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WASTE CONNECTIONS OF CANADA

Ridge Landfill Expansion: Climate Change Impact Assessment

Appendix D3B

January 2020

Waste Connections of Canada

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Errata Sheet

Ridge Landfill Environmental Assessment Report: Appendix D3B Climate Change Impact Assessment

The Draft Ridge Landfill Environmental Assessment (EA) Report and supporting documentation (appendices) were provided for review and comment to the MECP, Stakeholders, Indigenous Communities and Organizations on July 22, 2019. The final version of the Ridge Landfill Environmental Assessment was revised where appropriate, to address the comments received. All revised versions of the final environmental assessment report and supporting documentation are posted on the website for the Ridge Landfill, www.ridgelandfill.com/our-future-plans.

As there were minimal changes required from the review for this particular document, it has not been reprinted for the final version. The changes to the document as described below, have been incorporated into the on-line and DVD versions.

Revisions to Appendix D3B – Climate Change Impact Assessment:

Errata No.	Section	Revision
1	All	Date changed – from July 2019 to January 2020
2	All	Report name changed - Draft Ridge Landfill EA to Ridge Landfill EA
3	Executive Summary	Confirmed, minor correction to existing emissions contribution from 1.2% to 1.3%.
4	Tables D3B-1 and D3B-4	Revised to include updated greenhouse gas emission rate calculations.
5	2.3	Revised to clarify that surface water monitoring will continue post-closure as well as remedial action that may be taken at that time.
6	2.7	Statement added describing a significant increase from existing conditions to future peak emissions, and minor correction to existing emissions contribution from 1.2% to 1.3%.
7	4.0	Bullet point added describing the significant increase from existing conditions to future peak emissions.

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APPENDICES

Acronyms, Abbreviations, Definitions

Act *(the), refers to the Environmental Assessment Act. Also known as EAA, or the EA Act.*

AIA*, Atmospheric Impact Assessment.*

BWTL*, Blenheim Wastewater Treatment Lagoons. The connection to the BWTL is via forcemain/ sanitary sewer (both terms used interchangeably).*

CCIA*, Climate Change Impact Assessment.*

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*[1]*.*

ECA*, Environmental Compliance Approval is a license or permit issued by the Ministry of the Environment, Conservation and Parks for the operation of a waste management facility or site.*

ECCC*, Environment and Climate Change Canada.*

Environment*, the Environmental Assessment Act defines environment to mean:*

- *Air, land or water;*
- *Plant and animal life, including human life;*
- *The social, economic and cultural conditions that influence the life of humans or a community;*
- *Any building, structure, machine or other device or thing made by humans;*
- *Any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities; or*
- *Any part or combination of the foregoing and the interrelationships between any two or more of them.*

GHG*, greenhouse gas.*

Haul Route*, this area refers to the right-of-way of the designated truck haul route to the landfill. Traffic to the landfill travel from Highway 401 via interchange 90, heading southeast along Communication Road (County Road 11), to Drury Line then along Erieau Road to the main site entrance of the landfill at 20262 Erieau Road.*

IC&I*, Industrial, Commercial and Institutional.*

[1] Ministry of the Environment, Conservation and Parks (1990). *Environmental Assessment Act*, R.S.O. 1990, c. E.18. Last Updated: July 2019.

***LCS**, Leachate Collection System.*

***LFG**, refers to landfill gas.*

***MECP**, Ministry of the Environment, Conservation and Parks; formerly Ministry of the Environment and Climate Change (MOECC), Ministry of the Environment (MOE), and Ministry of the Environment and Energy (MOEE).*

***MOVES**, Motor Vehicle Emissions Simulator.*

***MTO**, Ministry of Transportation Ontario.*

***NIR**, National Inventory report.*

***OMMAH**, Ontario Ministry of Municipal Affairs and Housing.*

***Off-site Study Area**, this generally refers to the area outside of the Ridge Landfill site boundary (also referred to as "off-site").*

***On-site Study Area**, this refers to the study area within the Ridge Landfill site boundary (also referred to as "on-site").*

***PIEVC**, Public Infrastructure Engineering Vulnerability Committee.*

***PPS**, Provincial Policy Statement.*

***ToR**, Terms of Reference, the approved terms of reference sets out the framework for the planning and decision-making process to be followed by the proponent during the preparation of an environmental assessment. In other words, it is the proponent's work plan for what is going to be studied. The environmental assessment must be prepared in accordance with the approved terms of reference.*

***U.S. EPA**, United States Environmental Protection Agency.*

***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.*

	Units
AADT	*Annual average daily traffic volumes*
CO_2e	*Carbon dioxide equivalent*
^oC	*degrees Celsius*
ha	*hectare*
HD	*Heavy duty vehicles*
km	*kilometre*
L	*litre*
LFG	*Landfill gas*
m	*metre*
m^3	*Cubic metres*
CH_4	*Methane*
masl	*metres above sea level*
Mt	*Mega-tonne (1 million tonnes)*
N_2O	*Nitrous Oxide*

Executive Summary

A Climate Change Impact Assessment was undertaken in support of the Environmental Assessment initiated by Waste Connections of Canada Inc. (Waste Connections) to expand the Ridge Landfill in the Municipality of Chatham-Kent.

This report examined the impact of the proposed Ridge Landfill expansion on climate change (climate change mitigation) and the impact of climate change on the Ridge Landfill Expansion (climate change adaptation). The results of the on-site impact assessment concluded that the current predicted emissions of greenhouse gases (GHG) are negligible compared to total provincial emissions. Scaling the GHG inventory to a representative regional (service area) value based on population, indicated the Ridge Landfill was not a significant contributor to service area GHGs when comparing existing conditions (1.3%) to future conditions (2.0%), and no increase in annual GHG emissions predicted to be attributable to the haul route from current to future conditions.

The removal of the southwest woodlot will be mitigated with a 2:1 replanting. This will have a negligible impact on net GHG emissions from the site.

Projected changes in climate are anticipated to be most significant for precipitation and temperature (heat). Changes in precipitation will be addressed within the design of the stormwater management system from the site to allow for capacity for future precipitation levels. Changes in temperature (heat) can affect outdoor workers and it is recommended that site protocols be reviewed periodically to reflect changing conditions.

Less significant projected changes are anticipated for high winds, precipitation (ice storm, ice accretion and hail). Adaptive measures have been identified as mitigative measures and include both physical measures (e.g., addition of permanent litter barriers) and operational practices (e.g. review and update of site protocols).

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1.0 Introduction

Waste Connections of Canada Inc. (Waste Connections) has undertaken an Environmental Assessment pursuant to the *Environmental Assessment Act* (*EA Act*)[2] to expand the Ridge Landfill in the Municipality of Chatham-Kent in accordance with the amended Terms of Reference (ToR) approved by Ontario's Minister of the Environment, Conservation and Parks (MECP) on May 1, 2018; to continue to provide long-term disposal capacity to serve the growing population and economy of the province of Ontario.

The Ridge Landfill has been in operation since 1966 and was expanded in 1999. In May 2019, Waste Connections owned 340 hectares (ha) of land at the Ridge Landfill, located at 20262 Erieau Road near Blenheim, Ontario in the Municipality of Chatham-Kent, and is operated by Waste Connections (**FIGURE D3B-1**). The site is approved to receive waste from the industrial, commercial and institutional (IC&I) sectors in Ontario, and residential waste from the Municipality of Chatham-Kent and the surrounding Counties of Essex, Lambton, Middlesex and Elgin.

FIGURE D3B-1: LOCATION OF RIDGE LANDFILL

[2] Ministry of the Environment, Conservation and Parks (1990). *Environmental Assessment Act*, R.S.O. 1990, c. E.18. Last Updated: July 2019.

The Landfill Site Area of 262 ha, is permitted by an Environmental Compliance Approval (ECA)[3] from the MECP; (formerly the Ministry of Environment and Climate Change) for waste management and environmental work purposes. 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 October 1, 2019, it is estimated that the existing Waste Fill Area at the Ridge Landfill site will provide waste disposal capacity until approximately March 1, 2021 at the current fill rate.

The approved capacity for the Ridge Landfill is 21 million cubic meters (m^3). The site is approved to accept a maximum of 1,300,000 tonnes of waste per year (the MECP approved annual waste disposal rate). The EA does not propose to increase the maximum annual fill rate (this would remain as-is); however, Waste Connections is seeking to increase the life of the facility for a 20 year planning period, from 2021 to 2041.

1.1 Work Plans

Work plans were prepared for each impact assessment study. The climate change work plan was prepared in September 2018.

The work plans were circulated to interested stakeholders, key government reviewers and Indigenous Communities and Organizations who desired to review them; and they were posted on the Future Plans page of the Ridge Landfill website for review and comment. The input received during that review has been carefully considered and incorporated into this study, where applicable.

1.2 Role of Climate Change in the Environmental Assessment

Dillon Consulting Limited ("Dillon") has been retained by Waste Connections to carry out a Climate Change Impact Assessment in support of the Ridge Landfill EA.

The primary objective of this assessment is to address the requirements of **Section 6.1(**2)(c) and (d) of the *EA Act*, as it pertains to the atmospheric environment; specifically:

(c) a description of,

(i) the environment that will be affected or that might reasonably be expected to be affected, directly or indirectly,

(ii) the effects that will be caused or that might reasonably be expected to be caused to the environment, and

[3] Ministry of the Environment, Conservation and Parks (2019). Waste Environmental Compliance Approval No. A021601.

(iii) the actions necessary or that may reasonably be expected to be necessary to prevent, change, mitigate or remedy the effects upon or the effects that might reasonably be expected upon the environment,

by the undertaking, the alternative methods of carrying out the undertaking and the alternatives to the undertaking;

(d) an evaluation of the advantages and disadvantages to the environment of the undertaking.

The role of the climate change discipline in the EA is to consider the potential net effects of the proposed landfill expansion on the characteristics of the surrounding area and also impacts of climate change on the proposed expansion. The criteria used in the assessment are designed to identify and evaluate the impacts of the landfill expansion as required by the *EA Act*[4] and related Code of Practice[5].

1.3 Scope of the Climate Change Assessment

The scope of the Climate Change Impact Assessment (CCIA) includes the impact of the project on climate change (climate change mitigation) and the impact of climate change on the project (climate change adaptation).

1.4 Overview of Report Contents

This report is structured as follows:

- **Section 1.0** presents an introduction to the study, a description of the site, and the role and scope of the CCIA;
- **Section 2.0**: describes the impact of the Project on Climate Change (Climate Change Mitigation), including: criteria/indicators, baseline greenhouse gases (GHGs), future GHGs, and impacts of the Project on Climate Change;
- **Section 3.0**: describes the impacts of Climate Change on the Project (Climate Change Adaptation), including: criteria/indicators, identification of climate hazards, baseline future climate, and climate change impacts on the Project; and
- **Section 4.0**: provides the conclusions.

[4] Ministry of the Environment, Conservation and Parks (1990). *Environmental Assessment Act*, R.S.O. 1990, c. E.18. Last Updated: July 2019.

[5] Ministry of the Environment, Conservation and Parks (2014). Code of Practice: Preparing and Reviewing Environmental Assessments in Ontario, January 2014.

2.0 Impact of Project on Climate Change (Climate Change Mitigation)

The impacts of the project on climate change were assessed by evaluating the potential increases in GHG emissions resulting from the site development. The approach to assessing the impact of the project on climate change is as follows:

- Step 1: Review emission estimation methodologies for determining average annual GHG emissions;
- Step 2: Review the existing operations and determine a baseline for average annual GHG emissions;
- Step 3: Review future operations and determine annual GHG emissions for three development scenarios (snapshots In time over the period of the expansion) of the preferred development alternative; and
- Step 4: Review potential increases in GHG emissions to the Project's contribution to the GHG profile of the province and region.

These are discussed within the following sections.

2.1 GHG Emissions Estimation Methodologies

Estimation of GHGs, specifically; carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from on-site activities (e.g., onsite equipment, LFG collection system, and flare) was completed using emission factors from industry accepted methodologies. In general the GHG calculations followed the same methodologies as documented within the Atmospheric Impact Assessment (AIA)[6] for the project.

As per consultation with the MECP, the emissions from the landfill footprints were estimated using United States Environmental Protection Agency (U.S. EPA) LandGEM models for each individual landfill area and utilizing the landfill gas generation rate for each of the development scenarios for the preferred alternative.

[6] Dillon Consulting Limited (2019). Ridge Landfill Expansion: Atmospheric Impact Assessment, December 2019.

Emissions from the landfill gas flares were estimated based on U.S. EPA LandGEM models, flare specifications, and U.S. EPA emission factors[7].

Non-road vehicle emissions were estimated using available U.S. EPA non-road engine emission factors[8] and the hours of operation[9].

On-road vehicle emissions were estimated using the U.S. EPA Motor Vehicle Emission Simulator (MOVES) model. MOVES was used to estimate an emission rate per unit distance for tailpipe emissions from the typical on-road vehicles expected at the site.

These methodologies were followed to allow for a comparison of potential GHG emissions from the existing conditions and preferred alternative's scenarios, as well as to be inclusive of all sources of GHG emissions from the site.

2.2 Assessment Criteria

The Climate Change Impact Assessment criteria, indicators, their rationale and data sources are shown in the following table:

Table D3B-1: Climate Change Impact Assessment Criteria

Criteria	Indicator	Rationale	Data Source
GHG emissions potential.	Quantitative assessment of GHG emissions (US EPA and Canadian National Inventory Report [NIR] emission factors).	A landfill has the potential to result in greenhouse gas emissions so it is necessary to characterize the emissions to be able to mitigate where possible.	• Existing and proposed facility characteristics including change in on-site woodlot, on-site vehicles, landfill gas management system. • US EPA AP-42. • Canada NIR. • US EPA LandGEM modelling.

[7] United States Environmental Protection Agency (2008). AP-42 Chapter 2.4 Municipal Solid Waste Landfills. Draft Section. October 2008.
[8] United States Environmental Protection Agency (2010). Exhaust and Crankcase Emission Factors for Non-road Engine Modelling – Compression-Ignition NR-009d. July 2010.
[9] Golder Associates Limited (2019). Ridge Landfill Expansion: Design and Operations Report Draft. July 2019.

2.3 Baseline GHG Emissions

The assessment of annual GHG emissions from the baseline (existing) condition was completed for operations during the last complete calendar year (2018). The operating conditions of the existing conditions are described briefly below:

The air emissions from sources on-site for the existing condition included:

- The use of two (2) landfill gas flares as part of the landfill gas collection system;
- Operations associated with vehicular traffic and material transfer at the active working face (located within the South Landfill area);
- The use of two (2) aggregate storage piles;
- Concrete crushing operations (occurs twice a year, five (5) days per event);
- Traffic activities along the paved and unpaved roads on-site; and
- Landfill gas that is generated from the Old Landfill, West Landfill, and South Landfill footprints.

A detailed calculation summary for the existing conditions is provided in Appendix D3B-1. Baseline GHG emissions were estimated to be approximately 391,000 tonnes of carbon dioxide equivalent (CO_2e) per year. **Table D3B-2** below provides a breakdown of the baseline (existing conditions) GHG emissions.

Table D3B-2: Annual Average GHG Emissions - Existing Conditions

Source Category	CO_2 Equivalents			Total tonnes CO_2e/year
	CO_2	CH_4	N_20	
	tonnes CO_2e/year	tonnes CO_2e/year	tonnes CO_2e/year	
Flare 1	74,960	13,456	-	88,416
Flare 2	74,960	13,456	-	88,416
Other(1)	5,238	<1	<1	5,239
Old Landfill	1,790	19,939	-	21,729
West Landfill	14,462	163,020	-	177,482
South Landfill	822	9,271	-	10,093
Total	**172,234**	**219,142**	**<1**	**391,377**

Table Note:
Sources included within the "Other" source category include on-site vehicle and non-road equipment emissions.

2.4 On-Site Activities Impact Assessment

After reviewing the cell sequencing plans for the lifecycle of the preferred landfill expansion alternative, three (3) development phases were identified as worst-case scenarios for this assessment. These scenarios are considered milestones in the development of the site and reflect the development of the different expansion areas (vertical expansion of Old Landfill and horizontal expansion of the South and West Landfills) as they are brought "on-line".

The assessment of annual GHG emissions from the preferred alternative was completed for the three development phases evaluated as part of the AIA (hereafter referred to as preferred alternative scenarios 1, 2, and 3) [10]. These scenarios are described briefly below.

The air emissions from sources on-site for the preferred alternative Scenario 1 were estimated from future operations during the year 2024 at the Ridge Landfill. The year 2024 was selected as the worst-case phase of development during the vertical expansion of the Old Landfill. Scenario 1 includes:

- The use of four (4) landfill gas flares as part of the landfill gas collection system;
- Operations associated with vehicular traffic and material transfer at the active working face (to be located within the Old Landfill vertical expansion area);
- Material transfer and vehicle operations at two (2) storage piles; soil and recycled aggregate;
- Concrete crushing operations (occurs twice a year, five (5) days per event);
- Wood grinding operations (occurs once a year, five (5) days per event);
- Traffic activities along the paved and unpaved roads on-site; and
- Landfill gas is generated from the Old Landfill (including vertical expansion), West Landfill, and South Landfill footprints.

A detailed calculation summary for Scenario 1 are provided in Appendix D3B-2. Scenario 1 GHG emissions were estimated to be approximately 521,000 tonnes of carbon dioxide equivalent (CO_2e) per year. **Table D3B-3** below provides a breakdown of the Scenario 1 GHG emissions.

[10] Dillon Consulting Limited (2019). Ridge Landfill Expansion: Atmospheric Impact Assessment, December 2019.

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Table D3B-3: Annual Average GHG Emissions – Preferred Alternative Scenario 1

Source Category	CO_2 Equivalents			Total tonnes CO_2e/year
	CO_2 tonnes CO_2e/year	CH_4 tonnes CO_2e/year	N_20 tonnes CO_2e/year	
Flare 1	50,109	8,990	-	59,099
Flare 2	50,109	8,990	-	59,099
Flare 3	50,109	8,990	-	59,099
Flare 4	50,109	8,990	-	59,099
Other(1)	5,180	<1	<1	5,180
Old Landfill (including vertical expansion)	4,826	53,749	-	58,576
Existing West Landfill	11,376	128,236	-	139,612
Existing South Landfill	6,642	74,867	-	81,509
Total	**228,462**	**292,813**	**<1**	**521,275**

Note:
Sources included within the "Other" source category include on-site vehicle and non-road equipment emissions.

The air emissions from sources on-site for the preferred alternative Scenario 2 were estimated from future operations during the 2028 year at the Ridge Landfill. The year 2028 was selected as the worst-case phase of development during the horizontal expansion of the South Landfill (expansion area "B"). Scenario 2 included:

- The use of five (5) landfill gas flares as part of the landfill gas collection system;
- Operations associated with vehicular traffic and material transfer at the active working face (to be located within the South Landfill expansion area "B");
- The use of two (2) aggregate storage piles;
- Concrete crushing operations (occurs twice a year, five (5) days per event);
- Wood grinding operations (occurs once a year, five (5) days per event);
- Leachate collection system (LCS) construction and cell excavation;
- Traffic activities along the paved and unpaved roads on-site; and
- Landfill gas that is generated from the Old Landfill (including vertical expansion), West Landfill, South Landfill, and South Landfill horizontal expansion area "B".

A detailed calculation summary for Scenario 2 are provided in Appendix D3B-3. Scenario 2 GHG emissions were estimated to be approximately 631,000 tonnes of carbon dioxide equivalent (CO_2e) per year. **Table D3B-4** below provides a breakdown of the Scenario 2 GHG emissions.

Table D3B-4: Annual Average GHG Emissions – Preferred Alternative Scenario 2

Source Category	CO_2 Equivalents			Total tonnes CO_2e/year
	CO_2	CH_4	N_2O	
	tonnes CO_2e/year	Tonnes CO_2e/year	tonnes CO_2e/year	
Flare 1	46,240	8,288	-	54,527
Flare 2	46,240	8,288	-	54,527
Flare 3	46,240	8,288	-	54,527
Flare 4	46,240	8,288	-	54,527
Flare 5	58,350	10,458	-	68,808
Other(1)	4,628	<1	<1	4,629
Old Landfill (including vertical expansion)	10,686	119,005	-	129,691
Existing West Landfill	9,694	109,276	-	118,970
Existing South Landfill	5,660	63,798	-	69,458
South Landfill expansion area "B"	1,722	19,413		21,135
Total	**275,699**	**355,101**	**<1**	**630,800**

Note:
Sources included within the "Other" source category include on-site vehicle and non-road equipment emissions.

The air emissions from sources on-site for the preferred alternative Scenario 3 were estimated from future operations during the 2039 year at the Ridge Landfill. The year 2039 was selected as the worst-case phase of development during the horizontal expansion of the West Landfill (expansion area "A"). Scenario 3 includes:

- The use of five (5) landfill gas flares as part of the landfill gas collection system;
- Operations associated with vehicular traffic and material transfer at the active working face (to be located within the West Landfill expansion area "A");
- Concrete crushing operations (occurs twice a year, five (5) days per event);
- Wood grinding operations (occurs once a year, five (5) days per event);

- Leachate collection system (LCS) construction and cell excavation;
- Traffic activities along the paved and unpaved roads on-site; and
- Landfill gas that is generated from the Old Landfill (including vertical expansion), West Landfill, South Landfill, South Landfill horizontal expansion area “B”, and West Landfill horizontal expansion area “A”.

A detailed calculation summary for Scenario 3 are provided in Appendix D3B-4. Scenario 3 GHG emissions were estimated to be approximately 733,000 tonnes of carbon dioxide equivalent (CO_2e) per year. **Table D3B-5** below provides a breakdown of the Scenario 3 GHG emissions.

Table D3B-5: Annual Average GHG Emissions – Preferred Alternative Scenario 3

Source Category	CO_2 Equivalents			Total tonnes CO_2e/year
	CO_2	CH_4	N_20	
	tonnes CO_2e/year	tonnes CO_2e/year	tonnes CO_2e/year	
Flare 1	54,034	9,694	-	63,728
Flare 2	54,034	9,694	-	63,728
Flare 3	54,034	9,694	-	63,728
Flare 4	54,034	9,694	-	63,728
Flare 5	68,186	12,233	-	80,419
Other(1)	1,049	<1	<1	1,050
Old Landfill (including vertical expansion)	6,882	76,644	-	83,526
Existing West Landfill	6,243	70,378	-	76,621
Existing South Landfill	3,645	41,088	-	44,733
South Landfill expansion area “B”	6,263	70,596	-	76,859
West Landfill expansion area “A”	9,372	105,640	-	115,011
Total	**317,777**	**415,354**	**<1**	**733,131**

Note:
Sources included within the “Other” source category include on-site vehicle and non-road equipment emissions.

Collected landfill gas (LFG) is directed to on-site flares for destruction. In addition, surface monitoring of LFG would be conducted annually to identify “hot spots”. Upon identification of hot spots or problem areas, remedial action would be taken, typically entailing improvements to the cover within the localized area of the hot spot or the installation of additional gas collection wells. This surface monitoring will be kept in place both during the operation of the landfill and post-closure. Proposed post-closure monitoring will be detailed in the post-closure plan to be submitted to the MECP for review and approval.

The landfill's operations include the use of heavy machinery and vehicular traffic which contribute to overall GHG emissions. Proper equipment maintenance and upkeep will help in reducing emissions from this equipment.

The air emissions from sources on-site during post closure were estimated during the 2042 year at the Ridge Landfill. Post-closure includes the use of five (5) landfill gas flares as part of the landfill gas collection system. A detailed calculation summary for post closure is provided in Appendix E. Post closure GHG emissions were estimated to be approximately 762,000 tonnes of carbon dioxide equivalent (CO_2e) per year. **Table D3B-6** below provides a breakdown of the post closure GHG emissions.

Table D3B-6: Annual Average GHG Emissions – Post Closure (Year 2042)

Source Category	CO_2 Equivalents			Total tonnes CO_2e/year
	CO_2	CH_4	N_20	
	tonnes CO_2e/year	tonnes CO_2e/year	tonnes CO_2e/year	
Flare 1	56,217	10,087	-	66,304
Flare 2	56,217	10,087	-	66,304
Flare 3	56,217	10,087	-	66,304
Flare 4	56,217	10,087	-	66,304
Flare 5	70,940	12,729	-	83,670
Old Landfill (including vertical expansion)	6,104	67,977	-	74,081
Existing West Landfill	5,537	62,419	-	67,957
Existing South Landfill	3,233	36,442	-	39,675
South Landfill expansion area "B"	5,555	62,613	-	68,168
West Landfill expansion area "A"	13,279	149,679	-	162,958
Total	**329,517**	**432,208**	**<1**	**761,725**

2.5 Assessment of Emissions from the Haul Route

Greenhouse gas emissions associated with haul route traffic were assessed using emission factors calculated with the U.S. EPA MOVES model. The total distance travelled by vehicles on the haul route was used to determine annual emissions in CO_2 equivalent in tonnes/year. The haul route assessment was only performed for the existing year, a no expansion scenario (2021) and the final year of landfill operation (2041) as the emissions for each scenario are predicted to be the same. **Table D3B-7, Table D3B-8**, and **Table D3B-9** show the greenhouse gas emissions for 2018, 2021 no expansion scenario, and 2041 respectively. **Table D3B-10** shows the expected greenhouse gas emissions due to site-related traffic on the haul route for the 2018 and 2041 scenarios. The results show that greenhouse gas emissions from site traffic are expected to decrease due to predicted emission reductions from vehicles.

Table D3B-7: 2018 GHG Emissions in CO_2e

Road Segment	AADT	HD percentage	Length (miles [km])	Total tonnes CO_2e/year
Erieau (Site access to Drury)	1,176	47%	1.2 [1.9]	526
Erieau (East from site)	672	27%	2.3 [3.7]	433
Drury	659	77%	2.6 [4.2]	878
Communication Road	6,048	21%	2.8 [4.5]	3,798
			Total:	**5,635**

Table D3B-8: 2021 No Expansion Scenario GHG Emissions in CO_2e

Road Segment	AADT	HD percentage	Length (miles [km])	Total tonnes CO_2e/year
Erieau (Site access to Drury)	594	21%	1.2 [1.9]	137
Erieau (East from site)	582	21%	2.3 [3.7]	258
Drury	65	44%	2.6 [4.2]	52
Communication Road	5,828	16%	2.8 [4.5]	2,423
			Total:	**2,870**

Table D3B-9: 2041 GHG Emissions in CO_2e

Road Segment	AADT	HD percentage	Length (miles [km])	Total tonnes CO_2e/year
Erieau (Site access to Drury)	1,228	45%	1.2 [1.9]	459
Erieau (East from site)	724	26%	2.3 [3.7]	361

Road Segment	AADT	HD percentage	Length (miles [km])	Total tonnes CO_2e/year
Drury	659	77%	2.6 [4.2]	806
Communication Road	6,591	21%	2.8 [4.5]	3,097
			Total:	**4,723**

Table D3B-10: GHG Emissions Attributable to Site Traffic on the Haul Route

Road Segment	AADT	HD Percentage	Length (miles [km])	Total tonnes CO_2e/year 2018	Total tonnes CO_2e/year 2041
Erieau (Site access to Drury)	633	80%	1.2 [1.9]	398	366
Erieau (East from site)	142	73%	2.3 [3.7]	161	147
Drury	633	80%	2.6 [4.2]	862	794
Communication Road	633	80%	2.8 [4.5]	794	724
Total:				**2,215**	**2,030**

The greenhouse gas assessment indicates that there is no predicted increase in annual greenhouse gas emissions attributable to the haul route as a result of the proposed landfill expansion. Extending the life of the landfill will result in site-associated traffic occurring past 2021 which will result in greenhouse gasses being released for an additional 20 years attributable to the site. Greenhouse gas emissions related to the haul route are expected to be less than 1% of the emissions from landfill operations.

2.6 Removal of Southwest Woodlot

The Ridge Landfill contains three (3) significant woodlots on-site (north, southeast, and southwest). In assessing the potential impact to the environment for the alternative methods, the removal of woodlots was taken into consideration. The preferred alternative was determined to be the least impactful expansion method and includes the removal of the southwest woodlot which is approximately 3.7 ha and located in the West Landfill expansion area “A” (all three (3) landfill development alternative methods included removal of this woodlot).

The removal of any woodlot will decrease the carbon sequestration of the site, increasing the net GHG emissions of the site. The annual CO_2e sequestration for the southwest woodlot is estimated to be 29 tonnes/year using methodologies provided in the Tree Canada Afforestation and Reforestation Protocol[11].

As the site was shown to emit 367,425 tonnes/year under the existing conditions, the annual carbon sequestration of the southwest woodlot represents 0.01% of the annual emissions. The

[11] Tree Canada (2015). Tree Canada Afforestation and Reforestation Protocol. Version 2.0. April 2015.

removal of the southwest woodlot will be mitigated with a 2:1 ratio of tree replanting off-site including a property owned by Waste Connections on the east side of Erieau Road. The new and existing berms around the perimeter of the site will also be planted with tree and vegetated.

Therefore, the removal of the southwest woodlot will have a negligible impact on the net GHG emissions of the site.

2.7 Project Impacts on Climate Change Assessment

The best available estimate of Ontario's reported GHG emissions is provided in the Environment and Climate Change Canada (ECCC) National Inventory Report (NIR). A review of the 2015 to 2017 GHG emission summaries from the ECCC NIR[12] show that Ontario had an average annual total GHG emission of 162 mega-tonnes (Mt) CO_2e.

The Ridge Landfill's existing conditions account for 0.39 Mt CO_2e which would result in a 0.2% contribution to Ontario's total GHG emission profile.

The average GHG emissions profile from future worst-case conditions (the 3 scenarios considered) would be 0.63 Mt CO_2e. This represents a reasonable annual estimate of future peak GHGs from the site, and does not account for years when there might be lower levels of on-site activities (e.g., no cell construction). The Ridge Landfill's future contribution to Ontario's total GHG emissions profile is estimated to be 0.4%.

A region specific GHG inventory is not available, and limited methodologies exist to accurately estimate the regional baseline GHGs. One cursory approach is to scale the provincial emissions by population. For the purpose of the assessment, the region is considered to be the service area of the landfill. Scaling GHG inventory emissions based on the populations of the service area and Ontario[13] results in an approximate service area annual total GHG emission of 31.3 Mt CO_2e. The Ridge Landfill's existing conditions account for 1.3% of the service area GHG emission profile. There is estimated to be a significant increase in GHG emissions from the existing conditions to the future peak conditions, however, the average GHG emissions under the annual estimate of future worst-case conditions accounts for 2.0% of the service area GHG emissions profile.

[12] Environment and Climate Change Canada (2019). National Inventory Report 1990-2017: Greenhouse Gas Sources and Sinks in Canada. Part 3. 2019.

[13] Statistics Canada (2017). Census Profile. 2016 Census, Chatham-Kent. Statistics Canada Catalogue no. 98-316-X2016001. Ottawa. Released November 29, 2017. Accessed November 27, 2018.

3.0 Impact of Climate Change on the Project (Climate Change Adaptation)

Various methodologies exist for the assessment of climate change risks on a project (assets and operations). One of the more recognized methodologies in Canada is the Engineers Canada Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol. The principles of the PIEVC protocol have been used to guide the impact of climate change on the Project.

The approach to assessing the impact of climate change on the project is as follows:

- **Step 1**: Review the project (current and future) and identify the climate hazards that have the potential to interact with it;
- **Step 2**: Compile climate data for baseline conditions, and develop projections for future climate;
- **Step 3**: For the climate hazards that change in the future, conduct an assessment of how those hazards may interact with the site's assets and operations. It was initially proposed that severity ratings be used to assist in prioritizing climate risks; however, the climate projections developed as part of Step 2 showed few hazards with significant projected change. Therefore, the approach taken was to assess all hazards that show some potential for change (versus focussing on priority hazards through the use of severity ratings); and
- **Step 4**: Where climate hazards interact with site assets and operations, identify adaptive measures that can be put in place to reduce the potential of asset loss or operational interruption.

These are discussed within the following sections.

3.1 Identification of Climate Hazards

The identification of climate hazards was done through engagement of site operations personnel, consultation with the project design team and based on the professional experience of the assessment team. The following climate hazards were identified as most relevant to the site operations.

- Winds: which may impact the levels of blowing litter, and may impact overhead power lines;
- Precipitation – Rain: which may impact the ability of the site's stormwater management system to function as designed;

- Precipitation – Snow: which may impact movement of vehicles and equipment on-site;
- Precipitation – Ice storm, ice accretion (accumulation): which may impact overhead power lines and impact movement of vehicles and equipment on-site;
- Precipitation – Hail: which may impact outdoor work and movement of vehicles on-site;
- Temperature – Heat: which may impact outdoor work;
- Drought: which may impact the integrity of the cover in capped areas of the landfill; and
- Lightning: which may impact outdoor work.

3.2 Baseline and Future Climate Conditions

For each of these key climate hazards, thresholds were developed that would represent levels at which impacts may occur. For some hazards, multiple thresholds were identified in recognition that varying levels of impact may be associated with a single hazard. An example of this is the impact of winds, where impacts on the site would increase in severity as higher wind thresholds are met. The thresholds were used to define current and future climate conditions.

Climate projections were completed for the year 2050, for the RCP8.5 climate scenario. RCP8.5 is consistently used as the most conservative estimate of climate projections (least actions in place to reduce greenhouse gases globally, and therefore highest potential change in climate). The projections therefore represent a reasonably conservative dataset for planning just beyond the end of the landfill expansion period and are shown in **Table D3B-11**. Data points highlighted in the table (orange text) were identified as the ones with the greatest potential for change between current and future climate.

Table D3B-11: Summary of Current and Future Climate

Climate Parameters	Threshold(s)	Current/Baseline Climate (1981-2010)[1]	Future Climate (2050, RCP8.5)[1]
Winds	80 km/hr gust	1 yr^{-1} 100%	1.2 yr^{-1} 100%
	90 km/hr gust	0.17 yr^{-1} >99%	0.21 yr^{-1} 100%
	120 km/hr gust	**0.05 yr^{-1} ~80%**	**0.06 yr^{-1} ~85%**
	Tornado – EF1+	1.7×10^{-4} yr^{-1} 0.5%	1.9 to 2.5×10^{-4} yr^{-1} 0.6-0.8%

Climate Parameters	Threshold(s)	Current/Baseline Climate (1981-2010)(1)	Future Climate (2050, RCP8.5)(1)
Precipitation - Rain	IDF Design Storm – 24 hour, 250-year return period	**0.004 yr^{-1} >10%**	**0.012 yr^{-1} >30%**
	25 mm in 1 day	4.3 yr^{-1} 100%	5.2 yr^{-1} 100%
	50 mm in 1 day	0.4 yr^{-1} >99%	0.47 yr^{-1} >99%
	75 mm in 1 day	**0.06 yr^{-1} >85%**	**0.13 yr^{-1} ~99%**
	100 mm in 1 day	**0.033 yr^{-1} < 65%**	**> 0.13 yr^{-1} ~ 99%**
Precipitation - Snow	15 cm in 1 day	1.3 yr^{-1} 100%	~1.0 yr^{-1} 100%
	25 cm in 1 day	0.09 yr^{-1} ~95%	< 0.09 yr^{-1} < 90%
Precipitation – Ice Storm, ice accretion	Severe ice storm – Accretions of 20-25 mm or more	**0.05 yr^{-1} ~80%**	**>0.07 yr^{-1} >85%**
Precipitation - Hail	Golf-ball or larger (≥45 mm) size hail occurrence	**0.006 to 0.01 yr^{-1} 15% to 25%**	**0.007 to 0.011 yr^{-1} 20% to 30%**
Temperature - Heat	Heat Warnings – T_{max} ≥ 31°C, T_{min} ≥ 21°C, for 2+ days	0.5 yr^{-1} >99%	3.25 yr^{-1} 100%
	Days T_{Max} ≥35°C	0.5 yr^{-1} >99%	9.0 yr^{-1} 100%
	Days T_{Max} ≥40°C	**0.03 yr^{-1} ~65%**	**0.27 yr^{-1} >99%**
Drought	Summer deficit of 64.61mm - RCP8.5 2050s mean deficit or more	0.16 yr^{-1} >99%	0.17 yr^{-1} >99%
Lightning	Any strikes near landfill site buildings and lot	0.022 yr^{-1} ~50%	0.024 yr^{-1} >50%

Table Note:
(1) Orange text identifies the climate parameter and threshold with the greatest potential for change between current and future climate.

3.3 Risk Assessment & Identification of Adaptive Measures

An important aspect of climate change risk assessment is developing an understanding of the current risks posed to site infrastructure and operations. Interviews with site personnel identified no significant historical impacts at the site that were natural hazard related. Historical extreme weather events such as ice storms and heavy precipitation events have had no noticeable impacts on site infrastructure and operations.

The analysis of how changes in climate may interact with site infrastructure and operations was done in consultation with site staff, and drew upon the experience of the project team in conducting climate change risk assessment. As part of the engagement of the site personnel, adaptive measures were identified to address these areas of potential future climate risk. The results of the analysis are documented in **Table D3B-12**.

Table D3B-12: Summary of Climate Interactions and Adaptive Measures

Climate Parameters	Threshold(s)	Potential Interactions	Adaptive Measures
Winds	120 km/hr gust	Increased migration of litter off-site. Potential for damage to shingles and siding on buildings.	Site currently uses both permanent and portable fences to prevent off-site migration of litter. More permanent and potentially higher fencing will be deployed as needed, along with more frequent strategic positioning of portable fences as wind conditions demand. Additional resources (staffing) will be called on, as necessary, to respond to events that lead to migration of litter off-site (i.e., pick up of litter). On-site buildings will be inspected periodically to assess the condition of roofing, windows, siding etc. and repairs/ replacement conducted as necessary.
Precipitation - Rain	IDF Design Storm – 24 hour, 250-year return period 75 mm in 1 day	Increased frequency of intense precipitation events can stress on-site stormwater	The proposed stormwater management systems have been designed and will be constructed with consideration of projected changes in climate.

Climate Parameters	Threshold(s)	Potential Interactions	Adaptive Measures
	100 mm in 1 day	management systems beyond their capacity. Inability to properly manage stormwater within the site could lead to localized flooding on the site and disruption to operations.	In addition to the design with climate projections considered, a large area has been identified on-site for stormwater management that can be used if needed in the future.
Precipitation – Ice storm, ice accretion	Severe ice storm – Accretions of 20-25 mm or more	Ice build-up on overhead utilities can lead to power outages at the site and disruption of operations.	Backup power generation exists at the site, with sufficient capacity to allow for ongoing operations in the event of short-term power outages. The site currently has practices in place to address on-site movement of vehicles and traffic along steep slopes when there is high snow accumulation and/or ice accumulation. These practices will be reviewed and adjusted as necessary in the future.
Precipitation - Hail	Golf-ball or larger (≥45 mm) size hail occurrence	Hail storms have the potential to disrupt outdoor operations, as there may be safety risks to outdoor workers.	Site safety protocols to be updated to reflect response plan to manage worker safety in the event of a hail storm. The site currently has practices in place to address on-site movement of vehicles and traffic along steep slopes when there is high snow accumulation and/or ice accumulation. These practices will be reviewed and adjusted as necessary in the future.
Temperature - Heat	Days T_{Max} ≥40°C	Increased days with Temperatures above 40°C can affect outdoor workers.	In general, equipment used at site have enclosed cabs that are climate-controlled. The site safety protocols will be updated to reflect response plan to manage worker safety in the event of periods with potential for heat stress.

In addition to areas identified through the analysis summarized above, the following were identified as areas where interactions between climate hazards may generate impacts, or where it may not be possible to properly characterize the potential for changes:

- **Changes in the rate of gas generation and potentially odour from the site** – This is an area that cannot be measured accurately. However, the site has a good track record of landfill gas management, and odour management. As on-going site monitoring has identified changes, the operator has repaired any cracks in the final cover, added gas collection wells and adjusted the treatment system (i.e., flares) to adapt. These practices that have been successfully deployed over the historical operations at the landfill, and will continue to be in place in the future.
- **Changes in rate of stormwater runoff** – The stormwater system servicing the site is designed to allow for precipitation to run off and be collected in the on-site ponds. The stormwater system is currently being designed for the future conditions, to account for future climate projections and therefore will continue to allow for rain to run off, be captured and managed appropriately.
- C**hanges in insects and pests** – This is an area that cannot be quantified. However, existing practices that are in place, along with site monitoring have allowed for appropriate management of any concerns related to pests and insects. The site will continue existing practices and adapt these practices as necessary in the future.
- **Changes in leachate volume** – The volume of leachate captured and requiring treatment may increase as a result of climate change and increased precipitation. The forcemain to the Blenheim Wastewater Treatment Lagoons (BWTL) has adequate capacity to convey the potential increased volume of leachate requiring treatment to the BWTL resulting from climate change. The BWTL will also have sufficient capacity to treat an increase in volume of leachate. Analysis of the capacity of the BWTL indicates that in the year 2040 (year of maximum future leachate volume), the BWTL are projected to be at less than 70% of its rated capacity (see Design and Operations Report Appendix D6-D).

4.0 Conclusions

The analysis presented in this report summarizes the impact of the proposed landfill expansion on climate change (climate change mitigation) and the impact of climate change on the project (climate change adaptation). The results of the analysis are as follows:

- The results of the on-site impact assessment show that the current predicted emissions of GHGs are negligible compared to total provincial emissions;
- There is estimated to be a significant increase in GHG emissions from the existing conditions to the worst-case future peak emissions. However, by scaling the provincial GHG inventory to a representative regional (service area) value based on population shows that the Ridge Landfill was not a significant contributor to service area GHGs from the existing conditions (1.3%) to the future conditions (2.0%);
- There was no predicted increase in annual GHG emissions attributable to the haul route from current to future conditions;
- The removal of the southwest woodlot will be mitigated by a 2:1 replanting program and will have a negligible impact on net GHG emissions from the site;
- Projected changes in climate are anticipated to be most significant for precipitation and temperature (heat);
- Changes in precipitation will be addressed within the design of the stormwater management system from the site to allow for capacity for future precipitation levels;
- Changes in temperature (heat) can affect outdoor workers and site protocols will be reviewed periodically to reflect changing conditions; and
- Less significant projected changes are anticipated for high winds, precipitation - ice storm, ice accretion and precipitation – hail. Adaptive measures have been identified that include both physical measures (e.g., addition of permanent liter barriers) and operational practices (e.g., review and update of site protocols).

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This Climate Change Impact Assessment Report is intended to provide a reasonable review of available information within an agreed work scope, schedule, and budget. This report was prepared by Dillon Consulting Limited(Dillon) for the sole benefit of Waste Connections and for use by Regulatory Agencies and Authorities for the purposes of approvals and permitting (collectively, the 'Permitted Uses'). The material in the report reflects Dillon's judgment in light of the information available to Dillon at the time of this report preparation. Any use other than the Permitted Uses which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties and Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix D3B-1

Existing Conditions Calculation Summary

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Table 1-1
LandGEM Results - Existing Conditions

Old Landfill - Operating Year 2018 (Closure 1999)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	1.39E+07	1.09E+07	2.79E+06
Methane	3.99E+06	4.02E+02	7.98E+05
Carbon dioxide	8.95E+06	3.29E+02	1.79E+06

West Landfill - Operating Year 2018 (Closure 2017)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	1.13E+08	8.84E+07	2.27E+07
Methane	3.26E+07	4.89E+07	6.52E+06
Carbon dioxide	7.23E+07	3.95E+07	1.45E+07

South Landfill - Operating Year 2018 (Closure 2021)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	6.45E+06	5.03E+06	1.29E+06
Methane	1.85E+06	2.78E+06	3.71E+05
Carbon dioxide	4.11E+06	2.25E+06	8.22E+05

Existing Scenario Worst-Case Landfill Gas Flare Flow Rate (m^3/year)(1)	Estimated Landfill Gas Collection Efficiency (%)(2)	Methane Concentration in Landfill Gas(3) (%)	Methane Gas Produced from LandGEM (m^3/year)	Methane Gas Flare Flow Rate (m^3/year)
83,413,974	80.0%	55.3%	51,650,328	46,127,928

Notes:

'(1) The 2018 emission inventory year of each landfill footprint was taken to provide an analysis of landfill gas generation emissions for the existing conditions.

(2) Landfill gas collection efficiency and methane concentration taken from Technical Memorandum "Ridge Landfill Expansion EA - Old landfill design optimization and information for visual, air and noise impact assessment of the preferred landfill expansion alternative" by Golder dated January 31, 2019.

(3) Landfill gas methane concentration taken from "Ontario Regulation 127, NPRI and Greenhouse Gas Emissions Reporting Year - 2017" by RWDI dated May 28, 2018.

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Table 1-2
Flare Emission Estimates - Existing Conditions

Source	Source ID	Contaminant	CAS No.	Molecular Weight	Total Emission Rate (g/s)[(1)(2)]
Flare 1	S1	Carbon Dioxide	124-38-9	44.01	2.38E+03
		Methane[(3)]	74-82-8	16.04	1.71E+01
Flare 2	S2	Carbon Dioxide	124-38-9	44.01	2.38E+03
		Methane[(3)]	74-82-8	16.04	1.71E+01

Notes:

(1) Emission estimates obtained from US EPA AP-42 Chapter 2.4 equations 4 and 6.
(2) Emission estimates obtained from landfill gas collection efficiency, combustion efficiency, and LandGEM generated emissions. The total emission rates for these estimates are split across both flares.
(3) Non combusted methane emissions were taken from the LandGEM generated emissions and a combustion efficiency of 96.5% equivalent to a destruction efficiency of 98% as per US EPA AP-42 Chapter 13.5-3 Industrial Flares.

Table 1-3
Estimated Landfill Footprint Emissions - Existing Conditions

Landfill	LandGEM Contaminant	Source ID	Fugitive Emissions (kg/year)	Contaminant	CAS No.	Total Emission Rate (g/s)
Old Landfill	Carbon Dioxide	S9	1.79E+06	Carbon Dioxide	124-38-9	5.68E+01
	Methane		7.98E+05	Methane	74-82-8	2.53E+01
West Landfill	Carbon Dioxide	S10	1.45E+07	Carbon Dioxide	124-38-9	4.59E+02
	Methane		6.52E+06	Methane	74-82-8	2.07E+02
South Landfill	Carbon Dioxide	S11	8.22E+05	Carbon Dioxide	124-38-9	2.61E+01
	Methane		3.71E+05	Methane	74-82-8	1.18E+01

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Table 1-4
Vehicle Activity - Existing Conditions

Road Segment	Activity	Description	Movements per Hour (inbound/outbound)	Percentage Equipment Operating in a Given Hour	Non-Road Vehicle Daily Operating Time per Equipment (hour)
Paved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 0-1	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Waste Drop off	Light Vehicles	6	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 1-2	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road	Concrete Crushing	Tri-Axle Truck	1	--	--
Segment 2-CC	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	Cat 430 Backhoe	2	0.50	6
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 2-3	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
				--	
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 3-4	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Hauling Soil	Tri-Axle Truck	4	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
				--	
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 4-WF	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Hauling Soil	Tri-Axle Truck	4	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
				--	
Unpaved Road	Hauling Soil	Tri-Axle Truck	4	--	--
Segment 4-SP1	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Working Face (WF)	Lift Waste Trailer to unload Waste	Landfill tipper	1	0.17	10
	Push and Spread Waste	CAT D8T Dozer	3	0.75	10
	Compact Waste	CAT 836K Landfill compactor	3	0.75	10
Storage Pile (SP1)	Soil excavation	CAT 345 Hydraulic Excavator	1	0.75	5
Concrete Crushing (CC)	Feed the crusher	Cat 336 Hydraulic Excavator	1	1.00	6
	Push the material	Cat D8T Dozer	1	1.00	6
	Create stockpiles	Conveyor/Stacker	1	1.00	10
	Crusher	Crusher	1	1.00	10

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Table 1-5
Non-Road Vehicles Emission Factors - Existing Conditions

Vehicle Type	Power Rating (hp)	Tier	Contaminant	CAS No.	Emission Factor[(1)] (g/hp-hr)
CAT 430 Backhoe	94	2	Carbon dioxide	124-38-9	589.2
CAT 735 Water Wagon	434	4	Carbon dioxide	124-38-9	530.6
CAT D8T Dozer	354	4	Carbon dioxide	124-38-9	530.6
CAT 836K Landfill compactor	562	4	Carbon dioxide	124-38-9	530.6
CAT 336 Hydraulic Excavator	314	4	Carbon dioxide	124-38-9	530.6
CAT 345 Hydraulic Excavator(2)	314	4	Carbon dioxide	124-38-9	530.6
John Deere 644K Front End Loader	232	4	Carbon dioxide	124-38-9	530.6
Landfill tipper	173	1	Carbon dioxide	124-38-9	530.0
Conveyor/Stacker	90	3	Carbon dioxide	124-38-9	589.8
Crusher	440	3	Carbon dioxide	124-38-9	530.5

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Estimated to be similar to the CAT 336 hydraulic Excavator.

Table 1-6
Non-Road Vehicles - Existing Conditions

Source	Source ID	Segment Length (m)	Vehicle Type	Description	Number of Equipment	Percentage of Equipment Operating Per Hour	Hours of Operation per Equipment (hrs)	Contaminant	CAS No.	Total 24-hr Emission Rate[(1)(2)] (g/s)
Paved Road	S7	735	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	2.11E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.93E+00
Unpaved Segment 1	$S8_{1-2}$	454	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.31E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.81E+00
Unpaved Segment 2	$S8_{2-CC}$	139	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	4.01E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	5.56E-01
Unpaved Segment 3	$S8_{2-3}$	711	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	2.05E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.84E+00
Unpaved Segment 4	$S8_{3-4}$	321	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	9.24E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.28E+00
Unpaved Segment 5	$S8_{4-WF}$	164	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	4.72E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	6.55E-01
Unpaved Segment 6	$S8_{4-SP}$	145	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	4.18E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	5.80E-01
Working Face	S4	--	Landfill tipper	Lift Waste Trailer to unload Waste	1	0.17	10	Carbon dioxide	124-38-9	1.06E+01
			CAT D8T Dozer	Push and Spread Waste	3	0.75	10	Carbon dioxide	124-38-9	6.52E+01
			CAT 836K Landfill compactor	Compact Waste	3	0.75	10	Carbon dioxide	124-38-9	1.04E+02
Storage Pile 1	S5	--	CAT 345 Hydraulic Excavator	Soil excavation	1	0.75	5	Carbon dioxide	124-38-9	9.64E+00
Concrete Crushing	S6	--	Cat 336 Hydraulic Excavator	Feed the crusher	1	1.0	6	Carbon dioxide	124-38-9	2.01E-04
			Cat D8T Dozer	Push the material	1	1.0	6	Carbon dioxide	124-38-9	1.30E+01
			Conveyor/Stacker	Create stockpiles	1	1.0	10	Carbon dioxide	124-38-9	6.14E+00
			Crushing	Crushing	1	1.0	10	Carbon dioxide	124-38-9	2.70E+01

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Emissions from the site maintenance vehicle (CAT 430 Backhoe) have been distributed based on the segment lengths.

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Table 1-7
Onroad Vehicles - Existing Conditions

Source	Source ID	Vehicle Type	Segment Length (m)	Number of Trips per hour (Inbound and Outbound)	Hourly Vehicle Distance Travelled (VKT)	Daily Vehicle Distance Travelled (VKT)[1]	Contaminant	CAS No.	Emission Factor[2] (g/VKT)	Total 24-hr Emission Rate (g/s)
Paved Road	S7	Refuse Truck	734.6	41	30.1186	301.186	Carbon dioxide	124-38-9	1.72E+03	6.01E+00
							Methane	74-82-8	3.25E-02	1.13E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.79E-05
		Light Vehicles	734.6	6	4.4076	44.076	Carbon dioxide	124-38-9	1.63E+03	8.33E-01
							Methane	74-82-8	5.05E-02	2.57E-05
							Nitrous oxide	10024-97-2	5.14E-03	2.62E-06
Unpaved Segment 1	$S8_{1-2}$	Refuse Truck	454.4	41	18.6304	186.304	Carbon dioxide	124-38-9	1.72E+03	3.72E+00
							Methane	74-82-8	3.25E-02	7.00E-05
							Nitrous oxide	10024-97-2	5.14E-03	1.11E-05
Unpaved Segment 2	$S8_{2-CC}$	Refuse Truck	139.2	1	0.1392	1.392	Carbon dioxide	124-38-9	1.72E+03	2.78E-02
							Methane	74-82-8	3.25E-02	5.23E-07
							Nitrous oxide	10024-97-2	5.14E-03	8.28E-08
Unpaved Segment 3	$S8_{2-3}$	Refuse Truck	711.2	40	28.448	284.48	Carbon dioxide	124-38-9	1.72E+03	5.67E+00
							Methane	74-82-8	3.25E-02	1.07E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.69E-05
Unpaved Segment 4	$S8_{3-4}$	Refuse Truck	321	44	14.124	141.24	Carbon dioxide	124-38-9	1.72E+03	2.82E+00
							Methane	74-82-8	3.25E-02	5.30E-05
							Nitrous oxide	10024-97-2	5.14E-03	8.40E-06
Unpaved Segment 5	$S8_{4-WF}$	Refuse Truck	164	44	7.216	72.16	Carbon dioxide	124-38-9	1.72E+03	1.44E+00
							Methane	74-82-8	3.25E-02	2.71E-05
							Nitrous oxide	10024-97-2	5.14E-03	4.29E-06
Unpaved Segment 6	$S8_{4-SP}$	Refuse Truck	145.2	2	0.2904	2.904	Carbon dioxide	124-38-9	1.72E+03	5.79E-02
							Methane	74-82-8	3.25E-02	1.09E-06
							Nitrous oxide	10024-97-2	5.14E-03	1.73E-07

Notes

(1) Based on the site operating 10 hrs/day.
(2) Emission factors generated from US EPA MOVES:

	MOVES Emission Factors	
	Refuse Trucks	Light Trucks
Compound	(g/VMT)	(g/VMT)
Carbon dioxide	2.77E+03	2.63E+03
Methane	5.22E-02	8.12E-02
Nitrous oxide	8.27E-03	8.28E-03

Appendix D3B-2

Preferred Alternative Scenario 1 Calculation Summary

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Table 2-1
LandGEM Results - Scenario 1

Old Landfill - Operating Year 2024 (Closure 2027)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	3.76E+07	2.93E+07	7.51E+06
Methane	1.07E+07	1.61E+07	2.15E+06
Carbon dioxide	2.41E+07	1.32E+07	4.83E+06

West Landfill - Operating Year 2024 (Closure 2017)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	8.93E+07	6.95E+07	1.79E+07
Methane	2.56E+07	3.84E+07	5.13E+06
Carbon dioxide	5.69E+07	3.11E+07	1.14E+07

South Landfill - Operating Year 2024 (Closure 2021)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	5.21E+07	4.06E+07	1.04E+07
Methane	1.50E+07	2.24E+07	2.99E+06
Carbon dioxide	3.32E+07	1.81E+07	6.64E+06

Landfill Gas Flare Flow Rate (m^3/year)(1)	Estimated Landfill Gas Collection Efficiency (%)(2)	Methane Concentration in Landfill Gas(3) (%)	Methane Gas Produced from LandGEM (m^3/year)	Methane Gas Flare Flow Rate (m^3/year)
111,519,907	80.0%	55.3%	77,000,246	61,670,509

Notes:

(1) The 2024 emission inventory year of each landfill footprint was taken to provide an analysis of landfill gas generation emissions for scenario 1.

(2) Landfill gas collection efficiency taken from Technical Memorandum "Ridge Landfill Expansion EA - Old landfill design optimization and information for visual, air and noise impact assessment of the preferred landfill expansion alternative" by Golder dated January 31, 2019.

(3) Landfill gas methane concentration taken from "Ontario Regulation 127, NPRI and Greenhouse Gas Emissions Reporting Year - 2017" by RWDI dated May 28, 2018.

Table 2-2
Flare Emission Estimates - Scenario 1

Source	Source ID	Contaminant	CAS No.	Molecular Weight	Total Emission Rate (g/s)[(1)(2)]
Flare 1	S1	Carbon Dioxide	124-38-9	44.01	1.59E+03
		Methane[(3)]	74-82-8	16.04	1.14E+01
Flare 2	S2	Carbon Dioxide	124-38-9	44.01	1.59E+03
		Methane[(3)]	74-82-8	16.04	1.14E+01
Flare 3	S3a	Carbon Dioxide	124-38-9	44.01	1.59E+03
		Methane[(3)]	74-82-8	16.04	1.14E+01
Flare 4	S3b	Carbon Dioxide	124-38-9	44.01	1.59E+03
		Methane[(3)]	74-82-8	16.04	1.14E+01

Notes:

(1) Emission estimates obtained from US EPA AP-42 Chapter 2.4 equations 4 and 6.

(2) Emission estimates obtained from landfill gas collection efficiency, combustion efficiency, and LandGEM generated emissions. The total emission rates for these estimates are split across all flares.

(3) Non combusted methane emissions were taken from the LandGEM generated emissions and a combustion efficiency of 96.5% equivalent to a destruction efficiency of 98% as per US EPA AP-42 Chapter 13.5-3 Industrial Flares.

Table 2-3
Estimated Landfill Footprint Emissions - Scenario 1

Landfill	LandGEM Contaminant	Source ID	Fugitive Emissions (kg/year)	Contaminant	CAS No.	Total Emission Rate (g/s)
Old Landfill	Carbon Dioxide	S9	4.83E+06	Carbon Dioxide	124-38-9	1.53E+02
	Methane		2.15E+06	Methane	74-82-8	6.82E+01
West Landfill	Carbon Dioxide	S10	1.14E+07	Carbon Dioxide	124-38-9	3.61E+02
	Methane		5.13E+06	Methane	74-82-8	1.63E+02
South Landfill	Carbon Dioxide	S11	6.64E+06	Carbon Dioxide	124-38-9	2.11E+02
	Methane		2.99E+06	Methane	74-82-8	9.50E+01

Table 2-4
Vehicle Activity - Scenario 1

Road Segment	Activity	Description	Movements per Hour (inbound/outbound)	Percentage Equipment Operating in a Given Hour	Non-Road Vehicle Daily Operating Time per Equipment (hour)
Paved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 0-1	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Public Waste Drop off	Light Vehicles	6	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	CAT 430 Backhoe	2	0.5	6
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 1-2	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	CAT 430 Backhoe	2	0.5	6
Unpaved Road	Concrete Crushing	Tri-Axle Truck	1	--	--
Segment 2-CC	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	Cat 430 Backhoe	2	0.5	6
				--	
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 2-3	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	CAT 430 Backhoe	2	0.5	6
Unpaved Road	Public Recycling (one way)	Tri-Axle Truck	2	--	--
Segment 3-RF	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	CAT 430 Backhoe	2	0.5	6
Unpaved Road	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
Segment 3-WF	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Hauling Soil	Tri-Axle Truck	4	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	CAT 430 Backhoe	2	0.5	6
Unpaved Road	Hauling Soil	Tri-Axle Truck	4	--	--
Segment 3-SP1	Water Wagon	CAT 735 Water Wagon	1	0.5	4
	Site Maintenance	CAT 430 Backhoe	2	0.5	6
Working Face (WF)	Lift Waste Trailer to unload Waste	Landfill tipper	1	0.2	10
	Push and Spread Waste	CAT D8T Dozer	3	0.75	10
	Compact Waste	CAT 836K Landfill compactor	3	0.75	10
Storage Pile (SP1)	Soil excavation	CAT 345 Hydraulic Excavator	1	0.75	5
Concrete Crushing (CC)	Feed the crusher	Cat 336 Hydraulic Excavator	1	1.0	6
(including wood grinding)	Push the material	Cat D8T Dozer	1	1.0	6
	Create stockpiles	Conveyor/Stacker	1	1.0	10
	Crusher	Crusher	1	1.0	10
	Wood Grinder	Wood Grinder	1	1.0	6
	Moving material	John Deere 644K Front End Loader	1	1.0	10

Table 2-5
Non-Road Vehicles Emission Factors - Scenario 1

Vehicle Type	Power Rating (hp)	Tier	Contaminant	CAS No.	Emission Factor(1) (g/hp-hr)
CAT 430 Backhoe	94	2	Carbon dioxide	124-38-9	589.2
CAT 735 Water Wagon	434	4	Carbon dioxide	124-38-9	530.6
CAT D8T Dozer	354	4	Carbon dioxide	124-38-9	530.6
CAT 836K Landfill compactor	562	4	Carbon dioxide	124-38-9	530.6
CAT 336 Hydraulic Excavator	314	4	Carbon dioxide	124-38-9	530.6
CAT 345 Hydraulic Excavator(2)	314	4	Carbon dioxide	124-38-9	530.6
John Deere 644K Front End Loader	232	4	Carbon dioxide	124-38-9	530.6
Landfill tipper	173	1	Carbon dioxide	124-38-9	530.0
Conveyor/Stacker	90	3	Carbon dioxide	124-38-9	589.8
Crusher	440	3	Carbon dioxide	124-38-9	530.5
Wood Grinder	580	3	Carbon dioxide	124-38-9	530.5

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Estimated to be similar to the CAT 336 ydraulic Excavator.

Table 2-6
Non-Road Vehicles - Scenario 1

Source	Source ID	Segment Length (m)	Vehicle Type	Description	Number of Equipment	Percentage of Equipment Operating Per Hour	Hours of Operation per Equipment (hrs)	Contaminant	CAS No.	Total 24-hr Emission Rate[(1)(2)] (g/s)
Paved Road	S7	734.6	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.29E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.79E+00
Unpaved Segment 1	$S8_{1-2}$	770	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.35E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.88E+00
Unpaved Segment 2	$S8_{2-CC}$	814	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.43E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.99E+00
Unpaved Segment 3	$S8_{2-3}$	289	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	5.09E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	7.06E-01
Unpaved Segment 4	$S8_{3-RF}$	707	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.24E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.73E+00
Unpaved Segment 5	$S8_{3-WF}$	391	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	6.87E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	9.53E-01
Unpaved Segment 6	$S8_{3-SP}$	663	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.17E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.62E+00
Working Face	S4	--	Landfill tipper	Lift Waste Trailer to unload Waste	1	0.17	10	Carbon dioxide	124-38-9	1.06E+01
			CAT D8T Dozer	Push and Spread Waste	3	0.75	10	Carbon dioxide	124-38-9	6.52E+01
			CAT 836K Landfill compactor	Compact Waste	3	0.75	10	Carbon dioxide	124-38-9	1.04E+02
Storage Pile	S5		CAT 345 Hydraulic Excavator	Soil excavation	1	0.75	5	Carbon dioxide	124-38-9	9.64E+00
Concrete Crushing Wood Grinding	S6		Cat 336 Hydraulic Excavator	Feed the crusher	1	1.0	6	Carbon dioxide	124-38-9	1.16E+01
			Cat D8T Dozer	Push the material	1	1.0	6	Carbon dioxide	124-38-9	1.30E+01
			Conveyor/Stacker	Create stockpiles	1	1.0	10	Carbon dioxide	124-38-9	6.14E+00
			Crushing	Crushing	1	1.0	10	Carbon dioxide	124-38-9	2.70E+01
			Wood Grinder	Wood Grinder	1	1.0	6	Carbon dioxide	124-38-9	2.14E+01
			John Deere 644K Front End Loader	Moving material	1	1.0	10	Carbon dioxide	124-38-9	1.42E+01

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Emissions from the site maintenance vehicle (CAT 430 Backhoe) have been distributed based on the segment lengths.

Table 2-7
Onroad Vehicles - Scenario 1

Source	Source ID	Vehicle Type	Segment Length (m)	Number of Trips per hour (Inbound and Outbound)	Hourly Vehicle Distance Travelled (VKT)	Daily Vehicle Distance Travelled (VKT)(1)	Contaminant	CAS No.	Emission Factor(2) (g/VKT)	Total 24-hr Emission Rate (g/s)
Paved Road	S7	Refuse Truck	735	41	30	301	Carbon dioxide	124-38-9	1.59E+03	5.55E+00
							Methane	74-82-8	4.49E-02	1.56E-04
							Nitrous oxide	10024-97-2	4.84E-03	1.69E-05
		Light Vehicles	735	6	4	44	Carbon dioxide	124-38-9	3.94E+02	2.01E-01
							Methane	74-82-8	1.41E-03	7.19E-07
							Nitrous oxide	10024-97-2	4.02E-03	2.05E-06
Unpaved Segment 1	S81-2	Refuse Truck	770	41	32	316	Carbon dioxide	124-38-9	1.59E+03	5.82E+00
							Methane	74-82-8	4.49E-02	1.64E-04
							Nitrous oxide	10024-97-2	4.84E-03	1.77E-05
Unpaved Segment 2	S82-CC	Refuse Truck	814	1	1	8	Carbon dioxide	124-38-9	1.59E+03	1.50E-01
							Methane	74-82-8	4.49E-02	4.23E-06
							Nitrous oxide	10024-97-2	4.84E-03	4.56E-07
Unpaved Segment 3	S82-3	Refuse Truck	289	40	12	116	Carbon dioxide	124-38-9	1.59E+03	2.13E+00
							Methane	74-82-8	4.49E-02	6.01E-05
							Nitrous oxide	10024-97-2	4.84E-03	6.48E-06
Unpaved Segment 4	S83-RF	Refuse Truck	707	2	1	14	Carbon dioxide	124-38-9	1.59E+03	2.61E-01
							Methane	74-82-8	4.49E-02	7.35E-06
							Nitrous oxide	10024-97-2	4.84E-03	7.92E-07
Unpaved Segment 5	S83-WF	Refuse Truck	391	44	17	172	Carbon dioxide	124-38-9	1.59E+03	3.17E+00
							Methane	74-82-8	4.49E-02	8.93E-05
							Nitrous oxide	10024-97-2	4.84E-03	9.62E-06
Unpaved Segment 6	S83-SP	Refuse Truck	663	2	1	13	Carbon dioxide	124-38-9	1.59E+03	2.44E-01
							Methane	74-82-8	4.49E-02	6.89E-06
							Nitrous oxide	10024-97-2	4.84E-03	7.42E-07

(1) Based on the site operating 10 hrs/day.
(2) Emission factors generated from US EPA MOVES:

	MOVES Emission Factors	
	Refuse Trucks	Light Trucks
Compound	(g/VMT)	(g/VMT)
Carbon dioxide	2.56E+03	6.33E+02
Methane	7.22E-02	2.27E-03
Nitrous oxide	7.78E-03	6.47E-03

Appendix D3B-3

Preferred Alternative Scenario 2 Calculation Summary

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Table 3-1
LandGEM Results - Scenario 2

Old Landfill - Operating Year 2028 (Closure 2027)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	8.32E+07	6.49E+07	1.66E+07
Methane	2.38E+07	3.57E+07	4.76E+06
Carbon dioxide	5.34E+07	2.92E+07	1.07E+07

West Landfill - Operating Year 2028 (Closure 2017)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	7.61E+07	5.92E+07	1.52E+07
Methane	2.19E+07	3.28E+07	4.37E+06
Carbon dioxide	4.85E+07	2.65E+07	9.69E+06

South Landfill - Operating Year 2028 (Closure 2021)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	4.44E+07	3.46E+07	8.88E+06
Methane	1.28E+07	1.91E+07	2.55E+06
Carbon dioxide	2.83E+07	1.55E+07	5.66E+06

South Landfill Expansion - Operating Year 2029[1] (Closure 2032)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	1.35E+07	1.05E+07	2.70E+06
Methane	3.88E+06	5.82E+06	7.77E+05
Carbon dioxide	8.61E+06	4.70E+06	1.72E+06

West Landfill Expansion - (Closure 2041)

Landfill Gas Flare Flow Rate (m^3/year)[2]	Estimated Landfill Gas Collection Efficiency (%)[3]	Methane Concentration in Landfill Gas[4] (%)	Methane Gas Produced from LandGEM (m^3/year)	Methane Gas Flare Flow Rate (m^3/year)
135,370,123	80.0%	55.3%	93,380,002	74,859,678

Notes:

(1) The South Landfill expansion will begin filling operations in 2028, therefore LandGem results from 2029 have been used in the Scenario 2 assessment as a conservative estimate of landfill gas generation.

(2) The 2028 emission inventory year of each landfill footprint was taken to provide an analysis of landfill gas generation emissions for scenario 2.

(3) Landfill gas collection efficiency taken from Technical Memorandum "Ridge Landfill Expansion EA - Old landfill design optimization and information for visual, air and noise impact assessment of the preferred landfill expansion alternative" by Golder dated January 31, 2019.

(4) Landfill gas methane concentration taken from "Ontario Regulation 127, NPRI and Greenhouse Gas Emissions Reporting Year - 2017" by RWDI dated May 28, 2018.

Table 3-2
Flare Emission Estimates - Scenario 2

Source	Source ID	Contaminant	CAS No.	Molecular Weight	Total Emission Rate (g/s)
Flare 1	S1	Carbon Dioxide	124-38-9	44.01	1.47E+03
		Methane(3)	74-82-8	16.04	1.05E+01
Flare 2	S2	Carbon Dioxide	124-38-9	44.01	1.47E+03
		Methane(3)	74-82-8	16.04	1.05E+01
Flare 3	S3a	Carbon Dioxide	124-38-9	44.01	1.47E+03
		Methane(3)	74-82-8	16.04	1.05E+01
Flare 4	S3b	Carbon Dioxide	124-38-9	44.01	1.47E+03
		Methane(3)	74-82-8	16.04	1.05E+01
Flare 5	S3c	Carbon Dioxide	124-38-9	44.01	1.85E+03
		Methane(3)	74-82-8	16.04	1.33E+01

Notes:

(1) Emission estimates obtained from US EPA AP-42 Chapter 2.4 equations 4 and 6.

(2) Emission estimates obtained from landfill gas collection efficiency, combustion efficiency, and LandGEM generated emissions. The total emission rates for these estimates are split across all flares.

(3) Non combusted methane emissions were taken from the LandGEM generated emissions and a combustion efficiency of 96.5% equivalent to a destruction efficiency of 98% as per US EPA AP-42 Chapter 13.5-3 Industrial Flares.

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Table 3-3
Estimated Landfill Footprint Emissions - Scenario 2

Landfill	LandGEM Contaminant	Source ID	Fugitive Emissions (kg/year)	Contaminant	CAS No.	Total Emission Rate (OU/s or g/s)
Old Landfill	Carbon Dioxide Methane	S9	1.07E+07 4.76E+06	Carbon Dioxide Methane	124-38-9 74-82-8	3.39E+02 1.51E+02
West Landfill	Carbon Dioxide Methane	S10	9.69E+06 4.37E+06	Carbon Dioxide Methane	124-38-9 74-82-8	3.07E+02 1.39E+02
South Landfill	Carbon Dioxide Methane	S11	5.66E+06 2.55E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.79E+02 8.09E+01
South Landfill Expansion	Carbon Dioxide Methane	S12	1.72E+06 7.77E+05	Carbon Dioxide Methane	124-38-9 74-82-8	5.46E+01 2.46E+01

Notes:
(1) Screening level taken from Interim Guide to Estimate and Assess Landfill Air Impacts (MECP, 1992).

Table 3-4
Vehicle Activity - Scenario 2

Road Segment	Activity	Description	Movements per Hour (inbound/outbound)	Percentage Equipment Operating in a Given Hour	Non-Road Vehicle Daily Operating Time per Equipment (hour)
Paved Road Segment 0-1	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Public Waste Drop off	Light Vehicles	6	--	--
	LCS Unloading Clear Stone	Tri-Axle Truck	10	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 1-2	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	LCS Unloading Clear Stone	Tri-Axle Truck	10	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 2-3	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	LCS Unloading Clear Stone	Tri-Axle Truck	10	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 2-RF	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 3-WF	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Hauling Soil	Tri-Axle Truck	4	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Working Face (WF) (including cell excavation, storage pile 1, and cell excavation)	Lift Waste Trailer to unload Waste	Landfill tipper	1	0.17	10
	Push and Spread Waste	CAT D8T Dozer	3	0.75	10
	Compact Waste	CAT 836K Landfill compactor	3	0.75	10
	Soil excavation	CAT 345 Hydraulic Excavator	1	0.75	5
	Cell excavation	CAT 336 Hydraulic Excavator	1	1.00	10
	Cell excavation	CAT 345 Hydraulic Excavator	1	1.00	9
	LCS unloading clear stone	CAT D8T Dozer	1	1.00	8
Concrete Crushing (CC) (including wood grinding)	Feed the crusher	Cat 336 Hydraulic Excavator	1	1.00	6
	Push the material	Cat D8T Dozer	1	1.00	6
	Create stockpiles	Conveyor/Stacker	1	1.00	10
	Crusher	Crusher	1	1.00	10
	Wood Grinder	Wood Grinder	1	1.00	6
	Moving material	John Deere 644K Front End Loader	1	1.00	10

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Table 3-5
Non-Road Vehicles Emission Factors - Scenario 2

Vehicle Type	Power Rating (hp)	Tier	Contaminant	CAS No.	Emission Factor[1] (g/hp-hr)
CAT 430 Backhoe	94	2	Carbon dioxide	124-38-9	589.2
CAT 735 Water Wagon	434	4	Carbon dioxide	124-38-9	530.6
CAT D8T Dozer	354	4	Carbon dioxide	124-38-9	530.6
CAT 836K Landfill compactor	562	4	Carbon dioxide	124-38-9	530.6
CAT 336 Hydraulic Excavator	314	4	Carbon dioxide	124-38-9	530.6
CAT 345 Hydraulic Excavator(2)	314	4	Carbon dioxide	124-38-9	530.6
John Deere 644K Front End Loader	232	4	Carbon dioxide	124-38-9	530.6
Landfill tipper	173	1	Carbon dioxide	124-38-9	530.0
Conveyor/Stacker	90	3	Carbon dioxide	124-38-9	589.8
Crusher	440	3	Carbon dioxide	124-38-9	530.5
Wood Grinder	580	3	Carbon dioxide	124-38-9	530.5

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Estimated to be similar to the CAT 336 ydraulic Excavator.

Table 3-6
Non-Road Vehicles - Scenario 2

Source	Source ID	Segment Length (m)	Vehicle Type	Description	Number of Equipment	Percentage of Equipment Operating Per Hour	Hours of Operation per Equipment (hrs)	Contaminant	CAS No.	Total 24-hr Emission Rate[(1)(2)] (g/s)
Paved Road	S7	735	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.56E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.17E+00
Unpaved Segment 1	$S8_{1-2}$	770	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.64E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.27E+00
Unpaved Segment 2	$S8_{2-3}$	814	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.73E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.40E+00
Unpaved Segment 3	$S8_{2-RF}$	1050	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	2.23E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	3.10E+00
Unpaved Segment 4	$S8_{3-WF}$	245	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	5.21E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	7.23E-01
Working Face Leachate collection system construction Storage pile 1 Cell excavation	S4	--	Landfill tipper	Lift Waste Trailer to unload Waste	1	0.17	10	Carbon dioxide	124-38-9	1.06E+01
			CAT D8T Dozer	Push and Spread Waste LCS unloading clear stone	3	0.75	10	Carbon dioxide	124-38-9	8.26E+01
			CAT 836K Landfill compactor	Compact Waste	1	1.0	8	Carbon dioxide	124-38-9	2.76E+01
			Cat 336 Hydraulic Excavator	Cell excavation	1	1.0	10	Carbon dioxide	124-38-9	1.93E+01
			CAT 345 Hydraulic Excavator	Soil excavation Cell excavation	1	0.75	5	Carbon dioxide	124-38-9	2.70E+01
Concrete Crushing Wood Grinding	S6	--	Cat 336 Hydraulic Excavator	Feed the crusher	1	1.0	6	Carbon dioxide	124-38-9	1.16E+01
			Cat D8T Dozer	Push the material	1	1.0	6	Carbon dioxide	124-38-9	1.30E+01
			Conveyor/Stacker	Create stockpiles	1	1.0	10	Carbon dioxide	124-38-9	6.14E+00
			Crushing	Crushing	1	1.0	10	Carbon dioxide	124-38-9	2.70E+01
			Wood Grinder	Wood Grinder	1	1.0	6	Carbon dioxide	124-38-9	2.14E+01
			John Deere 644K Front End Loader	Moving material	1	1.0	10	Carbon dioxide	124-38-9	1.42E+01

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Emissions from the site maintenance vehicle (CAT 430 Backhoe) have been distributed based on the segment lengths.

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Table 3-7
Onroad Vehicles - Scenario 2

Source	Source ID	Vehicle Type	Segment Length (m)	Number of Trips per hour (Inbound and Outbound)	Hourly Vehicle Distance Travelled (VKT)	Daily Vehicle Distance Travelled (VKT)[1]	Contaminant	CAS No.	Emission Factor[2] (g/VKT)	Total 24-hr Emission Rate (g/s)
Paved Road	S7	Refuse Truck	734.6	41	30	301	Carbon dioxide	124-38-9	1.67E+03	5.82E+00
							Methane	74-82-8	4.85E-02	1.69E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.79E-05
		Light Vehicles	734.6	6	4	44	Carbon dioxide	124-38-9	3.71E+02	1.89E-01
							Methane	74-82-8	9.42E-04	4.80E-07
							Nitrous oxide	10024-97-2	3.20E-03	1.63E-06
Unpaved Segment 1	$S8_{1-2}$	Refuse Truck	770.3	41	32	316	Carbon dioxide	124-38-9	1.67E+03	6.10E+00
							Methane	74-82-8	4.85E-02	1.77E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.88E-05
Unpaved Segment 2	$S8_{2-3}$	Refuse Truck	814	8	7	65	Carbon dioxide	124-38-9	1.67E+03	1.26E+00
							Methane	74-82-8	4.85E-02	3.66E-05
							Nitrous oxide	10024-97-2	5.14E-03	3.88E-06
Unpaved Segment 3	$S8_{2-RF}$	Refuse Truck	1050	2	2	21	Carbon dioxide	124-38-9	1.67E+03	1.26E+00
							Methane	74-82-8	4.85E-02	3.66E-05
							Nitrous oxide	10024-97-2	5.14E-03	3.88E-06
Unpaved Segment 4	$S8_{3-WF}$	Refuse Truck	245.2	44	11	108	Carbon dioxide	124-38-9	1.67E+03	1.26E+00
							Methane	74-82-8	4.85E-02	3.66E-05
							Nitrous oxide	10024-97-2	5.14E-03	3.88E-06

(1) Based on the site operating 10 hrs/day.
(2) Emission factors generated from US EPA MOVES:

	MOVES Emission Factors	
	Refuse Trucks	Light Trucks
Compound	(g/VMT)	(g/VMT)
Carbon dioxide	2.69E+03	5.97E+02
Methane	7.81E-02	1.52E-03
Nitrous oxide	8.28E-03	5.16E-03

Appendix D3B-4

Preferred Alternative Scenario 3 Calculation Summary

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Table 4-1
LandGEM Results - Scenario 3

Old Landfill - Operating Year 2039 (Closure 2027)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	5.36E+07	4.18E+07	1.07E+07
Methane	1.53E+07	2.30E+07	3.07E+06
Carbon dioxide	3.44E+07	1.88E+07	6.88E+06

West Landfill - Operating Year 2039 (Closure 2017)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	4.90E+07	3.82E+07	9.80E+06
Methane	1.41E+07	2.11E+07	2.82E+06
Carbon dioxide	3.12E+07	1.71E+07	6.24E+06

South Landfill - Operating Year 2039 (Closure 2021)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	2.86E+07	2.23E+07	5.72E+06
Methane	8.22E+06	1.23E+07	1.64E+06
Carbon dioxide	1.82E+07	9.96E+06	3.65E+06

South Landfill Expansion - Operating Year 2039 (Closure 2032)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	4.91E+07	3.83E+07	9.83E+06
Methane	1.41E+07	2.12E+07	2.82E+06
Carbon dioxide	3.13E+07	1.71E+07	6.26E+06

West Landfill Expansion - Operating Year 2039 (Closure 2041)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	7.35E+07	5.73E+07	1.47E+07
Methane	2.11E+07	3.17E+07	4.23E+06
Carbon dioxide	4.69E+07	2.56E+07	9.37E+06

Landfill Gas Flare Flow Rate (m^3/year)(1)	Estimated Landfill Gas Collection Efficiency (%)(2)	Methane Concentration in Landfill Gas(3) (%)	Methane Gas Produced from LandGEM (m^3/year)	Methane Gas Flare Flow Rate (m^3/year)
158,191,663	80.0%	55.3%	109,224,661	87,479,990

Notes:

(1) The 2039 emission inventory year of each landfill footprint was taken to provide an analysis of landfill gas generation emissions for scenario 3.

(2) Landfill gas collection efficiency taken from Technical Memorandum "Ridge Landfill Expansion EA - Old landfill design optimization and information for visual, air and noise impact assessment of the preferred landfill expansion alternative" by Golder dated January 31, 2019.

(3) Landfill gas methane concentration taken from "Ontario Regulation 127, NPRI and Greenhouse Gas Emissions Reporting Year - 2017" by RWDI dated May 28, 2018.

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Table 4-2
Flare Emission Estimates - Scenario 3

Source	Source ID	Contaminant	CAS No.	Molecular Weight	Total Emission Rate (g/s)
Flare 1	S1	Carbon Dioxide	124-38-9	44.01	1.71E+03
		Methane(3)	74-82-8	16.04	1.23E+01
Flare 2	S2	Carbon Dioxide	124-38-9	44.01	1.71E+03
		Methane(3)	74-82-8	16.04	1.23E+01
Flare 3	S3a	Carbon Dioxide	124-38-9	44.01	1.71E+03
		Methane(3)	74-82-8	16.04	1.23E+01
Flare 4	S3b	Carbon Dioxide	124-38-9	44.01	1.71E+03
		Methane(3)	74-82-8	16.04	1.23E+01
Flare 5	S3c	Carbon Dioxide	124-38-9	44.01	2.16E+03
		Methane(3)	74-82-8	16.04	1.55E+01

Notes:

(1) Emission estimates obtained from US EPA AP-42 Chapter 2.4 equations 4 and 6.

(2) Emission estimates obtained from landfill gas collection efficiency, combustion efficiency, and LandGEM generated emissions. The total emission rates for these estimates are split across all flares.

(3) Non combusted methane emissions were taken from the LandGEM generated emissions and a combustion efficiency of 96.5% equivalent to a destruction efficiency of 98% as per US EPA AP-42 Chapter 13.5-3 Industrial Flares.

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Table 4-3
Estimated Landfill Footprint Emissions - Scenario 3

Landfill	LandGEM Contaminant	Source ID	Fugitive Emissions (kg/year)	Contaminant	CAS No.	Total Emission Rate (OU/s or g/s)
Old Landfill	Carbon Dioxide Methane	S9	6.88E+06 3.07E+06	Carbon Dioxide Methane	124-38-9 74-82-8	2.18E+02 9.72E+01
West Landfill	Carbon Dioxide Methane	S10	6.24E+06 2.82E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.98E+02 8.93E+01
South Landfill	Carbon Dioxide Methane	S11	3.65E+06 1.64E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.16E+02 5.21E+01
South Landfill Expansion	Carbon Dioxide Methane	S12	6.26E+06 2.82E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.99E+02 8.95E+01
West Landfill Expansion	Carbon Dioxide Methane	S13	9.37E+06 4.23E+06	Carbon Dioxide Methane	124-38-9 74-82-8	2.97E+02 1.34E+02

Notes:
(1) Screening level taken from Interim Guide to Estimate and Assess Landfill Air Impacts (MECP, 1992).

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Table 4-4
Vehicle Activity - Scenario 3

Road Segment	Activity	Description	Movements per Hour (inbound/outbound)	Percentage Equipment Operating in a Given Hour	Non-Road Vehicle Daily Operating Time per Equipment (hour)
Paved Road Segment 0-1	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Public Waste Drop off	Light Vehicles	6	--	--
	LCS unloading of clear stone	Tri-Axle Truck	10	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 1-2	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	LCS unloading of clear stone	Tri-Axle Truck	10	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 2-3	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 2-RF	Public Recycling (one way)	Tri-Axle Truck	2	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 3-WF	Waste (non-IC&I/C&D)	Tri-Axle Truck	8	--	--
	Waste (IC&I/C&D Waste)	Tri-Axle Truck	32	--	--
	Hauling Soil	Tri-Axle Truck	4	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Unpaved Road Segment 3-CC	Hauling Soil	Tri-Axle Truck	4	--	--
	Concrete Crushing	Tri-Axle Truck	1	--	--
	Water Wagon	CAT 735 Water Wagon	1	0.50	4
	Site Maintenance	CAT 430 Backhoe	2	0.50	6
Working Face (WF) (including LCS construction and cell excavation)	Lift Waste Trailer to unload Waste	Landfill tipper	1	0.17	10
	Push and Spread Waste	CAT D8T Dozer	3	0.75	10
	Compact Waste	CAT 836K Landfill compactor	3	0.75	10
	Cell excavation	CAT 345 Hydraulic Excavator	1	1.00	9
	LCS unloading clear stone	CAT D8T Dozer	1	1.00	10
Concrete Crushing (CC) (including storage pile 1 and wood grinding)	Feed the crusher	Cat 336 Hydraulic Excavator	1	1.00	6
	Push the material	Cat D8T Dozer	1	1.00	6
	Create stockpiles	Conveyor/Stacker	1	1.00	10
	Crusher	Crusher	1	1.00	10
	Soil excavation	CAT 345 Hydraulic Excavator	1	0.75	5
	Wood Grinder	Wood Grinder	1	1.00	6
	Moving material	John Deere 644K Front End Loader	1	1.00	10

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Table 4-5
Non-Road Vehicles Emission Factors - Scenario 3

Vehicle Type	Power Rating (hp)	Tier	Contaminant	CAS No.	Emission Factor[1] (g/hp-hr)
CAT 430 Backhoe	94	2	Carbon dioxide	124-38-9	589.2
CAT 735 Water Wagon	434	4	Carbon dioxide	124-38-9	530.6
CAT D8T Dozer	354	4	Carbon dioxide	124-38-9	530.6
CAT 836K Landfill compactor	562	4	Carbon dioxide	124-38-9	530.6
CAT 336 Hydraulic Excavator	314	4	Carbon dioxide	124-38-9	530.6
CAT 345 Hydraulic Excavator(2)	314	4	Carbon dioxide	124-38-9	530.6
John Deere 644K Front End Loader	232	4	Carbon dioxide	124-38-9	530.6
Landfill tipper	173	1	Carbon dioxide	124-38-9	530.0
Conveyor/Stacker	90	3	Carbon dioxide	124-38-9	589.8
Crusher	440	3	Carbon dioxide	124-38-9	530.5
Wood Grinder	580	3	Carbon dioxide	124-38-9	530.5

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Estimated to be similar to the CAT 336 ydraulic Excavator.

Table 4-6
Non-Road Vehicles - Scenario 3

Source	Source ID	Segment Length (m)	Vehicle Type	Description	Number of Equipment	Percentage of Equipment Operating Per Hour	Hours of Operation per Equipment (hrs)	Contaminant	CAS No.	Total 24-hr Emission Rate(1)(2) (g/s)
Paved Road	S7	735	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.14E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.58E+00
Unpaved Segment 1	$S8_{1-2}$	770	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.19E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.66E+00
Unpaved Segment 2	$S8_{2-3}$	814	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.26E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	1.75E+00
Unpaved Segment 3	$S8_{2-RF}$	1050	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	1.63E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.26E+00
Unpaved Segment 4	$S8_{3-WF}$	201	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	3.11E-01
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	4.32E-01
Unpaved Segment 5	$S8_{3-CC}$	1386	CAT 430 Backhoe	Site Maintenance	2	0.5	6	Carbon dioxide	124-38-9	2.15E+00
			CAT 735 Water Wagon	Water Wagon	1	0.5	4	Carbon dioxide	124-38-9	2.98E+00
Working Face LCS construction Cell excavation	S4	--	Landfill tipper	Lift Waste Trailer to unload Waste	1	0.17	10	Carbon dioxide	124-38-9	1.06E+01
			CAT D8T Dozer	Push and Spread Waste LCS unloading clear stone	3	0.75	10	Carbon dioxide	124-38-9	8.70E+01
			CAT 836K Landfill compactor	Compact Waste	1	1.0	10	Carbon dioxide	124-38-9	9.76E-02
			CAT 345 Hydraulic Excavator	Cell excavation	1	1.0	9	Carbon dioxide	124-38-9	1.74E+01
Concrete Crushing Storage pile 1 Wood grinding	S6	--	Cat 336 Hydraulic Excavator	Feed the crusher	1	1.0	6	Carbon dioxide	124-38-9	1.16E+01
			CAT 345 Hydraulic Excavator	Soil excavation	1	0.75	5	Carbon dioxide	124-38-9	9.64E+00
			Cat D8T Dozer	Push the material	1	1.0	6	Carbon dioxide	124-38-9	1.30E+01
			Conveyor/Stacker	Create stockpiles	1	1.0	10	Carbon dioxide	124-38-9	6.14E+00
			Crushing	Crushing	1	1.0	10	Carbon dioxide	124-38-9	2.70E+01
			Wood Grinder	Wood Grinder	1	1.0	6	Carbon dioxide	124-38-9	2.14E+01
			John Deere 644K Front End Loader	Moving material	1	1.0	10	Carbon dioxide	124-38-9	1.42E+01

Notes

(1) Emission factors taken from the US EPA document "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition NR-009d", July, 2010.
(2) Emissions from the site maintenance vehicle (CAT 430 Backhoe) have been distributed based on the segment lengths.

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Table 4-7
Onroad Vehicles - Scenario 3

Source	Source ID	Vehicle Type	Segment Length (m)	Number of Trips per hour (Inbound and Outbound)	Hourly Vehicle Distance Travelled (VKT)	Daily Vehicle Distance Travelled (VKT)(1)	Contaminant	CAS No.	Emission Factor(2) (g/VKT)	Total 24-hr Emission Rate (g/s)
Paved Road	S7	Refuse Truck	734.6	41	30.1	301.2	Carbon dioxide	124-38-9	1.63E+03	5.70E+00
							Methane	74-82-8	5.06E-02	1.76E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.79E-05
		Light Vehicles	734.6	6	4.4	44.1	Carbon dioxide	124-38-9	2.93E+02	1.50E-01
							Methane	74-82-8	4.48E-04	2.29E-07
							Nitrous oxide	10024-97-2	2.85E-03	1.45E-06
Unpaved Segment 1	$S8_{1-2}$	Refuse Truck	770.3	41	31.6	315.8	Carbon dioxide	124-38-9	1.63E+03	5.98E+00
							Methane	74-82-8	5.06E-02	1.85E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.88E-05
Unpaved Segment 2	$S8_{2-3}$	Refuse Truck	814	40	32.6	325.6	Carbon dioxide	124-38-9	1.63E+03	6.16E+00
							Methane	74-82-8	5.06E-02	1.91E-04
							Nitrous oxide	10024-97-2	5.14E-03	1.94E-05
Unpaved Segment 3	$S8_{2-RF}$	Refuse Truck	1050	2	2.1	21.0	Carbon dioxide	124-38-9	1.63E+03	3.97E-01
							Methane	74-82-8	5.06E-02	1.23E-05
							Nitrous oxide	10024-97-2	5.14E-03	1.25E-06
Unpaved Segment 4	$S8_{3-WF}$	Refuse Truck	200.8	44	8.8	88.4	Carbon dioxide	124-38-9	1.63E+03	1.67E+00
							Methane	74-82-8	5.06E-02	5.17E-05
							Nitrous oxide	10024-97-2	5.14E-03	5.26E-06
Unpaved Segment 5	$S8_{3-CC}$	Refuse Truck	1385.9	2	2.8	27.7	Carbon dioxide	124-38-9	1.63E+03	5.24E-01
							Methane	74-82-8	5.06E-02	1.62E-05
							Nitrous oxide	10024-97-2	5.14E-03	1.65E-06

(1) Based on the site operating 10 hrs/day.
(2) Emission factors generated from US EPA MOVES:

	MOVES Emission Factors	
	Refuse Trucks	Light Trucks
Compound	(g/VMT)	(g/VMT)
Carbon dioxide	2.63E+03	4.72E+02
Methane	8.14E-02	7.21E-04
Nitrous oxide	8.28E-03	4.59E-03

Appendix D3B-5

Air Dispersion Modelling Files

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Table 5-1
LandGEM Results - Post Closure

Old Landfill - Operating Year 2042 (Closure 2027)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	4.75E+07	3.71E+07	9.50E+06
Methane	1.36E+07	2.04E+07	2.72E+06
Carbon dioxide	3.05E+07	1.67E+07	6.10E+06

West Landfill - Operating Year 2042 (Closure 2017)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	4.35E+07	3.38E+07	8.69E+06
Methane	1.25E+07	1.87E+07	2.50E+06
Carbon dioxide	2.77E+07	1.51E+07	5.54E+06

South Landfill - Operating Year 2042 (Closure 2021)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	2.54E+07	1.98E+07	5.07E+06
Methane	7.29E+06	1.09E+07	1.46E+06
Carbon dioxide	1.62E+07	8.83E+06	3.23E+06

South Landfill Expansion - Operating Year 2042 (Closure 2032)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	4.36E+07	3.39E+07	8.72E+06
Methane	1.25E+07	1.88E+07	2.50E+06
Carbon dioxide	2.78E+07	1.52E+07	5.55E+06

West Landfill Expansion - Operating Year 2042 (Closure 2041)

Contaminant	Landfill Gas Generated from LandGEM (kg/year)	Landfill Gas Generated from LandGEM (m^3/year)	Landfill Gas Not Collected (kg/year)
Total landfill gas	1.04E+08	8.11E+07	2.08E+07
Methane	2.99E+07	4.49E+07	5.99E+06
Carbon dioxide	6.64E+07	3.63E+07	1.33E+07

Landfill Gas Flare Flow Rate (m^3/year)(1)	Estimated Landfill Gas Collection Efficiency (%)(2)	Methane Concentration in Landfill Gas(3) (%)	Methane Gas Produced from LandGEM (m^3/year)	Methane Gas Flare Flow Rate (m^3/year)
164,583,249	80.0%	55.3%	113,657,017	91,014,537

Notes:

(1) The 2042 emission inventory year of each landfill footprint was taken to provide an analysis of landfill gas generation emissions for post closure.

(2) Landfill gas collection efficiency taken from Technical Memorandum "Ridge Landfill Expansion EA - Old landfill design optimization and information for visual, air and noise impact assessment of the preferred landfill expansion alternative" by Golder dated January 31, 2019.

(3) Landfill gas methane concentration taken from "Ontario Regulation 127, NPRI and Greenhouse Gas Emissions Reporting Year - 2017" by RWDI dated May 28, 2018.

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Table 5-2
Flare Emission Estimates - Post Closure

Source	Source ID	Contaminant	CAS No.	Molecular Weight	Total Emission Rate (g/s)
Flare 1	S1	Carbon Dioxide	124-38-9	44.01	1.78E+03
		Methane(3)	74-82-8	16.04	1.28E+01
Flare 2	S2	Carbon Dioxide	124-38-9	44.01	1.78E+03
		Methane(3)	74-82-8	16.04	1.28E+01
Flare 3	S3a	Carbon Dioxide	124-38-9	44.01	1.78E+03
		Methane(3)	74-82-8	16.04	1.28E+01
Flare 4	S3b	Carbon Dioxide	124-38-9	44.01	1.78E+03
		Methane(3)	74-82-8	16.04	1.28E+01
Flare 4	S3c	Carbon Dioxide	124-38-9	44.01	2.25E+03
		Methane(3)	74-82-8	16.04	1.61E+01

Notes:

(2) Emission estimates obtained from US EPA AP-42 Chapter 2.4 equations 4 and 6.

(3) Emission estimates obtained from landfill gas collection efficiency, combustion efficiency, and LandGEM generated emissions. The total emission rates for these estimates are split across all flares.

(3) Non combusted methane emissions were taken from the LandGEM generated emissions and a combustion efficiency of 96.5% equivalent to a destruction efficiency

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Table 5-3
Estimated Landfill Footprint Emissions - Post Closure

Landfill	LandGEM Contaminant	Source ID	Fugitive Emissions (kg/year)	Contaminant	CAS No.	Total Emission Rate (OU/s or g/s)
Old Landfill	Carbon Dioxide Methane	S9	6.10E+06 2.72E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.94E+02 8.62E+01
West Landfill	Carbon Dioxide Methane	S10	5.54E+06 2.50E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.76E+02 7.92E+01
South Landfill	Carbon Dioxide Methane	S11	3.23E+06 1.46E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.03E+02 4.62E+01
South Landfill Expansion	Carbon Dioxide Methane	S12	5.55E+06 2.50E+06	Carbon Dioxide Methane	124-38-9 74-82-8	1.76E+02 7.94E+01
West Landfill Expansion	Carbon Dioxide Methane	S13	1.33E+07 5.99E+06	Carbon Dioxide Methane	124-38-9 74-82-8	4.21E+02 1.90E+02

Notes:
(1) Screening level taken from Interim Guide to Estimate and Assess Landfill Air Impacts (MECP, 1992).