December 2022 / Rev February 2023

Volume 1

Environmental Assessment of the Township of North Dundas Waste Management Plan

9.0 Description of the Environment Potentially Affected for Landfill Expansion

This section presents an overview of existing environmental conditions on and in the area of the Boyne Road Landfill.

9.1 Atmosphere

This section of the EASR provides a summary of the existing environment conditions for air quality (including odour) and noise in the Site-vicinity Study Area, as described in Sections 9.1.1 and 9.1.2, respectively.

9.1.1 Air Quality

9.1.1.1 Methodology

The general approach used for assessing the atmospheric effects of the proposed landfill expansion, and documented in this assessment, supports the philosophy of the EA as a planning and decision-making process and conforms to the general methodology presented in the approved ToR. The specific study methods that will be used in the assessment of effects are described in the following sections and were summarized in Section 8.2.

9.1.1.2 Study Area

For the purposes of assessing air quality, odour and GHG; the study areas are defined in Section 8.1. Air (health-related compounds) and dust emissions are required to meet provincial requirements at and beyond the landfill site boundary. Provincial odour guidelines apply to off-site sensitive receptors. Odour emissions may travel further than 500 m, but any effects are expected to be within 1.5 km of the Site Study Area.

The locations of the closest sensitive receptors in all wind directions have been identified and reviewed for inclusion in the air quality assessment. Sensitive receptor locations were identified using the MECP definition in section 30(8) of *O.Reg.* 419/05 (Ontario, 2005) and the definition of “human receptors” in MECP guidance document “Methodology for Modeling Assessments of Contaminants with 10 Minute Average Standards and Guidelines under *O. Reg.* 419/05” (MECP, 2016). Specifically, locations where “human activities regularly occur” or that meet any of the following definitions:

- a health care facility
- a senior citizens’ residence or long-term care facility
- a child care facility
- an educational facility
- a dwelling
- a place where discharges of a contaminant may cause a risk to human health

The MECP released draft odour guidance for comment in May 2021; however, at the time of preparing this EA, this guidance has not been finalized and is therefore not considered in this study.

Sensitive receptors included in the air quality and odour assessment are illustrated on Figure 9-1. The majority of the red existing sensitive receptors identified are dwellings.

9.1.1.3 Timeframe

The air quality and odour assessments focus on the operations phase of the proposed landfill expansion.

During the post-closure phase, the only anticipated activities potentially related to emissions to the air are landfill gas, site performance monitoring, and maintenance. Once the landfill operational activities have ceased, a final landfill cover will be in place; therefore, the overall emissions from the landfill during the post-closure phase will be less than during the operational phase.

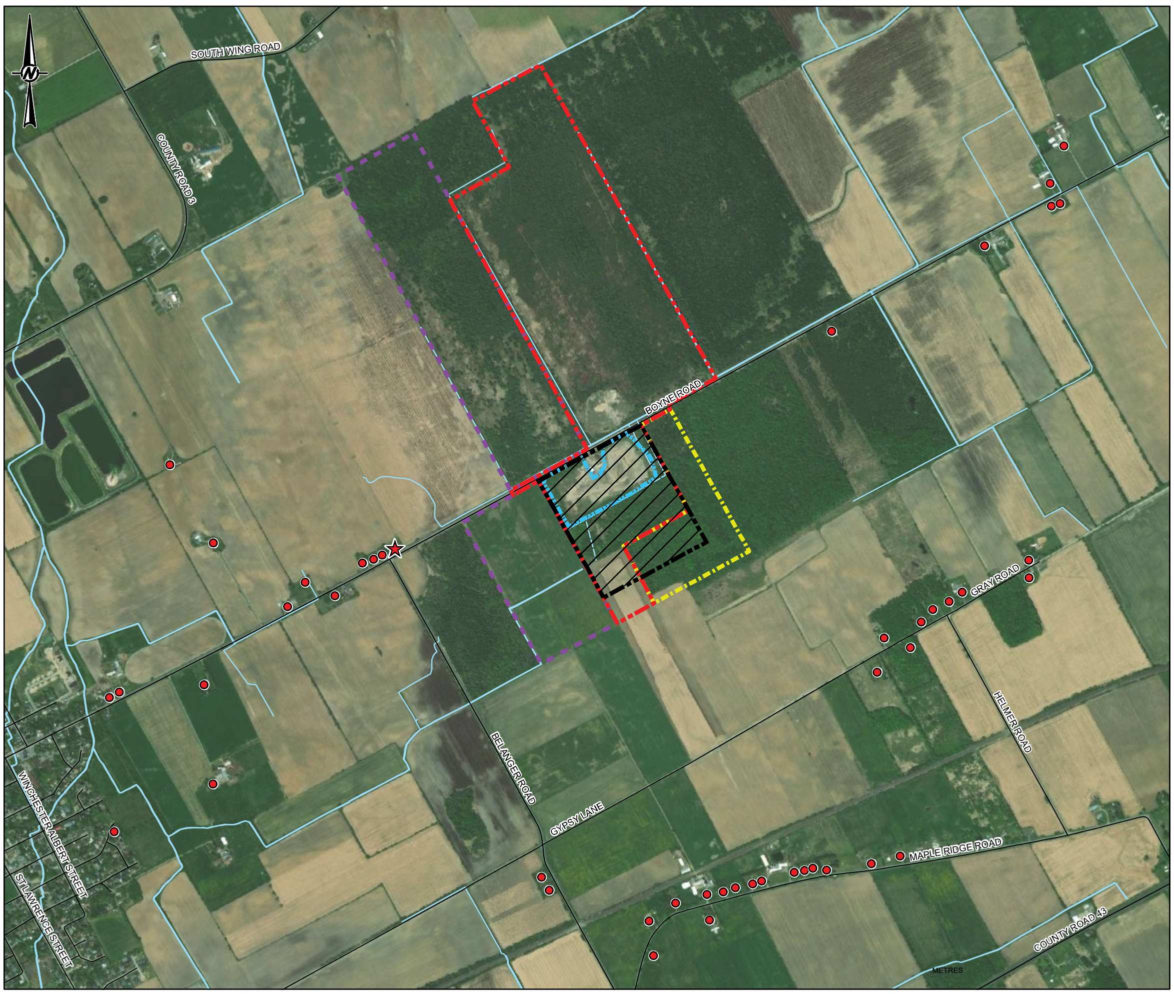
9.1.1.4 Air Quality Indicator Compounds

The assessment of air quality focuses on predicting changes in the concentrations of indicator compounds. These indicator compounds represent compounds that are typically emitted from landfills, have the highest potential to cause adverse and/or non-mitigatable effects, and for which air quality criteria exist:

- **Particulate matter**: SPM, PM_{10}, and $PM_{2.5}$
- **Combustion gases**: NO_X represented by nitrogen dioxide (NO_2), SO_2, and CO
- **Other Indicator Compounds**: H_2S, C_2H_3Cl, odour (expressed as whole odour (OU/m^3))

These compounds are associated with various landfill operations. Particulate matter is typically associated with airborne dust from vehicles travelling on on-site roads and unpaved roads/haul routes, as well as material loading and unloading activities. Products of combustion (NO_2, SO_2 and CO) are associated with the exhaust from on-site vehicles. Emissions of hydrogen sulphide and vinyl chloride are the result of breakdown of waste material within the landfill. To identify potential impacts to air quality, the predicted air quality concentrations resulting from the proposed undertaking will be compared to existing ambient air quality objectives and criteria limits for the above compounds.

Ozone (O_3) has been identified as an indicator for the proposed landfill expansion even though it will not be directly emitted as a result of the landfill expansion works and activities; however, it will be used to calculate NO_2 in the effects assessment. Ozone is not emitted directly into atmosphere but is associated with the reaction of NO_X and Volatile Organic Compounds (VOCs) (MECP, 2018c).



LEGEND

RECEPTORS

- EXISTING
- RECEPTOR WITH HIGHEST PREDICTED MAXIMUM CONCENTRATION
- INTERMITTENT WATERCOURSE
- WATERCOURSE
- ROADWAY
- APPROXIMATE PROPERTY BOUNDARY OF LANDFILL SITE
- EXISTING LANDFILL FILL AREA
- TOWNSHIP OWNED PROPERTY
- APPROXIMATE BOUNDARY OF CONTAMINANT ATTENUATION ZONE
- SITE STUDY AREA

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

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1:15,000 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
AIR SENSITIVE RECEPTORS

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-02-03
DESIGNED	PLE
PREPARED	JEM
REVIEWED	YJM
APPROVED	PLE

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.1.2	0	**9-1**

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25mm

Whole odour, represented as an odour threshold value and described as “odour units” (OU/m^3), is the primary method used in Ontario to quantify the presence of odorous compounds in air. The concentration of whole odour can be measured at a facility and evaluated through the use of an odour panel. The panel is exposed to the odorant at various dilution thresholds. Due to the variability in human perception of odour, the point at which 50 percent of the panel can detect the odour is used as the threshold odour concentration. An odour unit (OU) is the number of dilutions required to reduce the odour to its detection threshold and is the emission variable used in dispersion modelling.

An odour concentration (as an OU) is not an indicator of the offensiveness of a particular odour. Offensiveness is a subjective factor that varies by individual, thus will not be considered.

9.1.1.5 Applicable Guidelines

The relevant air quality criteria to be used for screening the air quality effects of the landfill expansion are Ontario criteria and federal standards and objectives where provincial guidelines are not available. The MECP has set guidelines related to ambient air concentrations that are summarized in *Ontario’s Ambient Air Quality Criteria* (AAQC) document (MECP, 2020b). The Ontario AAQCs are characterized as desirable ambient air concentrations and they are an indicator of good quality in an area. They are not regulatory limits and therefore can be exceeded. The Ontario AAQCs are used for screening the air quality effects in environmental assessments, for studies using ambient air monitoring data, and for assessment of general air quality in a community or across the province (MECP, 2020b).

There are two sets of federal objectives and criteria: the National Ambient Air Quality Objectives (NAAQOs) and the Canadian Ambient Air Quality Standards (CAAQSs) (formerly National Ambient Air Quality Standards). Similar to the Ontario AAQCs, the NAAQOs are benchmarks that can be used to facilitate air quality management on a regional scale and provide goals for outdoor air quality that protect public health, the environment, or aesthetic properties of the environment (CCME, 1999). The federal government has established the following levels of NAAQOs (Health Canada, 1994):

- The maximum ***Desirable*** level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for unpolluted parts of the country and for the continuing development of control technology.
- The maximum ***Acceptable*** level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.

The CAAQSs have been developed under the *Canadian Environmental Protection Act, 1999*, and include standards for $PM_{2.5}$, NO_2, SO_2 and ozone that must be achieved by 2020 (Government of Canada, 2013). Like the Ontario AAQCs, the CAAQSs are not regulatory limits and are used as national targets for $PM_{2.5}$, NO_2, SO_2 and ozone, excluding Quebec (CCME, 2014). These more stringent standards were adopted because, as stated by the CCME (emphasis added):

> *Canadians living in heavily populated and industrialized areas of the country may be exposed to potentially harmful levels of outdoor air pollutants, at concentrations that exceeded established standards.* (CCME 2014)

However, the key aspect of “CAAQS Achievement” (i.e., compliance), as stated by the CCME, is (emphasis added):

> *Achievement of the CAAQS means that the measured air pollutant concentration in an air zone does not exceed the CAAQS numerical value.* (CCME 2014)

These values are reported based on a series of monitoring stations located in airsheds across Canada and, in this context, an “air zone” refers to a local or regional sub-region of the established provincial or territorial airsheds. Currently, Southern Ontario and Southern Quebec are treated as a single Airshed (East Central) and Southern Ontario, excluding Hamilton and Sarnia, is designated as a single air zone.

For conservatism in this assessment, the lower of the Ontario AAQCs and the CAAQS, where applicable, will be used for comparison to the maximum modelled concentrations. However, comparing the maximum predicted concentrations to the CAAQS standards is not appropriate for the following reasons:

- Neither the Site Study Area nor the Site-vicinity Study Area represent an “air zone”, the region over which the CCME states that achievement of the CAAQS is to be evaluated / compared.
- There are not heavily populated or industrialized areas located within the Site-vicinity Study Area. Therefore, there is no exposure pathway by which:
  - *Canadians living in heavily populated and industrialized areas of the country may be exposed to potentially harmful levels of outdoor air pollutants, at concentrations that exceeded established standards.* (CCME, 2014).

A summary of the applicable Ontario and federal objectives and criteria are listed in Table 9-1.

Table 9-1: Relevant Ambient Air Quality Criteria for Indicator Compounds

Substance	Averaging Period	Ontario Ambient Air Quality Guidelines[a] (micrograms per cubic metre ($\mu g/m^3$))	Canadian Ambient Air Quality Standards[b] ($\mu g/m^3$)	Desirable National Ambient Air Quality Standards and Objectives[c] ($\mu g/m^3$)	Acceptable National Ambient Air Quality Standards and Objectives[c] ($\mu g/m^3$)	Criteria ($\mu g/m^3$)
SPM[d]	24-Hour	**120**	—	—	120	120
	Annual	**60**[e]	—	60	70	60
PM_{10}	24-Hour	**50**[f]	—	—	—	50
$PM_{2.5}$	24-Hour	27[g]	**27**[g]	—	—	27
	Annual	8.8	**8.8**	—	—	8.8
NO_2	1-Hour	**400**[h]	**79**[i]	—	400	400/79
	24-Hour	**200**[h]	—	—	200	200
	Annual	—	**22.5** [i]	**60**	100	22.5/60
SO_2	10 Minute	**180**	**—**	**—**	**—**	180
	1-Hour	**100**	170[j]	450	900	100
	24-Hour	**—**	—	**150**	300	150
	Annual	**10**	10.5[j]	30	60	10
CO	1-Hour	36,200	—	**15,000**	35,000	15000
	8-Hour	15,700	—	**6,000**	15,000	6000
O_3	1-Hour	**165**	—	100	160	165
	8-Hour	—	**118**	—	—	118

Substance	Averaging Period	Ontario Ambient Air Quality Guidelines[(a)] (micrograms per cubic metre (µg/m³))	Canadian Ambient Air Quality Standards[(b)] (µg/m³)	Desirable National Ambient Air Quality Standards and Objectives[(c)] (µg/m³)	Acceptable National Ambient Air Quality Standards and Objectives[(c)] (µg/m³)	Criteria (µg/m³)
H_2S	10 Minute	**13**	—	—	—	13
	24-Hour	**7**	—	—	—	7
Vinyl Chloride	24-Hour	**1**	—	—	—	1
	Annual	**0.2**	—	—	—	0.2

Notes:
(a) MECP (2020)
(b) CAAQS published in the Canada Gazette Volume 147, No. 21 - May 25, 2013. Final standard phase in date of 2020 used (CCME, 2014).
(c) CCME (1999).
(d) SPM in Ontario is defined as Suspended Particulate Matter (<44 µm diameter).
(e) Geometric mean.
(f) Interim AAQC and is provided as a guide for decision making (MECP, 2020b)
(g) Compliance is based on the 98th percentile of the annual monitored data averaged over three years of measurements.
(h) Standard is for NO_X but is based on the health effects of NO_2.
(i) Canadian ambient air quality standard for NO_2 is effective from 2025. The 1-hour standard is based on the three-year average of the 98th percentile of the daily maximum 1-hour average concentration.
(j) Canadian ambient air quality standard for SO_2 is effective from 2025. The 1-hour standard is based on the three-year average of the 98th percentile of the daily maximum 1-hour average concentration.

Bolded values represent the criteria to be used in the assessment.

For odour, the MECP uses a guideline of 1 odour unit (OU/m³) based on the 99.5 percentile on a 10-minute time averaging period to assess the potential for nuisance. One OU/m³ is the concentration at which 50% of the population can perceive an odour; therefore, 1 OU/m³ is typically used as an indicator for the likelihood of nuisance.

9.1.1.6 Existing Conditions

The background air quality represents the existing conditions before the proposed landfill expansion. Sources may include industrial facilities, roadways, long range transboundary air pollution, small regional sources and large industrial sources. The existing landfill emission sources may also contribute to the local air quality. The emissions sources for the existing landfill will be characterized as part of the impact assessment of this EA (in Section 13.1) for comparison to the landfill expansion impacts.

The existing air quality was characterized using publicly available monitoring station data. Field studies were not undertaken to characterize the existing air quality. Adequate data was available from existing sources to characterize regional air quality and was used to describe background air quality within the Site-vicinity Study Area; however, it may not accurately describe the local variations in concentrations that will result from emissions from existing sources at the Boyne Road landfill site. As discussed above, these emissions will be modelled in Section13.1.

9.1.1.6.1 Air Quality Monitoring Data

Background air quality was characterized using observations from the Environment and Climate Change Canada (ECCC) National Air Pollution Surveillance Network (NAPS) air quality monitoring stations (ECCC, 2019). The closest air quality monitoring station is located at 960 Carling Avenue in Ottawa, Ontario (Ottawa Central Station). Two other NAPS air quality monitoring stations were selected, Bedford and Third Street in Cornwall, Ontario (Memorial Park Cornwall Station), and 1128 de la Guerre in Saint-Anicet, Quebec (Saint-Anicet Station). The locations of these monitoring stations are indicated on Figure 5-1.

The proposed landfill expansion is located in a rural location. A wind-rose for the area is provided in Volume 2 Appendix B-1 and indicates that the predominant wind direction is from the west-northwest.

The Ottawa Central (NAPS ID 60106) is one of the closest NAPS station to the proposed landfill expansion (approximately 45 km north-northwest), so it is expected that the area of the Boyne Road Landfill will experience similar wind patterns and impacts from regional transport of compounds as this station; as such, as noted in Section 5.2, this station is located in a more urban setting and would therefore be impacted by local sources that are less typical of a rural environment. All air quality indicator compounds with the exception of CO, SO_2, and vinyl chloride are monitored at this station.

The Memorial Park Cornwall NAPS station (61201) located approximately 47 km away to the east-southeast was selected due to Cornwall's proximity to North Dundas; however, as noted in Section 5.2, this station is located in a more urban setting and would therefore be impacted by local sources that are less typical of a rural environment. All air quality indicator compounds with the exception of CO and SO_2 are monitored at this station.

The Saint-Anicet NAPS station (54401) station located approximately 76 km away was selected due to the similar rural land use and proximity to the Great Lakes/Highway 401 corridor as the proposed landfill expansion. All air quality indicator compounds are monitored at this station; however, particulate is only available for two years.

There is no monitoring data available for SPM and PM_{10}; however, the background SPM and PM_{10} concentrations can be estimated from the available $PM_{2.5}$ monitoring results. $PM_{2.5}$ is a subset of PM_{10}, and PM_{10} is a subset of SPM. Therefore, it is reasonable to assume that the ambient concentrations of SPM will be greater than corresponding PM_{10} levels, and PM_{10} concentrations will be greater than the corresponding levels of $PM_{2.5}$. The mean levels of $PM_{2.5}$ in Canadian locations are found to be about 54% of the PM_{10} concentrations and about 30% of the SPM concentrations (Lall et al., 2004). By applying this ratio, it is possible to estimate the background SPM and PM_{10} concentrations for the study area of interest.

Hydrogen sulphide is not measured at any of the above three stations; therefore, the 1-hour background concentration was taken from the ECCC's draft screening Assessment for H_2S (ECCC, 2017) and converted to the relevant averaging periods using MECP recommended methodologies in the *Air Dispersion Modelling Guideline for Ontario* (MECP, 2017)

Background air quality data was primarily taken from the Saint-Anicet Station as this is the most representative station closest to the Site Study Area. A copy of the full Background air quality study is included as Volume 2 Appendix B-1.

The background air quality is provided in Table 9-2 and compared to the air quality criteria identified in Section 9.1.1.5. All background concentrations to be used in the assessment are below the relevant air quality criteria.

Table 9-2: Background Air Quality

Indicator	Averaging Period	Air Quality Criteria (µg/m³)	Background Concentrations (µg/m³)	Percentage of Air Quality Criteria (%)
SPM	24-hour	120	38.58	32.15%
SPM	Annual	60	21.50	35.83%
PM_{10}	24-hour	50	21.44	42.87%
$PM_{2.5}$	24-hour	27	11.58	42.87%
$PM_{2.5}$	Annual	8.8	6.45	73.29%
NO_2	1-Hour	400 / 79	9.40	2.35%/11.91%
NO_2	24-Hour	200	8.91	4.46%
NO_2	Annual	32	4.93	15.42%
SO_2	10-min	180	4.32	2.40%
SO_2	1-Hour	100	2.62	2.62%
SO_2	24-Hour	150	3.06	2.04%
SO_2	Annual	10	1.12	11.25%
CO	1-Hour	15,000	343.57	2.29%

Indicator	Averaging Period	Air Quality Criteria (µg/m³)	Background Concentrations (µg/m³)	Percentage of Air Quality Criteria (%)
CO	8-Hour	6,000	343.57	5.73%
O_3	1-Hour	165	84.39	51.14%
O_3	8-Hour	123.6	91.25	73.83%
H_2S	10-min	13	0.84	6.46%
H_2S	24-hour	7	0.21	3.00%
Vinyl Chloride	24-Hour	1	0.0038	0.38%
Vinyl Chloride	Annual	0.2	0.0015	0.76%

9.1.1.6.2 Review of Existing Odour Complaints Data

Odour complaints may occur from nearby residents of a landfill. As of the date of this report, the Boyne Road Landfill has not received an odour complaint related to its operations.

9.1.2 Noise

The following methodology was carried out to characterize the existing acoustic environment:

- Identification of Study Areas including noise sensitive receptors
- Determination of applicable noise criteria
- Determination of existing ambient noise levels without the Boyne Road Landfill in the vicinity of the Boyne Road Landfill and along the Haul Routes

This sub-section presents a characterization of the existing acoustic environment. The characterization of the existing environment serves as the baseline condition for which the potential noise impacts of the Boyne Road Landfill proposed expansion will be assessed.

The methodology used for the noise assessment was based on the MECP publications *"Noise Guidelines for Landfill Sites"* (Landfill Guidelines) (MECP, 1998) and *"Environmental Noise Guideline Stationary and Transportation Sources – Approval and Planning Publication NPC-300"* (NPC-300) (MECP, 2013). These guidelines outline the sound level limit criteria for evaluating landfilling operations and ancillary facilities (i.e., stationary noise sources). A description of key noise concepts is presented in Volume 2 Appendix C-1.

9.1.2.1 Point(s) of Reception

Points of Reception (POR(s)) were identified for the noise assessment within the Site-vicinity Study Area defined for noise. A desktop review was completed using orthoimagery, readily available public information and information provided by the Township to identify potential PORs in the vicinity of the Boyne Road Landfill where human activity is expected to occur. PORs were identified in general accordance with NPC-300. NPC-300 defines PORs as sensitive land uses with human activity, including dwellings, campsites or campgrounds, sensitive institutional uses (e.g., educational, nursery, hospital, healthcare, community centre, place of worship, or detention centre), or sensitive commercial uses (e.g., hotel or motel).

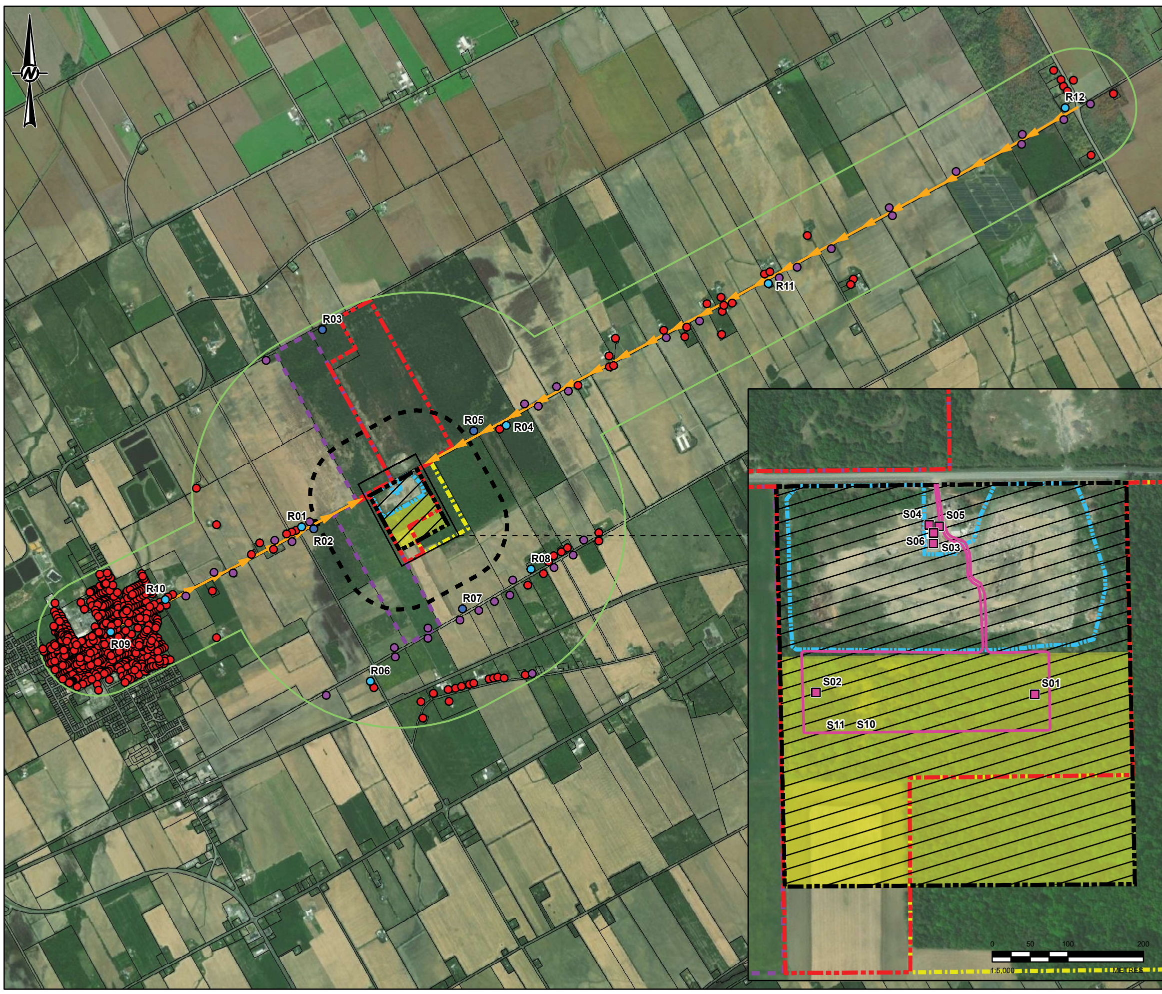
Existing PORs are located in all directions from the Boyne Road Landfill with the greatest concentration of existing PORs located approximately 2 km west of the Boyne Road Landfill in the Village of Winchester. There are accessible vacant lands located in the vicinity of the Landfill and therefore, in accordance with NPC-300, these were identified as vacant PORs. Existing and vacant PORs were identified for the noise assessment within the Site-vicinity Study Area defined for noise. It is noted that the Village of Winchester is more than 2000 m from the Landfill but within 500 m of the Haul Route. The following are key aspects regarding the land use and identification of noise sensitive PORs:

- Most lands within the Site-vicinity Study Area defined for noise are zoned as “Rural District” according to the Township’s Official Plan. This land use designation allows for noise sensitive uses.
- The Township currently follows the United Counties of Stormont, Dundas, and Glengarry Official Plan (the Official Plan) (SDG, 2018). The Official Plan states “*Development within 500 metres of an existing waste management system shall generally be discouraged unless supported by an appropriate study or studies which confirm that there will be no negative impacts on the proposed development related to current uses/activities associated with the normal operation of the waste management system*.” The Township will be revisiting their zoning bylaws in 2022, designating a minimum separation distance of 500 m between the Boyne Road Landfill property boundary and noise sensitive land uses as defined in NPC-300 (Landfill 500 m Buffer Zone). In the interim, the Township has adopted this condition.
- The land directly adjacent and to the east of the Landfill is owned by the Township and is vacant. The Township will not permit noise sensitive land uses on these lands even though zoned as “Rural District” since they are within the Landfill 500 m Buffer Zone.
- There are vacant lands located to the northwest, west and southwest identified as CAZ. These lands are not owned by the Township, but the Township has control over the groundwater rights through easement agreements; as such, a water supply well cannot be drilled on these lands. With the absence of a municipal water source, this CAZ eliminates the potential for development on these vacant lands for a noise sensitive use. Therefore, the Township will not permit noise sensitive land uses on these CAZ vacant lands since potable water supply is not permitted and they are within the Landfill 500 m Buffer Zone.
- As per NPC-300, noise levels are to be predicted for both existing and vacant PORs that do not meet the interim zoning requirement above (i.e., within the Landfill 500 m Buffer Zone). The Township provided a letter to the MECP providing assurances that the Township has adopted the interim zoning requirement. A copy of the letter to the MECP is provided in Volume 2 Appendix C-2.

Figure 9-2 presents all of the PORs that were identified within the Site-vicinity Study Area and Haul Routes. The most sensitive of these PORs, in all directions from the Site and Haul Route, were carried forward in the assessment to capture the greatest potential impacts. A total of 12 of the identified PORs were selected as being representative of the most sensitive PORs in the Site-vicinity Study Area with respect to the Boyne Road Landfill for further assessment, which are summarized in Table 9-3. Representative PORs were not identified within the Landfill 500 m Buffer Zone.

Table 9-3: Summary of Noise Assessment Representative Points of Reception Locations

Point of Reception ID	Description	UTM Coordinates (NAD83, Zone 18T)
R01	Residence 700 m west of the Boyne Road Landfill and 30 m from the Haul Route	396756 mE 4996343 mN
R02	Vacant lot 500 m west of the Boyne Road Landfill and along the Haul Route	396857 mE 4996327 mN
R03	Vacant lot 1400 m north of the Boyne Road Landfill	396933 mE 4998014 mN
R04	Residence 850 m east of the Boyne Road Landfill and 50 m from the Haul Route	398490 mE 4997203 mN
R05	Vacant lot 900 m east of the Boyne Road Landfill and along the Haul Route	398215 mE 4997156 mN
R06	Residence 1250 m southwest of the Boyne Road Landfill	397339 mE 4995038 mN
R07	Vacant lot 900 m south of the Boyne Road Landfill	398119 mE 4995650 mN
R08	Residence 1150 m southeast of the Boyne Road Landfill	398699 mE 4995987 mN
R09	Residence 2500 m west of the Boyne Road Landfill and 20 m from the Haul Route	395138 mE 4995456 mN
R10	Residence 1950 m west of the Boyne Road Landfill and 20 m from the Haul Route	395603 mE 4995729 mN
R11	Residence 3350 m east of the Boyne Road Landfill and 40 m from the Haul Route	400708 mE 4998402 mN
R12	Residence 6300 m east of the Boyne Road Landfill and 45 m from the Haul Route	403222 mE 4999890 mN



LEGEND

RECEPTORS

- EXISTING
- VACANT
- REPRESENTATIVE - EXISTING
- REPRESENTATIVE - VACANT
- NOISE SOURCE
- NOISE SOURCE
- HAUL ROUTES (NOISE STUDY AREA)
- LOT BOUNDARY
- PROPOSED LANDFILL EXPANSION AREA
- NOISE SITE-VICINITY STUDY AREA
- APPROXIMATE PROPERTY BOUNDARY OF LANDFILL SITE
- EXISTING LANDFILL FILL AREA
- TOWNSHIP OWNED PROPERTY
- CONTAMINANT ATTENUATION ZONE
- SITE STUDY AREA
- 500 m AROUND PROPERTY ZONED FOR WASTE DISPOSAL

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
2. SERVICE LAYER CREDITS: SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

0 400 800 1,600

1:32,000 METRES

CLIENT

TOWNSHIP OF NORTH DUNDAS

PROJECT

INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE

NOISE ASSESSMENT – EXISTING CONDITIONS AND IMPACT ASSESSMENT

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-02-14
DESIGNED	PLE
PREPARED	JEM/MG
REVIEWED	YJM
APPROVED	PLE

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	**9-2**

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9.1.2.2 Noise Criteria

The Landfill Guidelines and NPC-300 outline the sound level limit criteria for evaluating landfilling operations and ancillary facilities (i.e., stationary noise sources), respectively.

The noise assessment was carried out at the representative PORs identified within the Site-vicinity Study Area, as discussed in Section 9.1.2.1. All representative PORs identified in this noise assessment are conservatively described as being located in a Class 3 area, as defined in NPC-300 as a rural area with an acoustical environment that is generally dominated by natural sounds. Note, PORs within the Village of Winchester may be best identified in a Class 2 area, as defined in NPC-300, but in completing a conservative assessment, a Class 3 designation was applied for the purposes of the EA Study.

The sound level limits for the Boyne Road Landfill landfilling operations are established in the Landfill Guidelines as 55 decibels (dBA) and 45 dBA during the daytime period (i.e., 7:00 a.m. to 7:00 p.m.) and nighttime period (i.e., 7:00 p.m. to 07:00 a.m.) respectively.

The Landfill Guidelines also outline the protocol for evaluating off-site vehicle traffic (i.e., Haul Routes) for which there are no specific sound level limits. In accordance with the Landfill Guidelines, the potential noise impact of off-site vehicles on the existing noise environment is described qualitatively based on a quantitative assessment of the potential increase to the one hour equivalent sound level ($L_{eq,1hr}$), as described in Table 9-4.

Table 9-4: Landfill Guidelines Qualitative Noise Impact Ratings for Off-site Vehicles

Sound Level Increase (dB)	Qualitative Rating
1 to 3 inclusive	Insignificant
3 to 5 inclusive	Noticeable
5 to 10 inclusive	Significant
10 and over	Very significant

The sound level limits for the Boyne Road Landfill ancillary facilities are established in accordance with NPC-300 for the daytime (7:00 a.m. to 7:00 p.m.), evening (7:00 p.m. to 11:00 p.m.), and nighttime (11:00 p.m. to 7:00 a.m.) periods. In assessing steady sounds from stationary noise sources, the MECP has established exclusionary Plane of Window (POW) and outdoor sound level limits for Class 3 areas. The POW is typically assessed at the center of a window (i.e., for a two-storey home, typically it would be at a height of 4.5 m above grade). An outdoor location is assessed at a location within 30 m of a dwelling façade at a height of 1.5 m above grade and within the property of the dwelling. The POW sound level limit for the noise sensitive receptors in a Class 3 area is described as follows:

> *The sound level limit at a POW POR is set as the higher of either the applicable exclusionary limit of 45 dBA in the daytime period of 07:00-19:00, 40 dBA in the evening period of 19:00-23:00 and 40 dBA in the night-time period of 23:00-07:00, or the minimum background sound level that occurs or is likely to occur during the time period corresponding to the operation of the stationary source under impact assessment.*

The outdoor sound level limit for the noise sensitive receptors in a Class 3 area is described as follows:

> *The sound level limit at an outdoor POR is set as the higher of either the applicable exclusionary limit of 45 dBA in the daytime period of 07:00-19:00 and 40 dBA in the evening period of 19:00-23:00, or the minimum background sound level that occurs or is likely to occur during the time period corresponding to the operation of the stationary source under impact assessment. In general, the outdoor POR will be protected during the night-time as a consequence of meeting the sound level limit at the adjacent POW.*

Note that for vacant lands, the location of the POR was assessed in accordance with NPC-300; either at the centre of the vacant lot, or within a 1 hectare portion of the vacant lot located in a manner consistent with the existing zoning by-law and the typical building pattern in the area, at a height of 4.5 m above grade.

The $L_{eq,1hr}$ MECP exclusionary sound level limits for steady sounds from stationary noise sources at a POR in a Class 3 area are summarized in Table 9-5 and used to assess compliance of the Boyne Road Landfill. The potential noise levels at each of the existing residences were predicted at both the POW and outdoor POR, but only the results from the location with the highest levels (i.e., POW or outdoor) are shown in the result tables.

Table 9-5: Sound Level Limits for Class 3 Area – Steady Stationary Sources

Time Period	POW MECP Exclusionary Sound Level Limit ($L_{eq,1hr}$, dBA)	Outdoor MECP Exclusionary Sound Level Limit ($L_{eq,1hr}$, dBA)
	Class 3	Class 3
Daytime (7:00 a.m. – 7:00 p.m.)	45	45
Evening (7:00 p.m. – 11:00 p.m.)	40	40
Nighttime (11:00 p.m. – 7:00 a.m.)	40	not applicable

For impulsive sounds from a stationary source, measured in dBAI, the sound level limit at a POR expressed in terms of the Logarithmic Mean Impulse Sound Level (L_{LM}) is the higher of: the applicable exclusionary level limit given in Table 9-6 and Table 9-7 for the POW and outdoor POR, or the background sound level for that POR.

Table 9-6: Stationary Sources (Impulsive Sounds) – Exclusionary Sound Level Limit Values of Logarithmic Mean Impulse Sound Level (L_{LM}, dBAI) POW of Noise Sensitive Spaces

Actual Number of Impulses in Period of One-Hour	Class 1 Area (7:00 a.m.-11:00 p.m.)/ (11:00 p.m.-7:00 a.m.)	Class 2 Area (7:00 a.m.-11:00 p.m.)/ (11:00 p.m.-7:00 a.m.)	Class 3 Area (7:00 a.m.-11:00 p.m.)/ (11:00 p.m.-7:00 a.m.)	Class 4 Area (7:00 a.m.-11:00 p.m.)/ (11:00 p.m.-7:00 a.m.)
9 or more	50/45	50/45	45/40	60/55
7 to 8	55/50	55/50	50/45	65/60
5 to 6	60/55	60/55	55/50	70/65
4	65/60	65/60	60/55	75/70
3	70/65	70/65	65/60	80/75
2	75/70	75/70	70/65	85/80
1	80/75	80/75	75/70	90/85

Table 9-7: Stationary Sources (Impulsive Sounds) – Exclusionary Sound Level Limit Values of Logarithmic Mean Impulse Sound Level (L_{LM}, dBAI) Outdoor POR

Time of Day	Actual Number of Impulses in Period of One-Hour	Class 1 Area	Class 2 Area	Class 3 Area	Class 4 Area
7:00 a.m. – 11:00 p.m.	9 or more	50	50	45	60
	7 to 8	55	55	50	65
	5 to 6	60	60	55	70
	4	65	65	60	75
	3	70	70	65	80
	2	75	75	70	85
	1	80	80	75	90

Impulsive sounds from stationary noise sources are currently not expected at the Boyne Road Landfill. Administrative controls as part of the normal landfill site operations are expected to minimize any potential impulsive sounds (i.e., tailgate slamming, equipment driving over ruts in on-site roadways, movement of waste containers). Therefore, due to the inherent administrative controls, it is expected that impulsive noise will not be a substantial noise source on-site and, accordingly, was not further assessed.

9.1.2.3 Existing Noise Levels

9.1.2.3.1 Methodology

A desktop assessment was completed to; establish the existing conditions in the noise Site-vicinity Study Area and assess the potential impacts due to the Boyne Road Landfill. Existing noise levels in the Site-vicinity Study Area are influenced by human activities, vehicle traffic, existing landfill operations and sounds of nature.

For this noise assessment, the establishment of existing conditions focused on the expected existing noise levels along the off-site Haul Routes as required by the MECP. To establish the expected existing noise levels for the haul route assessment, the assessment of existing traffic along the Haul Routes, without the existing landfill traffic, was undertaken.

The noise predictions for road traffic along the Haul Routes were carried out using the MECP's Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT), which is the basis of the DOS-based STAMSON modelling software provided by the MECP. Road traffic was assessed over a one-hour period, corresponding to the time of the greatest predicted impact due to the Boyne Road Landfill.

Existing and anticipated Boyne Road Landfill noise levels due to road traffic were established using existing (2021) and future (2048, with and without the landfill) peak hour traffic provided in the Traffic Impact Study prepared for the Boyne Road Landfill (Sections 9.9 and 13.9). To assess the greatest predicted impact, an hourly background road traffic noise level is required during the hour when this occurs, which may differ from when the existing road traffic peak hour occurs. Therefore, the Annual Average Daily Traffic (AADT) is typically required to calculate hourly background road traffic volumes and respective noise levels. For the purposes of the noise assessment, it was assumed that peak hour traffic presented in the Traffic Impact Study is representative of 10% of the AADT, a generally accepted practice. The hourly traffic breakdown for existing traffic (in the absence of the existing landfill) was assumed using data provided in the US Environmental Protection Agency (US EPA) software Motor Vehicle Emissions Simulator. The medium and heavy truck percentages were assumed using the City of Ottawa's *Environmental Noise Control Guidelines* (City of Ottawa, 2016). Speed limits were provided in the Traffic Impact Study.

Based on information provided in the Traffic Impact Study, background road traffic volumes in the Site-vicinity Study Area are expected to grow faster than the expected Boyne Road Landfill traffic over the Township's waste management planning period (i.e., 25 years, from 2023 to 2048). Therefore, the year 2023 was considered for the noise assessment, where the expected change in noise levels due to Boyne Road Landfill traffic is expected to be greatest over background traffic levels. Existing Boyne Road Landfill traffic was removed from the existing (2021) traffic data based on guidance from the MECP for the purposes of this assessment. This is considered to be a conservative approach to the haul route analysis. The background 2023 traffic was calculated from the 2021 existing traffic (without the landfill traffic), considering the 15% COVID-19 adjustment and the 1% growth rate considered in the Traffic Impact Study. Peak hour Boyne Road Landfill traffic for 2023 was back-calculated from the projected 2048 peak hour traffic provided in the Traffic Impact Study, using the expected increase in Boyne Road Landfill traffic from 2023 to 2048 of 5.5%. It was assumed that the relative distribution of Boyne Road Landfill vehicles (i.e., percentage of cars/medium trucks/heavy trucks) will not change with the proposed expansion. Peak hour Boyne Road Landfill traffic was modelled for the hours between 8:00 a.m. and 10:00 a.m. and 2:00 p.m. and 4:00 p.m., based on information provided in the Traffic Impact Study. The road traffic modelling results, further discussed in Section 13.1.2. indicated the predictable worst case hour was from 2:00 p.m. to 3:00 p.m..

A summary of the road traffic data is provided in Table 9-8.

Table 9-8: Summary of 2023 Background and Boyne Road Landfill Road Traffic Data

Road Segment	Speed Limit (km/hr)	2023 Background Traffic (Without Landfill)			2023 Boyne Road Landfill Traffic	2023 Boyne Road Landfill Traffic
		AADT	% of AADT During Hour with Worst Case Impacts[1]	% Car / Medium Truck / Heavy Truck	Peak Hour Traffic	% Car / Medium Truck / Heavy Truck
Main Street between St. Lawrence Street and Ottawa Street	50	3860	6%	88 / 7 / 5	29	65 / 15 / 20
St. Lawrence Street South of Main Street	50	3512	6%	88 / 7 / 5	14	65 / 15 / 20
Boyne Road Between Ottawa Street and the Boyne Road Landfill	80	1056	6%	88 / 7 / 5	29	65 / 15 / 20
Boyne Road Between the Boyne Road Landfill and County Road 7	80	1056	6%	88 / 7 / 5	9	65 / 15 / 20
County Road 7 North of Boyne Road	80	1558	6%	88 / 7 / 5	1	65 / 15 / 20
County Road 7 South of Boyne Road	80	1750	6%	88 / 7 / 5	9	65 / 15 / 20

Notes: [1]Hour with worst case predicted noise impact due to the Boyne Road Landfill is the 2:00 p.m. to 3:00 p.m. hour, as described in Section 13.1.2

9.1.2.3.2 Results

As discussed in Section 9.1.2.3.1, existing noise levels in the Site-vicinity Study Area are influenced by human activities vehicle traffic, existing landfill operations and sounds of nature. As described in Section 9.1.2.2, the Site-vicinity Study Area is conservatively described as a Class 3 area. Existing conditions in the Site-vicinity Study Area are generally consistent with a Class 3 area, however based on the existing traffic volumes on specific roads in the area, it is expected that existing conditions near some roads may be elevated.

For this noise assessment, existing conditions were determined only for the haul route assessment as required by the MECP. Only representative PORs with existing noise sensitive land uses that were within 500 m of the Haul Routes were assessed.

Predicted 2023 road traffic noise levels without landfill traffic are presented in Table 9-9 for the predictable worst case hour (i.e., the hour when Boyne Road Landfill impacts are predicted to be the greatest).

Table 9-9: Predicted 2023 Haul Route Noise Levels Without Existing Landfill Traffic

Receptor	2023 One-Hour Road Traffic Noise Level – Without Existing Landfill Traffic (dBA)
R01	56
R04	52
R09	60
R10	58
R11	53
R12	54

Notes: Hour with worst case predicted noise impact due to the Boyne Road Landfill is the 2:00 p.m. to 3:00 p.m. hour, as described in Section 13.1.2

9.2 Geology and Hydrogeology

Numerous subsurface and hydrogeological investigations and groundwater monitoring programs have been completed at the Boyne Road Landfill since 1991, which has resulted in a thorough understanding of the geological and hydrogeological setting of the existing landfill. Landfill site conditions have been determined based on published resources and subsurface conditions encountered during borehole drilling programs, monitoring well installations in overburden and bedrock, in situ hydraulic conductivity testing, groundwater level measurements and groundwater sampling and analysis. An ongoing annual groundwater monitoring program has been completed at the landfill site since 1991. A plan of the Boyne Road Landfill site showing all borehole and monitoring well locations is provided on Figure 9-3.

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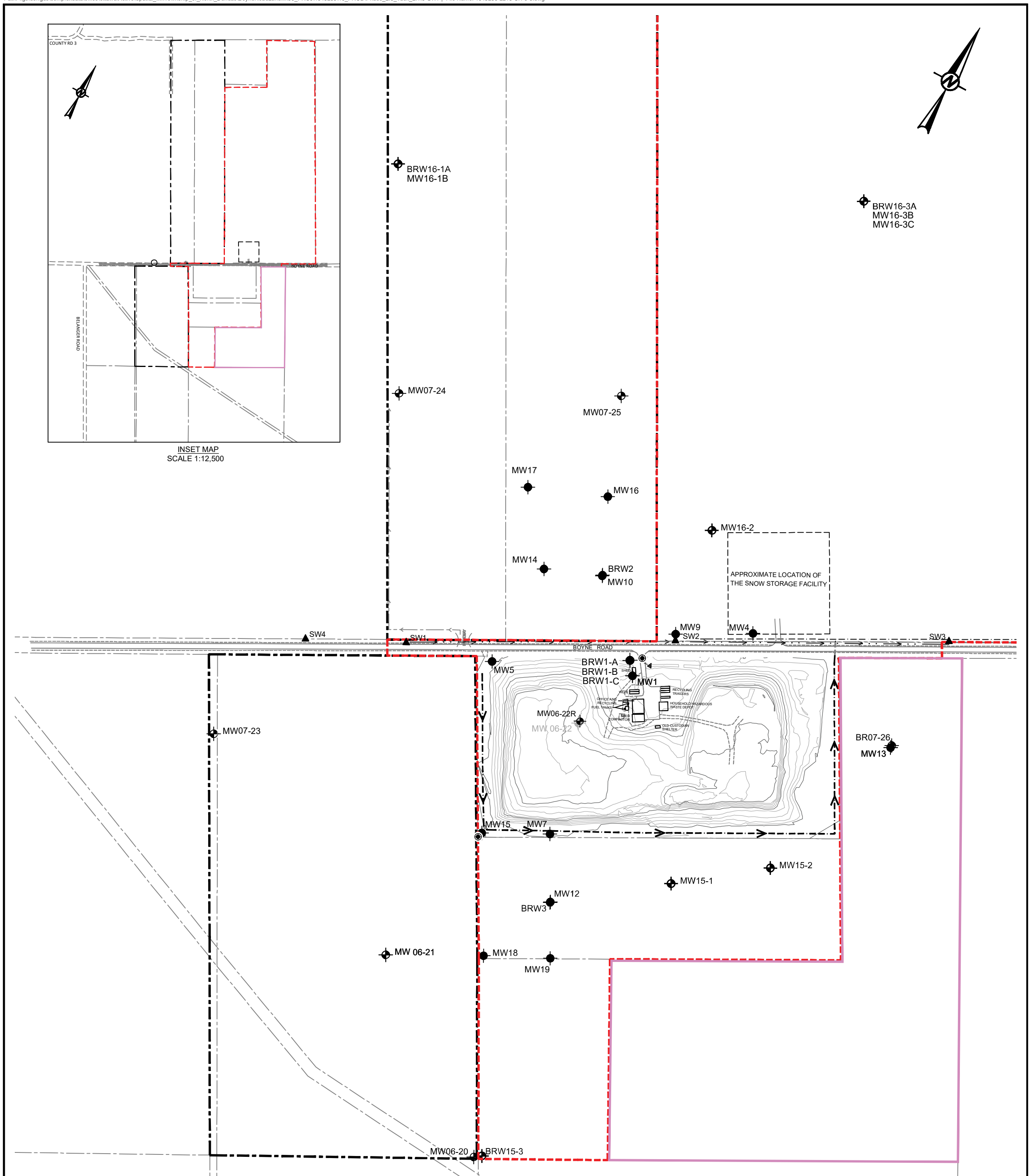


LEGEND

- DESTROYED MONITORING WELL NO LONGER IN USE
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY GOLDER ASSOCIATES LTD.
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY OTHERS
- APPROXIMATE SURFACE WATER SAMPLING LOCATION IN PLAN
- GEO-REFERENCING POINTS
- 85.0 GROUND SURFACE CONTOURS (M), BASED ON RESULTS OF THE SURVEYS CONDUCTED IN 2008, 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 AND 2020
- APPROXIMATE PROPERTY BOUNDARY OF LANDFILL SITE
- APPROXIMATE BOUNDARY OF CONTAMINANT ATTENUATION ZONE
- ADDITIONAL LAND OWNED BY TOWNSHIP
- APPROXIMATE LOCATION OF PERIMETER DITCH AND INFERRED FLOW DIRECTION
- INFERRED FLOW DIRECTION IN THE DRAINAGE DITCH ALONG BOYNE ROAD

NOTES

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY STANTEC CONSULTING LTD.
2. 2008 AND 2010 SURVEYS COMPLETED BY STANTEC CONSULTING LTD.
3. MAY 2012, JULY 2013, NOVEMBER 2014, DECEMBER 2015, NOVEMBER 2016, DECEMBER 2017, DECEMBER 2018 AND NOVEMBER 2019, APRIL 2020 AND DECEMBER 2020 SURVEYS COMPLETED BY GOLDER ASSOCIATES LTD.
4. COORDINATE SYSTEM: MTM ZONE 9 NAD83

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-31
PREPARED	ABD
DESIGN	RM
REVIEW	PS
APPROVED	PAS

TITLE
BOYNE LANDFILL SITE PLAN

PROJECT No.	PHASE/TASK	Rev.	FIGURE
1648253	2.0/2.2.0	0	9-3

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

9.2.1 Geology

9.2.1.1 Regional Geology

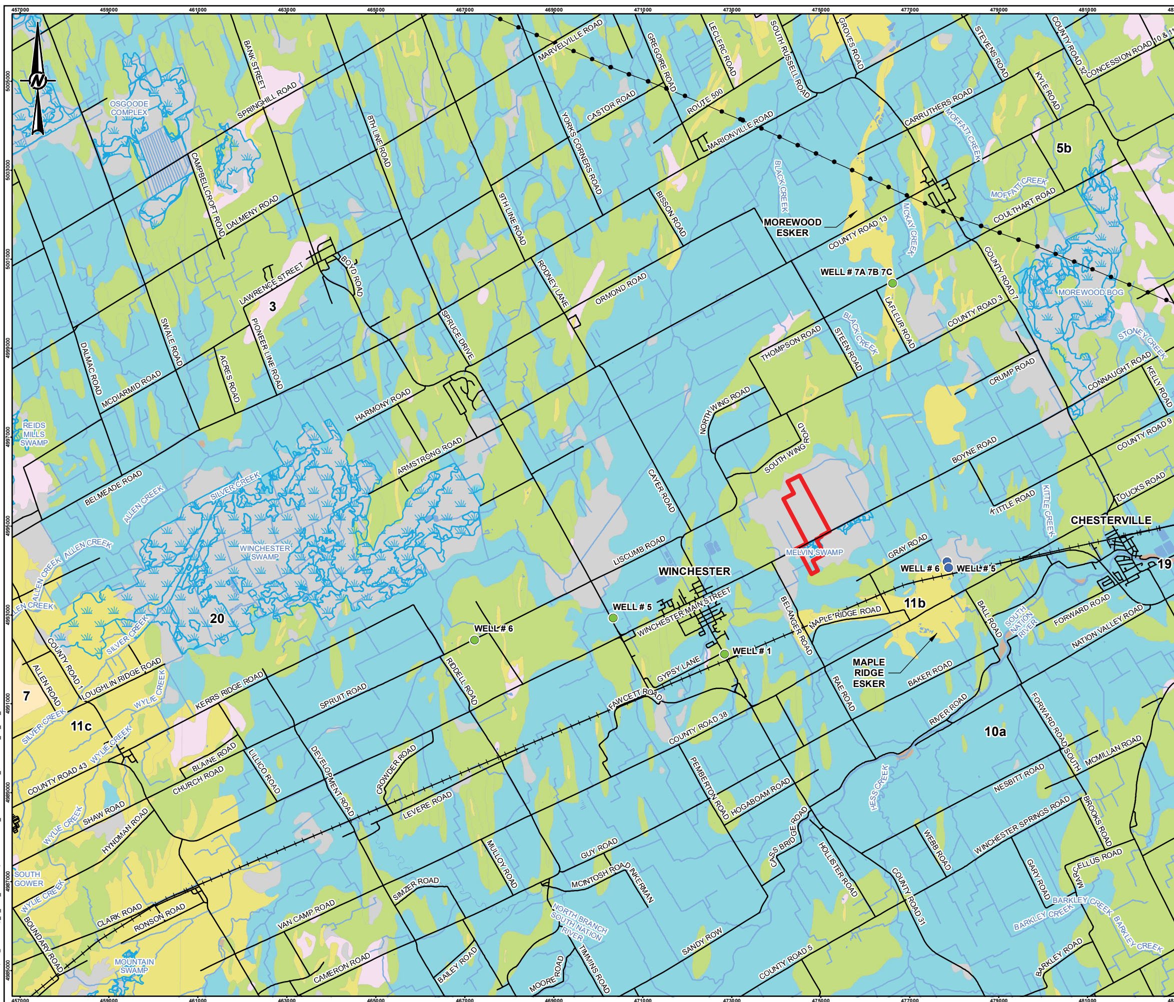
Published geological maps indicate that overburden in the area of the Boyne Road Landfill site consists of: organic deposits comprised primarily of peat; underlain by offshore marine deposits comprised of clay, silty clay, and silt; underlain by silty sand and sandy silt till (Geological Survey of Canada, 1982). The overburden geology in the Wider Study Area is shown on Figure 9-4. Published geological maps (refer to Figure 9-5) indicate that bedrock in the Wider Study Area consists mainly of limestone of the Bobcaygeon and Gull River Formations (Ontario Geological Survey, 2007; Ministry of Natural Resources, 1985).

The topography in the general area in which the Boyne Road Landfill site is situated is generally flat lying to undulating. Ground surface elevations in the Site Study Area typically range from approximately 73.5 to 75.0 masl, but have historically ranged from 71.41 to 77.69 masl since monitoring biannually began in 2005. The stratigraphic sequence is derived from recently deposited materials of glacial, glacio-fluvial and marine origins. Spatially the most dominant units consist of glacial tills and marine clays, with a thickness ranging between a few m to 20 m. The glacial tills in the Wider Study Area tend to be stony and sandy and are generally characterized as silty sands.

There are the occurrences of glacio-fluvial deposits within the Wider Study Area. These long and narrow ice-contact stratified drifts are north-south trending features comprised of well-sorted coarse sands and gravels that deposited in melt-water channels within glaciers that covered the area long ago. The most prominent features within the Wider Study Area are the Morewood Esker (part of the Vars-Winchester Esker Complex) and the Maple Ridge Esker, both of which are labelled on Figure 9-4. There is also the Loughlin Ridge located approximately 11 km west of Winchester.

The Vars-Winchester Esker has been the subject of investigations by the Geological Survey of Canada, using geophysical methods to locate and characterize the esker where it is not present at surface but is buried beneath marine clay deposits. These studies have been focused on sections of the Vars-Winchester esker in the Russell- Embrun area, north of the Morewood Esker section within the Township.

The Morewood Esker is a north-south linear feature that is some 7.5 km long by approximately 250 m wide at the surface (average subsurface width of the esker is ~800 m). The presence of the esker is reflected by topography and the position of a number of sand and gravel pits located along the esker. The esker material generally consists of a highly permeable and transmissive 100 to 200 m wide esker core of well sorted sand and gravel, cobbly gravels and sandy gravels. The core is flanked by finer soils, grading from sands to silts and clays. The esker is entrenched into the glacial till and its base is generally at or near the underlying bedrock surface; the sandy flanks of the esker area frequently overlain by marine clays. The surficial signature of the esker core is delineated in places by a small topographical ridge reworked by nearshore processes (former beach). Elsewhere the presence of the esker core is only inferred and may be discontinuous in places (Cummings and Russell, 2007; Golder, 1995 and 2003).



LEGEND

- CHESTERVILLE WELL LOCATION
- WINCHESTER WELL LOCATION
- ROADWAY
- RAILWAY
- UTILITY LINE
- WATERCOURSE
- WATERBODY
- WETLAND
- APPROXIMATE BOUNDARY OF BOYNE RD LANDFILL SITE

OGS SURFICIAL GEOLOGY

- 3. **PALEOZOIC BEDROCK**
- 5b. **TILL:** STONE-POOR, SANDY SILT TO SILTY SAND-TEXTURED TILL ON PALEOZOIC TERRAIN
- 7. **GLACIOFLUVIAL DEPOSITS:** RIVER DEPOSITS AND DELTA TOPSET FACIES
- 10a. **FINE-TEXTURED GLACIOMARINE DEPOSITS:** SILT AND CLAY, MINOR SAND AND GRAVEL; MASSIVE TO WELL LAMINATED
- 11b. **COARSE-TEXTURED GLACIOMARINE DEPOSITS:** SAND, GRAVEL, MINOR SILT AND CLAY; LITTORAL DEPOSITS
- 11c. **COARSE-TEXTURED GLACIOMARINE DEPOSITS:** SAND, GRAVEL, MINOR SILT AND CLAY; FORESHORE AND BASINAL DEPOSITS
- 19. **MODERN ALLUVIAL DEPOSITS:** DAY, SILT, SAND, GRAVEL, MAY CONTAIN ORGANIC REMAINS
- 20. **ORGANIC DEPOSITS:** PEAT, MUCK, MARL

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. ONTARIO GEOLOGICAL SURVEY 2010. SURFICIAL GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 128-REV
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2018
3. SERVICE LAYER CREDITS:
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 1,000 2,000 4,000
1:85,000 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

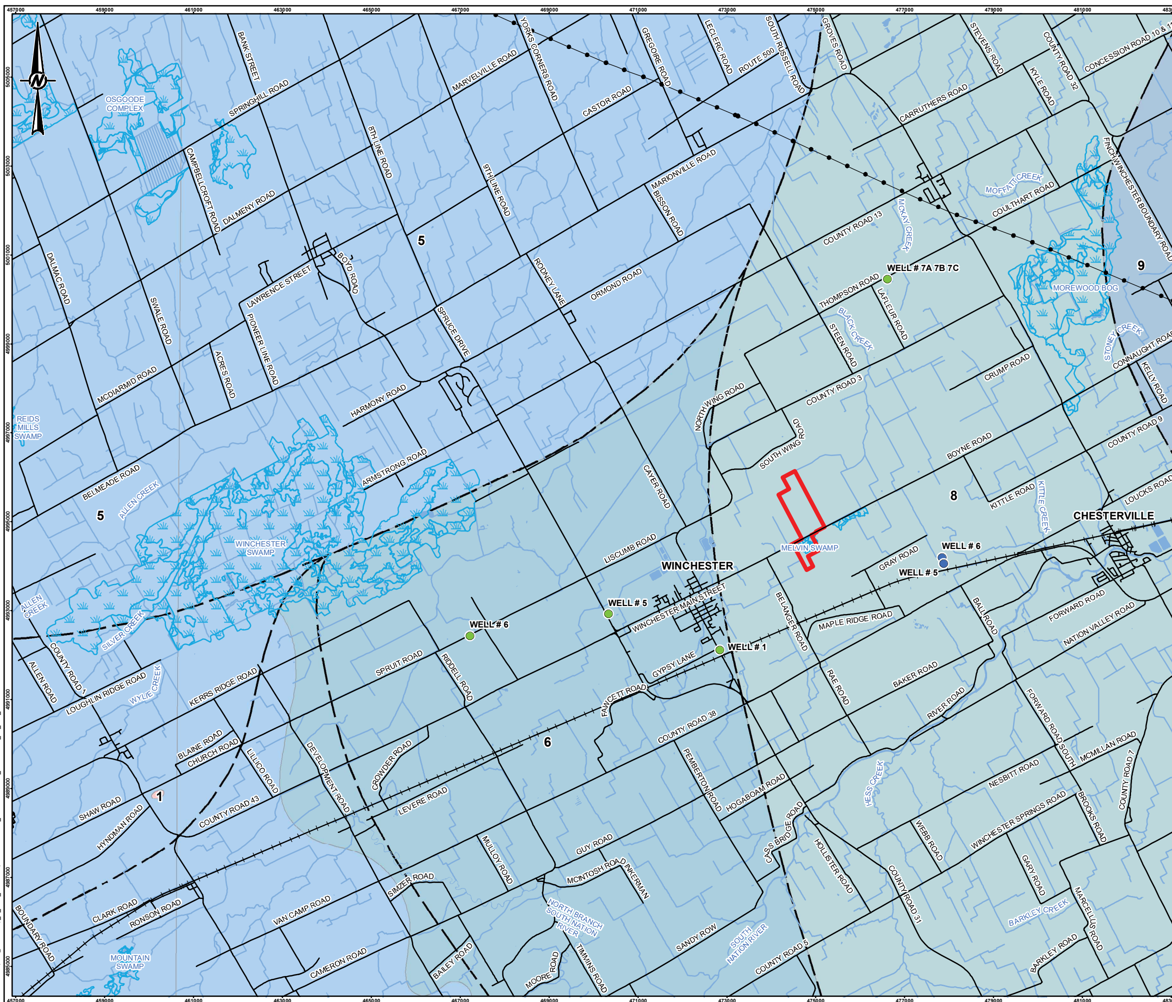
PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
SURFICIAL GEOLOGY

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-01-28
DESIGNED	----
PREPARED	BR
REVIEWED	BH
APPROVED	PAS

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	**9-4**



LEGEND

- CHESTERVILLE WELL LOCATION
- WINCHESTER WELL LOCATION
- ROADWAY
- RAILWAY
- UTILITY LINE
- WATERCOURSE
- WATERBODY
- WETLAND
- FAULT
- APPROXIMATE BOUNDARY OF BOYNE RD LANDFILL SITE

OGS BEDROCK GEOLOGY

- 9: BOBCAYGEON FORMATION - LIMESTONE, WITH MINOR SHALES IN UPPER PART
- 8: GULL RIVER FORMATION - LIMESTONE, WITH DOLOSTONE BEDS TOWARDS BASE
- 6: ROCKCLIFFE FORMATION - SANDSTONE, SHALE, LIMESTONE, DOLOSTONE
- 5: OXFORD FORMATION - DOLOSTONE, MINOR SHALE AND SANDSTONE
- 1: PRECAMBRIAN

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. ARMSTRONG, D.K. AND DODGE, J.E.P. 2007. PALEOZOIC GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE--DATA 219
2. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2018
3. SERVICE LAYER CREDITS:
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 1,000 2,000 4,000
1:85,000 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
BEDROCK GEOLOGY

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-01-28
DESIGNED	----
PREPARED	BR
REVIEWED	BH
APPROVED	PAS

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	**9-5**

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

The Maple Ridge Esker is comprised of an assortment of sand, gravel, clay, ice-contact stratified drift, and till, and has been referred to as a terminal moraine. This esker deposit is oriented east-west and its eastern end portion is located approximately 4 km west of Chesterville. Its surface expression is approximately 3 km in length and between 0.2 and 1.5 km wide. The core of the esker consists of coarse sand and gravel with gravel content increasing towards the north. In the southern portion of the esker, glacial till exists (Golder, 2003a). Several sand pits are present towards the east end of the Maple Ridge Esker.

As illustrated on Figure 9-4, there is no surficial feature reflecting the presence of the Vars-Winchester Esker in the intervening land area that extends 4 km north-south between the southern end of the Morewood Esker and the north side of the Maple Ridge Esker. Previous investigations in this intervening area between these two esker features as part of several previous studies to provide additional groundwater supplies for Winchester and Chesterville have found that the overburden is of generally limited thickness, and the soil conditions encountered are not the coarse granular core or finer sand flanks that are characteristic of the esker. The geophysical studies used to locate the esker where it is buried beneath clay soil deposits were not carried out in this intervening area. Although the Vars-Winchester Esker is shown as being present in this intervening area in published information (Cummings and Russell, 2007), it has not been encountered in previous targeted investigations, suggesting that it may be discontinuous in this area of the Township.

9.2.1.2 Boyne Road Landfill Geology

Based on subsurface conditions encountered during borehole drilling programs (refer to Figure 9-3 for borehole and monitoring well locations) completed at the landfill site, overburden in the area consists of the following:

- A topsoil/peat unit (between 0 and 2 m in thickness). This unit is generally thickest to the north of Boyne Road.
- A silt/clay unit at surface or underlying topsoil/peat where present (generally between 0 and 3 m in thickness). However, the thickness of this unit appears to increase to the north and east of the Site-vicinity Study Area, with a maximum thickness of 5.8 m encountered at BH16-3.
- A silty sand/sandy silt till (between 0.9 and 6.0 m in thickness) was encountered where boreholes were advanced through the base of the silt/clay unit. A 1.9 m thick sequence of sand and gravel was encountered at the top of surface of this unit at BH16-3.

Bedrock, consisting of limestone (interbedded with shale), has been encountered at between 1.4 and 11.6 mbgs. The greatest depth to bedrock encountered during the drilling of on-site boreholes was encountered at BH16-3, located to the northeast of the landfill site about midway through the Township-owned lands north of Boyne Road. The least depth to bedrock was observed to the south of the existing fill area at MW15-1 and MW15-2, where auger refusal was encountered at 1.7 mbgs and 1.4 mbgs, respectively.

The position of the Boyne Road Landfill relative to the mapped overburden and bedrock geology is shown on Figures 9-4 and 9-5, respectively.

Available borehole logs are included in Volume 2 Appendix D-1. A Cross-section of the site geology from existing borehole data is provided on Figure 9-5B. The location of the cross-section in Figure 9-5B is presented on Figure 9-5A.

9.2.2 Hydrogeology

9.2.2.1 Regional Aquifers

The following sub-sections outline the general characteristics of both the bedrock and overburden aquifers in the Wider Study Area.

9.2.2.1.1 Bedrock Aquifers

Groundwater flow in the bedrock aquifers is controlled by and occurs along and through fractures and bedding plane features (secondary porosity). The contact zone between the upper weathered bedrock surface and the overburden materials (basal till) has an enhanced permeability and thus has a higher hydraulic conductivity than the lower, more massive bedrock. The Gull River Formation, the most predominant bedrock in the Wider Study Area, is regionally known to have low transmissivities and potable quality at a regional scale. Individual water supplies in the mostly rural Township obtain their water from drilled wells completed at various depths in the bedrock. There are also three wells completed in bedrock that form part of the water supply for the Village of Winchester located west of the village (refer to Wells #1, 5 and 6 on Figure 9-4).

The bedrock aquifers in the Wider Study Area are largely overlain by several metres of low permeability clays and silts that act as an aquitard by storing water and transmitting it slowly to the aquifer. Thus, the bedrock aquifers in the Wider Study Area are considered mostly to be confined/semi-confined. A review of the water level information within the MECP Water Well Information System (WWIS) indicates that, on a regional scale, flow in the bedrock is from southwest to northeast. On a more local scale, groundwater flow in the bedrock is generally towards the rivers that exist within the Wider Study Area (East Castor River and South Nation River).

Recharge to the bedrock aquifers likely occurs where the bedrock outcrops, where the overburden is thin, or in areas where relatively permeable sediments are in contact with the bedrock. The main recharge areas are expected to be in areas of topographic highs. Some recharge occurs from storage in the overlying aquitard. Recharge through the aquitard may occur in areas of local topographic lows where depression-focused recharge may occur.

9.2.2.1.2 Overburden Aquifers

The overburden in the Wider Study Area is mainly comprised of marine clay and glacial till. The hydraulic conductivity of the clay is very low, and water is transmitted very slowly through the matrix of the clay. The clay is considered an aquitard and not suitable for the development of a water supply. Even though the glacial till has a higher hydraulic conductivity than the marine clays, it is perhaps only capable of providing adequate well yields for an individual water supply in very localized areas.

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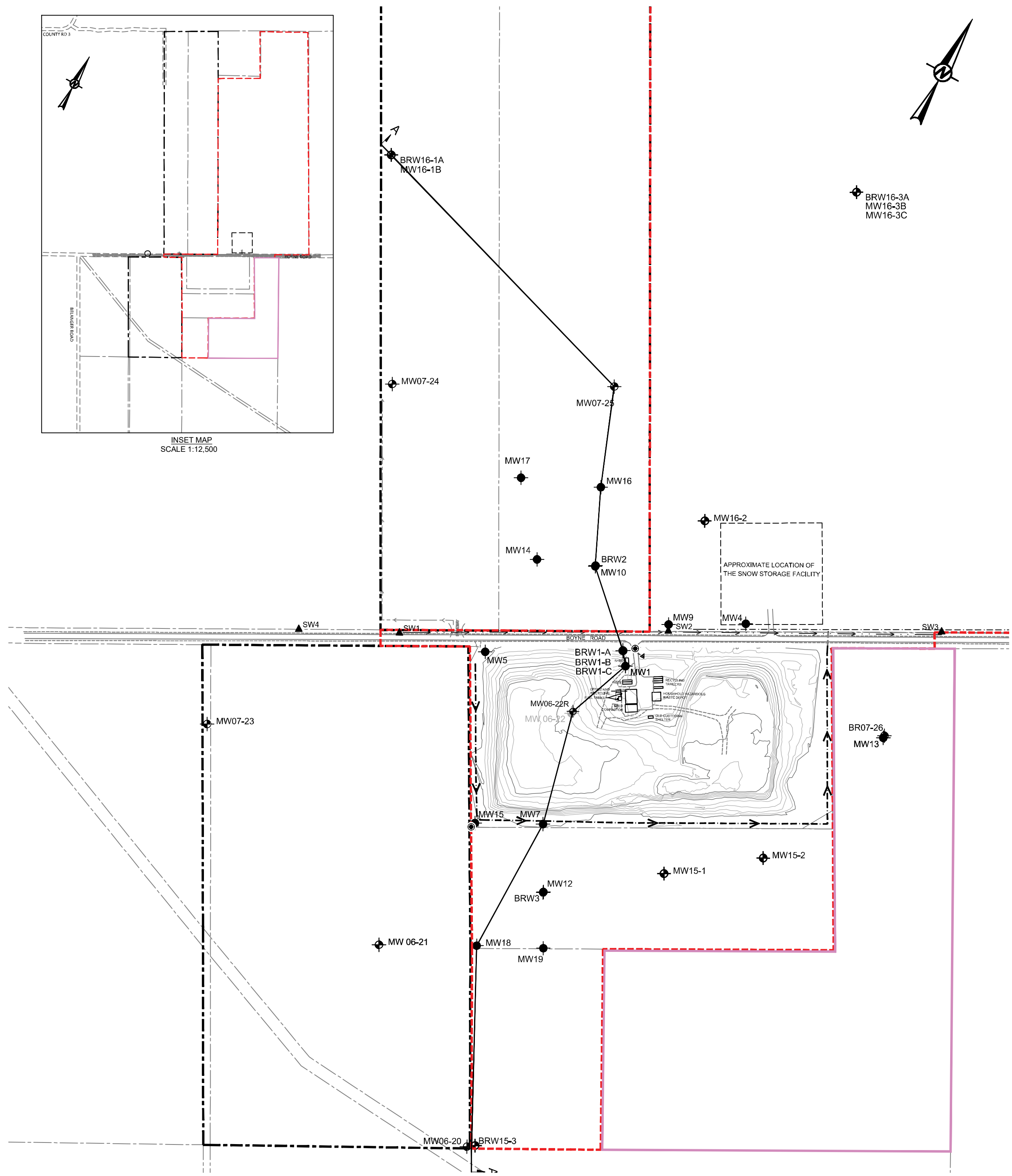


LEGEND

- DESTROYED MONITORING WELL NO LONGER IN USE
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY GOLDER ASSOCIATES LTD.
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY OTHERS
- APPROXIMATE SURFACE WATER SAMPLING LOCATION IN PLAN
- GEO-REFERENCING POINTS
- 85.0 GROUND SURFACE CONTOURS (M), BASED ON RESULTS OF THE SURVEYS CONDUCTED IN 2008, 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 AND 2020
- APPROXIMATE PROPERTY BOUNDARY OF LANDFILL SITE
- APPROXIMATE BOUNDARY OF CONTAMINANT ATTENUATION ZONE
- ADDITIONAL LAND OWNED BY TOWNSHIP
- APPROXIMATE LOCATION OF PERIMETER DITCH AND INFERRED FLOW DIRECTION
- INFERRED FLOW DIRECTION IN THE DRAINAGE DITCH ALONG BOYNE ROAD
- CROSS-SECTION LOCATION (SEE FIGURE 9-5B FOR DETAILED CROSS-SECTION)

NOTES

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE

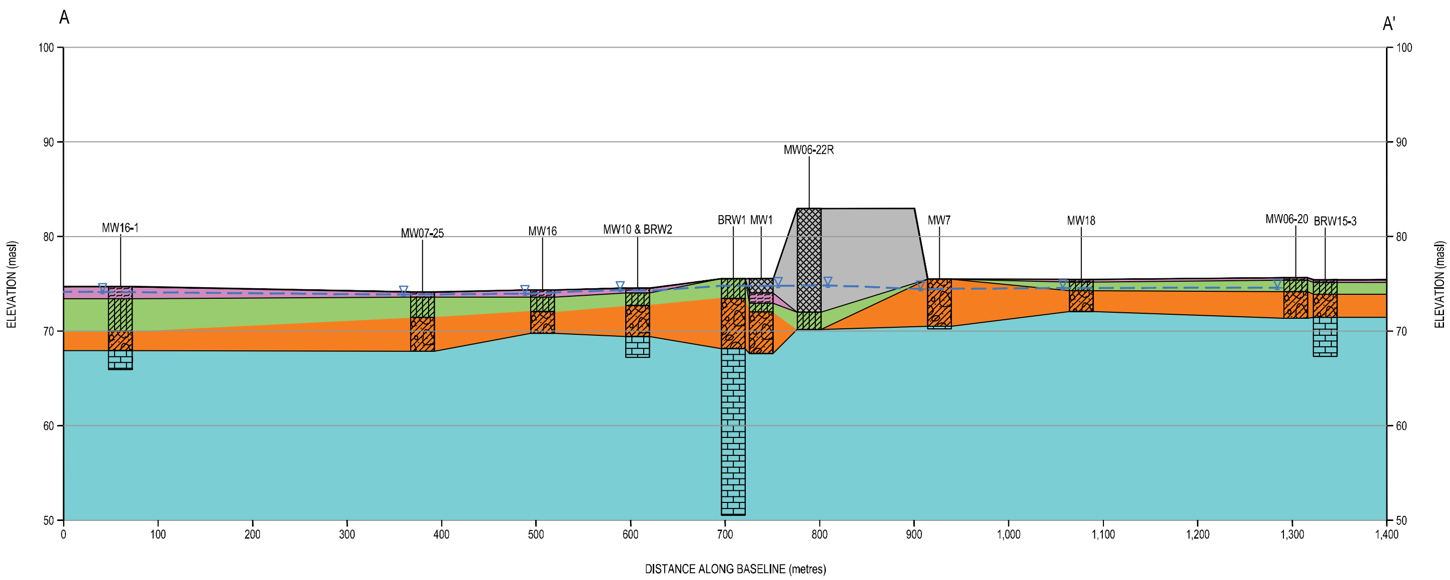
1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY STANTEC CONSULTING LTD.
2. 2008 AND 2010 SURVEYS COMPLETED BY STANTEC CONSULTING LTD.
3. MAY 2012, JULY 2013, NOVEMBER 2014, DECEMBER 2015, NOVEMBER 2016, DECEMBER 2017, DECEMBER 2018 AND NOVEMBER 2019, APRIL 2020 AND DECEMBER 2020 SURVEYS COMPLETED BY GOLDER ASSOCIATES LTD.
4. COORDINATE SYSTEM: MTM ZONE 9 NAD83

0 100 200

1:2,500 METRES

CLIENT TOWNSHIP OF NORTH DUNDAS			PROJECT INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN
CONSULTANT	YYYY-MM-DD	2021-08-31	TITLE **LOCATION OF GEOLOGICAL CROSS-SECTION OF BOYNE ROAD LANDFILL SITE**
WSP GOLDER	PREPARED	ABD	
	DESIGN	RM	
	REVIEW	PS	PROJECT No. 1648253 / PHASE/TASK 2.0/2.2.0 / Rev. 0 / FIGURE 9-5A
	APPROVED	PAS	

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



LEGEND

- WASTE FILL
- TOPSOIL/PEAT
- SILTY CLAY
- SILTY SAND / SANDY TILL
- BEDROCK
- GROUNDWATER LEVEL (APRIL 2020)

0 10 20
1:400 VERTICAL METRES

0 100 200
1:4,000 HORIZONTAL METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE
2. FOR DETAILED STRATIGRAPHY SEE RECORD OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 9-5A

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
GEOLOGICAL CROSS-SECTION OF BOYNE ROAD LANDFILL SITE

CONSULTANT

wsp GOLDER

YYYY-MM-DD	2022-10-17
DESIGNED	RM
PREPARED	JEM
REVIEWED	PAS
APPROVED	PAS

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	9-5B

The coarse grained glaciofluvial deposits within the Morewood Esker (~8 km northeast of Winchester), and the Maple Ridge Esker (~4 km west of Chesterville), and potentially the Loughlin Ridge (~11 km west of Winchester) form excellent local aquifers. Wells constructed within these deposits typically have high yields of potable water. The Morewood Esker, the Maple Ridge Esker and the Loughlin Ridge are principally unconfined, but confined conditions could persist where the marine clays overlay the coarse-grained materials on the margins of the deposits, or where the deposits are entirely buried (if present). These aquifers are recharged by infiltrating precipitation (diffuse) and by the surface ponds created by gravel extraction operations (locally) below the water table. The majority of recharges occurs along the length of the esker feature where the coarse granular central core and sandy flanks of the eskers are exposed at the surface (Cummings and Russell, 2007). The permeable material that comprises the core of the eskers is underlain by less permeable till and/or bedrock. Previous hydrogeological evaluations completed for the wellfield in the Morewood Esker (Golder, 2003; Golder and Sauriol, 2005) and the Maple Ridge Esker (Golder, 2003a), indicate that it is likely that the two eskers have some inflow from an adjacent source such as permeable material overlying the bedrock that then is connected to the eskers, although this has not been conclusively determined.

9.2.2.2 Boyne Road Hydrogeology

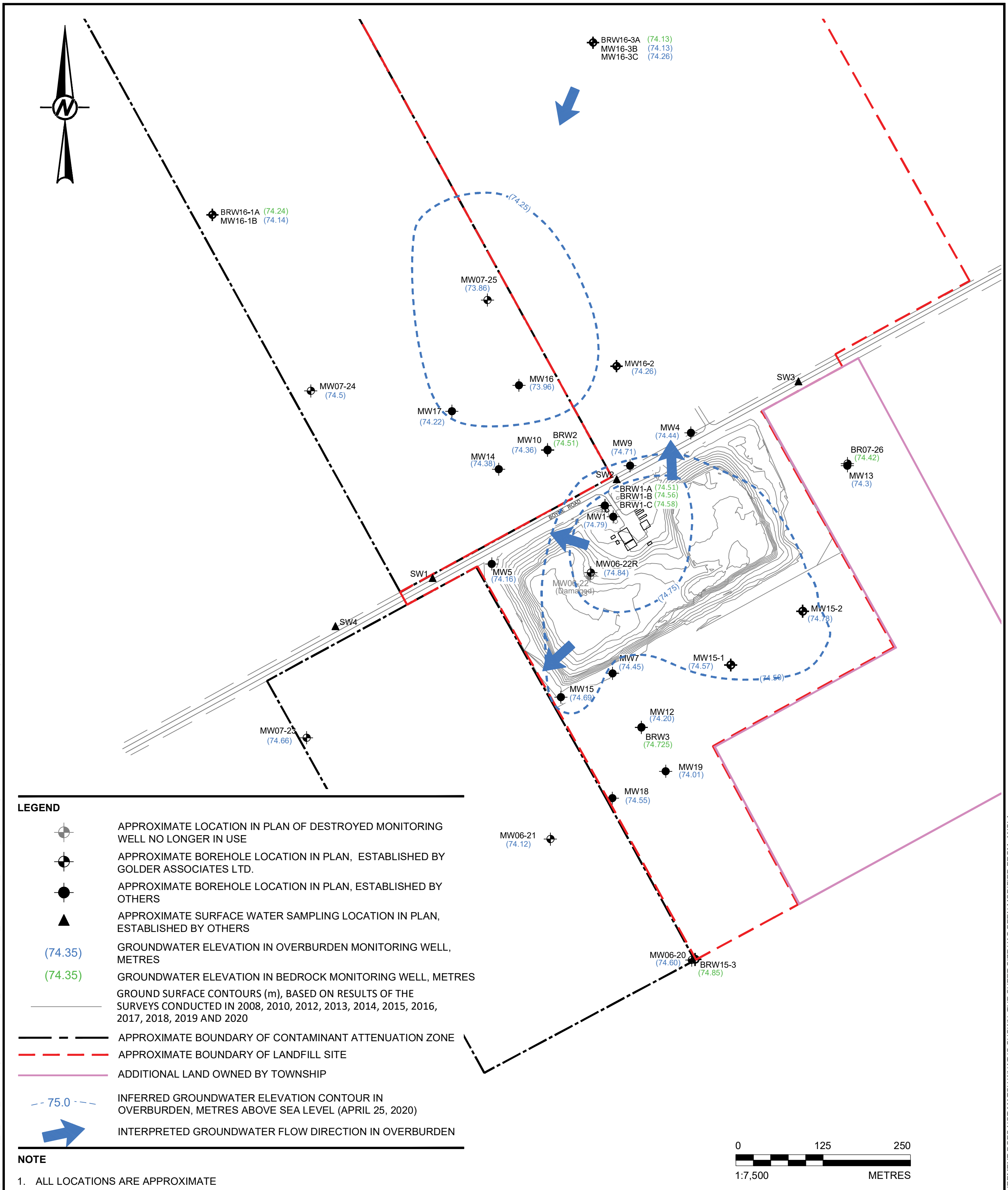
9.2.2.2.1 Groundwater Elevations and Groundwater Flow Directions

Topography in the Site and Site-vicinity Study Areas is flat; as a result, hydraulic gradients, and groundwater flow directions may vary temporarily/seasonally and can be influenced by very slight variations in groundwater elevations. Based on review of topographic maps of the Wider Study Area, the regional groundwater flow direction is expected to be north, toward the East Castor River (located approximately 4 km to the north).

Groundwater levels have been measured biannually in monitoring wells at the landfill site since 2005. This data base shows that the water levels are fairly consistent over time, as are the seasonal variations in interpreted groundwater flow direction(s) and hydraulic gradients, and the estimated average groundwater velocity.

Within the Site Study Area, groundwater elevations may be influenced by leachate buildup within the waste mound, resulting in a local groundwater divide in close proximity to the landfill. Data from both historical groundwater elevations and historical groundwater chemistry indicate that local groundwater mounding associated with the waste pile has been influencing local groundwater flow direction in the Site Study Area. However, the radial groundwater flow caused by the mounding does not affect groundwater flow patterns beyond the immediate vicinity of the waste pile. Groundwater flow in the area to the north of the Site Study Area is generally to the north, and groundwater flow in the area to the south of the Site Study Area is generally to the south. These flow directions can be variable with flow to the north occasionally being to the northeast and flow to the south occasionally being to the southwest or southeast. Contours generated from groundwater elevations measured at the landfill site and in the Site-vicinity Study Area in the overburden in April and August 2020 (which are consistent with historical trends) are presented in on Figures 9-6 and 9-7, respectively.

Groundwater elevation in the bedrock show very minimal spatial variation. Historically, groundwater levels at BRW1 and BRW3 indicated that groundwater flow was to the south in the area immediately south of the landfill site. Further south of the landfill site, groundwater levels at BRW3 and BRW15-3 indicated the bedrock groundwater flow was to the north. Groundwater flow directions in the bedrock have been observed to vary historically.



CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

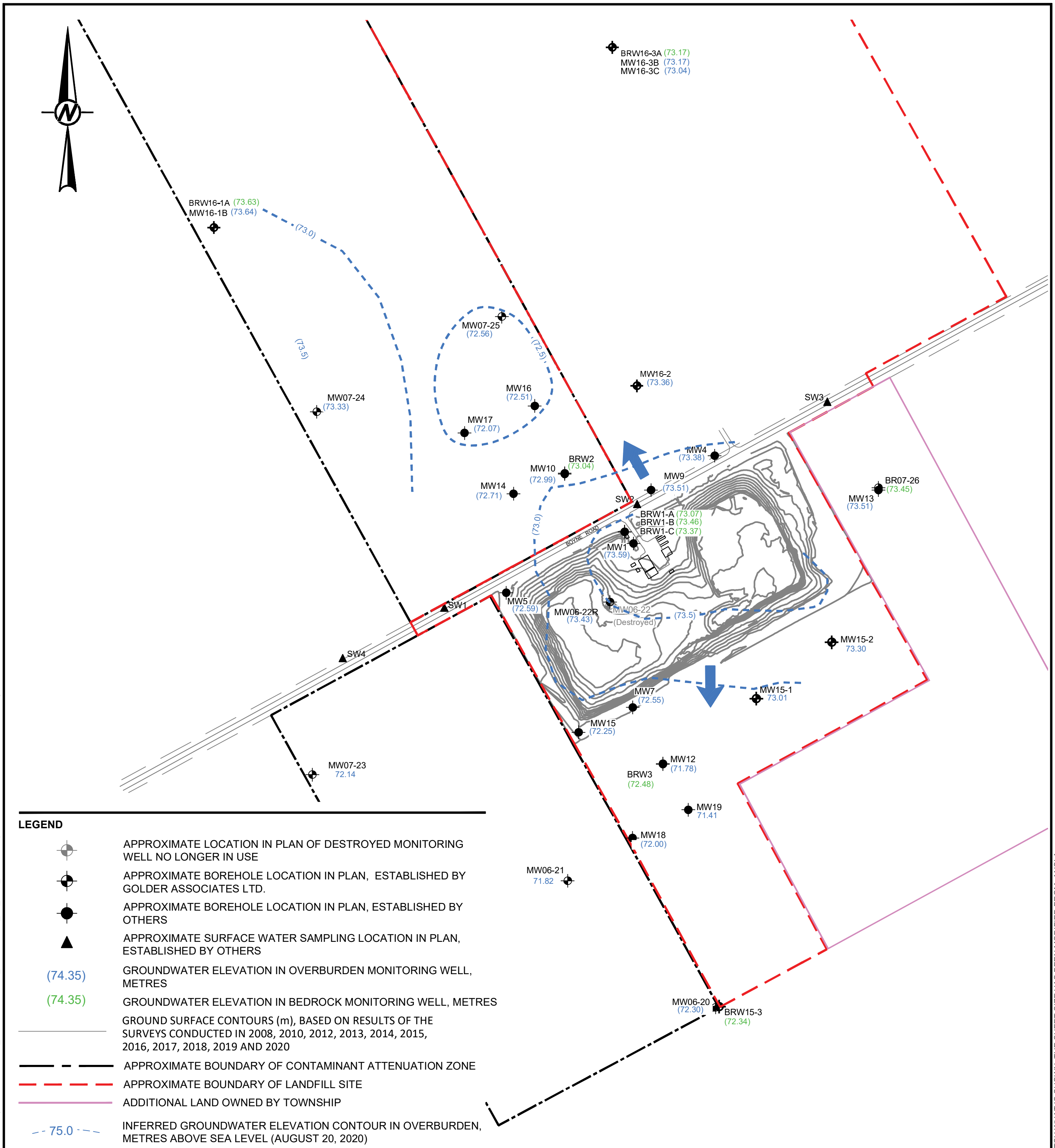
CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2021-08-31
PREPARED	ABD
DESIGN	RM
REVIEW	PS
APPROVED	PAS

TITLE
GROUNDWATER FLOW IN OVERBURDEN, APRIL 2020

PROJECT No.	PHASE/TASK	Rev.	FIGURE
1648253	2.0/2.2.0	0	9-6



LEGEND

- APPROXIMATE LOCATION IN PLAN OF DESTROYED MONITORING WELL NO LONGER IN USE
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY GOLDER ASSOCIATES LTD.
- APPROXIMATE BOREHOLE LOCATION IN PLAN, ESTABLISHED BY OTHERS
- APPROXIMATE SURFACE WATER SAMPLING LOCATION IN PLAN, ESTABLISHED BY OTHERS
- (74.35) GROUNDWATER ELEVATION IN OVERBURDEN MONITORING WELL, METRES
- (74.35) GROUNDWATER ELEVATION IN BEDROCK MONITORING WELL, METRES
- GROUND SURFACE CONTOURS (m), BASED ON RESULTS OF THE SURVEYS CONDUCTED IN 2008, 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 AND 2020
- APPROXIMATE BOUNDARY OF CONTAMINANT ATTENUATION ZONE
- APPROXIMATE BOUNDARY OF LANDFILL SITE
- ADDITIONAL LAND OWNED BY TOWNSHIP
- 75.0 INFERRED GROUNDWATER ELEVATION CONTOUR IN OVERBURDEN, METRES ABOVE SEA LEVEL (AUGUST 20, 2020)
- INTERPRETED GROUNDWATER FLOW DIRECTION IN OVERBURDEN

NOTE

1. ALL LOCATIONS ARE APPROXIMATE

0 125 250

1:7,500 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-31
PREPARED	ABD
DESIGN	RM
REVIEW	PS
APPROVED	PAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
GROUNDWATER FLOW IN OVERBURDEN, AUGUST 2020

PROJECT No.	PHASE/TASK	Rev.	FIGURE
1648253	2.0/2.2.0	0	9-7

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25 mm
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9.2.2.2.2 Hydraulic Gradients

Based on groundwater elevations measured in overburden monitoring wells, the horizontal hydraulic gradient in the area of the waste mound (in the general direction of the interpreted horizontal groundwater flow) is typically measured at approximately 0.005 m/m.

North of the waste mound area (in the main interpolated direction of horizontal groundwater flow), hydraulic gradients in the order of 0.001 – 0.01 m/m are typically measured. South of the waste mound, lower hydraulic gradients in the order of 0.001 – 0.003 m/m are observed, with a negative (northwards) hydraulic gradient occasionally measured at the southern-most boundary of the Site Study Area. Hydraulic gradients to the east and west of the landfill site are much lower than the north or south direction, typically in the order of 0.0005 m/m.

Horizontal gradients in the bedrock have historically been weak and variable in direction.

Vertical hydraulic gradients from the overburden to the bedrock vary by location; with upwards, downwards and negligible vertical gradients being observed across the Site Study Area. The bedrock monitoring well located in the area of the waste mound features three groundwater screens, BRW1-A, BRW1-B and BRW1-C. Historically, weak and oscillating gradients in bedrock are observed at this location, with overall downward vertical hydraulic gradients being typically observed.

9.2.2.2.3 Horizontal Hydraulic Conductivity

Estimates of horizontal hydraulic conductivity of overburden materials in the area of the Site Study Area, as determined based on the results of slug tests and grain size distribution analysis completed as part of previously completed studies, are presented below in Table 9-10. The geometric mean horizontal hydraulic conductivity (based on slug test analysis) for the monitoring wells included in the table below is 2.1 x 10^{-3} cm/second.

Table 9-10: Summary of Horizontal Hydraulic Conductivity Measurements from OMM (1991)

Monitoring Well	Testing Method	Depth Interval (metres)	Hydraulic Conductivity (cm/second)
MW1	Laboratory Index Properties Slug Test Grain Size Distribution Laboratory Index Properties	3.05 – 3.66 (silt) 6.42 – 7.92 (till) 4.57 – 5.18 (till) 6.10 – 6.71 (till)	2.3×10^{-7} 1.0×10^{-2} 1.9×10^{-5} 8.0×10^{-5}
MW2	Grain Size Distribution Grain Size Distribution	1.52 – 2.13 (silt) 3.05 – 3.66 (till)	1.0×10^{-9} 5.8×10^{-5}
MW3	Slug Test Slug Test	4.30 – 6.70 (till) 4.30 – 6.70 (till)	1.5×10^{-3} 1.3×10^{-3}
MW4	Slug Test	7.30 – 8.80 (till)	1.4×10^{-3}
MW5	Slug Test Slug Test	2.80 – 4.30 (till) 2.80 – 4.30 (till)	1.3×10^{-3} 3.4×10^{-3}
MW6	Slug Test	3.14 – 4.70 (till)	1.6×10^{-3}

Hydrogeological investigations conducted at the landfill site in 2015 and 2016 included slug tests in eight monitoring wells screened in the silty sand or sandy silt till, three monitoring wells screened in the clay/silt, and five monitoring wells screened in the limestone bedrock. The results of analyses of these tests are summarized in Table 9-11 below. The resulting geometric mean for the overburden monitoring wells of 3×10^{-4} cm/s is one order of magnitude lower than the value previously reported by OMM (1991), and likely reflects the higher silt and clay content in the soils adjacent to the most recently installed monitoring wells.

Table 9-11: Summary of Horizontal Hydraulic Conductivity Measurements from 2015 and 2016

Monitoring Well	Geological Unit	Hydraulic Conductivity (cm/second)
MW16-3C	Clayey Silt	3×10^{-7}
MW16-1B	Till/Clayey Silt	2×10^{-5}
MW16-2	Till/Clayey Silt	5×10^{-5}
MW16-3B	Sandy Silt with Gravel	3×10^{-5}
15-1	Till	8×10^{-3}
MW06-20	Till	1×10^{-3}
MW06-21	Till	8×10^{-4}
MW07-23	Till	7×10^{-3}
MW16	Till	4×10^{-3}
MW18	Till	2×10^{-3}
MW5	Till	2×10^{-3}
15-3	Limestone	3×10^{-4}
BR07-26	Limestone	6×10^{-4}
BRW16-1A	Limestone	3×10^{-5}
BRW16-3A	Limestone	3×10^{-3}
BRW2	Limestone	1×10^{0}

9.2.2.2.4 Groundwater Velocity

The average linear groundwater velocity in the overburden, in the area of the waste mound was calculated based on the geometric mean hydraulic conductivity (3.0×10^{-4} cm/s), the average observed horizontal hydraulic gradient in the interpreted direction of groundwater flow (0.005 m/m), and an assumed average porosity of 35 percent. For unconsolidated deposits such as silts and sands, typical porosity values range from 25 to 50 percent (Freeze and Cherry, 1979). An average porosity of 35 percent is assumed for the overburden deposits in the area of the landfill site. In 2020, the average linear groundwater velocity in the vicinity of the waste mound is estimated to be about 1 m/yr. and has ranged between 0.9 and 45 m/yr. (as measured between 2007 and 2020) but is typically within the range of 1 – 4 m/yr.

The average linear groundwater velocity in the overburden in the areas north and south of the waste mound is lower than what is measured within the waste mound vicinity; the groundwater velocities estimated in August 2020 were 0.33 m/yr, 0.23 m/yr, and 0.02 m/yr in the north, south, and west directions of groundwater flow from the waste mound respectively. Higher reported groundwater velocities in previous years have been the result of higher historical groundwater levels observed at MW06-22 and the associated higher horizontal hydraulic gradients in the area of the waste mound. Recent reporting has indicated a lower degree of mounding in MW06-22R and lower groundwater velocities. Based on the upper bound of the typical groundwater velocity (4 m/yr), it is estimated that the leachate plume could be expected to have travelled approximately 220 m from the waste fill area during the 55 years of operation at the landfill site (as of 2020). This slow groundwater velocity is as expected considering the low horizontal hydraulic gradients (reflective of the flat topography) and the clay and till soils in the area of the landfill.

9.2.2.2.5 Groundwater Quality and Leachate Indicators

Monitoring wells MW13 and BR07-26 (to the east of the Site Study Area) have been established as representative of background water quality in the overburden and the bedrock, respectively. Monitoring well MW06-22 and the replacement well MW06-22R are screened in the silty sand unit immediately below the waste mound and have been used as indicators of leachate strength at the landfill site. Based on a comparison of background groundwater quality, leachate quality and mobility of the leachate parameters, leachate indicator parameters for the landfill site are alkalinity, aluminum, ammonia, barium, biological oxygen demand (BOD), boron, chloride, cobalt, conductivity, dissolved organic carbon (DOC), hardness, iron, manganese, phenols, potassium, sodium, and total dissolved solids (TDS). Use of chloride as a leachate indicator parameter is complicated due to the additional sources of chloride such as road salting activities along Boyne Road and the snow storage facility northeast of the landfill site. Based on the relatively low concentrations of chloride observed at the background monitoring locations, chloride remains a useful leachate indicator parameter for monitoring locations upgradient (south) of Boyne Road and the snow storage facility.

Sampling of groundwater quality at the Boyne Road Landfill site is conducted twice annually and reported annually and includes the analysis of general chemistry, metals, and volatile organic compounds. Current assessment of the groundwater program concludes that the existing landfill is currently in compliance with the Reasonable Use Concept and MECP Guideline B-7 (MOE, 1994). With reference to the monitoring well locations shown on Figure 9-3, a summary of the 2020 groundwater assessment is presented below:

- To the west of the landfill site, landfill leachate impacts have been delineated, with monitoring well MW07-23 interpreted to be potentially impacted leachate.
- To the south of the landfill site, landfill leachate impacts have been delineated with MW06-20 interpreted to be potentially impacted and BRW15-3 interpreted to be not impacted by landfill leachate.
- To the north of the landfill site, landfill leachate impacts have been delineated. Monitoring wells at the northern extent of the monitoring network have been interpreted to not be impacted by landfill leachate (MW07-24, MW16-1A, MW16-1B, MW16-3A, MW16-3B and MW16-3C).

- Concentrations of leachate indicator parameters at each monitoring location have been generally consistent for the last several years with the exception of increasing trends in the concentrations of several parameters at MW1, MW5, MW16, BRW1-B, and BRW2, all of which are located on the landfill Site Study Area or within the buffer/CAZ in areas relatively close to the waste footprint.
- Within locations monitored in the bedrock there is limited leachate impact except at BRW2 and BRW3, which are located within 100 m of the waste footprint and are interpreted to be impacted by landfill leachate.

The 2020 groundwater monitoring and reporting program assessment indicates that a total of eleven locations (monitoring wells MW1, MW4, MW5, MW9, MW16, MW17, MW19, MW06-21, MW16-2, BRW2, and BRW3) are interpreted as impacted by landfill leachate. These locations are located in close proximity of the waste footprint, or within the existing landfill property located north, south, and southwest of the waste footprint. The extent of possible leachate impacts on groundwater based on monitoring is in reasonably good agreement with that from the estimate based on average groundwater velocity.

9.2.2.2.6 PFAS Sampling Results in Groundwater Quality

Groundwater samples were collected for the analysis of perfluoroalkyl and polyfluoroalkyl substances (PFAS) compounds in August 2021. Groundwater samples were obtained at five locations: MW06-22R, MW07-23, MW06-20, MW07-25, and MW4. These locations were selected to characterize PFAS quality in the source leachate (MW06-22R), in the vicinity of the snow storage facility (MW4), and to check for the presence of downgradient PFAS in the north, west, and south directions from the waste footprint (MW07-25, MW07-23 and MW06-20, respectively).

The PFAS results are summarized in Table-9-12. Multiple PFAS compounds were detected in leachate quality well MW06-22R. The sum of the select PFAS compound concentrations tentatively identified by the MECP in this sample is 1423.8 ng/L. No PFAS compounds were detected in the samples collected at MW4 and MW06-20. Trace PFAS compounds were detected at MW07-23 and MW07-25; the groundwater samples from these locations had a summation of select PFAS compound concentrations of 0.45 ng/L and 20.62 ng/L, respectively. With the exception of the leachate quality well, all locations reported sums of select PFAS compound concentrations below the MECP suggested drinking water value of 70 ng/L. This indicates that, where present, PFAS compounds are in the groundwater in the immediate vicinity of the waste mound and not migrating in downgradient directions on-site or off-site at concentrations of potential concern to off-site groundwater users.

Table 9-12: Summary of August 2021 PFAS Sampling at Boyne Road Landfill

PFAS Compound	Unit	MW06-22R	MW07-23	MW06-20	MW07-25	MW4
4:2 Fluorotelomer sulfonic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
6:2 Fluorotelomer sulfonic acid	ng/L	**77**	<1.7	<1.7	<1.7	<1.7
8:2 Fluorotelomer sulfonic acid	ng/L	<9.7	<0.87	<0.86	<0.86	<0.87
Perfluorobutanesulfonic acid	ng/L	**26**	<0.43	<0.43	**1.1**	<0.44
Perfluorobutanoic acid	ng/L	**170**	<1.7	<1.7	**14**	<1.7
Perfluorodecanesulfonic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluorodecanoic acid	ng/L	**7.8**	<0.43	<0.43	<0.43	<0.44
Perfluorododecanesulfonic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluorododecanoic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluoroheptanesulfonic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluoroheptanoic acid	ng/L	**180**	<0.43	<0.43	**4.0**	<0.44
Perfluorohexadecanoic acid	ng/L	<9.7	<0.87	<0.86	<0.86	<0.87
Perfluorohexanesulfonic acid	ng/L	**150**	<0.43	<0.43	**1.2**	<0.44
Perfluorohexanoic acid	ng/L	**420**	<0.43	<0.43	**8.6**	<0.44
Perfluorononanesulfonic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluorononanoic acid	ng/L	**16**	<0.43	<0.43	<0.43	<0.44
Perfluorooctadecanoic acid	ng/L	<9.7	<0.87	<0.86	<0.86	<0.44
Perfluorooctanesulfonamide	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluorooctanesulfonic acid	ng/L	**120**	<0.43	<0.43	**0.52**	<0.44
Perfluorooctanoic acid	ng/L	**530**	**0.45**	<0.43	**6.3**	<0.44
Perfluoropentanesulfonic acid	ng/L	**8.4**	<0.43	<0.43	<0.43	<0.44
Perfluoropentanoic acid	ng/L	**230**	<0.43	<0.43	**13**	<0.44
Perfluorotetradecanoic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluorotridecanoic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Perfluoroundecanoic acid	ng/L	<4.8	<0.43	<0.43	<0.43	<0.44
Sum of detected Select MECP PFAS Compounds	ng/L	1423.8	0.45	0	20.62	0

Notes:
Red Text indicates select MECP PFAS Compounds; non-detects were treated as zero concentrations
Bold Text indicates detection of PFAS Compounds

9.2.2.3 Groundwater Supply and Source Water Protection

The Township relies on groundwater from drilled wells for potable water supply. The Villages of Winchester and Chesterville each have communal water supplies from high capacity drilled overburden wells located within the Morewood Esker (refer to Winchester Wells 7a, b and c on Figure 9-4) and Maple Ridge Esker (refer to Chesterville Wells 5 and 6 on Figure 9-4), respectively. The remainder of the Township relies on individual wells that generally obtain their water from zones within the bedrock.

The North Dundas Drinking Water System (System) supplies treated water to Winchester and Chesterville. The System derives its water supply from three communal wells completed in bedrock within and to the west of Winchester (Winchester Wells No. 1, 5 and 6), and two well fields completed in overburden sediments, comprised of three communal wells (Winchester Wells No. 7a, 7b, and 7c) and two communal wells (Chesterville Wells No. 5 and 6). The locations of the wells are illustrated on Figure 9-4. Each of the bedrock wells and the well fields are equipped with its own disinfection system and pumping facility located in a pump house that either contains the well head (Winchester Wells No. 1, 5, 6 and Chesterville Well No. 5) or is located near the well heads (Chesterville Well No. 6 and Winchester Wells No. 7a, 7b and 7c). The disinfecting system injects sodium hypochlorite solution into the water. The pumping facilities use either a submersible or a turbine pump to deliver water to the distribution system. The Ontario Clean Water Agency is the operating authority of the System.

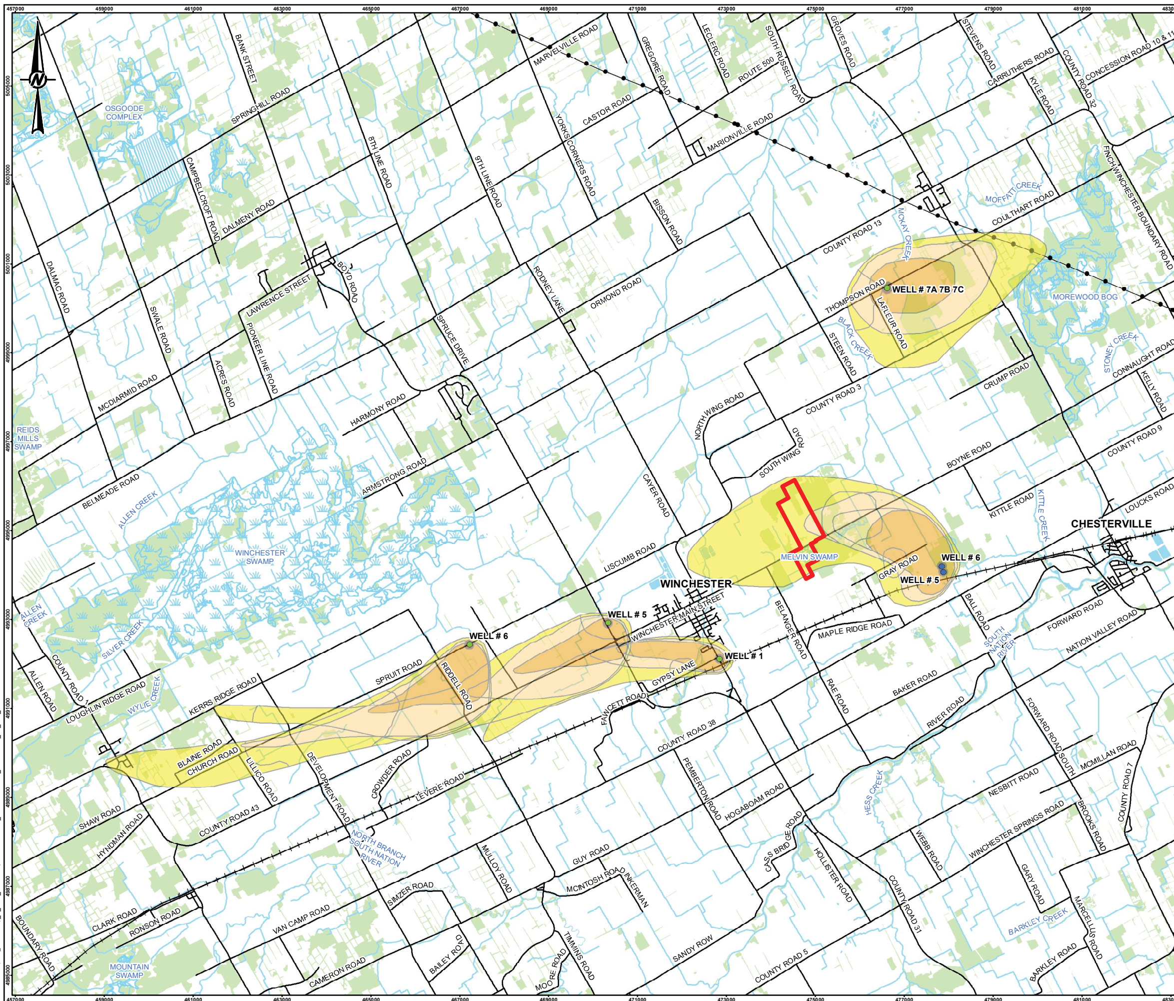
As part of source protection planning undertaken by the RRC and SNC an Assessment Report for the South Nation Source Protection Area was completed. As part of the Assessment Report, a Wellhead Protection Area (WHPA) Study and a vulnerability assessment was completed for each of the Winchester and Chesterville communal wells.

The following four wellhead protection zones were defined for each well:

- Zone A – 100 metre radius pathogen security/prohibition zone
- Zone B – 2-year horizontal Time of Travel (ToT) pathogen management zone
- Zone C – 5-year ToT dense non-aqueous phase liquid /contaminant protection zone
- Zone D – 25-year ToT secondary protection zone

These zones are used to assist in identifying the various levels of potential risks faced by municipal supply wells from pathogens and chemical contaminants. Figure 9-8 shows the capture zones that comprise the WHPAs for each of the wells in the System.

The Boyne Road Landfill exists within the existing WHPA-D of the Chesterville wellfield with a vulnerability score of 4. The current Source Protection Plan (SNC and RRC, 2016a) for the Chesterville wellfield indicates that the provincial policies concerning waste only apply to WHPAs A and B and portions of WHPA-C for which the vulnerability score is 8 or higher. Waste sites are not prohibited within WHPA-D. The site is also located in surface water vulnerable areas intake protection zone-3, having a highly vulnerable aquifer scoring 6 and a significant groundwater recharge area. Additionally, the groundwater flow direction of leachate impacted groundwater is not indicated to be traveling eastward (as discussed in Section 9.2.2.2.1) towards the Chesterville Wells.



LEGEND

- CHESTERVILLE WELL LOCATION
- WINCHESTER WELL LOCATION
- ROADWAY
- RAILWAY
- UTILITY LINE
- WATERCOURSE
- WATERBODY
- WETLAND
- WOODED AREA
- APPROXIMATE BOUNDARY OF BOYNE RD LANDFILL SITE

DRINKING WATER SOURCE PROTECTION AREAS

- WELLHEAD PROTECTION AREA (WHPA) A
- WELLHEAD PROTECTION AREA (WHPA) B
- WELLHEAD PROTECTION AREA (WHPA) C
- WELLHEAD PROTECTION AREA (WHPA) D

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2018
2. WELLHEAD PROTECTION AREAS DIGITIZED FROM SOUTH NATION CONSERVATION GEOPORTAL WEBSITE.
3. SERVICE LAYER CREDITS:
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

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1:85,000 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
WELLHEAD PROTECTION AREAS

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-01-28
DESIGNED	----
PREPARED	BR
REVIEWED	BH
APPROVED	PAS

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	**9-8**

The definition of the current WHPA's is based on groundwater modelling, and so reflects the approach taken to the modelling. From review of the modelling approach used for the Chesterville communal wells No. 5 and 6 (SNC and RRC, 2016a; WESA, 2006), the area of the Melvin Swamp located immediately north of Boyne Road opposite the landfill area was defined as a regional recharge area. As such, the modelling defined the recharge area for these wells as the Melvin Swamp, which is reflected in the shape and extent of the capture zones of these wells that swings northwest towards the Swamp. However, this simplified modelling approach did not take into account that the majority of the recharge to these esker features (in this case the Maple Ridge Esker) occurs from direct precipitation on areas of the permeable esker core materials that are exposed at surface (as previously described in Section 9.2.1.1). Also, as previously described in Section 9.2.1.1, previous investigations in the intervening area between the Morewood and Maple Ridge Eskers have not been able to locate the esker (either exposed or buried). It is interpreted, therefore, that the majority of the recharge to the Maple Ridge Esker is much more local and occurs on the mapped esker itself. The potential for an actual connection between the groundwater in the area of the Boyne Road landfill and recharge to Chesterville wells No. 5 and 6 (to which the source water protection requirements currently apply) is unlikely to be as reflected by the capture zones of the WHPA.

The Boyne Road Landfill is not interpreted to be having an impact on the Winchester, Chesterville, or nearby residential wells due to its location within the geological setting, the local hydrogeology and its remote location from residents.

9.3 Surface Water

The following provides a description of the existing surface water conditions in the area of the Boyne Road Landfill site.

9.3.1 Drainage

The surface water Site-vicinity Study Area is located in a rural agricultural area of flat to undulating farmland. Drainage in this area is via a network of constructed municipal drains, primarily the Volks Municipal Drain and the Quart Municipal Drain (historically known as the Irving-Quart Drain or Irving Drain). The area directly east and south of the existing landfill mound is forested with a shallow groundwater level.

Drainage along the northern extents of the landfill mound is directed towards the Boyne Road ditch along the south side of the road. This includes the operations area of the landfill, which is centrally located along the north of the current disposal area. The remainder of the landfill drains to a constructed drainage ditch (perimeter drain) that was constructed along the west, south, and east boundaries of the approved disposal area of the landfill site (fill area) in 1991, as indicated on Figure 9-9. Surface water runoff from the fill area drains into this perimeter drain, which then discharges to the south roadside ditch along Boyne Road. The roadside ditch flows east and then is directed north, under Boyne Road via a culvert located near the northeast corner of the landfill. The roadside ditch along the north side of Boyne Road is part of the Volks Municipal Drain and flows east and discharges into Black Creek, approximately 1.5 km east of the landfill Site Study Area. Black Creek is a tributary of the East Castor River.

The upstream extent of the Quart Municipal Drain is located southwest of the fill area, outside of the landfill site property, and within the landfill site's contaminant attenuation zone to the west. The Quart drain adjacent to the landfill has been historically observed as dry and does not connect to the drainage course identified as Reach 4 in the biological assessment (refer to Section 9.4.2) or the perimeter drain that services the landfill fill area.

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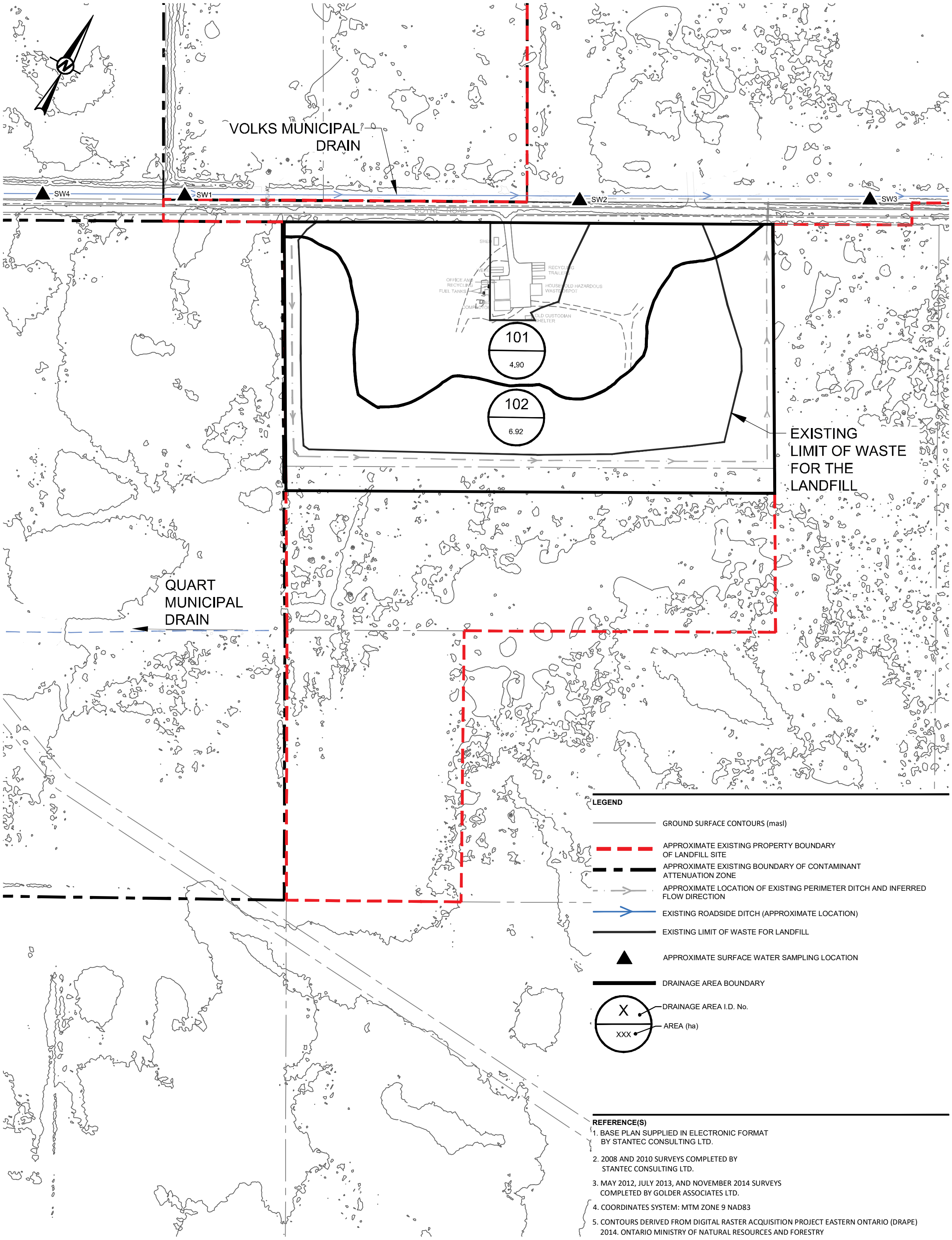

LEGEND

- GROUND SURFACE CONTOURS (masl)
- APPROXIMATE EXISTING PROPERTY BOUNDARY OF LANDFILL SITE
- APPROXIMATE EXISTING BOUNDARY OF CONTAMINANT ATTENUATION ZONE
- APPROXIMATE LOCATION OF EXISTING PERIMETER DITCH AND INFERRED FLOW DIRECTION
- EXISTING ROADSIDE DITCH (APPROXIMATE LOCATION)
- EXISTING LIMIT OF WASTE FOR LANDFILL
- APPROXIMATE SURFACE WATER SAMPLING LOCATION
- DRAINAGE AREA BOUNDARY
- X — DRAINAGE AREA I.D. No.
- XXX — AREA (ha)

REFERENCE(S)

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY STANTEC CONSULTING LTD.
2. 2008 AND 2010 SURVEYS COMPLETED BY STANTEC CONSULTING LTD.
3. MAY 2012, JULY 2013, AND NOVEMBER 2014 SURVEYS COMPLETED BY GOLDER ASSOCIATES LTD.
4. COORDINATES SYSTEM: MTM ZONE 9 NAD83
5. CONTOURS DERIVED FROM DIGITAL RASTER ACQUISITION PROJECT EASTERN ONTARIO (DRAPE) 2014. ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY

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1:3,000 METRES

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2022-01-11	ISSUED FOR CLIENT REVIEW	MHK	ZS/ABD	MHK	DVK

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

CONSULTANT

wsp GOLDER

OTTAWA
1931 ROBERTSON ROAD
OTTAWA, ONTARIO
CANADA
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TITLE
PRE-DEVELOPMENT DRAINAGE AREA PLAN

PROJECT NO.	PHASE/TASK	REV.	of	FIGURE
1648253	2.0/2.2.0	0		9-9

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

25 mm

9.3.2 Surface Water Quantity

The north drainage area for the landfill mound is about 4.9 ha. The southern portion of the waste mound that drains to the perimeter ditch is about 6.92 ha. The area directly south of the mound, which is the location for the proposed expansion, is part of a deciduous swamp area where water is close to surface for the majority of the year. Due to the generally flat lying topography and lack of detailed topographic survey information in the area south of the existing landfill, it is difficult to determine the surface flow direction in this area and how much of the area directly drains to the perimeter ditch around the landfill and/or how much flows in other directions.

9.3.3 Surface Water Quality

There are four landfill surface water monitoring stations located within the drainage ditch (Volks Drain) along the north side of Boyne Road (opposite the disposal area). SW1 and SW4 are located upstream of the landfill site (with SW4 being the furthest upstream), SW2 is located opposite (north) of the disposal area, and SW3 is located downstream of the landfill site. The locations of the surface water monitoring stations are also shown on Figure 9-9. Surface water monitoring stations are not located within the perimeter drain along the west, south, and east boundaries of the fill area, as surface water within it has continually been observed to be stagnant.

Surface water quality is regularly sampled in the Volks Drain as part of the Boyne Road Landfill Site monitoring program, with similar surface water programs having been completed at the landfill site since 1992.

The ongoing annual surface water monitoring program indicates that there are periodic impacts on surface water quality in the roadside ditch from landfill leachate, either due to landfill site runoff or the seepage of leachate-impacted groundwater into the Volks Drain. The Provincial Water Quality Objectives (PWQO) (MOE, 1994a) and the Canadian Water Quality Guidelines for freshwater aquatic life (CWQG) (CCME, 2007) have historically been used as the assessment criteria in the evaluation of surface water from the landfill. Two provincial policies relate directly to the protection or restoration of satisfactory surface water quality (MOE, 1994a). Policy 1 states that, where water quality is better than the PWQO, it shall be maintained at or above the objective. Policy 2 states that water quality that does not meet the PWQO shall not be further degraded and all practical measures shall be taken to upgrade the water quality to the objectives. An upper tolerance limit (UTL) calculation using background surface water quality data at SW1 is used to evaluate if Policy 2 conditions exist. Surface water quality in the roadside ditch along Boyne Road is evaluated for compliance with these policies. Evaluation of Policy 2 could be made using a combination of UTL calculations and 75th Percentile of background concentrations; however, for all parameters at this Site, the UTL calculation is the controlling evaluation criteria and the 75th percentile is used for comparison purposes only. Landfill leachate indicator parameters identified in the monitoring well representative of leachate at the Boyne Road Landfill Site are also used to characterize and assess the surface water quality observed in the roadside ditch.

In 2020, surface water was sampled at surface water stations SW1, SW2, SW3, and SW4 in April, August, and November. Concentrations of nitrate, total phosphorus, iron, and phenols at background surface quality monitor SW1 did not meet the assessment criteria in 2020 and hence some of these parameters may be considered Policy 2 parameters at this location. When considering all available data at background surface water quality monitor SW1, the parameters dissolved oxygen, nitrate, total phosphorus, iron, and phenols may be considered Policy 2. All other parameters monitored have been considered Policy 1. Concentrations of these parameters considered Policy 2 that do not meet the assessment criteria downstream of the Site Study Area do not necessarily indicate landfill leachate impact. In 2020, a number of parameters exceeded the PWQO (Policy 1) at downstream stations. However, not all of these parameters are interpreted to be landfill leachate indicator parameters and, as such, assessment criteria exceedances for non-leachate indicator parameters are interpreted to be at least partially attributable to a secondary source(s).

During the 2020 monitoring sessions the only leachate indicator parameters found to exceed the assessment criteria at downstream locations SW2 or SW3 were iron in all sessions, chloride in August and November, and phenols in April and August. Iron concentrations exceeded the assessment criteria at upstream monitoring locations SW1 and SW4 in August 2020, and no measured downstream iron concentrations exceeded the UTL (Policy 2) in any 2020 monitoring session. Chloride exceeded the assessment criteria and UTL at SW4 in August and November 2020, and no measured downstream chloride concentrations exceeded the UTL (Policy 2). Phenols exceeded the assessment criteria at SW1 and SW4 in August 2020, and a downstream exceedance of the UTL was measured in August 2020. The If Policy 2 was evaluated with the 75th Percentile of background concentrations, iron and chloride concentrations would have exceeded Policy 2 in August and November 2020 at SW2 and SW3, and phenols would have exceeded Policy 2 in April and August 2020 at SW2 and SW3 (although it is noted that SW1 would have also exceeded Policy 2 criteria for phenols in August 2020 using the 75th percentile of background concentrations).

It is noted that the ditch containing the surface water monitoring locations receives runoff and groundwater discharge from the poorly drained areas of Boyne Road, which is underlain by organic peat soils known to contain elevated iron and phenols (and other parameters associated with degrading vegetation). The influence of road salt applied to Boyne Road and possibly the snow storage area located northeast of the landfill may also contribute to the presence of chloride, hardness and conductivity in the roadside drainage ditch. Thus, the drainage ditch is considered to have been in compliance with provincial surface water management policies (Policy 2) during the 2020 monitoring sessions. This 2020 surface water compliance assessment is consistent with historical assessments at the landfill site.

Surface water quality is also reported by the Provincial (Stream) Water Quality Monitoring Network for the Castor River at an upgradient location from the Site Study Area, near the Township of Russell. The water quality data observed here is generally comparable to the water quality observed at local background stations SW1 and SW4.

A surface water quality sample was attempted to be collected from the Quart Municipal Drain in June 2021 following a rain event, but there was insufficient water available in the ditch to collect a sample. This ditch has historically been observed as dry.

9.4 Biology

9.4.1 Methodology

A high level methodology for the assessment of biology existing conditions was provided in Section 8.2 and is outlined in further detail in the report sections below.

9.4.1.1 Desktop Assessment

Golder conducted a desktop review of published natural heritage data and information available for the Site and the Site-vicinity Study Areas. This information served to identify significant natural features, SAR as well as S1 – S3 (extremely rare – rare to uncommon) species known to be present. Information sources consulted included:

- MNRF NHIC Make-a-Map geographic explorer for S1-S3 species reported in the Study Area, and natural areas information queries (MNRF, 2021a)
- Existing and readily available information (including any watershed studies) and mapping available through the SNC
- UCSDG Official Plan (UCSDG, 2018)
- Atlas of Breeding Birds of Ontario (Cadman, et al., 2007)
- eBird online database (eBird, 2021)
- Atlas of the Mammals of Ontario (Dobbyn, 1994)
- Bat Conservation International (BCI, 2021)
- Ontario Odonate Atlas (Jones et. al., 2021)
- Ontario Reptile and Amphibian Atlas (Ontario Nature, 2021)
- DFO Aquatic Species at Risk Maps (DFO, 2021)
- Information contained in natural heritage related map layers from Ontario Base Map series, NRVIS mapping and LIO
- Existing high-resolution aerial imagery and mapping

A formal information request was also submitted to the MNRF. The information received in the response from the MNRF (Volume 4, Appendix G2) has been incorporated into this report, as appropriate.

9.4.1.2 Species at Risk Screening

A SAR screening was completed for the Site and Site-vicinity Study Areas and focused on the review of records and range maps pertaining to species that are designated as threatened or endangered under the Ontario *Endangered Species Act*, 2007 (ESA) (Ontario, 2007), and species that are listed as endangered or threatened under Schedule 1 of the *Species at Risk*

Act, 2002 (SARA) (Canada, 2002) that may occur in the vicinity of the Site-vicinity Study Area.

Data from the field surveys described below were used in combination with the desktop data to determine a final probability of SAR and/or SAR habitats being present within the Site and Site-vicinity Study Area.

9.4.1.3 Field Surveys

Field surveys were undertaken on the Site and the Site-vicinity Study Area, to the extent feasible considering land access, as outlined in Table 9-13.

Table 9-13: Survey Dates and Type

Year	Date(s)	Survey Type(s)
2015	July 19	Biological Site Reconnaissance
	May 30	Nocturnal Anuran Survey, Eastern Whip-poor-will Survey; Plant Community and Wetland Survey; Visual Encounter Survey (VES)
	June 3	Eastern Whip-poor-will Survey
2018	June 8	Breeding Bird Survey; Plant Community Survey; VES
	June 21	Breeding Bird Survey; Bat Habitat and Detector Set-up and Bat Habitat Survey; Plant Community Survey; VES
	June 26	Nocturnal Anuran Survey; Eastern Whip-poor-will Survey, VES
	October 4	Fish Habitat Survey; VES
2020	April 1	Headwater Drainage Features Assessment (Visit 1)
	April 14	Nocturnal Anuran Survey
	May 13	Headwater Drainage Features Assessment (Visit 2)
2020	July 17	Headwater Drainage Features Assessment (Visit 3), Fish Community Survey
	September 19	Fish Community Survey, Plant Community Survey
2021	February 11	Bat Roost Habitat Survey

9.4.1.3.1 Terrestrial Surveys

Botanical Surveys, Ecological Land Classification and Wetland Boundaries

Three plant community surveys were conducted at the Site Study Area and accessible Site-vicinity Study Area in spring, early and late summer. During these surveys, the Site Study Area was assessed using Ecological Land Classification (ELC) standard protocols (Lee et al., 1998) to map the plant communities. Locations of any plant SAR encountered were mapped using a hand-held GPS. The plant community surveys were timed to capture the active period for the majority of native plant species, and a list of all plant species encountered at the Site Study Area was compiled. General notes on near-surface soil characteristics were collected, as per the methodologies of ELC.

Efforts to locate butternut trees (*Juglans cinerea*) were focused on the landfill site. Butternut health assessments were to be undertaken on any butternut trees identified on the Site Study Area by qualified Butternut Health Assessors (i.e., certified by the MNRF). The assessments were to be performed according to standardized MNRFF protocols (MNRF, 2013b) and using the methods as outlined in Butternut Health Assessment Guidelines (MNRF, 2014a) and Butternut Health Assessment in Ontario (FGCA, 2010), with all relevant information entered into the standard Butternut Data Collection Forms (1 and 2). The calculations and analysis were to be performed using the Butternut Retainable Tree Analysis electronic table, updated by the MNRF in 2013.

In addition to the ELC and plant surveys, habitat structure and features specific to the habitat requirements of the SAR identified in the desktop assessment on the Site Study Area were also noted, if present.

Boundaries of the wetlands on the Site Study Area were determined according to the protocols of the Ontario Wetland Evaluation System (OWES) (MNRF, 2014).

9.4.1.3.2 Breeding Bird Surveys

Two early morning breeding bird surveys were conducted on the Site Study Area in June 2018, following standard protocols (Sauer et al., 2008; Cadman et al., 2007). Surveys were conducted at point-count stations distributed throughout all habitats on the Site Study Area (including potential SAR habitat) and occurred between 30 minutes before sunrise and 10:00 a.m. to encompass the period of maximum bird song. A list of all species was compiled, and the locations of any SAR were marked using a hand-held GPS.

Eastern whip-poor-will (*Caprimulgus vociferus*) is known to occur in the vicinity of the Site Study Area. Golder conducted three visits in 2018 to survey for this species, following the draft MNRF methodology (MNRF, 2014b). These surveys consisted of nocturnal point counts from vantage points throughout the Site Study Area. Surveys were conducted during suitable conditions as identified by the protocol.

9.4.1.3.3 Herpetile Surveys

Two anuran (frog and toad) call-count surveys were conducted during early summer 2018 to capture mid- and late-season calling anurans. An April call-count survey was conducted in 2020 to capture early-calling species. The surveys followed the point count methodology outlined in the Marsh Monitoring Program (Bird Studies Canada, 2003). Stations were distributed across the Site Study Area, based on the locations of potential breeding habitat, and following spacing requirements in the methodology.

9.4.1.3.4 Bat Surveys

Bat surveys were conducted on the Site Study Area and included the use of acoustic bat detectors (Wildlife Acoustics SM3BAT+®). Two bat detectors were deployed and programmed to record bat calls for at least 10 consecutive nights, as per MNRF recommended protocols (MNRF, 2011). Each station was located to provide coverage of the Site Study Area and target areas where bats would most likely be roosting, commuting or feeding. The microphones were programmed to record from 30 minutes before sunset to 30 minutes after sunrise. The data were analyzed and auto-classified using SonoBat 4.2.1 nnE. The Sonobat program is specifically intended for discrimination of bats to the species level wherever possible, and validation of the species-level classification was conducted by Golder's bat acoustic specialist.

After the acoustic data was analyzed, Golder performed a search for individual trees in the vicinity of each acoustic monitoring station that may provide suitable bat maternity roost habitat. These searches were performed in winter (i.e., leaf-off conditions), allowing for a clear view of each tree, which assists in locating cavities, hollows, etc. that may be used for roosting.

9.4.1.3.5 Wildlife Habitat and Visual Encounter Surveys

During all field surveys, area searches for wildlife (VES) were conducted, including for those species groups not specifically targeted through the surveys described above. These VES were conducted following recommended procedures (McDiarmid, 2012; Bookhout, 1994; Pyle, 1984), where possible. All species observed (including direct observations, calls, tracks and other signs) were recorded. Specific attention was paid to searching for suitable habitat for S1 – S3 species, as well as micro-habitats that may provide significant wildlife habitat (e.g., vernal pools, rock outcrops, seeps and springs, etc.).

9.4.1.3.6 Aquatic Surveys

Headwater Drainage Features Assessment

Golder completed field investigations to confirm the flow and connection of the surface water features on the Site Study Area and to complete a Headwater Drainage Features (HDF) assessment. This assessment evaluated and classified each feature following the Evaluation, Classification, and Management of Headwater Drainage Features Guidelines (the Guidelines) developed by the Toronto and Region Conservation Authority and Credit Valley Conservation (TRCA and CVC, 2014). The assessment is based on data collected in the on-site surface water features according to Ontario Stream Assessment Protocol (OSAP) Section 4 Module 11 – Unconstrained Headwater Sampling (Gorenc and Stanfield, March 2017). Information gathered included basic measurements (wetted width and depth; feature width; bankfull depth; flow rates; etc.) as well as information on substrates, sediment deposition, barriers to fish movement, riparian conditions, etc.

Fish Habitat Survey

Golder conducted a fisheries habitat assessment in the fall of 2018 to characterize aquatic features and potential fish habitat within the Site Study Area. A second spring habitat assessment was performed in 2020 overlapping with HDF investigations. Golder has developed technical procedures for measuring and characterizing fish habitat in watercourses and waterbodies.

Examples of habitat features that were assessed, if encountered, are:

- channel unit type (riffle, run, pool, flat etc.)
- location of potential obstacles and barriers to fish passage
- representative bankfull widths, wetted widths and water depths
- evidence of groundwater seeps
- dominant substrate type
- in-stream cover, overhead cover
- aquatic macrophyte growth
- riparian cover and surrounding land use

If encountered, habitat characteristics were documented through digital photographs of both typical and sensitive features. In-situ field water quality information was collected in each of the watercourses on the Site Study Area, and included temperature, dissolved oxygen, pH and conductivity.

Fish Community Surveys

The objective of the fish community survey was to identify fish species that utilize the watercourses at the Site Study Area and their relative abundance (proportion of catch). Prior to undertaking fish community surveys in 2018 and 2020, Golder obtained a license to collect fish for scientific purposes from the MNRF. An attempt to conduct fish community surveys was conducted in fall 2018, then again in mid-summer and early fall 2020. Conditions encountered during each visit ranged from very shallow to dry, and fish community surveys were not possible.

9.4.1.4 Analysis of Significance and Sensitivity and Impact Assessment

An assessment was conducted to determine the significance and sensitivity of natural features as well as significant species observed or determined to have the potential to exist on the Site or the Site-vicinity Study Areas. The assessment was completed by comparing natural environment data collected through background material and the field surveys to published resources, and through a detailed analysis using the methods and criteria outlined in the Natural Heritage Reference Manual (NHRM) (MNRF, 2010), Significant Wildlife Habitat Technical Guide (SWHTG) (MNRF, 2000) and the Significant Wildlife Habitat Ecoregion Criterion Schedules (SWHECS) (MNRF, 2015).

9.4.1.5 Assessment of Wildlife Risk Potential

Golder completed an assessment of wildlife risk potential at the Site and the Study-vicinity Areas in accordance with the Wildland Fire Risk Assessment and Mitigation Reference Manual (MNRF, 2017). Golder's assessment employed the evaluation matrix provided in Appendix 4 of MNRF (2017). As part of the assessment, to feed into the evaluation matrix, Golder compared the forest habitats at the Site Study Area against the characteristics of hazardous forest types (Table 4-1 of MNRF, 2017).

9.4.2 Aquatic Ecosystems

9.4.2.1 Surface Water Features

There is a constructed watercourse (perimeter ditch) that follows the perimeter of the current landfill, flowing south along the western side of the landfill site (Reach 1), then east across the landfill site (Reach 3), then north along the eastern side of the landfill site (Reach 4) before connecting through a culvert under Boyne Road with Volks Municipal Drain, that runs along the north side of Boyne Road (Figure 9-10). There is another channelized watercourse/ditch (Reach 2) that flows into the perimeter ditch from the south (Figure 9-10). West of the Site Study Area within the Site-vicinity Study Area is the Quart Municipal Drain.

9.4.2.1.1 Reach 1

Reach 1 is an intermittent channelized stream/ditch that flows south from Boyne Road, along the western side of the landfill area on the landfill site before turning east, through a culvert under an access road, where it meets up with Reach 3. During the April 2020 survey, this reach had low flow, with a depth of 100 to 200 millimetres (mm). Wetted width was 1.5 m and bankful width was 2.2 m. Substrate was silt, clay, and organics. During the May 2020 survey, there was no visible flow, and water depth was 50 to 100 mm. Very little to no instream habitat features were observed, with the exception of some downed woody debris and a small proportion of emergent vegetation such as grasses. This reach was dry during the July and September 2020 surveys. Refer to Table 9-14 for basic water quality parameters.

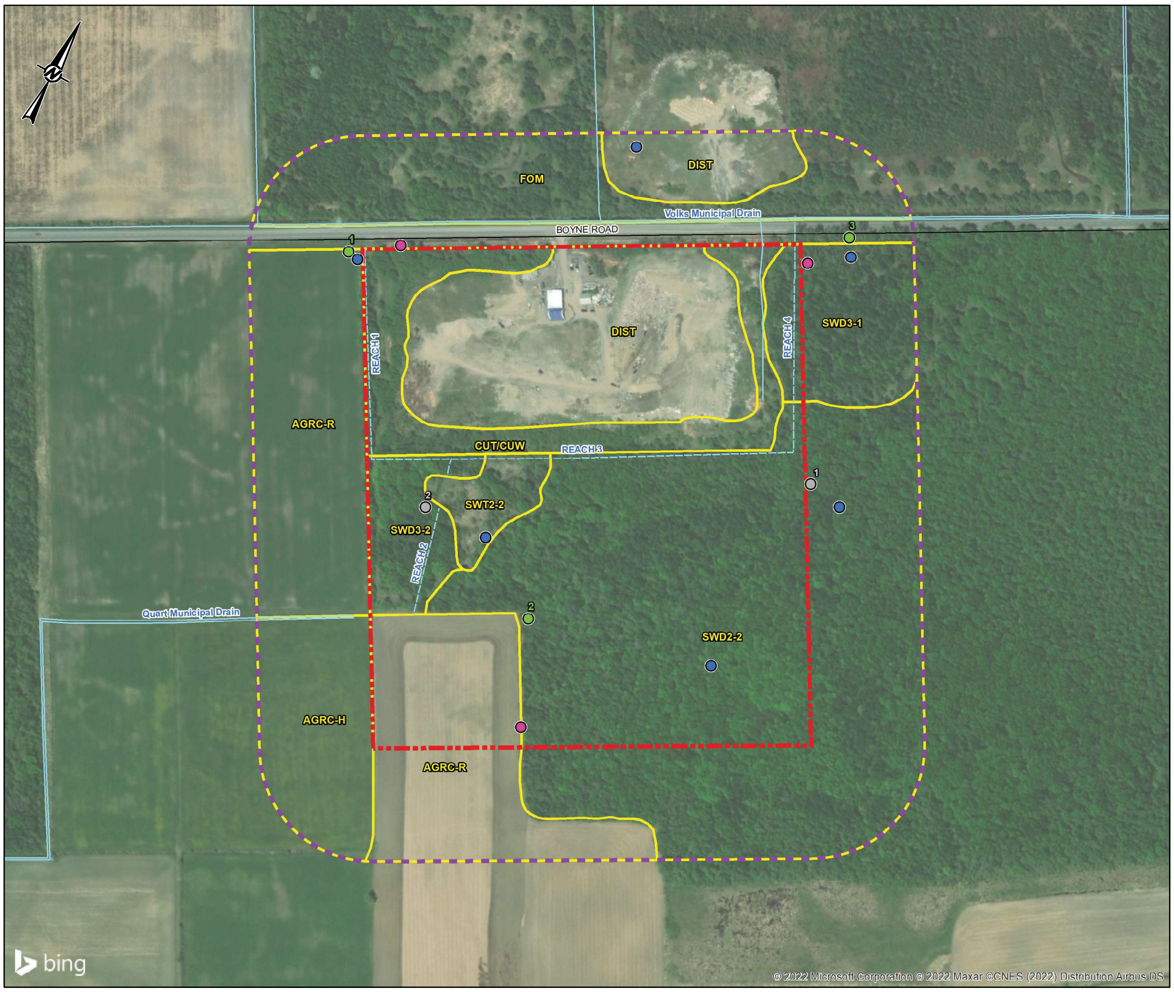
9.4.2.1.2 Reach 2

Reach 2 is an intermittent channelized stream/ditch that flows from a tile drain in a row crop field towards the south of the landfill site, where it runs north through a culvert under an access road before meeting up with Reach 3. During the April 2020 survey, this reach had low flow, with a depth of 100 to 140 mm. Wetted width was 1.9 m and bankfull width was

2.5 m. Substrate was silt, clay, and organics. During the May 2020 survey, there was no visible flow, with some portions of the streambed was dry. Very little to no instream habitat features were observed, with the exception of some downed woody debris and a small proportion of emergent and submerged plants such as grasses and forbs. This reach was dry during the July 2020 and September 2020 surveys. Refer to Table 9-14 for basic water quality parameters.

9.4.2.1.3 Reach 3

Reach 3 is an intermittent channelized stream/ditch that parallels the southern boundary of the existing landfill before meeting up with Reach 4. During the April 2020 survey, this reach had low to moderate flow, with a depth of 100 to 280 mm. Wetted width was 2.5 m and bankful width was 2.5 m. Substrate was silt, clay, and organics. During the May 2020 survey, there was low flow. Very little to no instream habitat features were observed, with the exception of some downed woody debris and vegetation such as grasses and forbs. This reach was dry during the July 2020 and September 2020 surveys. Refer to Table 9-14 for basic water quality parameters.



LEGEND

- BAT SURVEY STATION
- BREEDING BIRD SURVEY STATION
- AMPHIBIAN CALL-COUNT SURVEY STATION
- EASTERN WHIP-POOR-WILL SURVEY STATION
- WATERCOURSE
- INTERMITTENT WATERCOURSE
- ROADWAY
- SITE STUDY AREA
- 120 m STUDY AREA
- ECOLOGICAL LAND CLASSIFICATION

AGRC-R: AGRICULTURAL ROW CROP
AGRC-H: AGRICULTURAL HAYFIELD
CUT/CUW: DECIDUOUS THICKET/OPEN WOODLAND
DIST: DISTURBED
FOM: MIXED FOREST
SWD2-2: GREEN ASH - MAPLE MINERAL DECIDUOUS SWAMP
SWD3-1: RED MAPLE MINERAL DECIDUOUS SWAMP
SWD3-2: SILVER MAPLE MINERAL DECIDUOUS SWAMP
SWT2-2: WILLOW MINERAL THICKET SWAMP

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2014
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: MTM ZONE 9 VERTICAL DATUM: CGVD28

0 40 80 160
1:4,000 METRES

CLIENT
TOWNSHIP OF NORTH DUNDAS

PROJECT
INDIVIDUAL ENVIRONMENTAL ASSESSMENT OF THE TOWNSHIP OF NORTH DUNDAS WASTE MANAGEMENT PLAN

TITLE
ECOLOGICAL LAND CLASSIFICATION AND BIOLOGICAL SURVEY STATION LOCATIONS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-01-28
DESIGNED	----
PREPARED	JEM
REVIEWED	YJM
APPROVED	PLE

PROJECT NO.	PHASE/TASK	REV.	FIGURE
1648253	2.0/2.2.0	0	9-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
25mm
0

9.4.2.1.4 Reach 4

Reach 4 is an intermittent channelized stream/ditch that parallels the eastern boundary of the existing landfill, flowing north through a culvert under Boyne Road into Volks Municipal Drain. During the April 2020 survey, this reach had low to moderate flow, with a depth of 100 to 200 mm. Wetted width was 3.7 m and bankfull width was 4.2 m. Substrate was silt, clay, and organics. During the May 2020 survey, there was low flow. Very little to no instream habitat features were observed, with the exception of some downed woody debris and a small proportion of submerged, emergent, and overhanging vegetation such as grasses, forbs, and multi-cellular algae. This reach was primarily dry during the July 2020 and September 2020 surveys, with water being restricted to isolated pockets of 2 to 5 centimetres (cm) in July. Refer to Table 9-14 for basic water quality parameters.

9.4.2.1.5 Volks Municipal Drain

Volks Municipal Drain is a permanent channelized stream that flows along the northern side of Boyne Road opposite the landfill area. This is the receiving feature of the on-site watercourse/perimeter ditch. Targeted surveys were not completed in this feature; however, it was observed to have low-moderate flow in April 2020, with low to no flow in July 2020 and September 2020. This feature was heavily vegetated during the July and September surveys, with dense aquatic vegetation, including submerged, floating, and emergent plants. Bankfull widths range from approximately 2.5 m to 4.5 m in the Site-vicinity Study Area.

9.4.2.1.6 Quart Municipal Drain

The Quart Municipal Drain has been historically observed as dry and does not connect to the perimeter ditch which services the landfill fill area. Although historically dry, the designed drainage of the ditch is towards the west and would also not permit flow into Reach 2. The feature is characterized as a linear depression, heavily vegetated with various grasses and goldenrods. It is approximately 3-4 m wide with a depth of approximately 0.5 m.

Table 9-14: Basic Water Quality Parameters of On-site Water Features

Water Feature	Air Temperature °C	Water Temperature °C	Dissolved Oxygen (mg/l)	pH	Specific Conductivity (µs)
Reach 1 *April 2020*	4	4.4	5.17	7.45	962
Reach 2 *April 2020*	4	3.7	14.05	8.4	910
Reach 3 *April 2020*	5	4.5	8.28	8.58	935
Reach 4 *April 2020*	5	3.8	6.34	7.93	921

Water Feature	Air Temperature °C	Water Temperature °C	Dissolved Oxygen (mg/l)	pH	Specific Conductivity (µs)
Reach 1 *May 2020*	10	5.9	6.9	8.8	758
Reach 2 *May 2020*	10	7.7	6.02	8.14	808
Reach 3 *May 2020*	10	8.6	8.52	8.13	1293
Reach 4 *May 2020*	11	6.5	6.22	7.68	638

9.4.2.1.7 Headwater Drainage Features Assessment

A Headwater Drainage Features Assessment was undertaken for each reach of the on-site watercourse/perimeter ditch according to the Guidelines (TRCA and CVC, 2014). Using the information collected during the field investigations, the following four characteristics of the reaches were classified according to the Guidelines:

- Hydrology
- Riparian conditions
- Fish and fish habitat
- Terrestrial habitat

The results of the classifications for each reach are presented in Volume 2 Appendix F-1. Figure 2 of the Guidelines provides a flow-chart that allows the assessor to input the various classifications determined for each of the four characteristics for each reach and arrive at a management recommendation for that reach. Based on the flow-chart, the management recommendations for each of the four reaches is “conservation”.

According to the Guidelines, a management recommendation of “conservation” entails maintaining, relocating or enhancing the feature and its riparian zone; maintain or replace on-site flows; maintain or replace external flows; use natural channel design techniques to maintain or enhance over-all productivity of the reach; and ensure downstream connection is maintained.