tonnes)	Depleted Capacity Between Two Mappings (m^3)	Apparent Density (kg/m^3)
1992	183,300	304,000	603
1993	216,500	244,800	743
1994	214,500	256,400	878
1995	201,700	239,300	882
1997	209,900	282,400	924
1998	215,500	285,100	623
1999	261,800	525,800	564

Notes:

- Values rounded to the next 100 for Waste Weight and Depleted Capacity.
- The 1996 annual report was not available at the time of writing.

The apparent density reported in *Table 2* is defined as the weight of waste divided by the volume of waste and daily/intermediate cover. The volume change due to landfilling between two subsequent surveys was calculated for each annual report and the waste weight for the exact same period of time was used to calculate the waste apparent density.

For additional context, we also reviewed the landfill compaction equipment for the Old Landfill. In 1990, a CAT 826C landfill compactor was purchased by the Ridge Landfill (Dillon, 1991, pg. 8). Prior to 1990, there was no “Equipment List” in the annual reports so it is unclear what compaction equipment was available on site. According to Tim Kozlof (former Landfill Manager), there was no landfill compactor during the earlier stages of Mound 2 operations. *Table 3* summarizes the type of compactors available on site from 1990.

Table 3: Site Compactors

Annual Report Date	CAT 826C Landfill Compactor	CAT 836 Landfill Compactor	Trashmaster Rex 3-70 Landfill Compactor
1990-1993	ü		
1994	ü		ü
1995	ü	ü	
1997- 1999		ü	

Note

- The 1996 annual report was not available at the time of writing.

The overall density for the Old Landfill was not calculated because waste tonnages are not available for the entire site history. The apparent density summarized on *Table 2* is considered high, with a maximum value of 924 kg/m³ and an average of 745 kg/m³ from 1992 to 1999. Also, large size compactors were used on site from 1990 to 1999. The 2016 annual mapping indicates that there have been some settlements, which contributes to a further increase to the apparent density.

Based on the data above, Mound 3 was filled with a high compaction rate, which limits the opportunity to gain landfill capacity through mining operations.

5.0 Leachate Levels Monitoring

Leachate levels were measured on February 24, 2017 at the six new leachate wells installed at the Old Landfill. Since an accurate base is not available for Mound 2, we will refer to leachate depth from the existing top of the landfill surveyed in March 2017.

The following leachate levels were measured from the existing ground on February 24, 2017 (refer to Figure 2):

- Mound 1: 5.3 m below top of landfill surface (mbgs) measured at both leachate wells M1W1 and M1W2;
- Mound 2: 7.1 to 9.2 mbgs measured at M2W1 and M2W2 respectively; and
- Mound 3: 14.2 to 15.2 mbgs measured at M3W1 and M3W2 respectively.

The leachate levels at Mound 1 and 2 are higher than the leachate levels at Mound 3. Higher leachate levels can indicate isolated perched leachate conditions or some leachate mounding, which add significant challenges to mining operations in Mounds 1 and 2 as described later in this report. The higher leachate levels at Mounds 1 and 2 could be attributed to liquids/sludge disposal and since these Mounds are older they had more opportunity for more infiltration and associated leachate generation.

6.0 Literature Review

A literature review was conducted of four Canadian and two American landfill sites that are pursuing or have completed landfill mining operations. The literature review is provided in *Appendix C* for each landfill followed by a discussion on problems and mitigation measures implemented during the mining operations.

Based on our literature review and site visits to the City of Barrie Landfill and Ocean County Landfill Corporation Site, landfill mining is only considered or completed when its benefits outweigh the associated high costs, and odour and health and safety concerns. *Table 4* below summarizes the reasons to consider landfill mining.

Table 4: Summary of Key Findings and Mining Reasons

Landfill Site	Key Findings	Reasons to Consider Landfill Mining
Trail Landfill, Ottawa	· Unlined existing site on sand setting. · Site with existing groundwater impacts. · No leachate mounding because the landfill base would not offer natural containment.	· Groundwater impacts mitigation. · Landfill capacity gain.
Sault Ste. Marie Municipal Landfill	· Unlined existing site on sand and gravel setting. · Site with existing groundwater impacts. · No leachate mounding because the landfill base would not offer natural containment.	· Groundwater impacts mitigation. · Landfill capacity gain.
City of Barrie Landfill	· Unlined existing site on sand setting. · Site with existing groundwater impacts. · No leachate mounding because the landfill base would not offer natural containment.	· Groundwater impacts mitigation. · Landfill capacity gain.
Blue Mountains Landfill	· Unlined existing site on sand and gravel setting. · Site with existing groundwater impacts. · Existing site was filled using trench and fill method, providing higher potential for landfill capacity gain. · No leachate mounding because the landfill base would not offer natural containment.	· Groundwater impacts mitigation. · Landfill capacity gain.
Perdido Landfill	· Unlined existing site on sand setting. · Site with existing groundwater impacts. · Existing site had leachate seeps. · Existing site had differential settlement. · Existing site was filled using trench and fill method, providing higher potential for landfill capacity gain.	· Groundwater impacts mitigation. · Landfill capacity gain.
Ocean County Landfill Corporation Site	· The site did not have enough soils for regular landfill operations. · There were limited vertical and horizontal options.	· Fines recovery supplemented soils deficit for landfill operations. · Landfill capacity gain.

Most of the mining drivers above do not apply to the Ridge Landfill as will be discussed in details as follows.

7.0 Site Specific Mining Assessment

This section provides discussions for the Old Landfill mining option at the Ridge Landfill.

7.1 Process Description

The typical mining process that would be followed at the Ridge Landfill should, in general, be completed according to the following sequence (for a process flow diagram, refer to *Figure 3*):

- *Planning* - Prepare and implement a health and safety plan, air quality monitoring plan, odour mitigation plan, dust and erosion and sedimentation control plans.
- *Mobilization* – Mobilize waste excavation, processing and transport equipment.
- *Site preparation* – Strip existing soil cover within the area to be mined for each day. Soil would be stockpiled for future cover use.
- *Waste excavation and pre-separation* – Excavate waste in lifts of approximately 3 m thick using an excavator and/or dozer. Materials that could be reused, recycled or cause damage to screening equipment (typically large size, bulky items) would be pre-separated. During waste excavations, large size materials (e.g. tires, long metal rebars, concrete rubble and boulders) could be pre-separated and stockpiled or stored for reuse or recycling, which may include mechanical processing such as shredding, grinding or crushing. However, it is expected that amount of waste that would be recyclable from the Old Landfill would be extremely low; the recovery rate at the Barrie Landfill mining operations was about 1-2% of the waste processed volume.
- *Waste screening* - Excavated waste materials that are not pre-separated would be loaded by an excavator into screening equipment (e.g. trommel screen). The screening process would mechanically separate fine parts (mainly soil), from the residual materials typically referred to as waste overs. In the case of the Ridge Landfill (unlike other reviewed landfills), additional efforts would be required to separate the fines fraction from the previously landfilled waste material because the soil applied as daily/intermediate cover at the Ridge Landfill would have been cohesive due to high clay content, and would require a shredder to break the material or as a minimum longer or more screening (e.g., two screens placed in series).
- *Fines* – Typically, the fines fraction would be hauled to the working face of the active cell for use as daily/intermediate cover, or temporarily stockpiled on the existing landfill footprint. The stockpiled fines would be used to offset the need for virgin soils in future daily/interim cover needs. However, the Ridge Landfill has a soil surplus and therefore additional soils for cover material is not expected to be needed. Because the natural soils are clayey, the successful recovery of fines in any significant amount is unlikely.

- *Waste overs* - The waste overs would be hauled to the working face of the active cell and immediately re-landfilled along with the regular incoming solid waste materials.
- *Compaction and cover* - Mined waste that is re-landfilled would be treated as regular waste, would be compacted and/or mixed with other waste and would be covered with daily cover at the end of each operating day.

7.2 Operational Requirements

The following are the minimum key operational requirements for mining of the Old Landfill:

- Prepare and implement an effective air quality and odour control plan.
- Prepare and implement an effective health and safety plan.
- Plan for an efficient layout and excavation sequence.
- Plan for the introduction of an additional shredder to break the cohesive soils prior to screening. Expect low recovery rate of recyclable materials (approximately 1-2% was achieved in Barrie).
- Have an active working face at the expansion area ready to receive wastes from the mining operations.
- Construct low points (sumps) to pump leachate out of the mining area.
- Construct stormwater separation berms as needed to minimize leachate volumes.

7.3 Potential Volume Recovery Rates in Air Space

The recovered air space (landfill capacity) rates ranged from 20% to 70% at the reviewed mining projects (*Appendix C*). Considering that Mound 3 was filled with a high waste density, and the presence of sludges and high moisture in Mounds 1 and 2, and the presence of cohesive soils in all Mounds, a realistic recovery rate of recyclables is expected to be extremely low.

A potential air space recovery volume for the Old Landfill is likely close to 20% of the mined volume. In addition, since the majority of the bottom of Mound 2 was filled with shallow trenches, its base could be excavated 6 m below the existing trenches following mining. The soil excavation volume below existing waste at Mound 2 is estimated at 0.8 million m^3.

It should be noted that the estimated 1 to 2% maximum volume of recycling materials potentially recoverable is included in the likely 20% airspace recovery volume.

7.4 Air Quality Assessment

An initial review of potential landfill mining impacts on air quality was completed. In 2010, the City of Barrie completed an air quality assessment to determine if mining and routine landfill operations could pose a human and environmental health concern. Air samples were collected and analyzed for target parameters of concern. The conclusions of the health assessment indicated that there were no unacceptable health risks to off-site residents resulting from the landfilling or mining activities at the City of Barrie Landfill.

A desktop screening assessment was completed for the Town of Blue Mountain's proposed landfill during the Environmental Assessment approvals process to assess potential air quality impacts associated with landfill mining operations. This screening assessment concluded that there would be no health risks related to landfill mining operations.

Based on the City of Barrie and the Town of Blue Mountain's mining experience, landfill mining operations are typically not expected to pose health risks at municipal landfills. However, health risks would be monitored during mining operations at the Old Landfill since its waste composition is different than a typical municipal landfill waste composition. Also, residents at the vicinity of the Ridge Landfill may raise concerns that could delay the Ridge Landfill Environmental Assessment approval.

Odours and dust generated during landfill mining operations may impact the air quality if not properly managed. Separate odour and dust assessments are presented as follows.

7.5 Odour Impact Assessment

7.5.1 Surface Monitoring of Emissions

Surface monitoring scans were completed at the Ridge Landfill in 2012 and 2013 by RWDI with the purpose to determine areas of elevated Total Hydrocarbon (THC) concentrations. Walkover surveys were conducted at the entire area of the Old Landfill using a handheld THC analyser.

Higher measurements of THC (as methane) were measured at the following locations in 2012 (RWDI, 2012):

- 7 spots at the final cover;
- 16 leachate manholes; and
- 1 red pipe.

Higher measurements of THC (as methane) were measured at the following locations in 2013 (RWDI, 2013):

- 48 spots at the final cover;
- 4 leachate manholes; and
- 1 red pipe, with leak near the cap.

The 2012 and 2013 findings indicate that landfill gas emissions, and therefore active decomposition of materials within the Mounds, are present.

The final cover design for the Old Landfill has a minimum of 1 metre of uncompacted soil including topsoil with no geomembrane. A review of the borehole logs (*Appendix A*) indicate that the final cover may be thinner than the minimum design at some locations, i.e. the final cover thickness ranges from 0.3 m to 0.7 m plus some mixed soil/waste.

7.5.2 Potential for Odour Emissions

Based on the records from site condition in 1983, at various locations in Mounds 1 and 2, liquid industrial waste and sewage sludge were co-disposed with solid waste. The borehole log records for Mounds 1 and 2 from January 2017 (two boreholes in each mound), show that below soil cover, there is a mixture of soil and domestic household waste (the depth varies between 4.6 m to 15.2 m) (*Appendix A*) and below that there is wet black sludge with no distinguishable waste and with "heavy waste" smell (with thickness between 3.7 m to 10 m) (*Appendix A*). In three out of four boreholes, the sludge begins at least 3.2 m below the leachate level and in the fourth borehole (M1W2), it is slightly above the leachate level (0.6m). In Mound 3, there is no record of sludge and it is just soil mixed with domestic, household waste (*Appendix A*).

Based on the recent boreholes in the 3 Mounds of the Old Landfill, Mounds 1 and 2 have odourous sludge beneath the mixture of soil and domestic waste. The household waste is at least 17 years old so it is expected to be mostly decomposed.

Old wastes generally have less odour potential; however, the type of waste also influences odour potential. Mound 3 is 17-25 years old and did not receive high quantities of sludges, while Mounds 1 and 2 are older and received higher quantities of liquid wastes and sludges. The borehole logs indicate that strong odours were observed at Mounds 1 and 2 when sludges were encountered (Appendix A).

Based on the experience of other sites, odour management measures would be required at mining in any of the Mounds with Mounds 1 and 2 having higher potentials for odour generation. Although Mound 3 waste is relatively younger, it is at least 17 years old in advanced stage of decomposition and based on the field observations recorded in the borehole logs, no strong odours were observed during Mound 3 drilling (*Appendix A*).

7.5.3 Odour Management

For odour management, different site-specific practices were employed in other landfill mining operations at other landfills. These practices include:

- Minimizing the active excavation area during the operation;
- Conducting the waste excavation during the cool and cold months and when there is little precipitation is often advantageous for drier sites. However, in the case of the Ridge Landfill, which is a wet and clayey site, waste excavation and mining operations during winter or colder months will likely not be feasible and can actually be problematic to screening equipment, causing poor recyclables recovery and mechanical issues;
- Increasing the slope of excavation to decrease the exposed area of waste;
- Monitoring meteorological conditions such as wind speed and direction and manage the operations based on the climatic conditions and location of sensitive receptors;
- Proactive and ongoing communication with neighbours and nearby residents;
- By-passing processing of highly odourous and/or young waste;

- Covering the waste with soil at the end of each work day; and
- Applying a foam control agent/masking agent/odour neutralizing agent to exposed waste surfaces and surfaces of coarse and fine-screened stockpiled materials to supress odour if problems arise. This may require an understanding of the types of compounds that are being emitted, so that appropriate odour control agents could be selected and made available at the site.

In most cases, odour management entailed on-going monitoring of operations and the application of a combination of measures at any given time.

7.6 Other Nuisances Effects

Dust, litter and noise are other typical nuisances that require mitigation during landfill mining operations. Although the Ridge Landfill is located in a remote and rural setting and dust, litter and noise are still important, and the general mitigation approaches for those nuisances are described in this section.

7.6.1 Dust and Airborne Contaminant Management

Mining operations have the potential to generate dust during dry periods (usually in the summer when the ground is dried up by higher temperatures). Dust can be generated by typical mining operations such as cover stripping, waste and soil excavation, screening and heavy equipment and truck traffic.

Dust is a concern because it may reduce visibility, generate airborne contaminants and potentially may become a nuisance to off-site receptors if not controlled at the source. Airborne contaminants should be controlled because they represent a safety hazard to site personnel and should be addressed in the health and safety plan.

A dust and airborne contaminant management plan should be prepared and implemented for mining operations. The dust and airborne contaminant management plan should include equipment used to control dust and describe the liquid and rate that will be applied as a minimum. Monitoring procedures should also be included in the dust and airborne contaminant management plan.

7.6.2 Litter Control

Several measures should be taken to minimize the amount of wind-blown debris leaving the landfill mining operations area.
Similar to regular landfilling operations, litter control measures to be applied during mining operations can be divided into two groups: preventative measures to limit the generation of litter and regular maintenance measures to collect and prevent litter from leaving the site. Those measures include covering loose waste, keeping the size of the exposed mining face to a minimum and using portable litter control fences.

7.6.3 Noise Control

Potential noise impacts may result from waste mining operations equipment. The operation of this equipment should be conducted in such a manner as to minimize noise impacts, whenever possible. All operation equipment used during waste mining activities should comply with the noise level limits outlined in the *"Noise Guidelines for Landfill Sites"* (MOECC, 1997) and the Municipal Noise By-Law.

7.7 Surface Water and Leachate Management

Clean surface water, originating from non-operating areas of the landfill (i.e., undeveloped areas or areas completed with final cover) will continue to be collected in a ditch inside the perimeter road and conveyed to one of the surface water management ponds that serves the existing Old Landfill. Berms or ditching will be used to divert any non-contaminated storm water away from landfill mining operations where it may cause operational problems and from operating areas where it may come in contact with waste.

Potentially contaminated surface water, such as that originating from mining operation areas where drainage may come in contact with waste or leachate, will not be discharged to the surface drainage system. This isolation of drainage from operating areas will be accomplished by grading of waste and daily/intermediate cover surfaces (i.e. interim separation berms, slopes and diversion ditches will be constructed as part of the landfill mining operations). All drainage from operating areas that may come in contact with waste or leachate will be collected and managed as leachate, i.e. allow infiltration within the open waste areas.

If perched leachate is encountered during waste excavations, low points (sumps) will be constructed to allow temporary pumping to drain the waste and to pump leachate out of the mining area. Surface water separation berms can also be constructed as needed to minimize leachate volumes.

7.8 Health and Safety Considerations

Prior to landfill mining operations, a site-specific health and safety plan should be prepared and implemented.

The health and safety plan should consider different potential hazards (physical, chemical and biological) associated with mining operations, such as gases (methane, hydrogen sulphide). Sharps, liquid waste and sludge, asbestos and equipment traffic will be identified and mitigated. The health and safety plan should include specific operating procedures to address air quality for on-site personnel, dust monitoring, airborne contaminant management, suspect wastes/liquids, personal protective equipment (PPE), decontamination procedures and emergency procedures.

The health and safety plan should include procedures to manage anticipated or confirmed hazardous materials. It should also address potential presence of any material of concern and include material-specific procedures such as asbestos handling or other materials or chemicals of concern.

The health and safety plan should include procedures to operate heavy equipment, processing equipment and tools. Heavy equipment and processing equipment should be provided with engineering controls.

7.9 Cost Estimate

Costing information for various landfill mining projects were collected as summarized below.

- City of Barrie Landfill mining: \$10 to \$15 per m^3 (information received from Chris Visser, Waste Connections).
- Blue Mountains Landfill mining: \$10 to \$20 per m^3 (information received from Chris Visser, Waste Connections).
- Ocean County Landfill Corporation Site: \$24 per m^3 (\$13.69 USD per yd^3) using union labour (Dillon Consulting, 2017b).

The mining cost for the Ridge Landfill is estimated at \$25 per m^3. The mining cost for the Ridge Landfill is expected to be higher due to the nature of the waste, soils and other site-specific conditions.

All costs per cubic meter above are for the mining component, i.e. it includes waste excavation, screening, loading, hauling and unloading at the working face and excludes liner and leachate collection system construction.

7.10 Evaluation Criteria

The following table provides a summary of our evaluation criteria prepared for each Mound of the Old Landfill.

Table 5: Criteria and Evaluation of Mining Potential

Criteria	Mound 1	Mound 2	Mound 3
Odour Potential (based on observations recorded on the leachate wells borehole logs and photographs)	· High	· High	· Medium
Leachate Levels	· High (5.3 m below top of landfill surface)	· High (7.3-9.1 m below top of landfill surface)	· Low (14.2-15.2 m below top of landfill surface)
H&S Concerns for On-Site Staff	· Lower than Mound 2, higher than Mound 3 · High leachate level · Types of waste · Odourous sludges	· Highest · High leachate level · Types of waste · Odourous sludges	· Lowest
Air Quality	· No health risks related to	· Same as Mound 1	· Same as Mound 1

Criteria	Mound 1	Mound 2	Mound 3
	landfill mining operations · No health related to airborne emissions are anticipated based on Barrie and Blue Mountains mining projects (to be confirmed by air quality monitoring during mining operations)		
Estimated Capacity Gain	· 0.4 million m^3	· 1.3 million m^3 (0.5 million m^3 mining and 0.8 million m^3 excavation under existing waste)	· 0.5 million m^3
Costs	· Relatively higher than Mound 3 due to intense liquid management · Probably equivalent to Mound 2	· Relatively higher than Mound 3 due to intense liquid management · Probably equivalent to Mound 1	· Lower than Mounds 1 and 2 · Comparable to the mining costs for the Ocean County Landfill Corporation Site

7.11 Opportunities and Risks with Mining the Old Landfill

Since landfill mining has high cost implications, mining projects usually have multiple benefits to offset the mining costs. As described in the literature review, the most common benefits are improvement of groundwater conditions, reduction of potential liabilities as a risk management strategy, gain landfill capacity, and supply soils for sites that have soil deficiency. We will discuss and test each opportunity and identify constraints applicable to the Old Landfill as follows.

7.11.1 Site-Specific Opportunities

The following are the typical opportunities associated with a landfill mining project and how they might apply to the Old Landfill:

- Remediation of groundwater impacts. This is the usually the main driver to complete landfill mining projects and typically occurs at sites with unfavourable hydrogeological conditions (i.e. high permeability soils such as sandy soil or gravel at the base of the landfill, or high groundwater levels). In the case of the Old Landfill, there are no groundwater impacts and the site meets regulatory requirements. The Ridge Landfill is located in a thick natural clay plain that serves as an in-situ clay liner, i.e. approximately 30 m thick till (clayey silt/silty clay).
- The trench and fill method used in the Old Landfill area represents an opportunity to gain airspace as the soils between existing trenches are excavated. This is applicable to most of Mound 2.

- Mining can typically address a shortage of soil for future landfill operations. The Ridge Landfill is in a soil surplus situation and therefore mining to access more soils or fines for future cover needs does not provide an opportunity in this instance.
- Mining can provide limited opportunity to extend landfill site life if there is no opportunity to complete a horizontal or vertical expansion. This does not apply to the Ridge Landfill since there are opportunities for horizontal and vertical expansions.

7.11.2 Site-Specific Risks

There are site-specific risks that on balance do not support mining operations at the Ridge Landfill as discussed below.

- The landfills that have been mined in Ontario (included in the literature review section) are located in sand/gravel deposits, which allow leachate to drain downwards while keeping the waste dry. The deep, low permeability in-situ clay base at the Old Landfill does not promote leachate subsurface infiltration, rendering mining of saturated (wet) wastes not practical below the leachate levels.
- The soils at the Ridge Landfill have a high clay content, which would make screening and separation of materials very challenging due to the soil cohesion nature and moisture holding capacity. A pre-screening process would likely be needed with the introduction of a shredder to break the cohesive materials or alternatively potentially increased processing time in the screener.
- Mounds 1 and 2 have a history of liquid co-disposal.
- The combination of the three site-specific factors above would require an intense level of moisture and liquid management, making mining more problematic. The mining operations may become even more difficult during winter or cold months as the moisture in the waste and soil cover freezes and attaches with the processing equipment. High leachate levels would delay mining operations and could cause more odours.

8.0 Summary and Conclusions

Based on the background and literature review, field investigations and assessment described in this report, there are limited advantages and strong reasons to not consider mining the Old Landfill as summarized below.

- Remediation is not a driver for mining the Old Landfill because there are no groundwater impacts and the site meets regulatory requirements.
- The thick in-situ clay liner (i.e. approximately 30 m thick clayey silt/silty clay till) that forms the base of the Old Landfill does not promote moisture drainage, creating leachate pockets within the waste that would make mining operations problematic.
- The cohesive nature of the local soil that was used as daily cover at the Old Landfill holds moisture and tends to attach with waste and processing equipment, making materials separation more challenging during mining operations.
- The amount of recyclables recovered is not anticipated to be significant (estimated between 1 and 2% based on the Barrie Landfill experience and the Old Landfill boreholes).
- Mining to gain airspace is not the only available option to expand the Ridge Landfill. Since the site has available land for horizontal expansion and there are opportunities to vertically expand the Old Landfill and the South Landfill, the limited volume achieved with landfill mining is actually not needed for the proposed landfill expansion.
- The amount of soils or fines that are generated through mining operations would not help the site soil management as the site has enough soil material for operations and closure needs.

In summary, unlike other landfills that are considering or have completed mining, the Ridge Landfill does not have the compelling benefits to mine versus the associated disadvantages of mining, i.e. cost, operational challenges, potential nuisances, site constraints, and health and safety concerns. The potential benefits associated with landfill mining are limited and are by far outweighed by the various concerns mentioned above.

As an option, the Old Landfill could be vertically expanded without mining considerations, since the existing ground contours are much lower than the maximum elevation allowed by the airport regulation.

References

Cornerstone Environmental (2014). Overliner of Landfill mining? Best Approach for a Landfill Expansion for an unlined Landfill, SWANA LF Symposium, March 26, 2014

Dewaele, P., and Brunet, S. (2017) Reclamation & Re-Engineering, Environmental Remediation, June/July 2017, www. canadianconsultingengineer.com

Dillon Consulting Limited (1981). Ridge Landfill Site Design and Operations Report, File No. 8935-01, August 1981

Dillon Consulting Limited (1983). Ridge Landfill Site Design and Operations Final Report, File No. 8935-03, December 1983

Dillon Consulting Limited (1984). Site Development and Operations, 1983 Annual Report, Ridge Landfill, File No. 8935-03, March 1984

Dillon Consulting Limited (1985a). Ridge Landfill Site, Design and Operations Final Report, File No. 8935-03, August 1985

Dillon Consulting Limited (1985b). Ridge Landfill Site, Site Development and Operations, 1984 Annual Report, File No. 8935-03, March 1985

Dillon Consulting Limited (1986). Ridge Landfill Site, Site Development and Operations, 1985 Annual Report, File No. 8935-05, March 1986

Dillon Consulting Limited (1987). Ridge Landfill Site, Site Development and Operations, 1986 Annual Report, File No. 1317-03-1, March 1987

Dillon Consulting Limited (1988). Ridge Landfill Site, Site Development and Operations, 1987 Annual Report, File No. 1317-04-1, March 1988

Dillon Consulting Limited (1989). Ridge Landfill Site, Site Development and Operations, 1988 Annual Report, File No. 1317-05-1, March 1989

Dillon Consulting Limited (1990). Ridge Landfill Site, Site Development and Operations, 1989 Annual Report, File No. 1317-06-1, April 1990

Dillon Consulting Limited (1991). Ridge Landfill Site, Site Development and Operations, 1990 Annual Report, File No. 1317-07-1, March 1991

Dillon Consulting Limited (1992). Ridge Landfill Site, Site Development and Operations, 1991 Annual Report, File No. 1317-08-0, March 1992

Dillon Consulting Limited (1993). Ridge Landfill Site, Site Development and Operations, 1992 Annual Report, File No. 92-1317-09-00, March 1993

Dillon Consulting Limited (1994). Ridge Landfill Site, Site Development and Operations, 1993 Annual Report, File No. 92-1317-10-01, March 1994

Dillon Consulting Limited (1995). Ridge Landfill Site, Site Development and Operations, 1994 Annual Operations Report, File No. 92-1317-11-01, March 1995

Dillon Consulting Limited (1996). Ridge Landfill Site, Site Development and Operations, 1995 Annual Operations Report, File No. 92-1317-12-01, March 1996

Dillon Consulting Limited (1998). Ridge Landfill Site, Site Development and Operations, 1997 Annual Operations Report, File No. 92-1317-14-01, March 1998

Dillon Consulting Limited (1999). Ridge Landfill Site, Site Development and Operations, 1998 Annual Report, File No. 92-1317-15-01, March 1999

Dillon Consulting Limited (2000). Ridge Landfill Site, Site Development and Operations, 1999 Annual Report, File No. 92-1317-16, April 2000

Dillon Consulting Limited (2002). Ridge Landfill Site Development, Operations and Monitoring, 2001 Annual Report, File No. 02-0079, April 2002

Dillon Consulting Limited (2011). Telephone Discussion Between Betsy Varghese (Dillon) and Sandy Coulter (City of Barrie) regarding City of Barrie Landfill mining, File No. 06-6988, June 2 , 2011

Dillon Consulting Limited (2013a). Telephone Discussion Between Betsy Varghese (Dillon) and Sandy Coulter (City of Barrie) regarding City of Barrie Landfill mining, Project No. 06-6988, October 21 , 2013

Dillon Consulting Limited (2013b). Telephone Discussion Between Stephen Betts (Dillon) and Jim Wraith (Tervita, Area Manager, Ontario, Environmental Services) regarding asbestos, hazardous materials and odour at the Barrie Landfill due to landfill mining, Project No. 06-6988, November 26 , 2013

Dillon Consulting Limited (2014). Memo of Barrie Landfill site visit by Fabiano Gondim, Project No. 06-6988, October 28, 2014

Dillon Consulting Limited (2015). Visit to the Ocean County Landfill Corporation Site (OCLC) by Fabiano Gondim, Project No. 15-2456, December 7, 2015

Dillon Consulting Limited (2017a). Sault Ste. Marie Municipal Landfill Design and Operations Report, Project No. 06-6988, March 2017

Dillon Consulting Limited (2017b). Telephone Discussion beteween Fabiano Gondim (Dillon) and Martin Ryan, P.Eng. (VP Engineering, Ocean County Landfill), April 27, 2017

Dillon Consulting Limited (2017c). Telephone Discussion beteween Fabiano Gondim (Dillon) and Daren Kirby (Operator/Lead head, Tervita, Barrie Landfill), April 28, 2017

Dillon Consulting Limited (2017d). Telephone Discussion beteween Fabiano Gondim (Dillon) and Jeff Fletcher (Manager of Solid Water and Environmental initiatives, Town of Blue Mountains), April 28, 2017

Food and Drug Directorate (Windsor, Ontario) letter to Kent County Heath Unit (Chatham, Ontario), June 1971.

Garter Lee Associates Ltd. (1981) Ridge Landfill Site Hydrogeological Study, July 1981

Garter Lee Associates Ltd. (1991) Ridge Landfill Site Geotechnical Investigation of New BFI Properties, File No. GLL 91-421, December 1991

Golder Associates Ltd. (2014). The Blue Mountains Landfill Design and Operation Plan (Revision #3), Report Number 12-1188-0045, February 2014

J.L. Richards & Associates Ltd. (2001). Appendix O, Landfill Reclamation Pilot Program, Trail Waste Facility Landfill Optimization/Expansion Project, Confirmation of alternative Methods, Project, No. 17546-02, July 2001

Jain, P., Townsend, T.G., Johnson, P. (2013). Case study of landfill reclamation at a Florida landfill site, Waste Management, 33, pg. 109–116

Ocean County Landfill Corporation Site (OCLC) Fact sheet, 2015

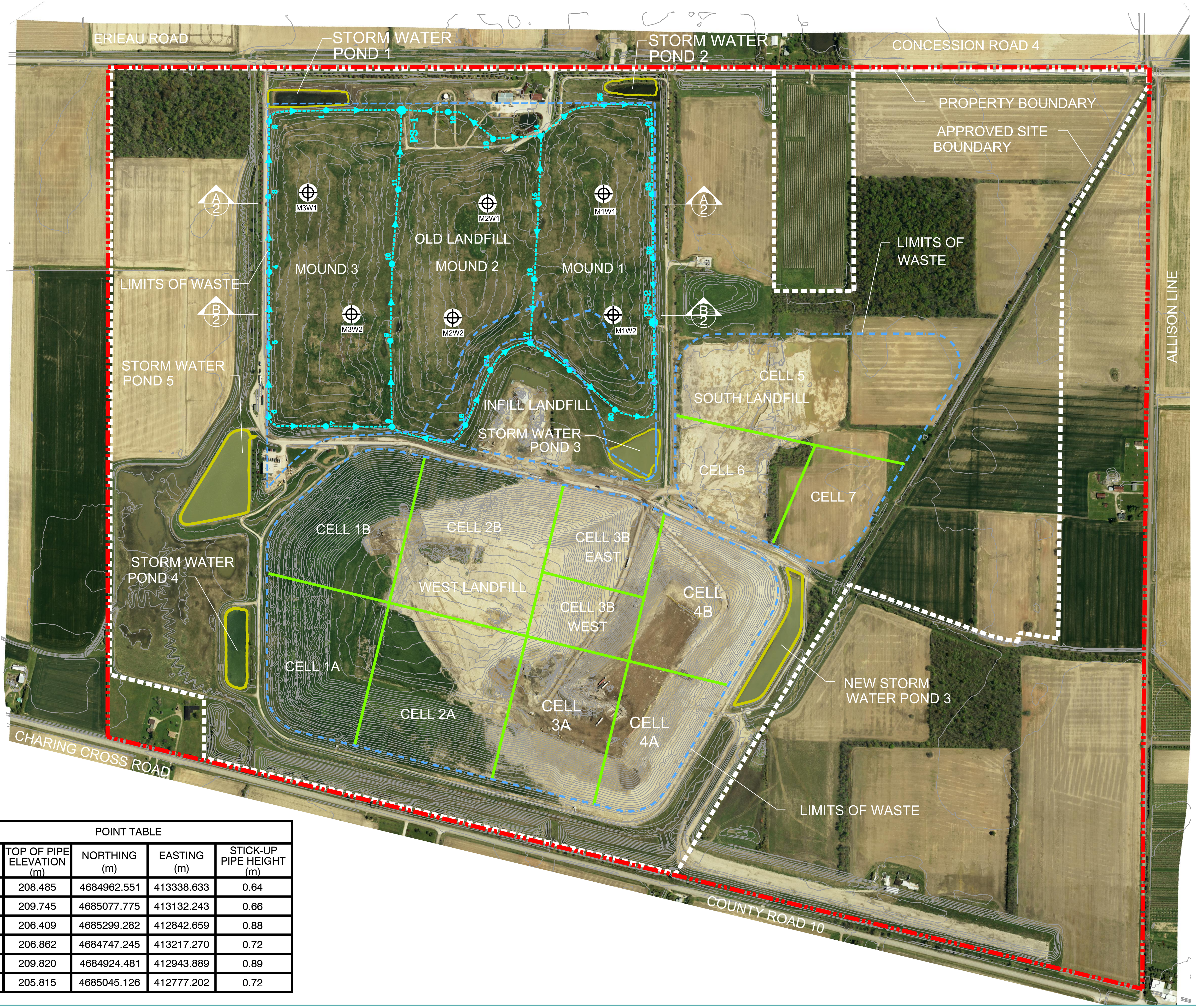
Ridge Landfill Corporation Limited letter to Kent-Chatham Heath Unit, October 1970.

RWDI Air Inc. (2012). Report – Total Hydrocarbon Survey – March 20, 2012, BFI Ridge Landfill, April 2012

RWDI Air Inc. (2013). Report – Total Hydrocarbon Survey – September 9, 2013, BFI Ridge Landfill, September 2013

Waste Connections (2004). Phase I Waste Excavation & Relocation Plan, Area F Expansion, Meadow Branch Landfill, July 2003, Revised July 2004

Figures



POINT TABLE				
No.	TOP OF PIPE ELEVATION (m)	NORTHING (m)	EASTING (m)	STICK-UP PIPE HEIGHT (m)
M1W1	208.485	4684962.551	413338.633	0.64
M2W1	209.745	4685077.775	413132.243	0.66
M3W1	206.409	4685299.282	412842.659	0.88
M1W2	206.862	4684747.245	413217.270	0.72
M2W2	209.820	4684924.481	412943.889	0.89
M3W2	205.815	4685045.126	412777.202	0.72

WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL

OLD LANDFILL MINING ASSESSMENT REPORT

Figure 1 - Site Plan

🟥	PROPERTY BOUNDARY
▭	APPROVED SITE BOUNDARY
—	CELL LIMITS
—	STORM WATER POND
⌖	MONITORING WELL
●10	MANHOLE CLEANOUT AND IDENTIFICATION
◄	LEACHATE COLLECTION PIPE
- - -	APPROVED LIMIT OF FILL FOR EXISTING LANDFILL
— · —	APPROVED LIMIT OF FILL FOR EXPANSION

TRUE NORTH

PLAN NORTH

SCALE 1:8,000

0 75 150 300m

Base Mapping Data from The Base Mapping Co. Ltd, May 16, 2016.

Ground elevations/co-ordinates and pipe stick-up heights for leachate wells obtained by Lance Tavener, Dillon Consulting, on March 21, 2017, using Trimble R10 GNSS GPS system.

CREATED BY: AZ
CHECKED BY: FG

File Location:
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DILLON CONSULTING

PROJECT: 152456
STATUS: DRAFT
DATE: 03/28/17

A—A

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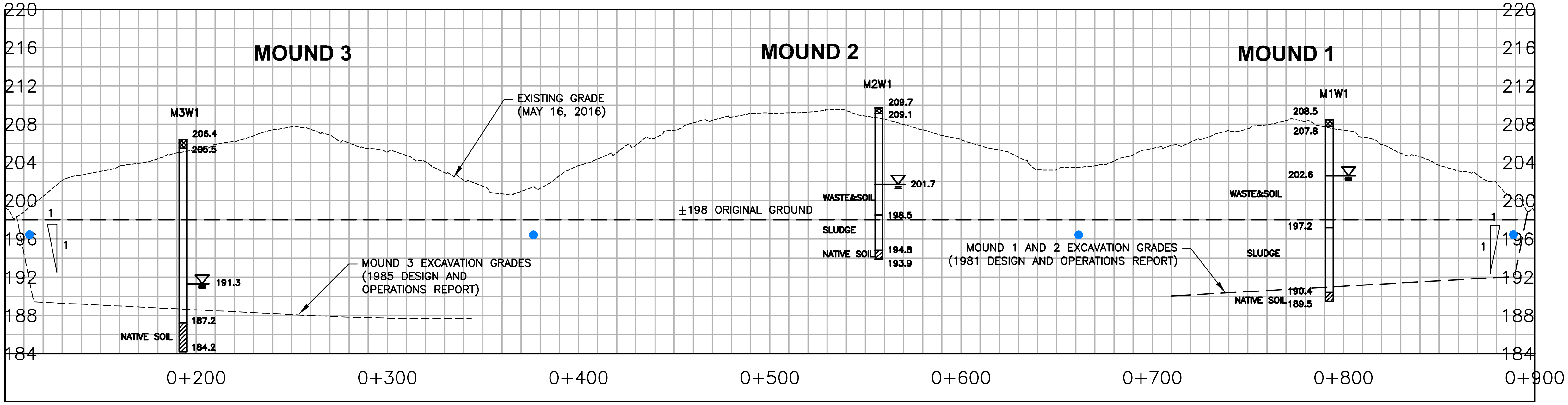
VERT: 1:500



B—B

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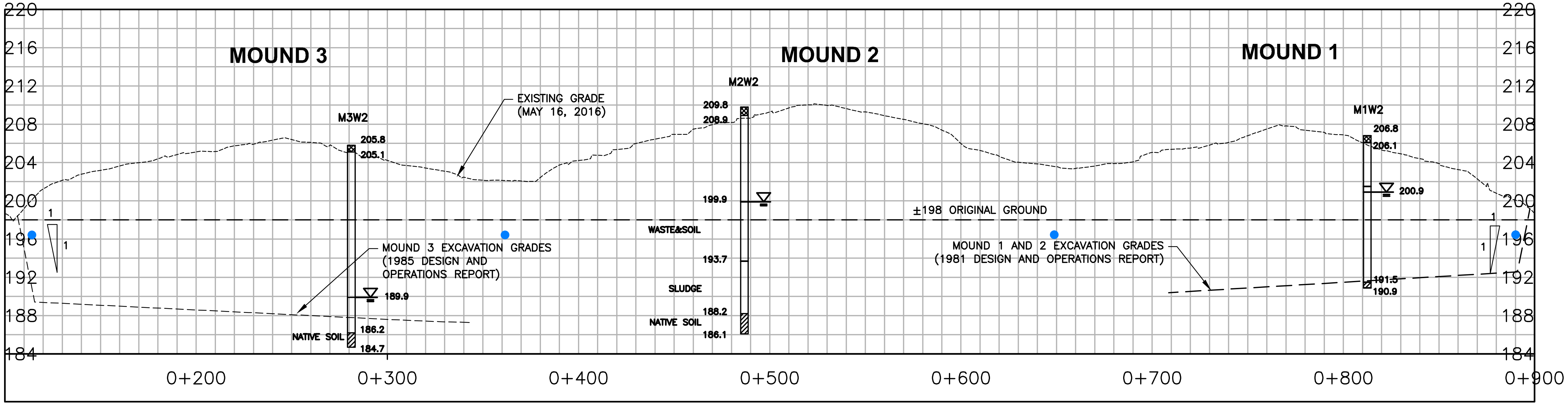


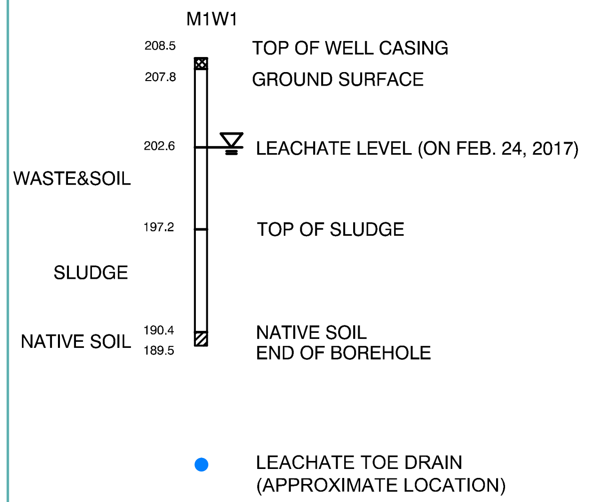
WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL

OLD LANDFILL MINING ASSESSMENT REPORT

Figure 2 - Cross Sections

LEGEND



Base Mapping Data from The Base Mapping Co. Ltd, May 16, 2016.

Ground elevations/co-ordinates and pipe stick-up heights for leachate wells obtained by Lance Tavener, Dillon Consulting, on March 21, 2017, using Trimble R10 GNSS GPS system.

CREATED BY: AZ
DESIGN BY: PS
CHECKED BY: FG

File Location:
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DILLON CONSULTING

PROJECT: 152456
STATUS: DRAFT
DATE: 03/28/17

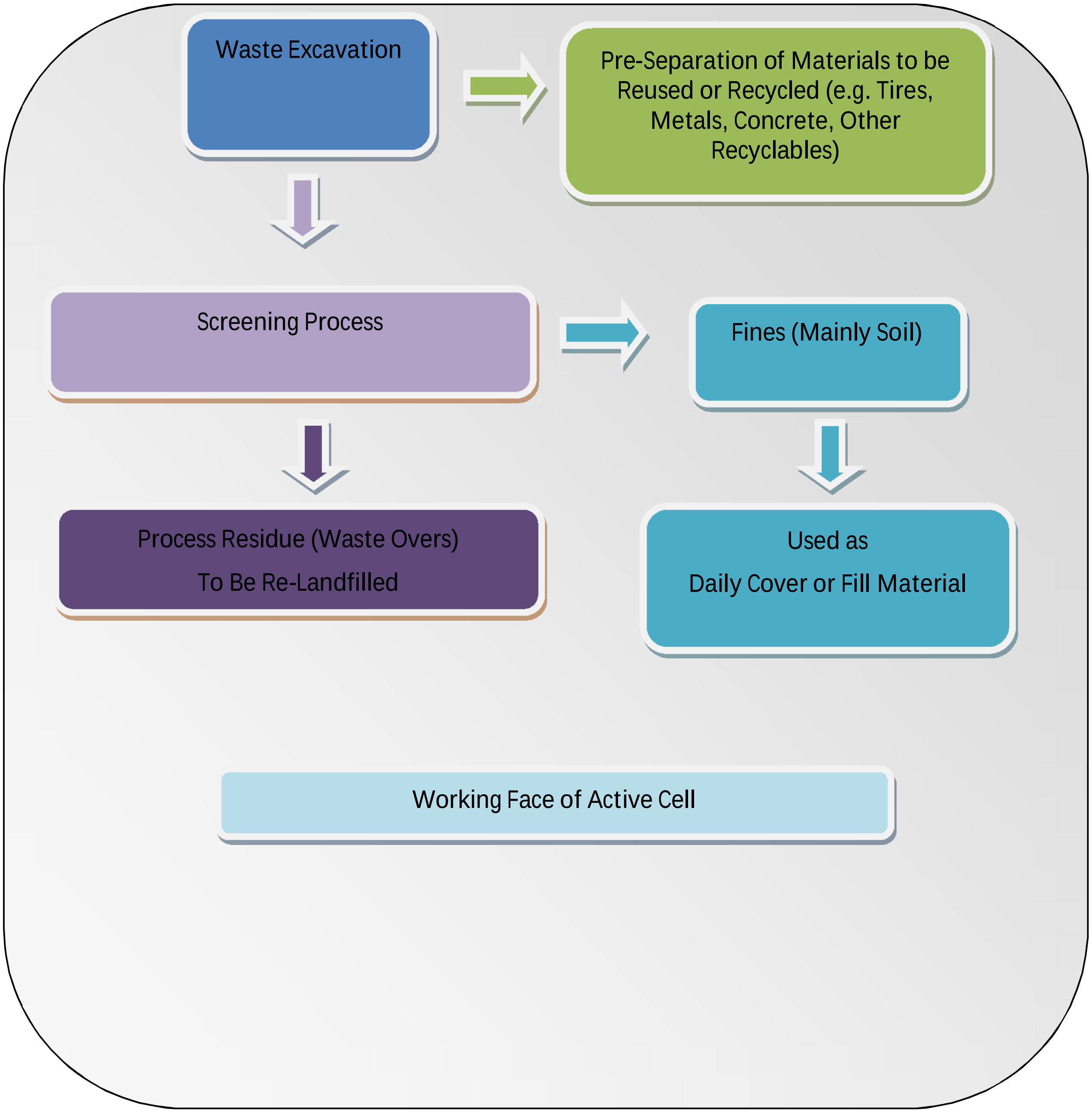


Figure 3 - Process Flow Diagram for Landfill Mining

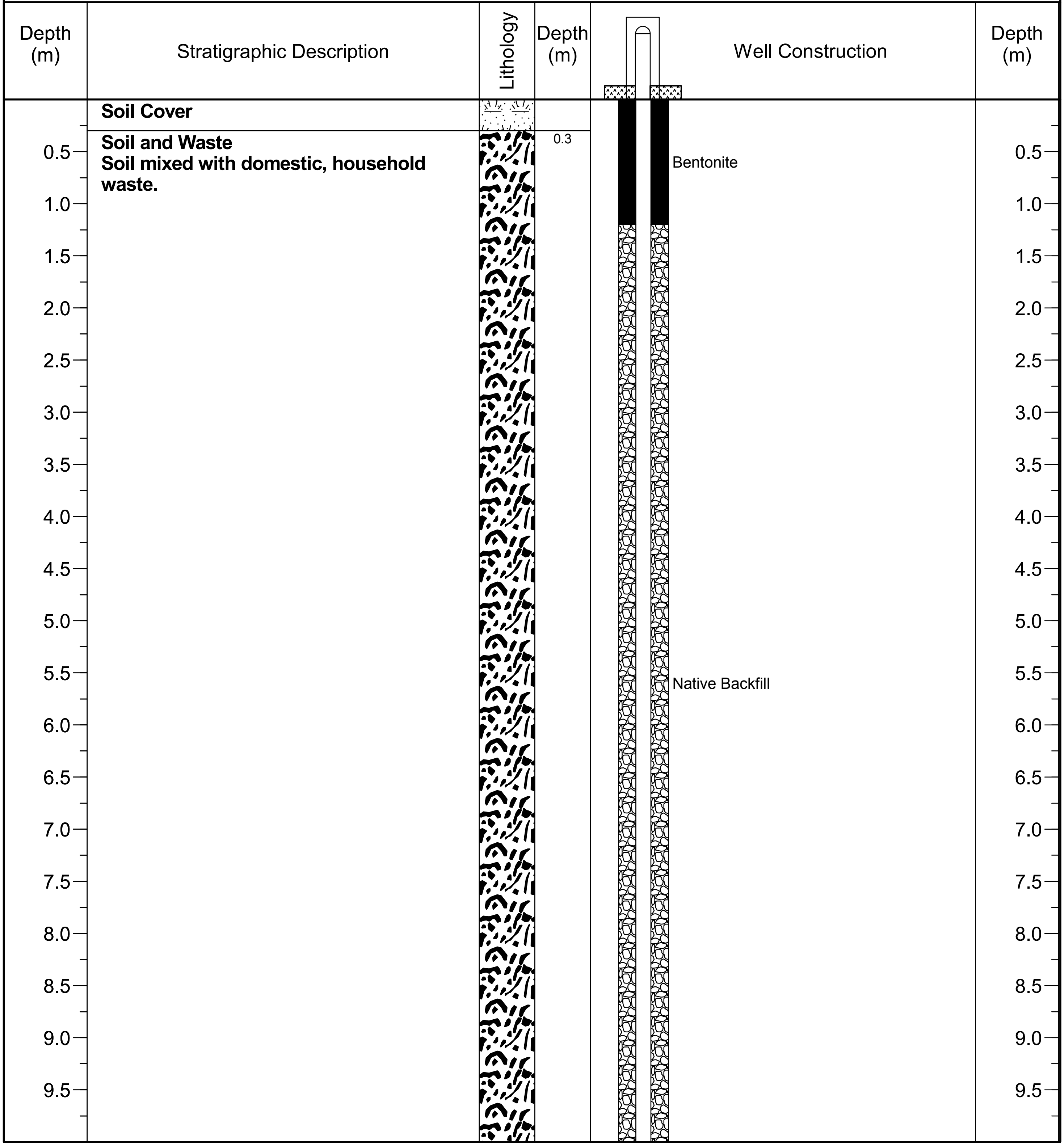
Appendix A

Leachate Well Borehole Logs

M1W1

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski
Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/23/17
Date Completed: 1/23/17

Stratigraphic Description	Depth (m)
Soil Cover	
Soil and Waste **Soil mixed with domestic, household waste.**	0.3



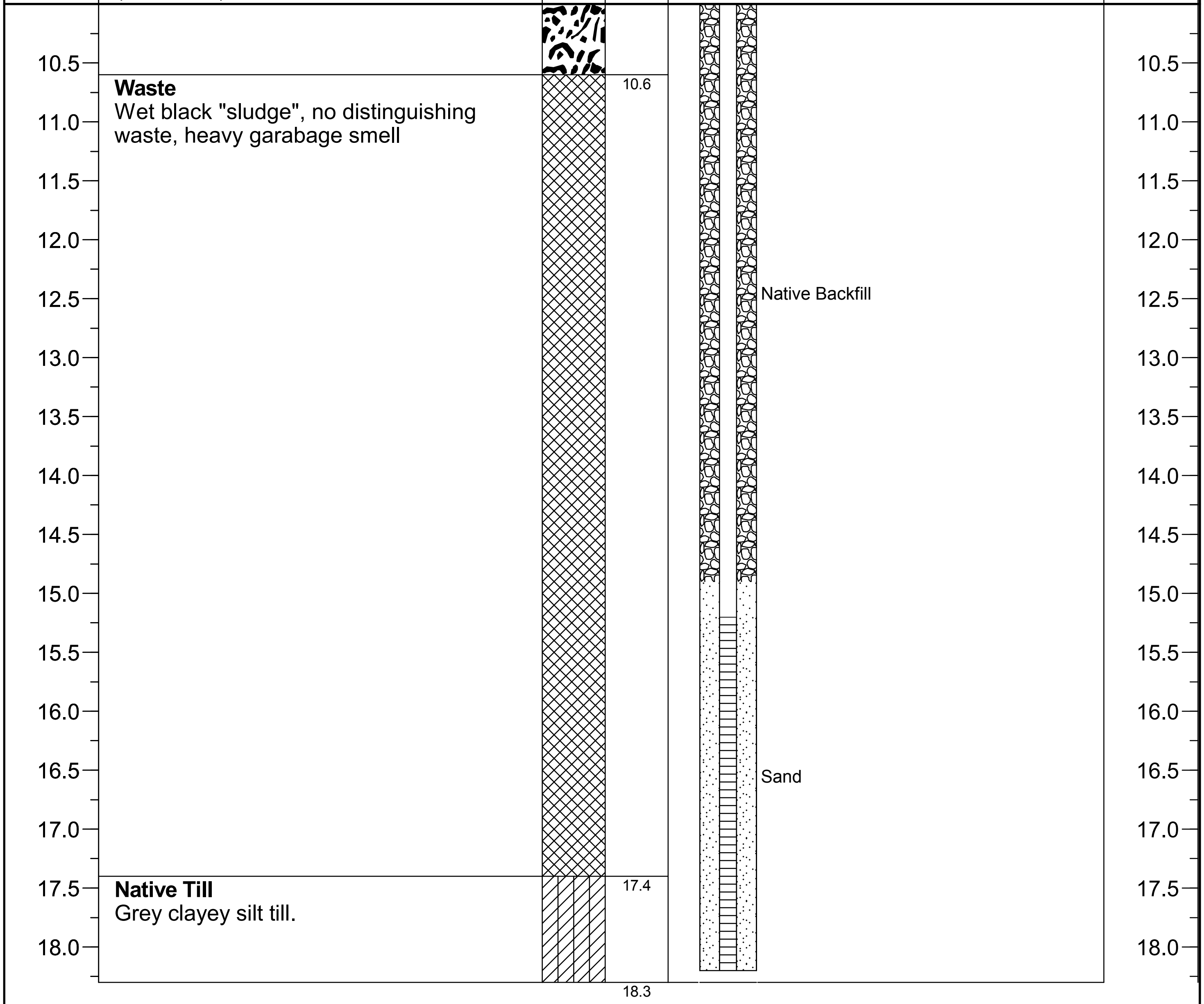
LITHOLOGY SYMBOLS
- Organics
- Fill
- Misc. Debris
- Clayey Silt

SAMPLE TYPE

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/23/17 Date Completed: 1/23/17

Depth (m)	Stratigraphic Description (continued)	Lithology	Depth (m)	Well Construction	Depth (m)
10.6	**Waste** Wet black "sludge", no distinguishing waste, heavy garabage smell		10.6		
17.4	**Native Till** Grey clayey silt till.		17.4		
			18.3		



LITHOLOGY SYMBOLS
▨ Organics
▨ Fill
▨ Misc. Debris
▨ Clayey Silt

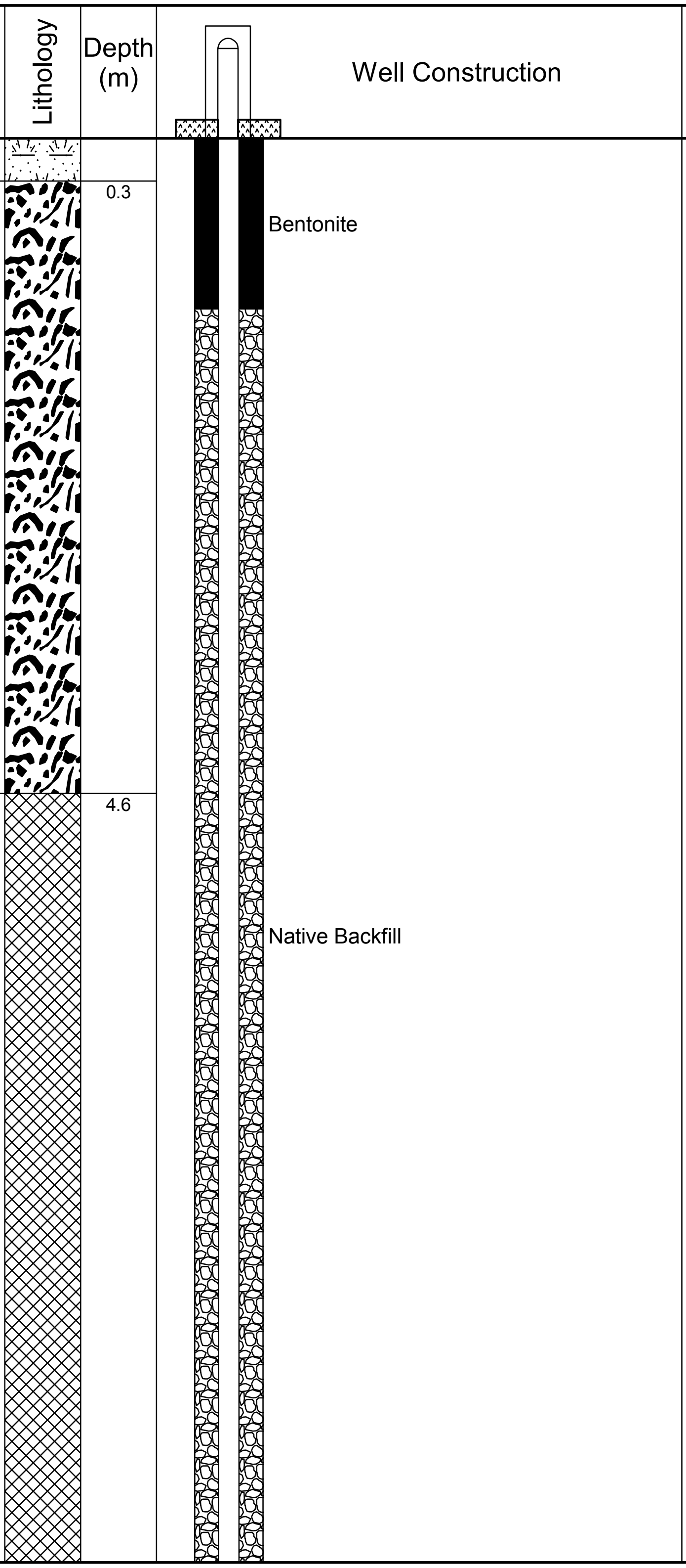
SAMPLE TYPE

M1W2

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/23/17 Date Completed: 1/24/17

Stratigraphic Description	Depth (m)
Soil Cover	
Soil and Waste Waste is domestic; clothes, food wrappers, household waste.	0.3
Waste Wet black "sludge", heavy garbage smell.	4.6



LITHOLOGY SYMBOLS

Organics	Misc. Debris
Fill	Clayey Silt

SAMPLE TYPE

M1W2

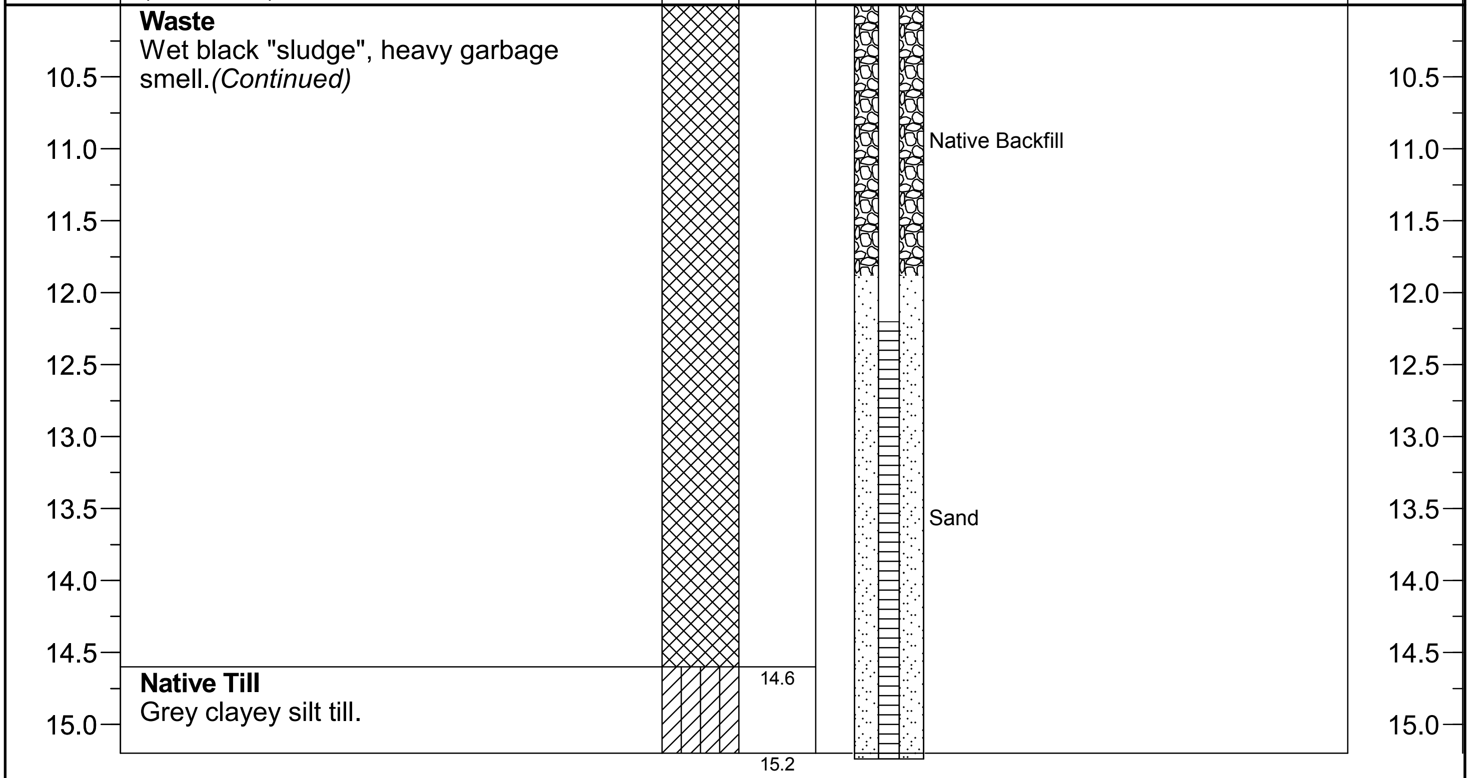
Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/23/17 Date Completed: 1/24/17

Depth (m) | Stratigraphic Description (continued) | Lithology | Depth (m) | Well Construction | Depth (m)

Waste
Wet black "sludge", heavy garbage smell.*(Continued)*

Native Till
Grey clayey silt till.



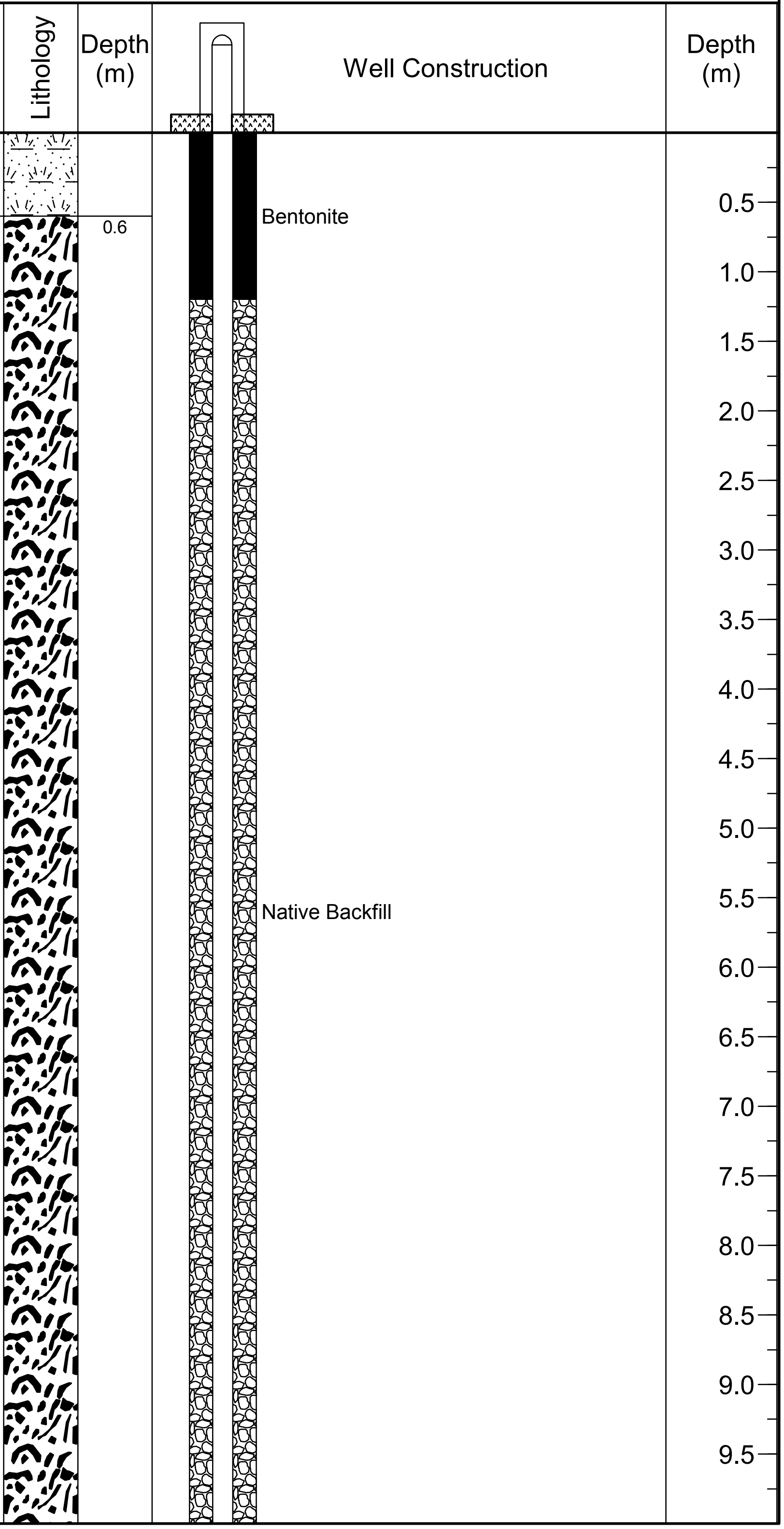
LITHOLOGY SYMBOLS
▨ Organics
▨ Fill
▨ Misc. Debris
▨ Clayey Silt

SAMPLE TYPE

M2W1

Client: Progressive
Project: Ridge Landfill Expansion
Project No.: 152456
Location: Blenheim ON
Drilling Co.: Direct Environmental
Drilling Method: Auger
Supervised by: J.Sikorski
Date Started: 1/24/17
Date Completed: 1/24/17

Depth (m)	Stratigraphic Description	Depth (m)
	Soil Cover	
0.5		
	Soil and Waste Black waste soil mixed with household waste.	0.6
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		
6.0		
6.5		
7.0		
7.5		
8.0		
8.5		
9.0		
9.5		



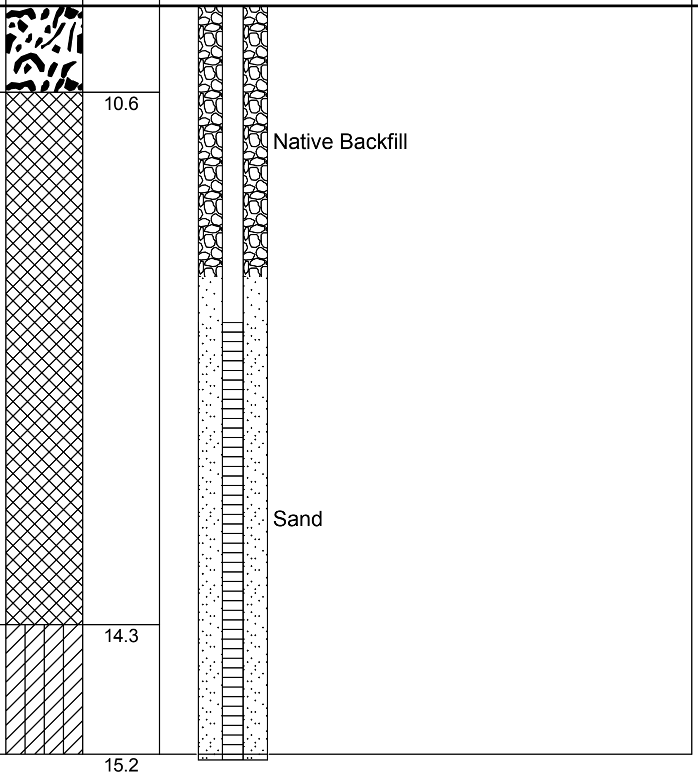
LITHOLOGY SYMBOLS
▨ Organics
▨ Fill
▨ Misc. Debris
▨ Clayey Silt

SAMPLE TYPE

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/24/17 Date Completed: 1/24/17

Depth (m)	Stratigraphic Description (continued)	Depth (m)	Depth (m)
10.5			10.5
	Waste Wet black "sludge", strong garbage smell.	10.6	
11.0			11.0
11.5			11.5
12.0			12.0
12.5			12.5
13.0			13.0
13.5			13.5
14.0			14.0
	Native Till Grey clayey silt till.	14.3	
14.5			14.5
15.0			15.0
		15.2	



LITHOLOGY SYMBOLS
Organics
Fill
Misc. Debris
Clayey Silt

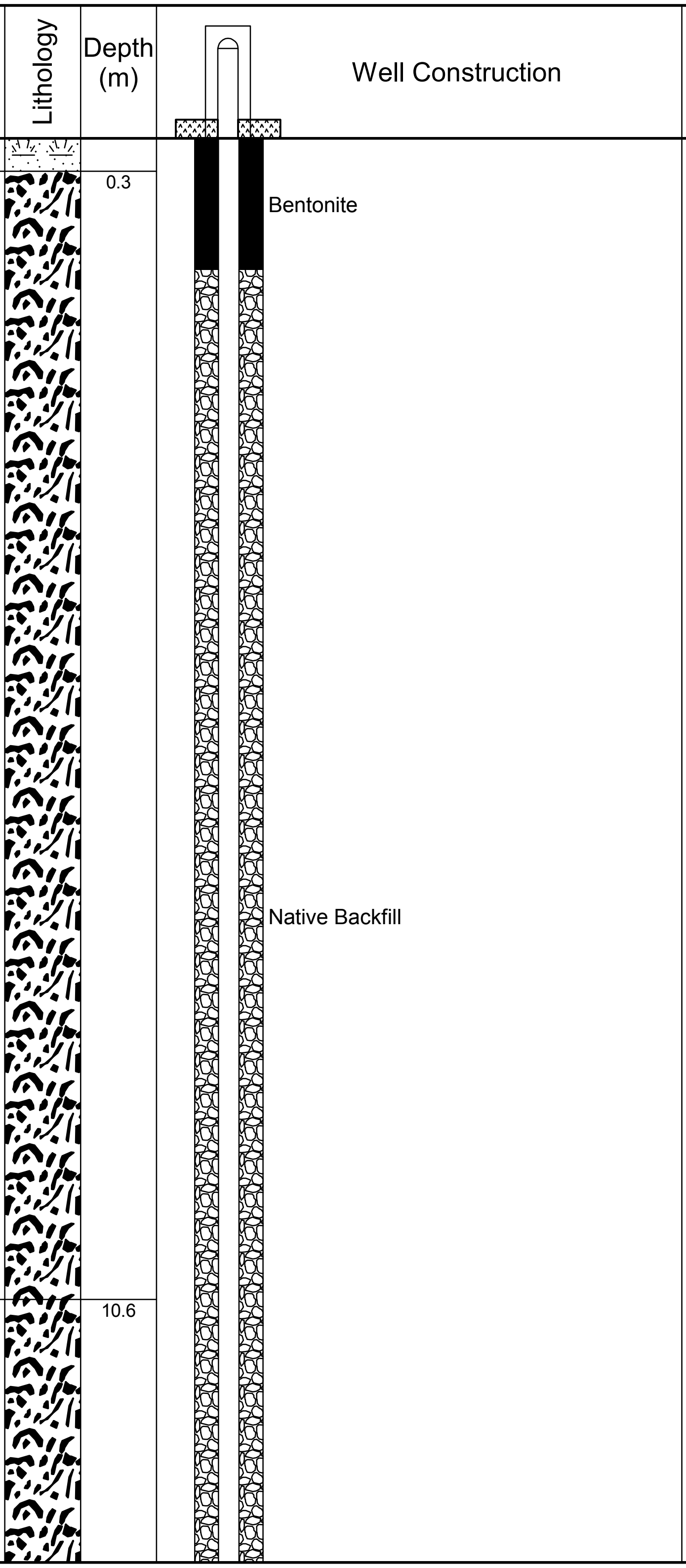
SAMPLE TYPE

M2W2

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski
Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/24/17
Date Completed: 1/25/17

Stratigraphic Description	Depth (m)
Soil Cover	
Soil and Waste Soil mixed with domestic, household waste, metal wires.	0.3
At 10.6m Metal wire mixed with black mush, and domestic waste.	10.6

Depth (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5



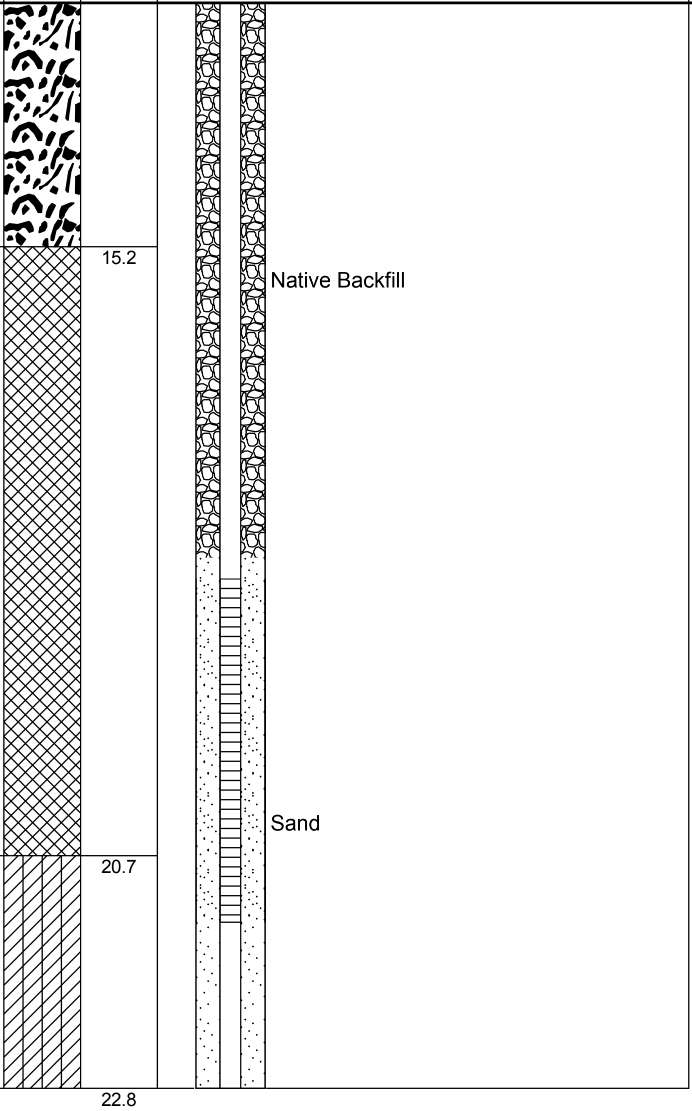
LITHOLOGY SYMBOLS
- Organics
- Fill
- Misc. Debris
- Clayey Silt

SAMPLE TYPE

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/24/17 Date Completed: 1/25/17

Depth (m)	Stratigraphic Description (continued)	Depth (m)	Depth (m)
13.5 14.0 14.5 15.0	**Soil and Waste** Soil mixed with domestic, household waste, metal wires.*(Continued)*		13.5 14.0 14.5 15.0
15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5 20.0 20.5	**Waste** Wet black "sludge", strong garbage smell.	15.2	15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5 20.0 20.5
21.0 21.5 22.0 22.5	**Native Till** Grey clayey silt till.	20.7	21.0 21.5 22.0 22.5
		22.8	



LITHOLOGY SYMBOLS

Organics	Misc. Debris
Fill	Clayey Silt

SAMPLE TYPE

Client: Progressive
Project: Ridge Landfill Expansion
Project No.: 152456
Location: Blenheim ON
Drilling Co.: Direct Environmental
Drilling Method: Auger
Supervised by: J.Sikorski
Date Started: 1/25/17
Date Completed: 1/26/17

Depth (m)	Stratigraphic Description	Lithology	Depth (m)	Well Construction	Depth (m)
	Soil Cover	▨		Cement	
0.5	**Soil and Waste** Black waste soil mixed with domestic waste.	▩	0.3	Bentonite	0.5
1.0		▩			1.0
1.5		▩			1.5
2.0		▩			2.0
2.5		▩			2.5
3.0		▩			3.0
3.5		▩			3.5
4.0		▩			4.0
4.5		▩			4.5
5.0		▩			5.0
5.5		▩		Native Backfill	5.5
6.0		▩			6.0
6.5		▩			6.5
7.0		▩			7.0
7.5		▩			7.5
8.0		▩			8.0
8.5		▩			8.5
9.0		▩			9.0
9.5		▩			9.5

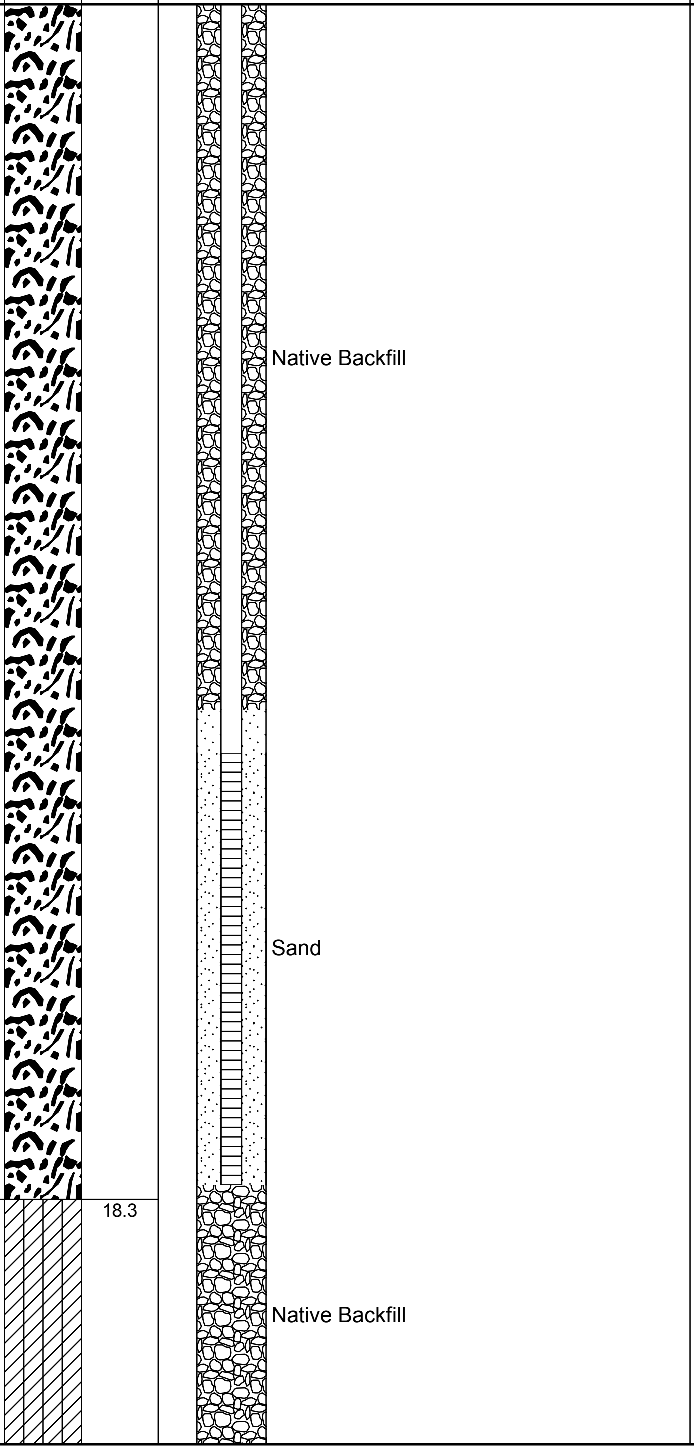
LITHOLOGY SYMBOLS
▨ Organics
▩ Misc. Debris
▧ Clayey Silt

SAMPLE TYPE

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/25/17 Date Completed: 1/26/17

Depth (m)	Stratigraphic Description (continued)
10.0–18.3	**Soil and Waste** Black waste soil mixed with domestic waste.*(Continued)*
18.3–20.0	**Native Till** Grey clayey silt till.



LITHOLOGY SYMBOLS
▨ Organics
▨ Clayey Silt
▨ Misc. Debris

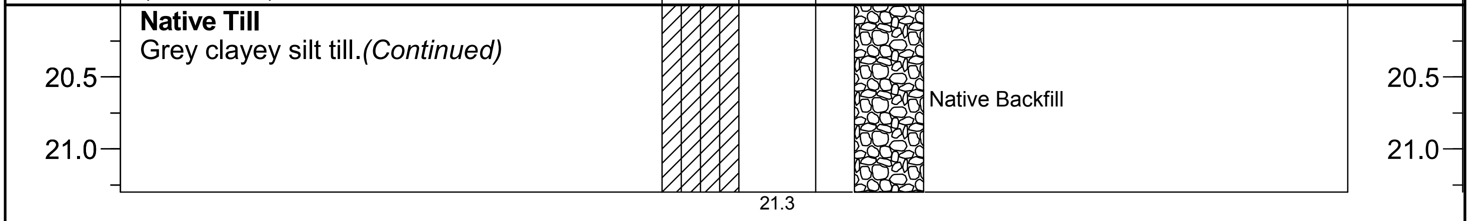
SAMPLE TYPE

M3W1

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: J.Sikorski

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/25/17
Date Completed: 1/26/17

Depth (m)	Stratigraphic Description (continued)	Lithology	Depth (m)	Well Construction	Depth (m)
20.5 21.0	**Native Till** Grey clayey silt till.*(Continued)*	▨	21.3	Native Backfill	20.5 21.0



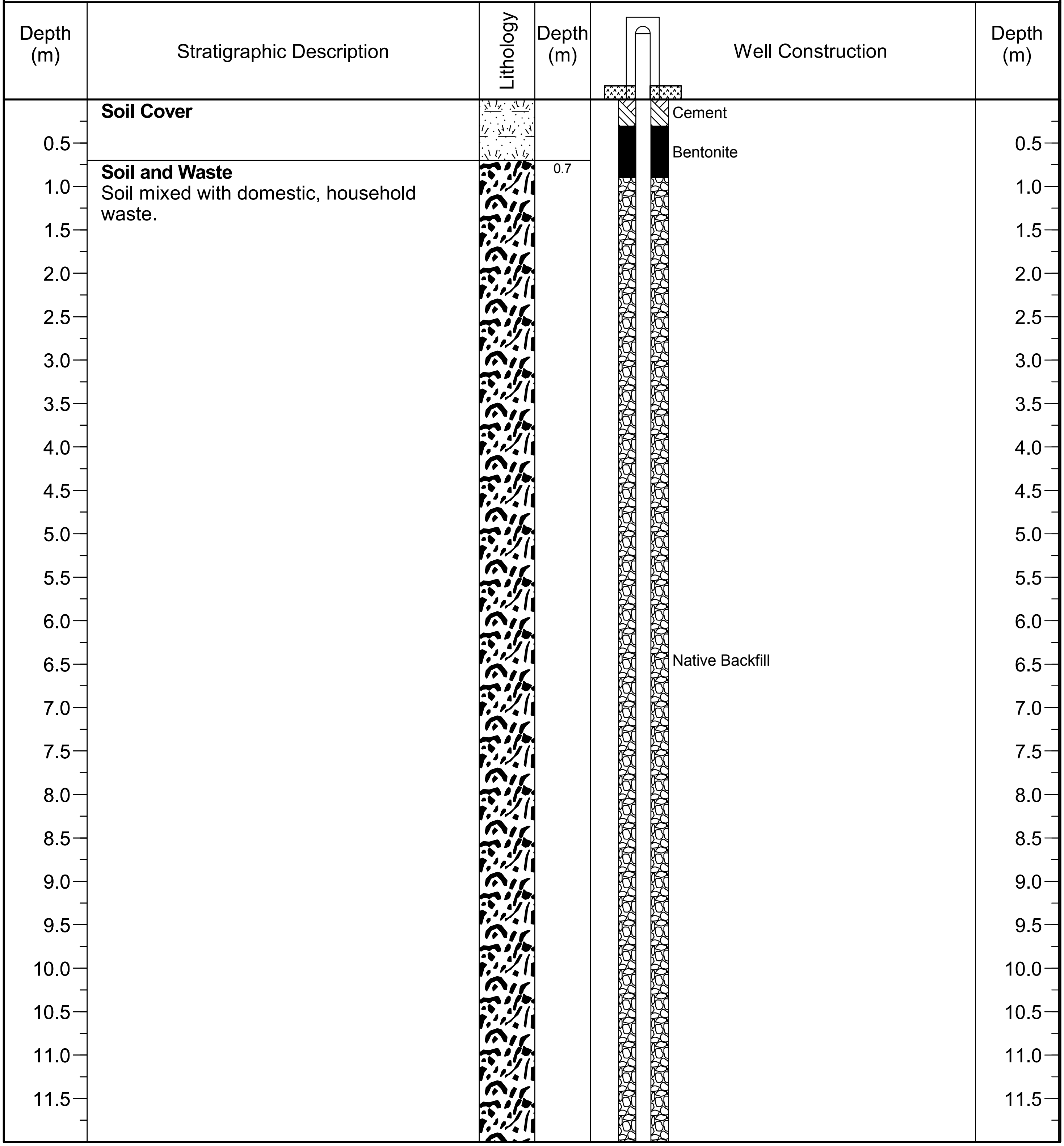
LITHOLOGY SYMBOLS
Organics
▨ Clayey Silt
Misc. Debris

SAMPLE TYPE

DILLON MW DEPTH RIDGE LANDFILL BH LEACHATE.GPJ DILLON TEMPLATE - JAN2011.GDT 3/21/17

M3W2

Client: Progressive
Project: Ridge Landfill Expansion
Project No.: 152456
Location: Blenheim ON
Drilling Co.: Direct Environmental
Drilling Method: Auger
Supervised by: M. Pardhan
Date Started: 1/26/17
Date Completed: 1/26/17



Soil Cover

Soil and Waste
Soil mixed with domestic, household waste.

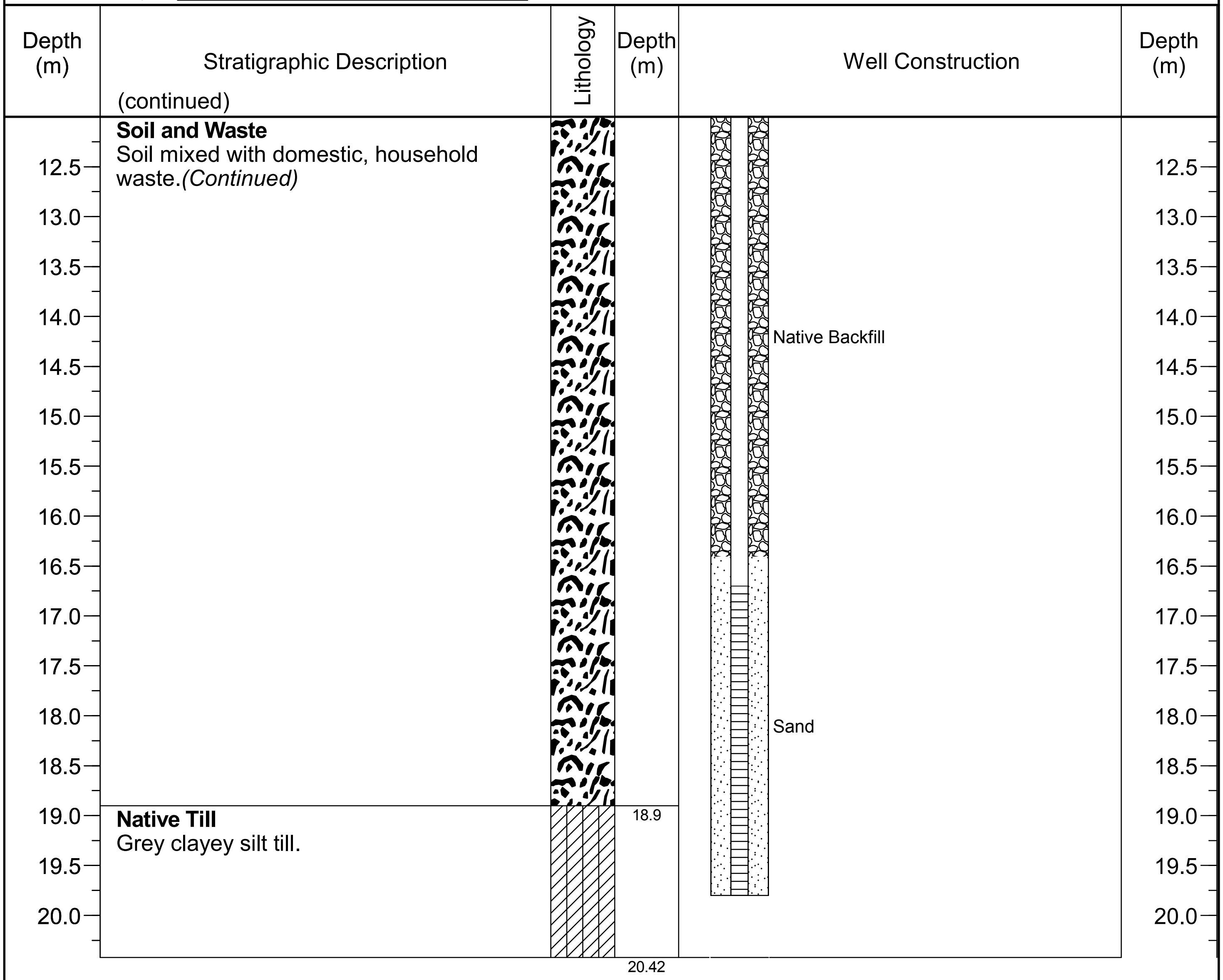
LITHOLOGY SYMBOLS
▨ Organics
▨ Clayey Silt
▨ Misc. Debris

SAMPLE TYPE

Client: Progressive
Project No.: 152456
Drilling Co.: Direct Environmental
Supervised by: M. Pardhan

Project: Ridge Landfill Expansion
Location: Blenheim ON
Drilling Method: Auger
Date Started: 1/26/17 Date Completed: 1/26/17

Depth (m)	Stratigraphic Description (continued)	Lithology	Depth (m)	Well Construction	Depth (m)
12.5 – 18.9	**Soil and Waste** Soil mixed with domestic, household waste.*(Continued)*				
18.9 – 20.42	**Native Till** Grey clayey silt till.		18.9		
			20.42		



LITHOLOGY SYMBOLS
- Organics
- Misc. Debris
- ▨ Clayey Silt

SAMPLE TYPE

Appendix B

Leachate Well Photographs

Photo #1: Mound 1 Hole 1 (M1W1) – 20 ft Depth - January 23, 2017

Photo #2: Mound 1 Hole 1 (M1W1) - 35 ft Depth - January 23, 2017

Photo #3: Mound 1 Hole 1 (M1W1) - 55 ft Depth - January 23, 2017

Photo #4: Mound 1 Hole 2 (M1W2) - 15ft Depth - January 23, 2017

Photo #5: Mound 1 Hole 2 (M1W2) - 45ft Depth - January 23, 2017

Photo #6: Mound 2 Hole 1 (M2W1) - 20 ft Depth - January 24, 2017

Photo #7: Mound 2 Hole 2 (M2W2) - 15ft Depth - January 24, 2017

Photo #8: Mound 2 Hole 2 (M2W2) - 35ft Depth - January 24, 2017

Photo #9: Mound 2 Hole 2 (M2W2) - 50ft Depth - January 24, 2017

Photo #10: Mound 3 Hole 1 (M3W1) - 30ft Depth - January 25, 2017

Photo #11: Mound 3 Hole 1 (M3W1) - 45 ft Depth - January 25, 2017

Appendix C

Literature Review

C.1.0 Introduction

We conducted a literature review of four Canadian and two American landfill sites that are pursuing or have completed landfill mining operations. A summary is provided for each landfill followed by a discussion on problems and mitigation measures implemented during the mining operations.

Tables C-1 and *C-2* in *Section C.8* provide a summary of key details for landfill mining operations obtained for Canadian and USA sites, respectively.

C.2.0 Trail Waste Facility Landfill (Reclamation Pilot Program)

The Trail Waste Facility Landfill (Trail Landfill) is located in Ottawa and its reclamation (mining), as a possible landfill expansion alternative, was proposed in October 1998. Landfill mining was considered because it could mitigate existing groundwater impacts (by mining the existing landfill and constructing a new lined disposal area) and provide additional landfill capacity. A pilot-scale mining project was approved and completed in 2001 to assess mining feasibility for further consideration. Specifically, the following was reviewed during the pilot test:

- State of decomposition of the waste;
- Landfill net volume gain;
- Recovered materials type, quantities and quality;
- Odour effects and management;
- Health and safety issues;
- Interaction between reclamation activities and operation of the gas extraction system;
- Leachate management required in conjunction with landfill cap removal;
- Review of the most effective methods of excavation, processing and re-landfilling; and
- Achievable rates of production and costs for landfill reclamation operations.

The landfill received domestic/residential and commercial wastes and had two capped stages and two operational stages at the time of the pilot program.

An area of 825 m² of Stage 1 of the Trail Landfill, which was in operation from May 1980 to July 1986, was chosen for the pilot program and six gas probes were installed to monitor the gas component concentration in February 2001. After removing soil cover, drainage layer, high density polyethylene geomembrane, sand bedding and subgrade material, 4440 m³ of waste (5.5 m thick) was excavated during an eight-day period in March 2001. The waste was processed using an Erin 165 finger screener during a 9-day period and the fines were used as daily cover and the rest of the waste was recompacted and relandfilled in the active working face of the landfill. The air space recovery for the pilot gained by processing and recompacting the waste was 18%.

The average existing apparent density was 580 kg/m³ (pre-mining) which increased to 650 kg/m³ after re-compaction (post-mining).

Waste characterization was performed on three 1.7 m³ representative samples from three locations and the result was as follows:

- Wood (7-13%);
- Plastics (17-22%);
- Paper (34-41%);
- Metals (6-7%);
- Glass (1%);
- Textiles (3-5%); and
- Fines (17-25%).

C.2.1 Concerns and Mitigation Measures

For this pilot work, management of leachate was not an issue due to low moisture content in the waste. Also, the weather conditions were favourable (i.e., no precipitation and low winds) during the pilot but for a full-scale operation over a long period of time, conditions would vary with the possibility of encountering saturated waste, perched leachate and unfavourable weather conditions that could result in the requirement to manage the leachate.

The decomposition of the biodegradable wastes produces landfill gas that would have associated odours and health and safety concerns during the excavation, processing, and re-landfilling of waste. Six gas probes were installed around the excavation perimeter to monitor and collect samples of landfill gas for characterization.

During the pilot project, temporary foam control agents were applied to the exposed waste surface in the excavation face and to the surfaces of the coarse and fine-screened stockpiled materials to control odours. Odour complaints associated with the mining pilot program were received from area residents from a distance up to 2.8 km from the pilot activities. Under full scale mining operations, odour emissions would vary by season and would require a more comprehensive and robust odour control plan.

In terms of health and safety, a minor fire developed under the screening unit's muffler which was extinguished using on-site hand held extinguishers. During the excavated waste characterization, five used hypodermic needles were encountered in one of the samples. The sorter was wearing hand protection, which prevented any injury.

The mining full-scale option was not chosen during the Trail Landfill expansion EA process as the selected preferred alternative did not include a mining component.

For additional details refer to *Table C-1* on *Section C.8*.

C.3.0 Sault Ste. Marie Municipal Landfill

The Sault Ste. Marie Municipal Landfill has an approved waste footprint of 44.6 ha and a disposal capacity of 2,260,000 m³ for waste and daily/intermediate cover.

The City is undergoing an EA where the preferred alternative is to expand the existing landfill to increase the site capacity to 6,460,000 m³ for disposal of solid residential, IC&I, construction and demolition (C&D) wastes and biosolids, assuming an apparent density of 0.56 t/m³. The proposed expansion alternative includes landfill mining as a component (i.e., excavate the existing waste and cover material, recover large size recyclable materials like tires, long metal rebars, concrete and boulders, earthen material or "fines" and return the residual waste to a lined cell).

The existing landfill has no liner and only a perimeter leachate control system and is located in gravel and sandy soils (i.e. highly permeable base). The site also has a soil deficit. The main driver behind landfill mining for the proposed expansion is to improve the groundwater conditions of the existing waste footprint with the installation of a liner. The secondary driver for mining is to recover fines to be used as daily/intermediate cover to offset the site soil deficit.

An area of approximately 3.4 ha is proposed to be mined and assuming an excavation of 320,000 m³ of waste and cover materials and 50% recovery, this will generate a disposal capacity of 160,000 m³ for waste and daily/intermediate cover.

C.3.1 Concerns and Mitigation Measures

As proposed in the Design and Operations Report, a site-specific health and safety plan should be prepared before mining operation and it should address:

- Physical, chemical and biological hazards such as gases (methane, hydrogen sulphide), sharps, wastewater biosolids, asbestos;
- Equipment traffic, and procedures to operate heavy equipment, processing equipment and tools; and
- Air quality, dust monitoring, airborne contaminant management, personal protective equipment (PPE), decontamination procedures and emergency procedures as well as procedures to manage anticipated or confirmed hazardous materials (e.g., asbestos).

A site specific preliminary odour management plan (OMP) was prepared as part of the EA. The OMP includes operational and administrative controls to mitigate odour emissions.

The proposed operational odour control measures for waste mining include:

- Minimize the area of active excavation to one day production whenever possible and cover with soil as soon as possible;

- Increase the slope of excavation considering the slope stability since a steeper slope will expose less waste and minimize odours (the slopes of exposed waste are expected to be between 4V:1H and 2H:1V);
- By-pass screening of waste where highly odourous waste (e.g., new waste) may be excavated;
- Avoid mining in known or suspected areas that may have perched leachate since perched leachate could cause odour emissions. Leachate or leachate impacted water should be drained or pumped as soon as possible to allow mining;
- Manage operations based on meteorological conditions to mitigate odour impacts. For example, avoidance of mining on hot days or when winds are blowing in the direction of residences and if possible conduct waste mining during wet days and/or colder months; and
- Use chemical and/or biological treatment to mitigate odour emissions.

The proposed administrative odour control measures for waste mining include:

- Training employees in the operational controls and related Standard Operating Procedures (SOPs);
- Selecting a contractor with adequate experience in waste mining projects and odour management;
- Incorporating requirements to strictly comply with the SOPs monitoring program; and
- Completing daily inspections of the active waste mining area(s) to document Site conditions, adherence to the control measures and SOPs, and potential odour impacts.

Another issue that needs to be addressed is dust and airborne contaminant management. Mining operations have the potential to generate dust during dry periods. Dust can be generated by typical mining operations such as cover stripping, waste and soil excavation, screening and heavy equipment and truck traffic. Dust is a concern because it may reduce visibility, generate airborne contaminants and potentially may become a nuisance to off-site receptors if not controlled at the source. A dust and airborne contaminant management plan should be prepared and implemented by the mining contractor and approved by the City and the contract administrator retained by the City.

For additional details refer to *Table C-1* on *Section C.8*.

C.4.0 City of Barrie Landfill

In 2008, the City of Barrie started a landfill mining program as part of the remedial plan to address groundwater impacts in a high permeable (i.e. sandy) soils base. The re-engineering plan consisted of three phases during which about 60% of the landfill was reclaimed and lined. The reclamation project extended the landfill life by 18 years from 2017 to 2035.

A pilot reclamation program was performed in 2008 to test the approach and the full scale reclamation started in the winter of 2009 and was completed in December, 2015. About 1.6 million m^3 of waste was excavated at the rate of 1,000 m³/day. Prior to reclamation, the remaining airspace was approximately 850,000 m^3 and it increased to 1,144,550 m^3 at the end of reclamation in 2015 (Dewaele and Brunet, 2017). Excavated materials were about 47% overs and 53% fines and approximately 50% of volume was recovered with the landfill mining operations. The fines composition on a weight basis consisted of 74% of fine-grained sand, 15% of dry combustible consisting largely of paper, fibre and plastic (Dewaele and Brunet, 2017)

The cost to mine the landfill was $10 to $15 per m^3 excluding liner and leachate collection system.

C.4.1 Concerns and Mitigation Measures

Odour was the major concern at the Barrie Landfill. The odour generation potential was grouped in different categories by the age of waste. Generally, younger wastes (within 7 years of being landfilled) are more odourous and so this waste was typically not processed but directly relocated to the new lined cell and landfilled immediately. Wastes between 7-14 years old were identified as having potential for odour but likely to be more manageable. Waste that was over 14 years old was assumed to be more stabilized and would generate less odours. Approximately 20% of the waste was re-landfilled without screening including newer waste with high odours during the excavation and asbestos (Dewaele and Brunet, 2017).

During the summer of 2010, an average of 10 complaints per day was received from local residents. The weather was checked regularly along with wind speed and direction to determine potential impacts to neighbouring residents and to plan mining operations accordingly. When possible, the operation was performed during wet conditions or the site was wetted to minimize odours. In addition, there was no screening of waste during the summer months (i.e., waste was excavated and then landfilled in the new cell immediately). Odour assessments were completed by taking readings regularly during the active mining periods.

For odour control, masking agents (200 Gallon reservoir attached to a fan), aerosols, foam canons and misters were used. The size of the open face of the operations was kept at a minimum and was covered with recaptured fines at the end of the day. Waste screening equipment was kept clean and operable to avoid downtime and delays to support odour control efforts.

Steeper working face reduced the exposed surface area and therefore reduced odour emissions. Interim waste slopes were as steep as 2:1 and sometimes the contractor excavated the waste at 1:1 slopes.

Only large items are typically recovered during mining operations. Recovered tires were shredded and used as internal road construction materials. Large concrete rubble was crushed and the aggregate used on site. Excavated wires from the landfill were contaminated with sand and debris to the point that the wires were not marketable to third party metal processors. The presence of wires and industrial fabrics slowed down the reclamation process (Dewaele and Brunet, 2017).

The landfill received asbestos during its operational life. There were Health & Safety protocols to handle asbestos, which included using respirators and other required PPE. When asbestos had been received at the landfill, it was bagged and tagged and their locations were marked at the landfill. During mining excavations, the asbestos containing materials was segregated and landfilled in the new lined cells. Asbestos was handled only during favourable weather conditions or alternatively the asbestos area was sprayed with water to minimize the potential for airborne releases of asbestos. Asbestos handling was avoided during windy conditions.

For additional details refer to *Table C-1* on *Section C.8*.

C.5.0 Blue Mountains Landfill

The Blue Mountains Landfill is owned and operated by the Town of The Blue Mountains and is located in Blue Mountains, Ontario. The total landfill property is about 23.1 ha and the landfill footprint is about 10.1 ha. The landfill includes the former Thornbury Landfill and the active Blue Mountains Landfill (collectively referred to as Blue Mountains Landfill) and it has been used for the disposal of waste since 1976. Both landfills are located in sandy deposits, rely on natural attenuation and do not have leachate collection systems. Both landfills received solid non-hazardous domestic waste and IC&I waste from within the municipal boundaries.

The Thornbury Landfill was capped with 1 m thick clayey soil cover material in 1996. The depth of the waste at the Thornbury Landfill is about 4 to 5 meters based on field investigations and with an area of approximately 2 ha, its volume is estimated to be 100,000 m³. The completed and partially filled portions of the Blue Mountains Landfill covers an area of about 8 ha and the thickness of the waste in the completed areas is estimated to be 6 m.

A vertical expansion combined with mining was approved in 2012 by MOECC. The main drivers for the landfill mining operations were to reduce groundwater impacts and to increase landfill capacity. The total landfill capacity of the proposed expansion was 470,000 m³ which increases the original capacity by 100,000 m³. The approval included the reclamation (mining) of the former Thornbury Landfill and the eastern one third of the Blue Mountains Landfill. The proposed reclamation project included 162,500 m³ of waste excavation in two stages of equal areas (Stage 1 in 2014 and Stage 2 in 2024). Based on previous field investigations, the overs to fines ratio was anticipated to be 40% to 60%.

The first phase of the landfill mining program was completed in 2014. Approximately 49,000 m³ of material was mined over one construction season at the Thornbury Landfill. The mining operations were relatively straightforward in this case because the waste was shallow and dry since it was buried through a trench and fill method with large amounts of native sandy soil and gravel between the waste trenches. Approximately $2.6 million was spent to mine 49,000 m³ ($53/m³) of material and to build a new cell with geomembrane/geosynthetic clay liner and leachate collection system. The cost for the landfill mining component ranged from $10 to $20 per m^3.

C.5.1 Concerns and Mitigation Measures

The Thornbury Landfill was closed in the 1970s and the eastern part of the Blue Mountains Landfill was capped in 1996 therefore the waste in the reclamation area was 20-40 years old and therefore significant odour would not be expected during the reclamation operations. However, proper operational procedures were followed to manage odour concerns. These procedures included: keeping the excavation face small and cover it as soon as possible, having an odour neutralizing foam sprayer on site for use as needed, monitoring the wind and weather conditions (temperature, precipitation, humidity, etc.) and adjusting the reclamation operation accordingly to manage potential odour impacts.

During landfill mining, oversized waste and overs were hauled, landfilled, and covered and in the case of equipment failure or emergency situations, waste was covered with a minimum of 150 mm thick layer of fines until it was properly landfilled. Temporary waste stockpiles that could not be landfilled on the same day were covered with 300 mm of fines. Exposed waste that would not be excavated immediately and be inactive for a period of time was covered with 300 mm fines. At the end of each day, active excavation face was covered with a minimum of 150 mm fines.

It was critical to control the placement of materials in the hopper of the screening plant because some materials such as metal bars, large metal items or concrete blocks can cause damage to the feeding belt or screen of the screening plant. Large sized materials were pulled out of the screening process using an excavator or backhoe to avoid damages to the screener.

During the reclamation process, appropriate temporary erosion and sediment control measures were necessary until the final grading was completed and the vegetation was established. Erosion and sedimentation controls were inspected regularly.

Although the reclamation operations were not expected to have significant noise impacts on the neighbouring residents (located 1 km minimum from the mining operations), the Town considered mitigation measures such as lowering the backup beeper sound level and installing additional temporary acoustical barriers.

A project specific health and safety plan was developed for the project addressing hazard identification, mitigative measures, safe operating procedures, air and dust monitoring, personal protective equipment, personal and equipment decontamination, and emergency procedures.

For additional details refer to Table C-1 on Section C.8.

C.6.0 Perdido Landfill

The Perdido Landfill is located in Florida, US, and is owned and operated by Escambia County Department of Solid Waste Management. The unlined area of the landfill covers approximately 18.2 ha

(45 acres) and received municipal solid waste from residential and commercial sources and non-hazardous waste from industrial waste from 1981 to 1990.

The trench and fill method was used for waste disposal and in early 1990 the unlined cells were capped with soil. A number of factors made the reclamation of the unlined cells a favourable option. Firstly, the unlined cells caused groundwater impacts at the site and benzene and vinyl chloride were encountered at elevated levels outside the property boundary. Secondly, due to leachate outbreaks (seeps) and differential settlement, the maintenance of the unlined cells had been a challenge. Thirdly, the landfill expansion into adjacent areas was limited due to site specific constraints. Lastly, the final grade of the unlined cells was at least 30 m below the permitted final grades for the adjacent lined cells and this elevation difference could be used for landfilling more wastes.

In 2006, a preliminary technical and economic feasibility assessment was performed by excavating eight test pits and screening the excavated waste as well as analysing data from 39 boreholes to estimate the depth of the waste and the final cover. It was estimated that 30% of the material in the unlined areas was final cover. The fine material, produced by screening the waste, was estimated to be 24% of the volume. The feasibility assessment results suggested that the reclamation cost was lower than the value of the recovered airspace, screening the excavated soil and using the fines as daily covers. The landfill capacity gain was mainly due to the fact that the new cells in the mining area could be developed with a much higher elevation.

A pilot program was performed in 2008 to evaluate the nature and volume of the waste as well the cost and technical feasibility of the reclamation before considering a full scale project. About 42,000 m³ of material was excavated from a 1 hectare (2.5 acre) section during the pilot period. The pilot program provided information and data that were used in the full scale program.

The full scale project was planned in two phases. Phase I was conducted from 2009 to 2011 and about 371,000 m³ of waste was excavated from a 6.8 ha (17 acre) area. The volume of the final cover soil was estimated to be 126,350 m³ (34%). The combination volume of final cover soil, reclaimed soil, and bermed soil was approximately 62% of the mined airspace.

C.6.1 Concerns and Mitigation Measures

The waste screening process slowed down the project because of frequent equipment breakdowns. In 2010, a second screener was set up to increase the screening rate; however, typically only one screen was operating at a time.

A major issue during the mining was the transport of sediments from the mined area before stabilization with vegetation. Clayey-silt sediment was transported with stormwater runoff from the reclamation area to the stormwater pond and covered the entire sand drainage layer. Silt barrier fences were used to control further impacts.

Odour was not a concern during the reclamation project as it dissipated with distance (over 2 km from the mining operations to the closest receptors) and waste was more than 20 years old.

Litter was controlled by installing litter control fences.

The reclamation cost for this project was \$11/m^3 (\$8.33 USD per m^3) of airspace. This relative low unit cost is due to the fact that the new lined cell was filled at the mining site with a much higher elevation, i.e. the unit cost was spread across all capacity. Therefore, this cost is not representative of a typical landfill mining project.

For additional details refer to Table C-2 on Section C.8.

7.0 Ocean County Landfill Corporation (OCLC) Site

The Ocean County Landfill Corporation (OCLC) Site is a privately owned and operated sanitary landfill in Manchester Township, New Jersey. The landfill is constructed above sandy soil and the water table is just below the landfill base. The OCLC property has approximately 280 hectares (700 acres) and it serves 33 municipalities including the Ocean County. It receives 453,000 tonnes (500,000 tons) of waste per year and its remaining capacity is expected to last for 25 years (from December 2015).

Landfill mining was proposed for this landfill as an expansion option since vertical expansion of the landfill was challenging due to height restrictions imposed by the New Jersey Department of Environmental Protection (NJDEP). Lateral expansion would not be a feasible option due to surrounding neighbourhoods and wetlands. Also, the site had a soil deficit and there was history of high amounts of recyclables being landfilled. Soils and fines were recovered and used for daily/intermediate cover.

An extensive test pit program was conducted in July 2007 to assess waste characterization, delineation of limits and also to measure Biochemical Methane Potential (BMP) and hydrogen sulfide exposure. The test pit was also used to conduct visual observation regarding waste decomposition, odour, moisture, and perched conditions. BMP testing showed that the waste was largely decomposed. No perched leachate was encountered during the test pit program and it was observed that a large amount of soil had been used as daily cover during the waste placement. The cover soils above and below the liner were also thicker than expected, which made the mining operations more attractive because the landfill needed soils for future operations.

The landfill received approval to mine 3.06 million m^3 (4 million yd^3) of waste over an area of 27.5 ha (68 acres), including a pilot test. Excavating this amount of waste, screening, re-compacting the covers, and using the fines as daily cover would add an additional 0.96 million m3 (1.25 million yd3) of landfill capacity, which equals 31% of additional capacity and expand the operating life of the landfill by 1.5 years.

Landfill mining was planned in 3 phases over a 15-year period. For Phase 1, it was planned to excavate and screen 1.15 million m^3 (1.5 million yd^3) of waste. The mining started in September 2014 and 150,000 m^3 (200,000 yd^3) waste was mined in the first year.

The mining cost was estimated at \$24 per m^3 (\$13.69 USD per yd^3) excluding liner and leachate collection system.

C.7.1 Concerns and Mitigation Measures

The concerns for this particular site were relatively moderate. To mitigate various concerns and adjust the operations, a pilot test and various test pits were completed.

To mitigate odours, a stationary odour misting system was installed on poles and the mining operations was planned to take place downstream of the landfill gas collection system when possible.

To mitigate health and safety concerns, hydrogen sulphide masks were used when needed and a general rule was adopted to never allow anyone to approach the trommel while in operation; if the trommel needed to be checked or maintained, it should first be shut down.

For additional details refer to *Table C-2* on *Section C.8*.

C.8.0 Summary of Additional Landfill Mining Information

Tables C-1 and *C-2* below provide a summary of key details for landfill mining operations for Canadian and USA sites.

Table C-1: Landfill Mining Summary for Canadian Sites

Name of the Landfill	Trail Landfill	Sault Ste. Marie Municipal Landfill	City of Barrie Landfill	Blue Mountains Landfill
Location	· Ottawa, ON	· Sault Ste. Marie, ON	· Barrie, ON	· Blue Mountains, ON
Filling History	· Stage 1 (before expansion approval): filling from May 1980 until July 1986	· Opened in the 1960s	· Opened in the 1960s	· Opened in 1976. The Thornbury site closed in 1994.
Current Phase of the Project	· Below information is from pilot phase in 2001. · Current status: EA approved June 1, 2005. Mining was not a component of the preferred alternative	· EA under approval. The Terms of Reference were approved. · The environmental impact assessment reports have been submitted to MOECC	· Completed (60% of the existing landfill was reclaimed and lined)	· Stage 1 completed, Stage 2 planned for the future
Mining Timeline	· Pilot: Feb 2001 (gas probe well installation). Excavation: March 6 to 15, 2001. Refuse processing: March 6 - 16, 2001 · Pilot: 8 days for excavation and hauling; 16 days for screening and processing of material · Full Scale (all Stage 1, 2 and east side of 3): Excavation and processing wouldl take approximately 10 years	· Mining will start after the EA is approved by MOECC · 3 years estimated	· 6 years for pilot and 3 phases · 2008 pilot program · Phase 1 completed in 2009 · Phase 2 completed in 2013 · Phase 3 from March 2013 to December 2015	· Stage 1: mining in 2014 and construction of lined cell in 2015 · Stage 2: planned to start in 2024 · Taking in account downtime, equipment breakdown, and weather condition etc., each stage should take between 9 months to a year to finish. Timeline assumes using screening equipment to handle approximately 500 m3/day over a 5 day working week with 8 hours per day
General Site Information	· Total site area: 200 ha with 85.2 ha footprint · Total approval capacity of 16,998,442 m^3 · Fill rate: 563,300 tonnes/year	· Existing fill Area: 25.8 ha · Proposed expansion fill area addition: 17.8 ha · Max fill rate: 78,500 tonnes/year	· Total site area of 121.3 ha with 18.6 ha footprint Approved capacity of 3,924,750 m^3 · Existing fill area: 18.6 ha Max fill rate: 81,000 tonnes/year	· Total site area of 23.1 ha with 10.1 ha waste footprint · 370,000 m^3 disposal capacity with approximately 52,000 m^3 remaining (as of 2012) · Site receives on average 4,330 tonnes of waste/year
Waste Type	· Solid residential, industrial, commercial and institutional (IC&I), construction and demolition (C&D) wastes and biosolids	· Solid residential, industrial, commercial and institutional (IC&I), construction and demolition (C&D) wastes and biosolids	· Solid residential, industrial, commercial and institutional (IC&I), construction and demolition (C&D) wastes and biosolids	· Solid residential, industrial, commercial and institutional (IC&I), construction and demolition (C&D) wastes and biosolids
Mining Area and Volumes	· Pilot: 825 m^2 surface area (4440 m^3 of refuse excavated)	· Proposed Mining Area: 3.4 ha · 320,000 m^3 to be excavated, of which 160,000 m3 will likely be recovered	· Excavated 1,620,000 m^3 (44% of the total licensed landfill volume) between 2009 and 2015 · Production rate: approximately 1000 m^3/day of material screening	· Total of 162,500 m^3 waste planned to be mined over 2 stages (81,250 m^3 each stage) · The volume of waste mined was actually 49,000 m^3 and the rest was relocated or not mined · Assumed production rate: approximately 500 m^3/day of material screening over 5 days a week,

Name of the Landfill	Trail Landfill	Sault Ste. Marie Municipal Landfill	City of Barrie Landfill	Blue Mountains Landfill
				8 hours/day
Recovery Rate (%)	· Pilot:18.2% airspace recovery · Overall: Approx. 13% estimated	· 50% (estimated)	· 50%	
Mining Depth (m)	· 8.5 m	· 10 m	· 20 m	· Up to 2.5 m
Types of Waste Recovered	· 79% of the overall recovered volume was recyclable content: · Wood (7-13%) · Plastics (17-22%) · Paper (34-41%) · Metals (6-7%) · Glass (1%) · Textiles (3-5%) · Fines (17-25%)	· Recovery of large size recyclable materials such as tires, long metal rebars, concrete rubble and boulders. · Fines material to be used as daily cover	· Recovery of large size recyclable materials such as tires, long metal rebars, concrete and boulders · Fines (approx. 875,000 m^3), tires (approx. 3 million tires recovered which were then ground up and used internally for internal road base)	· Recovery of large size recyclable materials (white goods, tires, long metal rebars, concrete rubble and boulders) represented 40% recovery of fine materials represented 60% of overall recovered materials
Waste Apparent Density	· Existing (pre-mining): 582.9 kg/m^3 · Re-compacted (post-mining): 646 kg/m^3	· 0.56 t/m^3	· 650-750 kg/m^3 · The apparent density of the re-compacted oversize fraction was 1,280 kg/m^3	· Historical range from 275 to 432 kg/m^3
Equipment Used/Proposed	· CAT 330 tracked Hydraulic shovel · Volvo articulated trucks · Erin 165 finger screener · CAT 826C (35 tonne) landfill compactor · CAT 330 excavator · CAT 320 c/w Grapple · CAT 980C rubber Tire Loader · Application odour suppressant	· 1 Dozer Cat D7 · 2 Excavators fitted with hydraulic "thumbs" · 2 Trommel screen(s) · Loader · 2 Articulated trucks Cat 735 · Top loading trucks to haul waste · 1 Hydraulic stacker (stacking conveyor) · Water truck for dust control · Odour misting system 1 Grinder	· 2 Dozer D6 · 2 Excavators · 2 McClosky MCB 733 · 2 Trommel screens · 1 50-ft stacker for the fines · 4 articulated haul trucks · 1 Cat 826 compactor · Odour misting system	· Dozers · Excavators with thumb · Trommel screens · Rubber tire loader · Articulated trucks · Top loading waste hauling vehicles · Conveyors/stackers · Water truck/tank for dust control/suppression · Odour suppressant foam sprayer · Odour neutralizing misting systems
Cost	· \$35/m^3 estimated for the full-scale mining project excluding liner and leachate collection system	· Not available (proposed mining is under approval)	· \$10 to \$15 per m^3 excluding the liner and leachate collection system	· \$10 to \$20 per m^3 excluding the liner and leachate collection system
References	· J.L. Richards & Associates Ltd. (2001) · https://www.ontario.ca/environment-and-energy/large-landfill-site-details?site=A461303 https://www.ontario.ca/page/trail-waste-facility-landfill-optimization-project	· Dillon (2017a) · Feb 2016 Open Public House Displays: http://saultstemarie.ca/Cityweb/media/PWT/Public%20Works/SolidWasteEAFeb9Displays.pdf	· Dillon (2011) · Dillon (2013a) · Dillon (2013b) · Dillon (2014) · Dillon (2017c) · https://www.ontario.ca/environment-and-energy/large-landfill-site-details?site=A250101 · http://www.barrie.ca/Living/GarbageAndRecycling/Pages/LandfillProject.aspx	· Golder (2014) · Dillon (2017d)

Table C-2: Landfill Mining Summary for American Landfills

Name of the Landfill	Perdido Landfill	Ocean County Landfill Corporation Site
Location	Cantonment, Florida	Manchester, New Jersey
Site History	Operational from 1981 to 1990 In early 1990 the unlined cells were capped with soil	
Mining Timeline	In 2006, a preliminary technical and economic feasibility assessment was performed A pilot program was performed in 2008 Phase 1 of the full scale project was conducted from 2009 to 2011	Started in Sept 2014 3 phases over a 15 year period
General Site Information	The unlined area of the landfill covers approximately 18.2 ha (45 acres)	Site area: 280 Ha (700 acres) Waste footprint: 120 Ha (300 acres) Sandy soil with water table below the landfill base. Approx. 500,000 tonnes of solid waste disposed on annual basis at $80 USD per ton
Waste Type	Received municipal solid waste from residential and commercial sources and non-hazardous waste from industrial sources	Serves 33 municipalities comprising the Ocean County
Mining Area and Volumes	For the pilot project about 42,000 m^3 material was excavated from a 1-ha section For the Phase 1, 371,000 m^3 waste was excavated from 6.8 ha area	Received approval to mine 3.06 million m^3 (4 million yd^3) Excavated 150,000 m^3 (200,000 yd^3) of material in the first year Mining started in September 2014 and still ongoing
Recovery Rate (%)	62%	Varied on a daily basis from 30% to 70%
Type(s) of Waste Recovered	Mostly fines, including soils	Recovery of large size recyclable materials such as tires, long metal rebars, concrete and boulders Fines used as daily cover Drums with chemicals or any concerning materials were not found Asbestos outside the dedicated area were not found
Equipment Used	Four Excavators One dozer Two Trommel screens Six articulated dump trucks	Excavator Trommel screen(s) 1 front end loader Truck(s) to haul waste 4 John Deere rock trucks
Cost	$11 per m^3 ($8.33 USD per m^3) Note that this cost is not representative of a typical mining project as explained above	$24 per m^3 ($13.69 USD per yd^3) excluding liner and leachate collection system
Source	Jain et al. (2013)	Cornestone Environmental (2014) Dillon (2015) Ocean County Landfill Corporation (2015) Dillon (2017b)

Appendix D

Leachate Alternative Supporting Documents

Chatham-Kent
Public Utilities Commission

Municipality of Chatham-Kent
Public Utilities Commission
325 Grand Avenue East,
PO Box 1191 Chatham, ON N7M 5L8
Tel: (519) 436-0119 Fax: (519) 352-3432
Toll Free: 1.800.714.7497

October 19, 2018

Cathy Smith, Project Manager
Ridge Landfill Expansion EA
Waste Connections

RE: Ridge Landfill EA - Leachate Management Alternatives - Dillion Consulting File: 152456

Dear Cathy:

This letter is in response to our meeting July 25, 2018, regarding Leachate Management Alternate methods.

The Chatham-Kent Public Utilities Commission (CK PUC) has evaluated the leachate flow from the Ridge Landfill to the Blenheim treatment lagoons and have found that, at this time, there is enough capacity to handle the flow generated form the landfill.

According to the Environmental Certificate of Approval (ECA) for the Blenheim Treatment lagoons;

> ***"Average daily flow of leachate into the Blenheim Lagoons shall not exceed 4,045m3/day, and peak flow shall not exceed 12,046m3/day."***

In 2018, May was the highest discharge month with a total discharge from Ridge Landfill of 18,517 m3 per month (597.32 m3 per day). This flow is well below the ECA for this treatment facility. At this time, the Blenheim lagoons have the capacity to handle the current flows of the landfill. The Water and Wastewater Master Plan completed for Chatham Kent identified the need for the upgrade of the Blenheim lagoons to a mechanical plant in the 2023 - 2027 horizon. The population and community growth projections that we have completed for the service area for the Blenheim Treatment Lagoons also indicate that the lagoons will be able to accommodate the anticipated Ridge Landfill leachate flows until the planned upgrade. Once complete, the treatment facility will have ample capacity to manage the flow from the Ridge Landfill over the long term.

Blenheim Treatment Lagoons have been receiving leachate from Ridge Landfill since 1998 and the quality of leachate has been tested and CK PUC has not seen any adverse effects in the lagoon effluent. The lagoons effluent currently meets or exceeds the ECA effluent discharge parameters.

The preferred method for CK PUC is to continue to receive leachate from Ridge Landfill to the Blenheim Lagoons via the forcemain that is in place. The alternative method is to transport leachate from the landfill to the Chatham Wastewater Treatment Plant (100 Irwin St, Chatham) for treatment. Transport by truck is the preferred method to convey leachate to the Chatham plant as the infrastructure is in-place to off-load trucks at the plant and most importantly, it allows PUC staff to control the release of the liquid onto the plant.

Regards,

Tim Sunderland,
General Manager

MEMO

TO: Cathy Smith, Project Manager, Ridge Landfill Expansion EA, Waste Connections

FROM: Fabiano Gondim, Dillon Consulting
Tihamer Csiba, Dillon Consulting

DATE: June 29, 2018

SUBJECT: Ridge Landfill EA - Leachate Management Alternatives

OUR FILE: 152456

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1. Background

The Alternative Methods were defined in the December 2017 Terms of Reference (ToR) as "various ways of carrying out the preferred undertaking that are technically and economically feasible". This definition is consistent with the *Code of Practice: Preparing and Reviewing Terms of Reference for Environmental Assessments in Ontario* published by the Ministry of the Environment and Climate Change (MOECC) (referred herein as "Code of Practice"). The ToR presented alternative methods for physical expansion of the landfill. The ToR also committed that Waste Connections would review the existing leachate collection system to confirm sufficient capacity for leachate management for an expanded landfill. As part of this review, Waste Connections committed to assessing other reasonable long-term leachate treatment alternatives as an activity concurrent with the evaluation of site development alternatives.

2. Purpose

This memo focuses on the leachate management component of the three proposed site development alternative methods, specifically with the treatment of the leachate. The purpose of this memo is to:

- Clearly identify the leachate management alternative methods for evaluation, in consideration of the site development alternative methods that have been proposed. According to the Code of Practice, the Alternative Methods should be described conceptually and in sufficient detail to allow for a comparative evaluation during the EA process.
- Describe the proposed approach to evaluate the identified leachate treatment alternatives. According to the Code of Practice, the range of alternative methods should be reasonable. Reasonable alternative methods should meet the criteria determined by the proponent and approved by the MOECC.

This memo will ultimately be incorporated into the EA document as part of the Alternative Methods chapter.

3. Leachate Management Alternative Methods

3.1 Leachate Treatment/Disposal Alternative Methods Identification

Leachate treatment and disposal may include onsite and/or offsite treatments as outlined below:

1. No on-site pre-treatment – discharge to an off-site treatment plant
2. On site pre-treatment – discharge to an off-site treatment plant for treatment. Treatment technologies could include:
   - Physical-chemical treatment only.
   - Biological treatment only.
   - Both physical-chemical and biological treatment.
3. Full on-site treatment of the leachate before discharging.

Table 2, below, outlines the leachate treatment alternative methods for consideration.

TABLE 1: LEACHATE TREATMENT ALTERNATIVE METHODS

Leachate Treatment Alternatives	Comments
No on-site pre-treatment and discharge to Blenheim WPCP (current method)	• Expansion of the Blenheim WPCP may be required. Plant expansion is recommended in the C-K Water & Wastewater Master Plan. The rated capacity of the WPCP may need to be increased, and as a result, more stringent effluent quality may also be required.
No on-site pre-treatment and discharge to a treatment facility other than Blenheim WPCP	• Discharge of leachate to municipally or privately owned facilities will be evaluated.
Pre-treatment and discharge to Blenheim WPCP	• The level of required pre-treatment will be assessed as part of the Blenheim WPCP utilization alternative. The rated capacity of the WPCP may need to be increased which could result in more stringent effluent quality being required.
Pre-treatment and discharge to a treatment facility other than Blenheim WPCP	• The level of required pre-treatment will be assessed as part of the evaluation of utilizing municipally or privately owned treatment facilities.
Full-treatment on-site and discharge to local drain	• To establish discharge limits, an Assimilative Capacity Study and Environmental Assessment of the drain would be required.

*Note: Neither Full-treatment on-site with discharge to Lake Erie nor leachate evaporation will be evaluated as alternative methods. Full-treatment and discharge to Lake Erie is not feasible due to the distance to Lake Erie and need for a new outfall. Natural evaporation is not feasible due to the large volume of leachate anticipated.

4. Leachate Treatment Alternative Methods Evaluation Criteria

The following criteria are proposed to be used to evaluate leachate treatment alternatives. These criteria are based on the criteria included in the approved amended Terms of Reference. Only those criteria appropriate for the evaluation of leachate treatment alternatives have been included in Table 3 below:

TABLE 3: LEACHATE TREATMENT ASSESSMENT CRITERIA

Criteria Group	Criteria
Socio-Economic	• Extent of off-site property required for leachate transmission.
	• Potential for displacement/disruption of residents and/or businesses off-site.
	• Potential for odour disruption.
Natural Environment	• Potential for loss/disruption of aquatic systems on-site.
	• Potential for loss/disruption of terrestrial systems on-site.
	• Potential impacts to groundwater quality.
	• Potential impacts to surface water quantity.
	• Potential for impact on Species at Risk.
	• Ability to contribute to the reduction of GHG emissions.
Design and Operations	• Potential for providing necessary service.
	• Flexibility of the on-site technology/equipment and ability to meet the Ministry of the Environment and Climate Change definition of proven technology.
	• Relative ease to implement/construct and maintain/operate the on-site technology/equipment of the proposed alternatives.
	• Ability of existing WPCPs to receive and treat leachate.
	• Ability of the on-site technology/equipment associated with the alternative to handle variable loadings and flows. • Ability of the on-site components of the alternative to operate during a power or equipment failure.

Criteria Group	Criteria
	• Ability to meet regulatory requirements.
	• Cost of facility.
Transportation	• Potential for traffic safety and operations impacts.

Appendix E

Landfill Gas Alternative Supporting Documents

TECHNICAL MEMORANDUM

DATE November 14, 2018 **Project No.** 18111331

TO Bill Allison, P.Eng.
Dillon Consulting Ltd.

CC

FROM Fabiano Gondim, P.Eng., Golder Associates Ltd. **EMAIL Fabiano_Gondim@Golder.com**

RIDGE LANDFILL EXPANSION EA – EVALUATION OF ALTERNATIVES – LANDFILL GAS CONTAMINATING LIFE SPAN AND SUBSURFACE MIGRATION

Introduction

As requested by Waste Connections of Canada Inc. (WCC), Golder Associates Ltd. (Golder) has prepared this Technical Memorandum as related to the Ridge Landfill Expansion Environmental Assessment (EA). In particular, this Technical Memorandum focuses on landfill gas (LFG) generation and subsurface migration potential in the context of the comparative evaluation of the proposed landfill expansion alternatives.

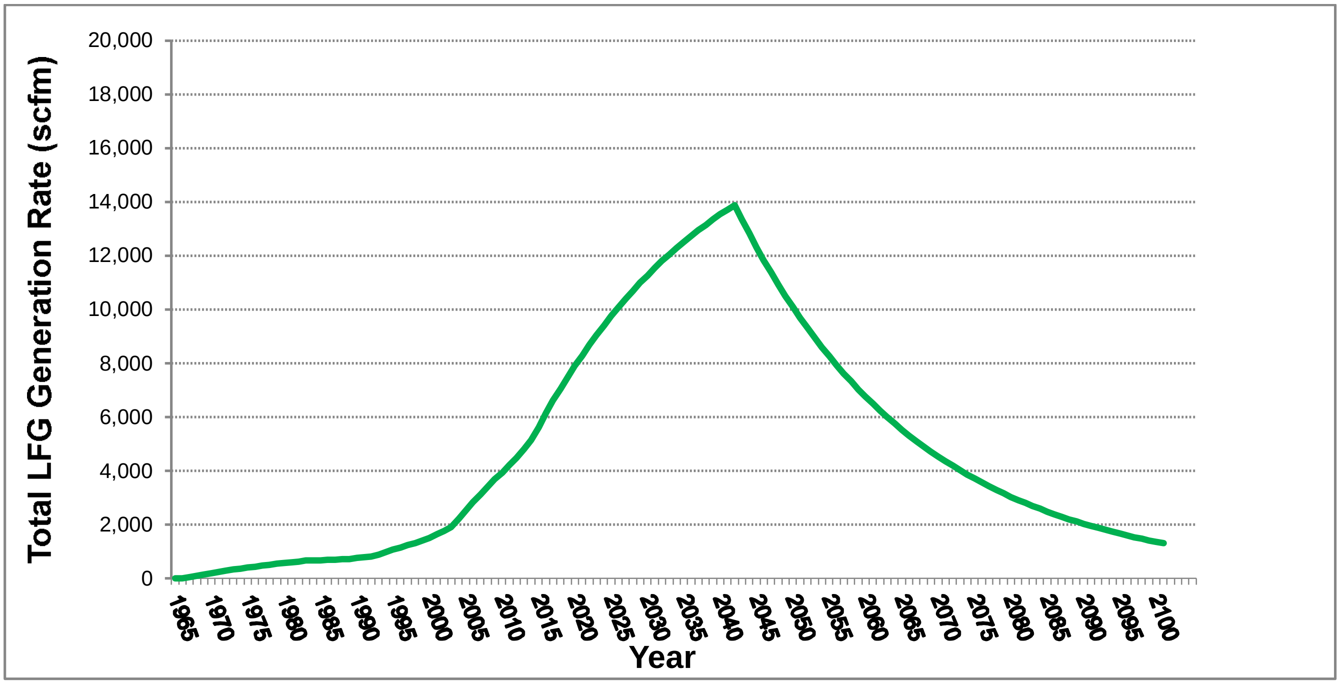
The proposed Ridge Landfill Expansion will retain the approved annual waste acceptance rate of 1.3 million tonnes of municipal solid waste (MSW) per year over a 20-year planning period, for a total of 26 million tonnes. As part of the EA, three landfill expansion alternatives have been developed, and each proposed expansion alternative has an equal disposal capacity to accommodate the additional total 26 million tonnes of MSW.

LFG Generation Rates

The LFG generation rate for the Ridge Landfill expansion was estimated using the Landfill Gas Emissions Model (LandGEM) Version 3.02. The LandGEM model was developed by the United States Environmental Protection Agency (USEPA) and is a first order decay model that estimates generation rates for total LFG and specific gas constituents such as methane, carbon dioxide, non-methane organic compounds, and individual air pollutants from MSW landfills.

LFG generation is a function of waste tonnages in place, annual waste disposal rate and two parameters that are specific to the type of waste and influenced by environmental conditions (i.e., Lo - potential methane generation capacity and k - methane generation rate). Since the waste tonnages, waste type and environmental conditions over the 20-year planning period are identical for the three proposed expansion alternatives, the LFG generation quantities will also be identical. Therefore, only one model run is necessary to estimate LFG generation common to the three proposed alternatives. The model results for LFG generation rates in standard cubic feet per minute (scfm) over time for the proposed Ridge Landfill expansion is presented in the following **Figure 1**.

Figure 1: Landfill Gas Generation Results



The LFG generation quantities illustrated in **Figure 1** are for total LFG generation (i.e., it includes all gas constituents). As explained above, this gas generation curve applies equally to the three proposed expansion alternatives because the waste tonnages to be placed on site and the type of waste will be identical for the three proposed alternatives over the 20-year planning period.

LFG Subsurface Migration Potential

At landfill sites, the potential for lateral subsurface migration of LFG and associated potential explosion hazard of methane (should it migrate and collect in confined spaces) is commonly assessed. Methane gas is lighter than air, it is explosive when present at a concentration of between 5 and 15 percent by volume in air, and it migrates under both concentration and pressure gradients.

LFG lateral subsurface migration potential is influenced by various site-specific factors such as type of native soil, groundwater elevation, landfill containment system design, and active LFG collection system. Methane gas explosion potential of migrated LFG depends on factors specific to the receptors, such as separation distance between the waste disposal areas and the receptor buildings, and construction characteristics and engineering controls at the receptor sites.

Based on the physical site setting of the Ridge Landfill, potential lateral migration of LFG through the subsurface is expected to be very limited. The native silty clay soil is about 30 metres deep, is generally homogeneous and has a low permeability. In addition, the upper groundwater level is relatively shallow. Those two site conditions are natural limiting factors for potential subsurface lateral migration of LFG between the waste disposal areas and potential receptors.

It is noted that a compacted clay liner is proposed for the side slopes of the proposed expansion cells. This proposed compacted clay liner will be constructed with native clay material to provide a low permeability barrier to potential migration of both leachate and LFG and will surround the perimeter of the new waste disposal areas. The existing waste disposal areas were constructed with lateral containment systems (either compacted clay cut-off walls or compacted clay liners). The lateral low permeability containment system adds an additional barrier to LFG migration. As well, there is a minimum 100-metre wide buffer between the proposed landfill footprint areas and the site property boundaries; there are also municipal drains that would intercept the lateral migration of any LFG in the unlikely event that it had migrated away from the landfill through the thin unsaturated zone.

The proposed landfill expansion will have an active LFG collection system that will collect LFG and relieve LFG pressures in the waste mass, which will also control potential lateral subsurface migration of LFG.

In light of the physical site setting, the engineered perimeter barrier systems around the landfill areas and the proposed active LFG collection system that will impose negative gas pressures in the waste mound, the potential for lateral migration at this site is negligible.

In the unlikely event of LFG migration, the on-site receptor buildings such as scale house, offices, maintenance building, and pump houses are equipped with a methane detection and alarm system. These existing (baseline) conditions are not expected to change with the proposed expansion.

The LFG assessment potential above applies to the three contemplated expansion alternatives, i.e., all three contemplated expansion alternatives have comparable negligible LFG subsurface migration potential.

The term ‘contaminating lifespan” typically refers to the period of time over which leachate, if released to the natural environment, would have an adverse effect. Applying this term to LFG in terms of the potential for subsurface migration of LFG, it is considered that the contaminating lifespan would be zero in view of the negligible potential for it to occur, let alone have an adverse effect as described above. In this regard, the three landfill expansion alternatives are equally preferred.

Closing

We trust this memorandum satisfies your current needs. If you have any questions regarding this memorandum, please contact the undersigned.

Fabiano Gondim, M.Eng., P.Eng.
Senior Waste Engineer

Paul Smolkin, P.Eng.
Principal

FRG/PAS

https://golderassociates.sharepoint.com/sites/34627g/deliverables/lfg assessment - evaluation of alternatives/tech memo_final_ridge lfg assessment_2018'11'22.docx

Appendix F

Additional Supporting Documents

MEMO

TO: Bill Allison
FROM: James Walker
DATE: November 27, 2018
SUBJECT: Ridge Landfill Expansion EA – Surface Water Quantity Assessment
OUR FILE: 15-2456

The purpose of this memo is to provide a summary of the results of the surface water quantity assessment for the proposed Ridge Landfill Expansion Environmental Assessment. Specifically, this memo is intended to provide the following information:

- The key design considerations and assumptions related to assessment of potential surface water quantity impacts;
- A summary of the methodology and results of the hydrologic analyses that were undertaken to evaluate the site development alternatives; and
- A summary of conclusions for the surface water quantity assessment.

Additional information regarding the study area as well as the surface water impact assessment criteria, indictors, and background data sources is provided in the Surface Water Impact Assessment – Baseline Assessment (November, 2018).

Key Design Considerations & Assumptions

The key design considerations and assumptions for the surface water impact assessment are outlined below.

Baseline Conditions

The assessment undertaken to establish baseline conditions reflects the pre-development (i.e., existing) site configuration. With respect to surface water quantity considerations, the baseline scenario involves the existing surface water management system as described in the Surface Water Impact Assessment – Baseline Assessment (November, 2018).

In general, the existing surface water management system is comprised of a network of ditches and culverts, which convey site runoff to one of six stormwater management (SWM) ponds. The existing SWM ponds were designed to provide water quantity and quality control prior to discharging to the municipal drains that transect the site. Additional water quality control is provided in the flood control facility at the confluence of the Howard and Duke Drains.

Landfill Expansion Alternatives

The surface water impact assessment involved an evaluation of the three site development alternatives (Alternatives 2, 3B, and 4). Information regarding the conceptual SWM plan for each alternative is provided below. SWM pond sizing and performance characteristics are provided in the Hydrology section of this memo.

Under all three of the site development alternatives, a segment of the Howard Drain would be re-aligned to accommodate the proposed landfill expansion, which includes approximately 1200 m of watercourse between the Alison Line crossing and the confluence with the Scott Drain.

Alternative 2

The conceptual SWM plan for Alternative 2 is shown on Figure 1 and described below.

- Surface runoff from the West Landfill expansion area would be conveyed by perimeter ditches to a new stormwater management pond (SWM Pond A1).
- Surface runoff from the South Landfill would be directed via ditches at the landfill perimeter to an additional new pond (SWM Pond B1).
- The new SWM ponds would provide quality and quantity control (as outlined in the Section below), prior to discharging to the Howard Drain.

This alternative also involves a vertical expansion of the Old Landfill. However, no significant modifications to the existing SWM system are proposed.

Alternative 3B

The proposed landfill expansion for Alternative 3B is similar to Alternative 2. The primary difference with respect to surface water management is that the South Landfill expansion (Area ‘B’) has a slightly smaller total footprint (approximately 12% smaller). As shown on Figure 2, the conceptual SWM plan involves the addition of two new ponds to (SWM Ponds A1 and A2) provide water quality and quantity control.

Also similar to Alternative 2, this alternative includes the vertical expansion of the Old Landfill. No significant modifications to the existing SWM system are proposed.

Alternative 4

As shown on Figure 3, the conceptual SWM plan involves the following:

- Similar to Alternative 2, surface runoff from the West and South Landfill expansion areas (‘A’ and ‘B’) would be conveyed via perimeter ditches to new SWM Ponds A1 and B1, respectively, which will outlet to the Howard Drain.
- Surface runoff from landfill expansion area ‘C’ would be conveyed via perimeter ditches to one of two new ponds (SWM Ponds C1 and C2) that will outlet to the Duke Drain.
- The new SWM ponds have been sized to provide quality and quantity control.

No changes to the Old Landfill are proposed for this alternative.

Design Criteria

The proposed SWM ponds have been designed as extended detention 'wet' ponds, in accordance with Stormwater Management Planning and Design Manual (MECP, 2013). A summary of the design criteria that have been adopted for conceptual design of the proposed SWM system for each landfill expansion alternative is provided below.

i) Quality control – 'Enhanced' level of water quality protection (i.e., 80% suspended solids removal efficiency). For the purpose of the analysis, a 35% level of imperviousness was applied for the proposed landfill expansion area.

ii) Erosion control – controlled release of the extended detention volume (40 m^3/ha) to provide protection against streambank erosion.

iii) Quantity control – attenuate peak flows from the 2-year through 250-year return period storm events at pre-development levels.

The surface water quantity assessment included an examination of hydrologic conditions under future climate change projections. Future rainfall projections for the year 2100 were determined for the Chatham WPCP climate station using the IDF_CC Tool 3.0 to calculate based on the RCP 4.5 scenario.

Hydrology

The surface water quantity assessment involved detailed hydrologic analyses to establish baseline conditions and evaluate the potential impacts for the site development alternatives. A description of the model setup and calibration, together with a summary of the results of the analyses, is provided below.

Model Setup & Calibration

A hydrologic model was developed using the HEC-HMS software program developed by the US Army Corps of Engineers. A summary of the model input parameters, calibration process, and results for baseline conditions is provided below, followed by the results of the analysis for the site development alternatives.

Baseline Conditions

To establish baseline conditions, a hydrologic model was created for the surface water assessment study area, which includes the watershed area for the Howard Drain and its tributaries. The watershed area was divided into multiple sub-catchments, as shown on Figure 4.

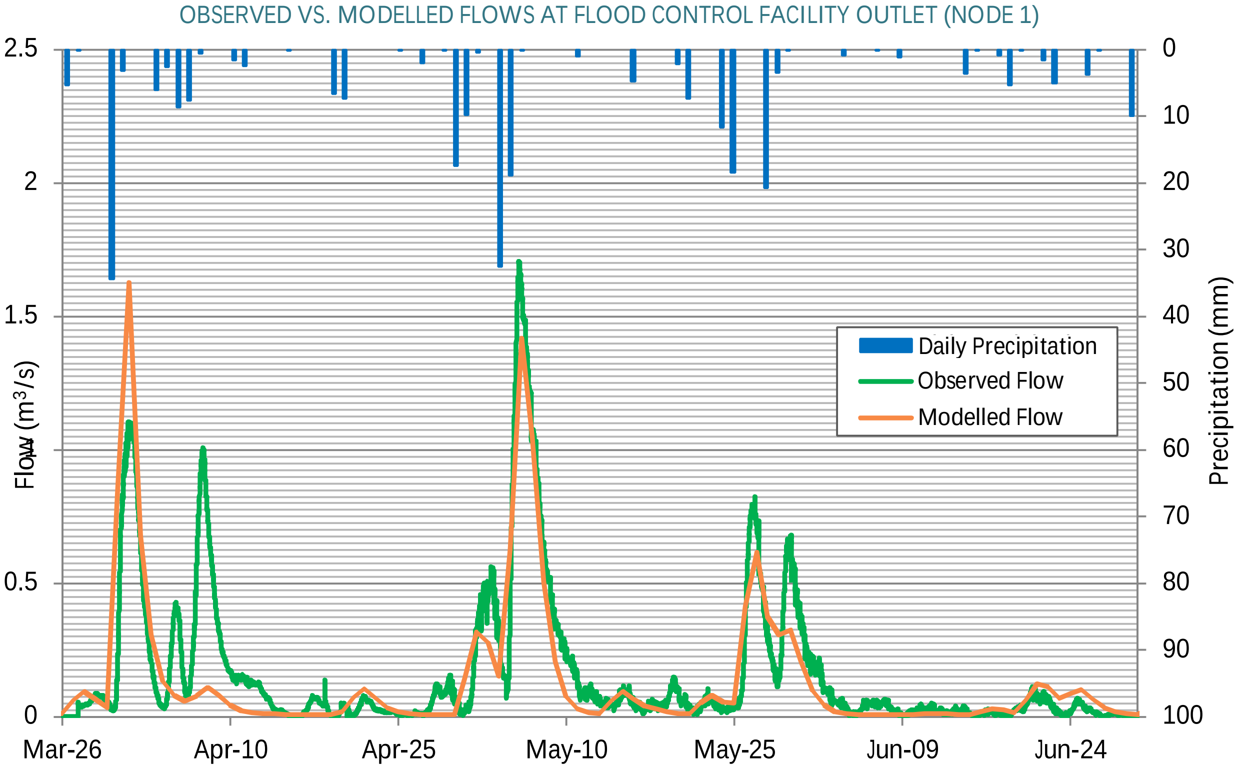
Hydrologic characteristics were determined based on topographic conditions, land use/ground cover, and soil type. A summary of the model input parameters for baseline conditions is provided in Table 1. The model utilized the Green-Ampt method to account for hydrologic losses.

TABLE 1. SUMMARY OF HEC-HMS MODEL INPUT PARAMETERS FOR BASELINE CONDITIONS

Catchment	Area (ha)	Initial Content	Saturated Content	Suction Head (mm)	Hydraulic Conductivity (mm/hr)	Imperviousness (%)
D-1	280.5	0.4	0.479	240	0.5	15
D-2	90.9	0.4	0.479	240	0.5	7.5
D-3	63.8	0.4	0.479	240	0.5	22.5
BFI-1	8.5	0.4	0.479	240	0.5	22.5
BFI-2	15.5	0.4	0.479	240	0.5	26.25
BFI-3	22.9	0.4	0.479	240	0.5	15
BFI-4	14.2	0.4	0.479	240	0.5	26.25
F-1	12.4	0.4	0.479	240	0.5	22.5
LF-1	10.2	0.4	0.479	240	0.5	11.25
LF-2-1	5.5	0.4	0.479	240	0.5	33.75
LF-2-2	6.1	0.4	0.479	240	0.5	33.75
LF-3	18.4	0.4	0.479	240	0.5	41.25
LF-4	23.6	0.4	0.479	240	0.5	41.25
LF-5	26.6	0.4	0.479	240	0.5	41.25
SR-1	5.9	0.4	0.479	240	0.5	7.5
FCF-1	21.9	0.4	0.479	240	0.5	56.25
H-1	222.8	0.4	0.479	240	0.5	15
H-2	32.8	0.4	0.479	240	0.5	22.5
H-5	18.1	0.4	0.479	240	0.5	11.25
S-1	112.7	0.4	0.479	240	0.5	15
S-2	51.5	0.4	0.479	240	0.5	18.75
S-3	5.5	0.4	0.479	240	0.5	48.75
M-1	123.0	0.4	0.479	240	0.5	11.25

The model was simulated continuously using daily precipitation and temperature data recorded in 2017 at the Ridgetown RCS climate station (ID 6137154) operated by Environment and Climate Change Canada. The Ridgetown climate station was selected as the data provided the most complete period of record. Gaps were filled using data recorded at the New Glasgow climate station, which was pro-rated based on the 1971-2000 climate normal data for the two stations. It is notable that the Chatham WPCP data was not selected due to considerable data gaps during the calibration period in 2017.

Based on the results of the continuous simulation, the flow hydrograph at the site outlet (Node 1) for the period of March 26 to June 30, 2017 is presented below. For the purpose of comparison, the graph also includes the measured flows over this period. Additional information regarding the flow monitoring program is included in the Surface Water Impact Assessment – Baseline Assessment (November, 2018).



The baseline hydrologic model results demonstrate a positive correlation with the observed flows at this location. Accordingly, it was determined that the model is suitably calibrated for the purpose of evaluating the site development alternatives.

Landfill Expansion Alternative Model Scenarios

Hydrologic model scenarios were developed to evaluate the site development alternatives. To complete the analysis, the baseline model was updated to account for the changes in hydrologic characteristics associated with each expansion alternative.

The conceptual SWM plan for each alternative was incorporated into its respective model. As shown on Figures 1 – 3 and described above, the SWM strategy generally includes ditching along the perimeter of the landfill expansion areas, which would convey surface runoff to a new SWM pond. Outflows from the SWM ponds are controlled by a compound outlet consisting of multiple orifices and an emergency overflow weir.

Design information for the proposed SWM ponds is summarized in Table 2.

TABLE 2. SUMMARY OF PROPOSED SWM POND DESIGN INFORMATION

Attribute	SWM Pond 6	SWM Pond 7	SWM Pond 8	SWM Pond 9
Landfill Expansion Area	A	B	C	C
Catchment Area (ha)	69.4	55.4	21.0	21.0
Pond Length (m)	415	365	215	215
Pond Width (m)	75	65	60	60
Pond Depth (m)	2.25	2.75	2.0	2.0
WATER QUALITY ENHANCEMENT				
Permanent Pool Depth (m)	0.25	0.40	0.25	0.25
Permanent Pool Volume (m3)	6,087	5,906	2,296	2,296
EROSION CONTROL				
Extended Detention Depth (m)	0.25	0.15	0.25	0.25
Extended Detention Volume (m)	6,434	4,000	2,482	2,482
WATER QUANTITY CONTROL				
Active Storage Depth (m)	1.50	1.85	1.0	1.0
Active Storage Volume (m)	52,518	51,195	14,339	14,339

The models prepared for the three landfill expansion alternatives were simulated for a range of storm events, including the 2, 5, 10, 25, 50, 100, and 250 year return periods. All of the storm events followed a 24 hour duration with a Soil Conservation Service (SCS) Type II rainfall distribution.

The rainfall data that utilized for the model simulations was obtained from the Short Duration Intensity-Duration-Frequency Data for the Chatham WPCP climate station (ID 6131415). The rainfall depth for the 250 year return period was projected through a frequency analysis of annual maximum data recorded at the climate station, using a Gumble distribution.

Separate model simulations were executed to evaluate hydrologic conditions for the 2-250 year return periods under the future climate change projections.

Summary of Results for Landfill Expansion Alternatives

The results of the hydrologic analyses for the baseline conditions model are summarized in Table 3, including the simulations using the current IDF rainfall data in addition to the 2100 future climate change projections.

TABLE 3. SUMMARY OF HEC-HMS MODEL RESULTS – BASELINE CONDITIONS

Return Period (Years)	Current IDF					2100 Future Climate Change				
	24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)		24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)	
		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)
2	51.3	7.2	256.6	7.5	293.4	60.1	11.5	331.6	12.1	337.8
5	64.4	14.5	369.8	15.1	420.6	77.6	24.2	491	25.6	557.1
10	73.1	21.1	448.9	22.1	509.5	93.1	29.1	639.1	31.1	723.7
25	84.1	26.5	552.8	28.2	626.5	111.4	43.9	834.3	47.4	945.6
50	92.2	28.8	630.8	30.8	714.3	125.1	39.8	953.2	42.6	1077.0
100	100.3	31.4	709.5	33.6	802.8	139.0	44.5	1091.8	47.7	1232.9
250	110.9	34.9	813.2	37.4	919.5	157.7	50.9	1277.4	54.6	1441.7

Table 4 provides a summary of the model results for Site Development Alternative 2. The results indicate that the peak flows and runoff volumes generated for all storm events under the current IDF and 2100 future climate scenarios are maintained at or below baseline conditions.

TABLE 4. SUMMARY OF HEC-HMS MODEL RESULTS – ALTERNATIVE 2

Return Period (Years)	Current IDF					2100 Future Climate Change				
	24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)		24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)	
		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)
2	51.3	7.0	252.8	7.2	289.3	60.1	11.1	327.6	11.5	373.4
5	64.4	13.5	365.6	14.1	416.1	77.6	22.7	486.8	23.8	552.3
10	73.1	19.7	444.6	20.6	504.9	93.1	28.1	634.8	29.9	718.8
25	84.1	25.8	548.2	27.4	621.5	111.4	33.6	814.2	35.8	920.5
50	92.2	27.9	626.1	29.6	709.0	125.1	37.9	948.4	40.5	1071.5
100	100.3	30.2	704.8	32.2	797.6	139.0	42.5	1087.3	45.4	1227.6
250	110.9	33.2	800.5	35.4	905.2	157.7	48.9	1273.8	52.4	1437.3

A summary of the model results for Site Development Alternative 3B is provided in Table 5. The results indicate that the peak flows and runoff volumes generated for all storm events under the current IDF and 2100 future climate scenarios are maintained at or below baseline conditions.

TABLE 5. SUMMARY OF HEC-HMS MODEL RESULTS – ALTERNATIVE 3B

Return Period (Years)	Current IDF					2100 Future Climate Change				
	24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)		24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)	
		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)
2	51.3	7.0	252.3	7.2	288.7	60.1	11.0	326.9	11.5	372.7
5	64.4	13.5	365.1	14.0	415.6	77.6	22.6	486.1	23.8	551.6
10	73.1	19.6	443.9	20.6	504.2	93.1	28.1	634.1	29.9	718.2
25	84.1	25.8	547.5	27.4	620.8	111.4	33.6	813.2	35.8	919.5
50	92.2	27.9	625.4	29.6	708.3	125.1	37.9	947.8	40.5	1070.9
100	100.3	30.2	704.1	32.1	796.1	139.0	42.5	1086.5	45.5	1226.9
250	110.9	33.2	800.0	35.4	904.7	157.7	48.9	1273.0	52.4	1436.5

Table 6 provides a summary of the model results for Site Development Alternative 4. The results indicate that the peak flows generated for all storm events under the current IDF and 2100 future climate scenarios are maintained at or below baseline conditions. There is a slight increase in the runoff volumes when compared to the baseline; however, the magnitude of increases are minimal (i.e., approximately 1-3%).

TABLE 6. SUMMARY OF HEC-HMS MODEL RESULTS – ALTERNATIVE 4

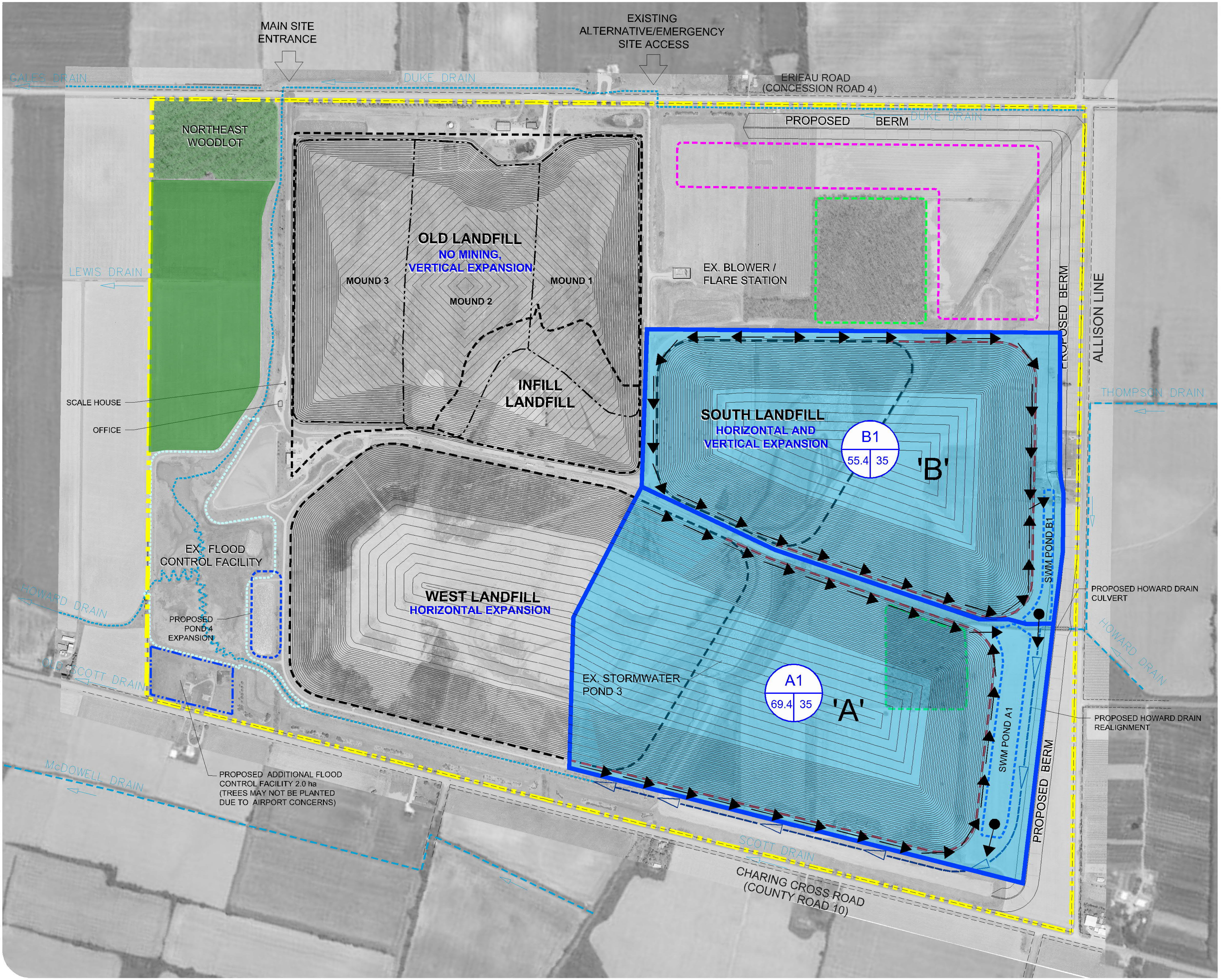
Return Period (Years)	Current IDF					2100 Future Climate Change				
	24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)		24 Hour Rainfall (mm)	Site Outlet (Node 1)		Study Area (Node 2)	
		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)		Flow (m^3/s)	Volume (1000 m^3)	Flow (m^3/s)	Volume (1000 m^3)
2	51.3	7.3	263.9	7.5	300.3	60.1	11.5	342.4	12.1	341.6
5	64.4	14.3	380.9	14.9	431.5	77.6	23.6	507.3	24.8	572.9
10	73.1	20.7	463.6	21.6	523.8	93.1	28.5	660.5	30.3	744.5
25	84.1	26.1	570.8	28.0	644.1	111.4	34.3	846.3	36.5	952.6
50	92.2	28.3	651.6	30.0	734.5	125.1	38.9	985.9	41.5	1109
100	100.3	30.7	733.0	32.7	825.9	139.0	43.4	1127.6	46.3	1267.9
250	110.9	33.8	832.4	36.0	937.0	157.7	50.7	1324.6	54.2	1488.1

Summary of Conclusions

The key conclusions of the surface water quantity assessment are summarized below.

1. Existing drainage conditions for the study area have been characterized based on site reconnaissance together with a comprehensive review of available background information (i.e., topography, land uses, soil types, and drainage features). In addition, a hydrometric monitoring program was implemented to measure flow conditions within the Howard Drain.
2. An examination of existing (pre-development) hydrologic characteristics was carried out for the study area to establish the baseline conditions for the surface water quantity assessment. The baseline assessment included hydrologic modelling of the Howard Drain watershed using the HEC-HMS software program. Continuous simulation results for the baseline hydrologic model demonstrate a positive correlation with the observed flows at this location. Accordingly, it was determined that the model provides a suitably calibrated tool for the purpose of evaluating the site development alternatives.
3. A hydrologic model scenario was also created for each of the site development alternatives to evaluate peak flow conditions downstream of the site (in comparison with baseline conditions). For the purpose of the assessment, two locations along the Howard Drain were selected for the flow comparison, including the site outlet and at the downstream limits or the study area (i.e., Howard Drain watershed outlet to Flook and Hinton Drain), as shown on Figure 4.
4. The baseline and site development model scenarios were simulated for the 2, 5, 10, 25, 50, 100, and 250 year return period storm events (24 hour SCS Type II storm distribution) based on current IDF data for the Chatham WPCP climate station. The 250 year rainfall depth was calculated through a frequency analysis of the Chatham WPCP annual maximum rainfall data.
5. The model scenarios were also simulated using future climate change rainfall projections for the year 2010 under the RCP 4.5 scenario, which were determined using the IDF-CC Tool Version 3.0.
6. The results of the hydrological analyses undertaken with the HEC-HMS model indicate that peak flows are maintained at or below the baseline condition for all three of the site development alternatives under the full suite of storm everts (2–250 year) including the current IDF and 2100 future climate conditions. In addition, the runoff volumes were maintained at or below the baseline condition for Site Development Alternatives 2 and 3B, while there were minor increases (in the order of 1-3%) for Site Alternative C.

Figures



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WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL
ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS
FIGURE 1 - ALTERNATIVE 1
CONCEPTUAL STORMWATER MANAGEMENT PLAN

🟨	PROPERTY LIMITS
⬚	APPROVED WASTE LIMIT
⬚	OLD LANDFILL EXISTING WASTE LIMIT
⇠	EXISTING WATER COURSE
🟥	PROPOSED WASTE LIMIT FOR EXPANSION AREAS
⬚	PROPOSED STORMWATER POND
⇠	PROPOSED WATERCOURSE
━	PROPOSED ROAD
🟩	EXISTING WOODLOT AREAS
←●	POND OUTLET TO HOWARD DRAIN

B1 — CATCHMENT ID
55.4 — AREA (HA)
35 — IMPERVIOUS %

0 100 200 400m

TRUE NORTH

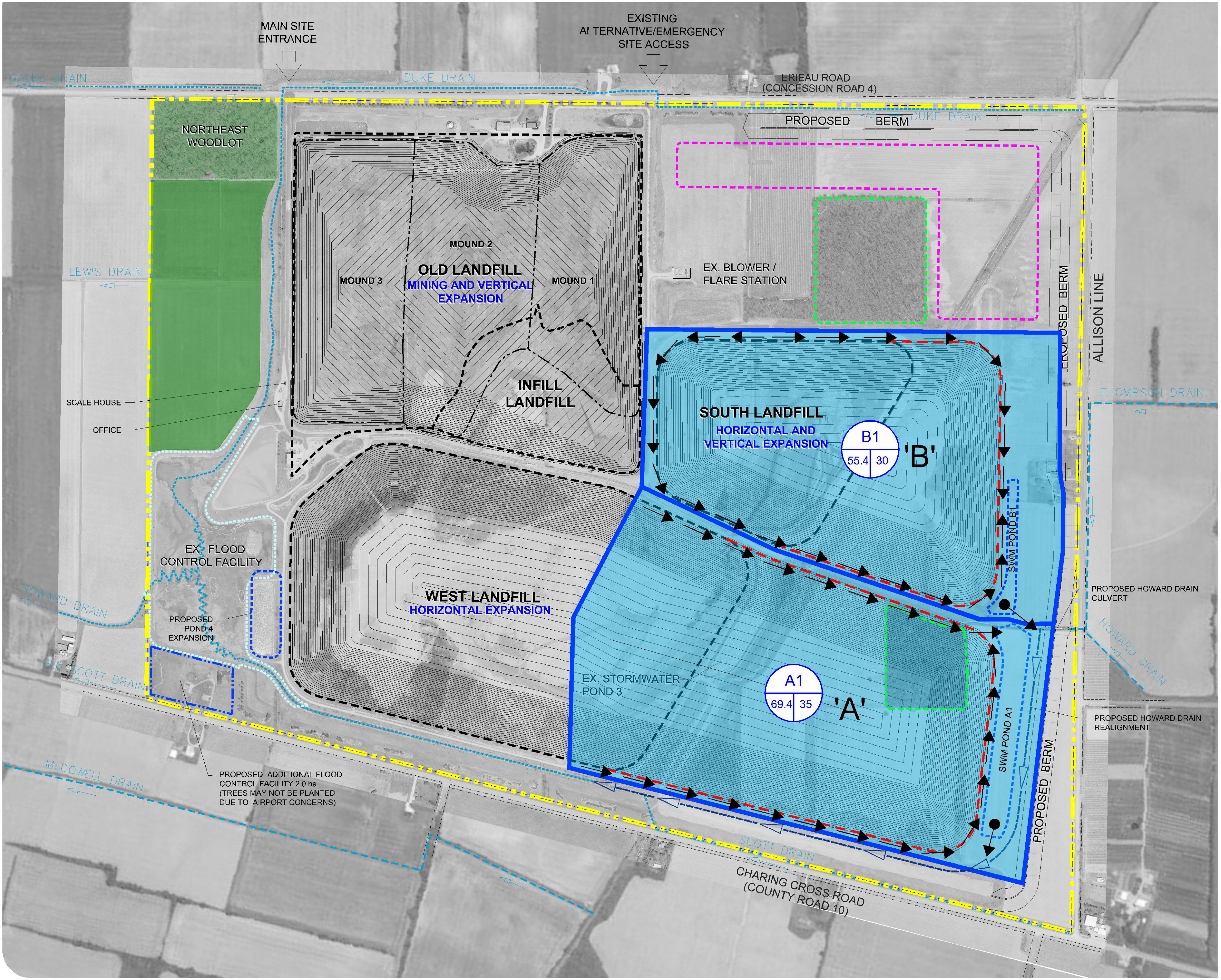
PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
CHECKED BY: CO
DESIGNED BY: FG

DILLON
CONSULTING

PROJECT: 15 2456
STATUS: DRAFT
DATE: 05/31/17



WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL

ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS

FIGURE 2 - ALTERNATIVE 2
CONCEPTUAL STORMWATER MANAGEMENT PLAN

🟨	PROPERTY LIMITS
⬚	APPROVED WASTE LIMIT
⬚	OLD LANDFILL EXISTING WASTE LIMIT
⇠	EXISTING WATER COURSE
🟥	PROPOSED WASTE LIMIT FOR EXPANSION AREAS
⬚	PROPOSED STORMWATER POND
⇠	PROPOSED WATERCOURSE
━	PROPOSED ROAD
🟩	EXISTING WOODLOT AREAS
←●	POND OUTLET TO HOWARD DRAIN

B1 — CATCHMENT ID
55.4 — AREA (HA)
35 — IMPERVIOUS %

0 100 200 400m

TRUE NORTH

PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
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PROJECT: 15 2456
STATUS: DRAFT
DATE: 05/31/17

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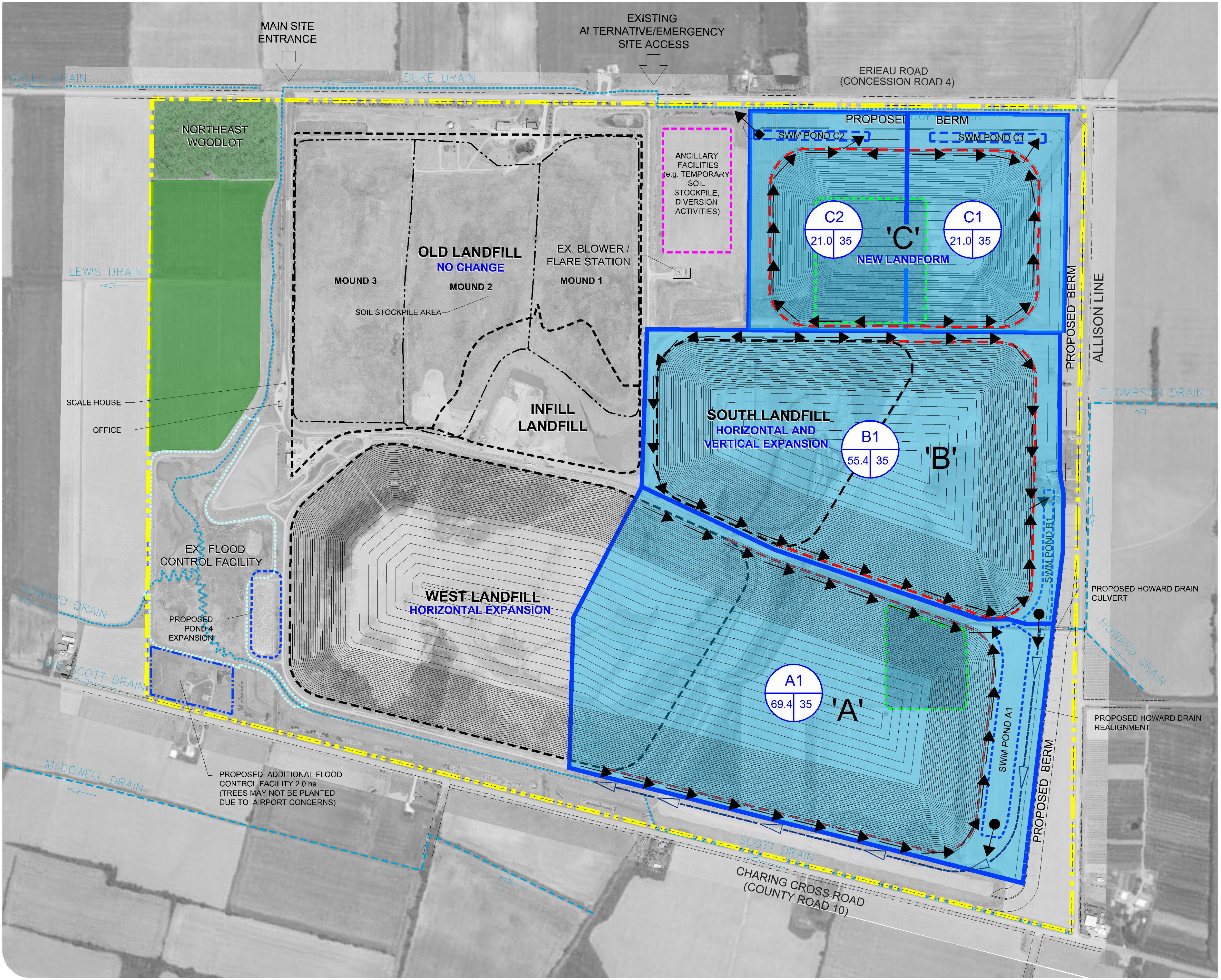

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WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL

ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS

FIGURE 3 - ALTERNATIVE 3
CONCEPTUAL STORMWATER MANAGEMENT PLAN

- PROPERTY LIMITS
- APPROVED WASTE LIMIT
- OLD LANDFILL EXISTING WASTE LIMIT
- EXISTING WATER COURSE
- PROPOSED WASTE LIMIT FOR EXPANSION AREAS
- PROPOSED STORMWATER POND
- PROPOSED WATERCOURSE
- PROPOSED ROAD
- EXISTING WOODLOT AREAS
- ◀● POND OUTLET TO HOWARD DRAIN
- ◀■ POND OUTLET TO DUKE DRAIN

B1 — CATCHMENT ID
55.4 35 — IMPERVIOUS %
AREA (HA)

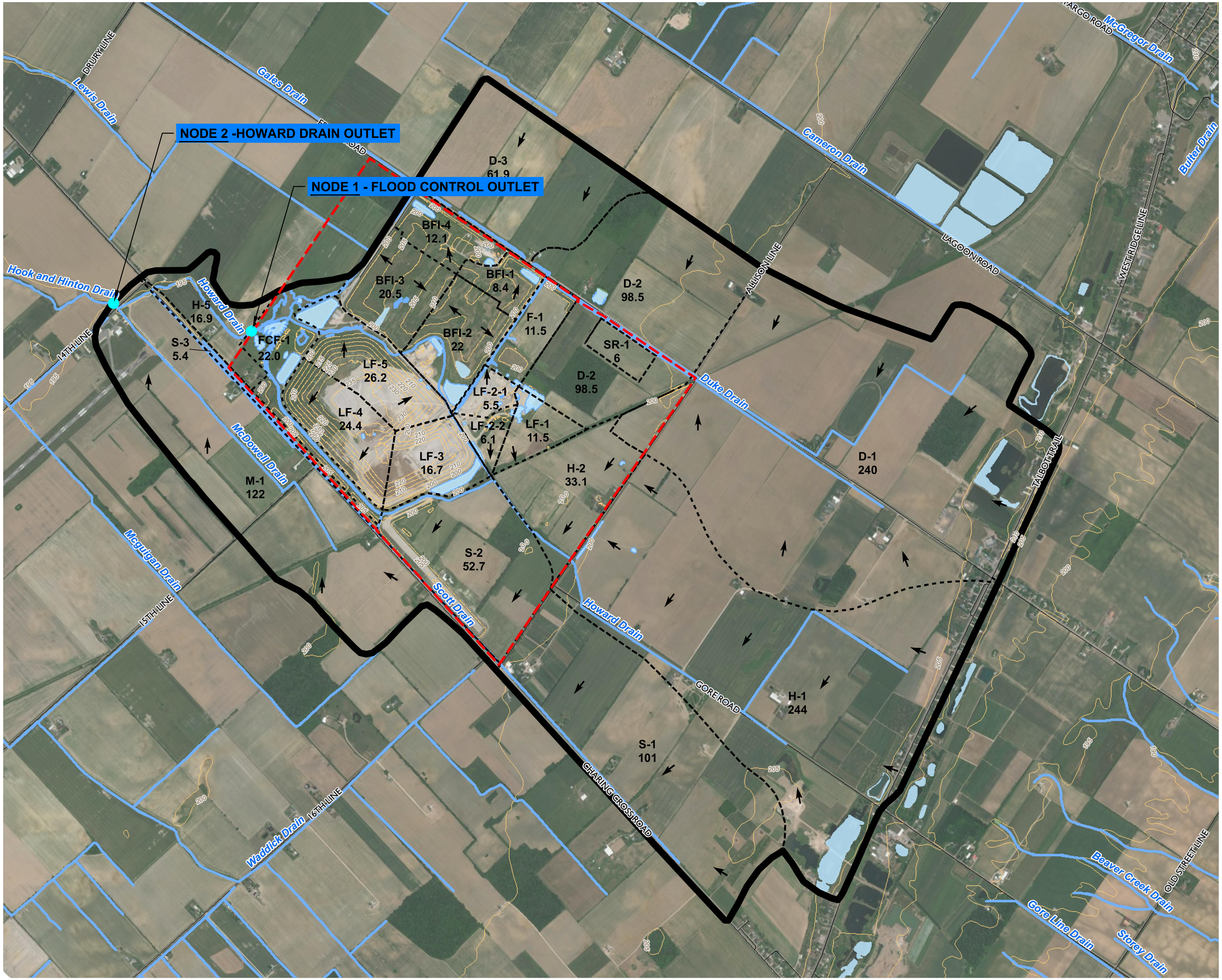
0 100 200 400m
TRUE NORTH
PLAN NORTH

MAP/DRAWING INFORMATION
MAPPING FROM THE BASE MAP CO. LTD.,
MAY 1, 2018

CREATED BY: SKB
CHECKED BY: CO
DESIGNED BY: FG

DILLON CONSULTING

PROJECT: 15 2456
STATUS: DRAFT
DATE: 05/31/17



WASTE CONNECTIONS OF CANADA

RIDGE LANDFILL

ENVIRONMENTAL ASSESSMENT

PROPOSED EXPANSION FILL AREAS

FIGURE 4
HOWARD DRAIN SUBWATERSHED

←	DIRECTION OF FLOW
—	WATERCOURSE/CONSTRUCTED DRAIN
—	CONTOURS (5m)
—	ROAD
- -	PROPERTY BOUNDARY
⬚	SUBWATERSHED BOUNDARY
- -	SUBAREA BOUNDARY
▬	WATERBODY
H-2 33	SUBAREA INDENTIFICATION AND AREA (ha)

SCALE 1:20000
0 200 400 600m

N
W E
S

MAP/DRAWING INFORMATION:
DATA PROVIDED BY MNR, ESRI BASEMAPS,
DILLON CONSULTING LTD.

MAP CREATED BY: NR/SKB
CHECKED BY: JW
MAP PROJECTION: NAD 1983 UTM ZONE 17N

DILLON CONSULTING

PROJECT: 15 2456
STATUS: DRAFT
DATE: 3/7/18

FILE: PW:\...\DOCUMENTS\PROJECTS\2015\152456 RIDGE LANDFILL TOR\...\152456-03-SITE-FIG4.dwg

References

California Department of Resources. (2016). CalRecycle Basics Alternative Daily Cover. Retrieved from: http://www.calrecycle.ca.gov/lgcentral/basics/adcbasic.htm

Dillon Consulting. (2017). Site Development, Operations and Monitoring 2018 Annual Report.

Dillon Consulting. (2015). Ridge Landfill 2014 Air Monitoring Report, BFI Canada, Inc.

Minister of the Environment. (2014b). Code of Practice for Preparing and Reviewing Environmental Assessments. Queen's Printer for Ontario. Retrieved from: https://www.ontario.ca/document/preparing-and-reviewing-environmental-assessments-ontario-0