# 2020 Annual Report, Kashwakamak Waste Disposal Site

Environmental Compliance Approval No. A380203

March 25, 2021

Prepared for:
The Corporation of the Township of North Frontenac

Cambium Reference: 10530-004

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## Executive Summary

The Kashwakamak Waste Disposal Site operates under Ministry of the Environment, Conservation and Parks Environment Compliance Approval No. A380203. The Site is on Lots 18 and 19, Concession 4 and 5, geographic Township of Barrie, Township of North Frontenac. The site is at 1749 Kashwakamak Lake Road, just north of the Village of Harlow, and is owned and operated by the Township of North Frontenac. The site consists of an approved fill area of 0.8 ha within a total site area of 6.6 ha and a maximum waste disposal capacity of 26,200 $m^3$.

The water level measurements indicated that groundwater flowed toward the southeast with a component to the northwest in the low lying (southeast) portion of the property.

Water chemistry data indicated that the leachate plume continued to be generated beneath the waste mound; however, the strength of the leachate was naturally attenuated within the property boundary. The trigger was not activated and confirmation sampling was not initiated. The site complied with the Ministry of the Environment, Conservation and Parks Reasonable Use Concept.

Approximately 140 $m^3$ of waste and cover material was landfilled at the Site between October 2019 and October, 2020, resulting in a remaining waste disposal capacity of 17,115 $m^3$ as of October 2020. Based on a calculated average annual volume of material of 210 $m^3$, this equates to more than 80 years of Site life remaining.

The Township of North Frontenac operated the Kashwakamak waste disposal site in compliance with the Environment Compliance Approval in 2020.

Recommendations have been made regarding the future operation of the Kashwakamak waste disposal site and work to be completed in 2021.

Respectfully submitted,

**Cambium Inc.**

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# 1.0 Introduction

The Corporation of the Township of North Frontenac (Township) retained Cambium Inc. (Cambium) to complete the 2020 annual monitoring program for the Kashwakamak waste disposal site (Site). The Site operates under Ontario Ministry of the Environment, Conservation and Parks (Ministry) Environmental Compliance Approval (ECA) No. A380203, last amended July 13, 2017 (Appendix A).

To aid in the understanding of the Site history and development, the following report is included digitally in the report package:

- *Kashwakamak Waste Disposal Site, Design, Operation & Closure Plan* (AECOM, 2010)

## 1.1 Site Location

The Site is on Lots 18 and 19, Concession 4 and 5, in the geographic Township of Barrie, Township of North Frontenac. The Site is at 1749 Kashwakmaka Lake Road, just north of the Village of Harlow (Figure 1). The Universal Transverse Mercator (UTM) coordinates for the site entrance are Zone 18T, 334841 m east, 4965739 m north.

## 1.2 Site Description

The Site is a natural attenuation landfill and is owned and operated by the Township. The Site is approved as a landfill for disposal of solid, non-hazardous municipal waste in accordance with ECA No. A380203, servicing the Township of North Frontenac. Site details are in Embedded Table 1. A Local Topography Plan is included as Figure 2 and an Existing Condition Plan is provided as Figure 3.

**Embedded Table 1 Site Details**

| | |
|---|---|
| Total Site Area | 6.6 ha |
| Approved Area of Refuse Placement | 0.8 ha |
| Total Capacity, not including Final Cover | 26,000 m³ |

## 1.3 Scope of Work

The scope of the 2020 monitoring program was based on the results of the 2019 program (Cambium, 2020), the requirements of Conditions Nos. 6 (6) and 6 (7) of the ECA, and included the following:

- Groundwater elevation monitoring
- Groundwater sampling and analysis
- Evaluation of groundwater quality against the Reasonable Use Concept (RUC) values developed in accordance with Ministry Guideline B-7
- An overview of site development and operations
- Preparation of this annual report

This report presents the results of the 2020 work program, provides an assessment of the current landfill impact of the Site on the surrounding groundwater environments, and a summary of the operational activities at the Site. Cambium has provided recommendations for the 2021 monitoring program and site operations based on the 2020 results and assessment.

# 2.0 Methodology

This section provides a brief description of the methodology followed to complete the 2020 monitoring program.

The work program was completed in 2020 to maintain compliance with the Site ECA and Ministry guidelines and regulations. As such, the environmental monitoring work program was completed consistent with the reports entitled *Guidance Manual for Landfill Sites Receiving Municipal Waste* (MOEE, 1993) and *Monitoring and Reporting for Waste Disposal Sites, Groundwater and Surface Water, Technical Guidance Document* (MOE, 2010).

Field tasks were completed following Cambium's Standard Operating Procedures developed from recognized standard procedures such as those listed above and the Ministry document *Guidance on Sampling and Analytical Methods for use at Contaminated Sites in Ontario* (MOEE, 1996). A health and safety program was developed for Site specific conditions and all Cambium personnel working on the project were familiarized and required to follow the identified protocol.

Groundwater samples were collected at the locations and frequencies shown in Table 1. All collected groundwater samples were stored in coolers with freezer packs and maintained at less than 10°C after collection and during transport to Caduceon Environmental Laboratories in Kingston, Ontario (Caduceon). Caduceon is accredited by the Canadian Associations for Laboratory Accreditation Inc. (CALA) for specific environmental tests listed in the scope of accreditation approved by the CALA.

## 2.1 Groundwater Monitoring Program

The following tasks were completed as part of the 2020 groundwater monitoring program:

- Prior to sampling, water levels were measured at each monitoring well using an electronic water level tape.
- The purge volume was calculated on-site during each monitoring event using the measured water level, well depth, and the borehole diameter. Each groundwater monitoring well to be

sampled was purged of approximately three well bore volumes. For wells with low recovery, at least one saturated borehole volume was purged prior to sampling. Purged water was disposed on-site, down-gradient of each respective well.

- Samples were collected using dedicated polyethylene tubing equipped with inertial-lift foot valves.
- Groundwater samples for metals and dissolved organic carbon (DOC) analysis were field filtered.
- Field measurements were recorded for pH, conductivity, temperature, dissolved oxygen (DO), and oxygen reduction potential (ORP).

Water levels were measured and groundwater samples were collected on June 4 and October 8 from the on-site monitoring wells listed below, with the following exceptions:

- MW03S was not sampled due to water being above the casing creating an unrepresentable sample in June
- DP12 had a limited sample in June and biological oxygen demand (BOD) and total suspended solids (TSS) were not analyzed
- Field notes were not collected at MW09 in June

Monitoring wells included in the groundwater monitoring program are shown on Figure 2. The UTM coordinates for the monitoring locations are in Table 2. Groundwater results are in Section 4.2. Field data sheets are in Appendix B. Laboratory Certificates of Analysis are in Appendix C. Photographs of each monitoring location are in Appendix D.

- MW01
- MW02
- MW03S
- MW03D
- MW04
- MW05
- DP06-R
- DP07-R
- DP08-R
- MW09
- DP11
- DP12

- DP13
- MW106S
- MW106D
- MW107S
- MW107D

Blind duplicate groundwater samples were collected from MW09 and MW107S during both sampling events as part of the Quality Assurance/Quality Control (QA/QC) program. As these field duplicates equate to at least 10% of the total samples collected, this is an adequate QA/QC program for groundwater. In addition to these samples, the laboratory completes internal QA/QC. The results of the QA/QC program are presented in Section 4.1.

## 2.2 Surface Water Monitoring Program

No surface water monitoring program exists for the Site as no discernable drainage features are at or near the Site.

## 2.3 Landfill Gas Monitoring Program

Landfill gas (LFG) is not actively managed at the Site. The large, open site area and isolated location from the public supports passive landfill gas management, which allows generated landfill gas to naturally disperse through the waste and naturally-permeable cover to the atmosphere.

Landfill gas monitoring was conducted at the groundwater monitoring wells in 2020 in conjunction with the June and October monitoring events. Total combustible gas concentrations were measured at each location, prior to collecting groundwater levels or samples, using a portable gas meter calibrated to methane. Exceptions are as follows:

- No reading was completed in June at MW03s due to water being above the casing and in October due to a broken pipe
- Field notes were not collected for MW09 in June
- No reading was completed at MW04 in June
- No reading was completed at MW106D in June due to meter malfunction.

- No reading was completed at DP06-R in October.

The landfill gas monitoring results for the 2020 monitoring program are in Table 6 and discussed in Section 4.3.

## 2.4 Topographic Survey

Cambium conducted a topographic survey of the Site on October 8, 2020. The survey was completed using a Topcon Real Time Kinematic (RTK) enabled HiPer II system with an FC-25 field controller. The survey data was used to prepare an updated plan of the Site using AutoCAD® software.

The survey was completed to determine the area and elevation of the waste mound and the stockpiles present at the Site. Survey data was then used to calculate the volume of waste deposited at the Site since the previous survey completed in October 2019 and the remaining capacity at the Site. The results of the topographic survey are discussed in Section 5.8.

## 2.5 Site Review and Operations Overview

Site operations were observed during site visits in June and October 2020. During these visits, the items listed below were inspected on accessed areas of the Site and observations noted in the field file. In January 2021, the Township provided additional 2020 site operations information. Site inspection results are presented in Section 5.0.

- Litter control
- Condition and layout of recycling bins
- Status of monitoring well security
- Condition and layout of access roads, access gates
- Site development
- Waste placement and compaction
- Cover material application

# 3.0 Geological and Hydrogeological Context

## 3.1 Topography and Drainage

The Site is in the Upper Mississippi subwatershed, within the Mississippi River watershed. The Mississippi River watershed is in southeastern Ontario and is composed of a complex network of rivers, streams, rapids, and over 250 lakes. The Mississippi River has a drainage area of 3,740 km² from its headwaters in Kilpecker Creek, in the Township of Addington Highlands, to its outlet at the Ottawa River in the City of Ottawa (MNR, 2006).

Based on regional topography, the Site is on the south side of a geographic high which parallels Lake Kashwakamak to the west forming a water-table divide. Overland flow from the Site is to the south and east toward an extensive low-lying forested area. There are no observable surface water features or flows from the Site; however, particularly during spring sampling events, ponded water is observed in the area of monitors MW107S/D and MW106S/D assumed to be connected to the wet area southeast of the Site. As shown on Figure 3, the wet area extends east and ultimately connects to Big Gull Lake, 2 km to the southeast. There are no provincially significant wetlands within 500 m of the Site.

### 3.1.1 Precipitation Data

A review of the 2020 precipitation data (Government of Canada, 2020) in comparison to the average precipitation data for 1981 to 2010 for the Drummond Centre Station (Government of Canada, 2015) indicated that the annual precipitation was normal; however, varied month to month. January, March, and August received more precipitation than normal, while May, June, September, and November received less. The monthly precipitation, as well as the amount of precipitation during and in the three days prior to the sampling events is summarized in Embedded Table 2. Refer to Appendix C for field sheets and climate data.

**Embedded Table 2 Historical and 2020 Precipitation Data**

| Sampling Date | Average Monthly Precipitation (mm) (1981 – 2010) | 2020 Precipitation (mm) | Precipitation During and Prior to Sampling (mm) |
|---|---|---|---|
| June 4 | 82.4 | 46.2 | 6.6 |
| October 8 | 78.5 | 76.4 | 2.6 |

## 3.2 Hydrogeology

Regionally, the Site is within a moderately undulating Precambrian peneplain, characterized by southwest trending metasedimentary bedrock ridges. It is expected that bedrock is thinly covered by sandy silt till overburden throughout the area. The bedrock beneath the Site is composed of carbonate and clastic metasediments.

A surficial bedrock ridge extending east into the Site from Kashwakamak Lake Road terminates about 80 m from the road, where it drops 3 m. Surficial bedrock continues on the southern and northern portions of the Site beyond this ridge where trees have been cleared in the area east of the ridge.

Based on the existing geological conditions, it would be expected that very little groundwater flow occurs in the bedrock below the landfill. Most flow is via the shallow subsurface through the landfill or overland surface water flow into the wet area southeast of the mound, when precipitation occurs. The landfill wastes are generally above the water table, although may be seasonally within the water table at the base of the waste beyond the bedrock ridge (AECOM, 2015).

There are currently 17 wells on-site including:

- Overburden: MW05, DP06-R, DP07-R, DP08-R, DP11, DP12, DP13, and MW106S.
- Bedrock: MW01, MW02, MW03S, MW03D, MW04, MW106-15D, MW107-15S, and MW107-15D.
- Interface: MW09

Most monitors are installed between 1.0 and 7.0 m below ground surface (bgs), with the exception of monitoring wells MW01 and MW03S installed 12 mbgs and monitor MW03D installed greater than 30 mbgs. Monitors MW01, MW02, MW03, MW04, and DP11 were installed up and cross-gradient to the waste mound, while the remaining monitors were installed down-gradient and south and southeast of the waste mound.

The following provides a chronological history of the monitoring well installations at the Site (available borehole logs for the Site are in Appendix E).

- MW01, MW02, and MW03 were installed at the Site in the early 1990s.
- MW04 and MW05 were installed in the autumn of 2009. MW04 was installed in bedrock and MW05 was installed in organic surficial soils (AECOM, 2010).
- Three drive-point piezometers (DP06, DP07, and DP08) were installed in the overburden in the autumn of 2009. DP06, DP07, and DP08 were constructed with galvanized steel and were replaced with monitors constructed from PVC and renamed to DP06-R (2014), DP07-R (2015), and DP08-R (2015), respectively (AECOM, 2010).
- MW09 was installed in 2011 and screened at the overburden/bedrock interface. Drive-point DP10 was also installed in 2011 as a leachate monitoring well (AECOM, 2015).
- DP10 was decommissioned and replaced by drive-point piezometers DP12 and DP13 in 2014 (AECOM, 2015).
- Drive-point piezometer DP11 was installed in 2014 to better understand background concentrations at the Site, particularly in the organic overburden.
- MW106S/D and MW107S/D were installed in 2015 to determine compliance at the down-gradient property boundary.

### 3.2.1 Well Records

Low to moderate water transmitting potential is expected within the bedrock aquifer as local domestic wells are commonly installed at depths of less than 30 mbgs. There are two residences along Kashwakamak Lake north of the groundwater divide, within 500 m of the

Site. Since these wells are installed at 24 and 28 mbgs in the deep bedrock unit, they are in a different aquifer than the overburden aquifer at the Site. Impacts to this deeper water supply aquifer from the Site are not expected. Logs for the domestic supply wells at these properties are included in Appendix E.

### 3.2.2 Groundwater Flow Direction

Historically, the general direction of groundwater flow in the deep bedrock was to the south and southeast from the waste disposal area toward an extensive forested, low-lying wet area (Figure 3). With the inclusion of the new monitoring wells in 2015, the groundwater flow has a component to the northwest from the southern property boundary, with flow to a low point near the southeast corner of the approved waste area. Regardless, on a regional scale, groundwater ultimately flows southeasterly from the Site.

The water level data collected in 2020 are in Table 2 and on Figure 4 and Figure 5. Water levels in the overburden and bedrock wells were consistent with historical results with the exception of DP06-R which was high in the spring. Seasonal fluctuations were present in the overburden and more substantial fluctuations were present in the bedrock wells. The water level at DP06-R was abnormally high in the spring.

Groundwater flow continued to the southeast through the waste mound in the overburden and a small northwest component of flow was near monitoring well nest MW106, consistent with calculations since 2015. In the spring groundwater in the bedrock mimicked the overburden pattern but in the autumn there was also a northeastern flow across the waste mound.

The groundwater flow directions and potentiometric surface are on Figure 6 and Figure 7. Hydraulic gradients calculated are in Embedded Table 3.

**Embedded Table 3 Summary of Horizontal Hydraulic Gradients**

| | Waste Mound Area | Southeast Low Lands |
|---|---|---|
| Overburden | | |
| Spring | 0.010 m/m | Limited flow |
| Autumn | 0.011 m/m | Limited flow |
| Bedrock | | |
| Spring | 0.005 m/m | 0.002 m/m |
| Autumn | 0.009 m/m | 0.005 m/m |

### 3.2.3 Vertical Gradients

Given there are monitoring well nests installed on-site, vertical gradients were calculated to determine the vertical direction of groundwater flow, particularly between different stratigraphic layers (i.e., overburden and bedrock) (Table 3). Downward gradients have been typical at monitor nests MW01/MW02 and MW03 and upward gradients have been typical at well nest MW107; however, seasonal fluctuations have sometimes been present. Limited vertical gradients at well nest MW106 prior to 2018, distinct upward gradients in 2018 and May 2019, then limited gradients in October 2019. In 2020 there was limited gradients at nested wells MW106 most consistent with historical results. Flooding in the area of well nest MW106 has likely caused the changing gradients. Nested wells MW01/MW02 and MW107 had downward gradients in June and upward gradients in October.

Given the generally competent structure of the bedrock, it is expected that groundwater will flow down to the shallow fractured bedrock, then follow the bedrock surface and travel southeast from the waste mound and Site.

### 3.2.4 Conceptual Site Model

Groundwater flow at the Site in the overburden and shallow fractured bedrock is southeasterly from the waste disposal area to the low-lying wet area. Given that the bedrock across the Site is relatively competent, low to moderate water transmitting potential is expected within the deeper bedrock aquifer. Vertical gradients across the Site have been inconsistent, likely due to

connectivity between the aquifers monitored and the intermittent flooding adjacent well nest MW106. It is interpreted that groundwater flows downward through the overburden unit and along the overburden-bedrock contact toward the south and southeast where it discharges to surface for at least part of the year.

# 4.0 Results and Discussion

Water quality results from the 2020 monitoring program are used to assess the existence, extent, and degree of impacts to the groundwater and surface water environments related to waste disposal site activities at the Site.

To ensure appropriate actions are in place to respond to degradation in groundwater quality beyond an acceptable level, site-specific trigger levels and contingency measures aid in the assessment of impacts from leachate contamination and help to prevent adverse impacts to the environments surrounding the waste disposal site.

This section presents the results of the 2020 monitoring program.

## 4.1 Quality Assurance / Quality Control

Results from the analyses completed on the blind duplicate QA/QC samples were evaluated. Parameter concentrations were considered significantly different if the relative percent difference (RPD) between the duplicate and the parent samples was greater than 30% when at least one result was greater than five times the reported detection limit (RDL).

The duplicate groundwater analyses were compared to the originals. Overall, the duplicate samples correlated well with the parent samples and met the data quality objective of 30%. Exceptions noted included:

- Arsenic at MW107S in the autumn
- TSS at MW107S and MW09 in the autumn

Considering the low variation between the parent and duplicate groundwater samples, the groundwater results were interpreted with confidence.

## 4.2 Groundwater Quality

The groundwater chemistry data obtained from the analysis of groundwater samples collected from the monitoring wells at the Site from 2009 to 2020 are in Table 4 for wells within the overburden and Table 5 for wells in the bedrock.

To assess water quality impacts related to landfill site operations, the analytical results for groundwater samples collected on-site were compared to background water quality and historical data, and compliance was assessed using RUC values developed in accordance with Ministry Guideline B-7 (MOEE, 1994a).

### 4.2.1 Background Groundwater Quality

When evaluating the impact of any waste disposal site on a groundwater resource, a reference point or value must be established to assist in determining the magnitude of the impact. In this respect, the quality of the groundwater that is non-impacted by the waste disposal site operation (background water quality) should be used for comparison purposes. Given the location of monitoring wells MW01 and MW02 (Figure 3), these wells have been used to determine background bedrock water quality at the Site (Table 5). Drive-point piezometer DP11 has been used to represent background overburden water quality at the Site, particularly in the shallow organic soils (Table 4).

Water quality data at monitors MW01 and MW02 have had low to moderate concentrations for most parameters, with sporadically elevated concentrations of alkalinity, total dissolved solids (TDS), calcium, and manganese. TSS concentration reached a historical high in October 2019 at MW01; concentrations decreased within historical ranges in 2020. MW02. Chloride and sodium have been increasing over time at both MW01 and MW02. Concentrations at these wells have been similar despite their different depths.

Background overburden water quality at DP11 has had many of the same elevated parameter concentrations as monitors MW01 and MW02; however, has also had elevated concentrations of chemical oxygen demand (COD), ammonia, total phosphorus, and barium. These elevated concentrations have been attributed to the organic soils that are saturated for at least part of the year. Total Kjeldahl nitrogen (TKN) has been decreasing since 2014 and TSS concentrations have been decreasing since peak concentrations in 2015. Increasing trends previously noted for alkalinity began to stabilize in 2019 and 2020. Increasing trends for ammonia and barium continued in 2020. Iron has fluctuated significantly and has increased overall since 2014.

Naturally elevated concentrations of alkalinity, TDS, DOC, iron, calcium, and manganese are present in the bedrock and overburden water quality at the Site. Furthermore, water quality in the overburden has had elevated concentrations when compared to the bedrock, particularly the nutrient parameters (COD, ammonia, TKN, total phosphorus).

### 4.2.2 Leachate Characteristics

Water quality at drive-point piezometers DP12 and DP13 (Table 4) was compared to background bedrock monitors MW01 and MW02, as well as background overburden monitor DP11. Embedded Table 4 lists the leachate indicator parameters (LIPs) determined for the Site following this comparison.

**Embedded Table 4 Leachate Indicator Parameters**

| | | | |
|---|---|---|---|
| alkalinity | conductivity | **TDS** | **DOC** |
| chloride | sodium | hardness | **barium** |
| boron | calcium | potassium | **iron** |
| magnesium | **manganese** | | |

Many of the identified LIPs, although elevated in the leachate, were also naturally elevated at the Site including the following and shown bolded in Embedded Table 4: TDS, DOC, iron, manganese, and barium. These parameters were examined with caution and were not the sole basis for determining impacts down-gradient of the Site.

Many LIP concentrations at DP13 have increased, particularly in recent years (e.g., conductivity, sodium, chloride, barium, potassium, manganese, etc.), as well as parameters not necessarily associated with leachate at the Site such as arsenic and ammonia. Conversely, some concentrations have decreased overtime such as DOC (despite a historical high in June 2020) and magnesium. Although concentrations have generally been less at DP12 than DP13, similar trends have occurred, with increasing concentrations for many LIPs (e.g., alkalinity, TDS, conductivity, calcium, chloride, magnesium, sodium, etc.). Stable trends continued at DP12 for LIPs DOC, iron, manganese, and potassium. Notably, barium concentrations at DP12 were less than the background overburden well DP11 confirming barium is naturally elevated in areas at the Site.

### 4.2.3 Down-Gradient Groundwater Quality - Overburden

Down-gradient overburden drive-points and monitoring wells include: MW05, DP06-R, DP07-R, DP08-R, and MW106S (Table 4). DP06-R, DP07-R, and DP08-R are 20 to 35 m east, southeast, and south of the waste disposal area, down-gradient of leachate drive-point piezometers DP12 and DP13. Monitor MW05 is 20 m southeast of the waste mound. Monitor MW106S is down-gradient of DP07-R, adjacent the southern property boundary (Figure 3).

In general, the following observations were made about the down-gradient water quality:

- The majority of LIPs have been elevated at DP06-R and MW05 when compared to concentrations at background monitor DP11, which is not unexpected given their proximity to the landfill. The water quality at these locations have been similar concentrations and followed similar trends with the exception of iron (greater at MW05). Notably, the majority of LIPs at monitors DP06-R and MW05 have been less than concentrations at DP13 but greater than DP12 (with the exception of magnesium in recent years and DOC). This suggests a greater influence of the landfill plume to the east of the waste disposal area supporting the inference of a southeast flow component. This also coincides with the location of the active disposal area.
- LIP concentrations at DP07-R and DP08-R were less than both leachate monitors (DP12 and DP13) and were less than concentrations at background piezometer DP11. The only exception was DOC; however, this was attributed to natural variations as it is commonly high in all the background monitoring well.
- LIPs concentrations at monitoring well MW106S were less than background drive-point DP11, except for DOC and iron, and concentrations were generally similar to DP08-R. The water quality indicated the leachate plume has yet to reach this location and the down-gradient property boundary in the overburden. Given the northwest flow component in this area, this was not unexpected.
- Some LIP concentrations showed variability across monitoring locations which were inconsistent with impact from the waste disposal site. For example, DOC, magnesium, and

iron were greater at some down-gradient locations than at the leachate monitors. This is attributed to specific conditions (i.e., natural variations) at these monitors which are situated in the lowland areas around the base of the waste disposal site.

Increasing concentration trends continued in 2020 for various LIPs at DP06-R and MW05 including chloride, conductivity, manganese, potassium, sodium, and TDS. Parameter concentrations at the remaining down-gradient monitors were comparable to their historical ranges and were stable. Where variations were noted, these were attributed to seasonal variations. DP07-R, DP08-R, and MW106S remained un-impacted by the Site.

Based on the 2020 data, impact to the overburden water quality has not changed markedly over the past year and continued to be naturally attenuated within 30 m down-gradient of the waste mound.

### 4.2.4 Down-gradient Groundwater Quality – Bedrock

Down-gradient bedrock monitoring wells MW03S, MW03D, and MW04 are adjacent and west of the waste mound, drive-point MW09 is 35 m east of the waste disposal area, and monitors MW106D and MW107S/D are 100 m southeast and 80 m south and down-gradient of the waste mound, respectively (Figure 3).

In general, the following observations were made about the down-gradient bedrock water quality (Table 5).

- Concentrations at monitors MW03S and MW03D have generally been similar to background concentrations with the exception of boron at MW03D which has been greater than the leachate concentrations. Sodium has also been elevated at MW03D compared to background concentrations and DP12, but less than the concentrations at DP13. Increasing chloride concentrations continued at MW03S in 2020, consistent with MW01 and MW02.
- Given the location of MW03S and MW03D cross-gradient to the waste mound and installation depths, impacts are expected to be minimal, if at all. As the water transmitting potential in the bedrock is noted to be low, it is expected the vertical migration of the leachate is limited. As such, the elevated concentrations at MW03D may provide insight

into naturally elevated concentrations in the deeper portion of the bedrock aquifer (i.e., greater than 30 mbgs) that could potentially upwell into the shallower bedrock aquifer.

- Concentrations at MW04 have been similar to background and MW03S, particularly to MW01. Where LIP concentrations have been greater at MW04 relative to the background water quality (e.g., barium, boron, potassium, etc.), the trends have been similar to those at MW01 indicating natural variations opposed to site-related impacts. Increasing trends of chloride and sodium continued in 2020, which mirrored the increasing trends reported at MW01 and MW02. Similar to MW03S/D, MW04 is cross-gradient to the waste mound and is not expected to be impacted.
- MW09 is impacted and concentrations have been similar to DP13 (and DP12). Concentrations of some LIPs have decreased over the past several years including alkalinity, barium, iron, and magnesium. Conversely, chloride and manganese have increased. These trends continued in 2020.
- With the exception of potassium, concentrations at MW106D and MW107S have been similar to each other and the background water quality at MW01 and MW02. Potassium has been elevated at MW106D. Where concentrations have been elevated at MW106D and MW107S compared to background (e.g., barium, boron, iron, DOC), the elevated concentrations have been attributed to the low-lying wetland environment in the area of the monitors. Impacts from the Site have not been present at these locations to date. Given the northwest flow component in this region, impacts are not expected at these locations.
- Concentrations at MW106S (overburden) and MW106D (bedrock) have been similar for many LIPs; however, boron, magnesium, and potassium (and sodium historically) have been greater at MW106D. Iron and DOC have been greater at MW106S. As both locations are not interpreted to be impacted, this may provide insight into the natural variations in the aquifers on-site.
- Many LIP concentrations have been elevated at MW107D, reporting concentrations similar to DP12 (i.e., alkalinity, calcium, conductivity, iron, manganese, DOC, potassium, sodium, TDS) and DP13 (i.e., barium, boron, magnesium). Given the location of this monitor,

groundwater flow direction toward the northwest in this area, and the low potential for water transmission in the bedrock at the Site, it is unclear if the source of the elevated concentrations at this location is site related or is due to natural variations in the water quality in the lowland. Chloride concentrations continued to increase in 2020, similar to many un-impacted wells on-site.

Other than the trends noted herein, water quality at the down-gradient bedrock wells remained stable in 2020. Impacts were evident at MW09 east of the waste mound; however, the remaining bedrock wells cross- and down-gradient of the waste mound (with the exception of MW107D) remained marginally impacted, if at all. The source of the elevated concentrations at MW107D is unclear at this time, but is not expected to be entirely site-related, if at all. Impacts are not interpreted to extend as far as the southern property boundary in the bedrock aquifer at this time.

### 4.2.5 Volatile Organic Compounds

The only detectable volatile organic compound (VOC) concentrations in 2020 were vinyl chloride at DP13 in June and October. The remaining VOC concentrations at all remaining wells were less than the RDLs in 2020.

### 4.2.6 Groundwater Trigger Mechanisms

To ensure appropriate actions are in place to respond to any potential degradation in groundwater quality beyond an acceptable level, site-specific trigger levels have been developed for the Site. These are the RUC values developed in accordance with Ministry Guideline B-7 (MOEE, 1994a). The Ministry Guideline B-7 states that, in accordance with the appropriate criteria for particular uses, a change in quality of the groundwater on an adjacent property will be accepted only as follows (Ministry Procedure B-7-1):

*The quality cannot be degraded by an amount in excess of 50% of the difference between background and the Ontario Drinking Water Standards (ODWQS) for non-health related parameters and in excess of 25% of the difference between*

*background and the ODWQS for health-related parameters. Background is considered to be the quality of the groundwater prior to any man-made contamination.*

The maximum concentration of a particular contaminant that is considered acceptable in the groundwater beneath an adjacent property is calculated in accordance with the following relationship:

$C_m = C_b + x (C_r - C_b)$

Where:
- $C_m$ = maximum concentration accepted
- $C_b$ = background concentration
- $C_r$ = maximum concentration permitted in accordance with the ODWQS
- x = a constant that reduces the contamination to a level that is considered by the Ministry to have a negligible effect on water use.
  i.e. 0.5 for non-health related parameters
  0.25 for health-related parameters.

The RUC values were calculated using the median value of the background concentration ($C_b$) from a minimum of the previous five sampling events as required by Ministry Eastern Region Technical Support Section. Where background concentrations were less than the laboratory RDL, the RDL was used as the background concentration. Where the background concentrations exceeded ODWQS, the $C_b$ value was set as the RUC value. The calculated $C_m$ values for the Site were set as the RUC values.

As prescribed in the *2014 Annual Report* (AECOM, 2015), the groundwater trigger mechanism for the Site is based on the RUC. The trigger mechanism is as follows:

*While the Reasonable Use Concept (RUC) B-7 remains in effect, the groundwater trigger parameters should be comprised of all of the chemical constituents listed in Columns 1 and 2 of Schedule 5 in the [2012] Ministry Landfill Standards. An exceedance for any listed chemical parameter should be defined as a numerical elevation of any analytical value above the RUC values at the down-gradient on-site monitors DP06-R, DP07-R, DP08-R, and MW09 related to the landfill.*

*Certain metals (iron and manganese) and organics (DOC) are ubiquitous constituents within a wetland setting and have naturally occurring wide ranges in concentrations. The examination of these parameters as impact indicators should be based on established*

*trends and gradients. If three consecutive RUC exceedances for any trigger parameter are deemed to be caused by the landfill, further investigations would be initiated to determine the significance of the exceedance, such as completing additional monitoring locations further down-gradient and closer to the property boundary. If further exceedances are confirmed based on the additional investigations with respect to the trigger above a contingency plan should be prepared and submitted after the third exceedance to the Ministry Regional Director for approval. Should a RUC exceedance occur during the next routine sampling event, the implementation of the contingency plan should proceed after the receipt of the exceedance.*

*Such a contingency plan should provide recommendations for i) the acquisition of additional bufferlands; ii) the timing for the acquisition of bufferlands (if acceptable to the Ministry); and iii) the subsequent quality monitoring program needed to confirm acceptable off-site groundwater impact.*

*Regardless of the RUC conformance, should any landfill perimeter monitor contain any constituent (excepting DOC, iron, manganese, and zinc) having a concentration exceeding the ODWQS on three consecutive occasions and is deemed to be caused by the landfill, an environmental study should be undertaken to establish that the bordering vegetation/bordering functions are not significantly affected by the leachate discharge.*

The RUC values were calculated for all parameters in the Columns 1 and 2 of Schedule 5 in the *Landfill Standards* (MOE, 2012), as designated by the trigger mechanism, described above. The groundwater trigger mechanism is the exceedance of the RUC concentration and/or ODWQS limit for one or more parameters at three consecutive sampling events, at any of the trigger locations. The prescribed trigger locations are DP06-R, DP07-R, DP08-R, and MW09.

Until changes discussed in Section 4.4 are approved in an amended ECA, MW106S, MW106D, MW107S, and MW107D as well as the historical compliance wells listed above will be included in the compliance assessment. Well nests MW106S/D and MW107S/D are at the southern property boundary and better assess site compliance opposed to using those wells

immediately down-gradient of the waste mound and in some cases known to be impacted (DP06-R and MW09).

#### 4.2.6.1 Compliance Assessment

The RUC concentrations were calculated for the Site using background water quality from monitoring wells. For overburden RUC concentrations were calculated using drive-point DP11; bedrock RUC concentrations were calculated using wells MW01 and MW02 (Table 4 and Table 5, respectively). The RUC overburden assessment included monitors DP06-R, DP07-R, DP08-R, and MW106S and the RUC bedrock assessment included monitors MW09, MW106D, MW107S, and MW107D. All parameter concentrations that exceed the RUC and/or the ODWQS criteria for three or more consecutive occasions are summarized in Embedded Table 5 and Embedded Table 6. RUC exceedances at the background monitors are also summarized in the respective tables for reference.

**Embedded Table 5 Summary of RUC/ODWQS Exceedances - Overburden**

| Parameter | DP11 | DP06-R | DP07-R | DP08-R | MW106S |
|---|---|---|---|---|---|
| Alkalinity | | √ | | | |
| Hardness | | √ | | | |
| TDS | √ | √ | | | |
| DOC | √ | √ | √ | √ | √ |
| Iron | √ | √ | | √ | √ |
| Manganese | √ | √ | | √ | √ |

**Embedded Table 6 Summary of RUC Exceedances - Bedrock**

| Parameter | MW01 | MW02 | MW09 | MW106D | MW107S | MW107D |
|---|---|---|---|---|---|---|
| Alkalinity | | | √ | | | √ |
| Hardness | | | √ | | | √ |
| TDS | | | √ | | | √ |
| DOC | | | √ | √ | √ | √ |
| Iron | | | √ | √ | √ | √ |
| Manganese | | | √ | √ | √ | √ |
| Barium | | | √ | | | √ |

4.2.6.1.1 Overburden

At trigger location DP06-R there were many RUC exceedances in 2020. These parameters were greater than background and were indicative of landfill-related impacts (Section 4.2.3). Given the greater number of RUC exceedances at monitors DP06-R versus DP07-R and DP08-R indicates a greater influence of leachate impacts east of the waste disposal area. This also coincides with the location of the active disposal area.

There were many RUC exceedances at MW106S in 2020. This monitor is down-gradient and southeast of the active area. It is unclear if the elevated concentrations are landfill-related or due to natural variations in the wetland.

Many similar RUC exceedances were in the overburden background monitor DP11 in 2020 (including: TDS, DOC, and iron). As such, elevated parameter concentrations were in-part attributed to natural variations in water quality. Continued monitoring will aid in interpreting the source of the elevated concentrations (i.e., site operations or natural occurring concentrations from the flooding and connection to the wetland southeast of the Site).

4.2.6.1.2 Bedrock

At trigger location MW09 there were many RUC exceedances in 2020. As discussed in Section 4.2.4, these elevated parameters are landfill-related impacts.

Monitors MW106D, MW107S, and MW107D had elevated concentrations of DOC, iron, and manganese. These monitors are within the wetland and experience seasonal ponding which contribute to these elevated concentrations.

Given the number of exceedances at monitor MW107D, impact at this location from the Site is possible; however, as discussed in Section 4.2.4, the source of the impact is speculative. It is unclear if the elevated concentrations are landfill-related impacts or natural variations in the water quality in the lowland/wet area.

As discussed in Sections 4.2.3 and 4.2.4, monitors MW106D and MW107S were not interpreted to be impacted by the Site. The source of the elevated concentrations at MW107D is unclear at this time, but is not expected to be entirely site-related, if at all. Impacts are not interpreted to extend as far as the southern property boundary in the bedrock aquifer at this time.

Based on the above, the trigger was not initiated in 2020 and Cambium maintains that the intent of the RUC is being met within the current property boundary.

## 4.3 Landfill Gas Monitoring

LFG, specifically methane and carbon dioxide, is derived from the decomposition of organic wastes. Production of LFG from landfilled wastes normally reaches a maximum rate approximately two years after placement and may continue at this rate for many years. The biological decomposition process results in the generation of LFG until some period, likely decades, after the landfilling of that waste ceases. Hazardous concentrations for methane are 5 to 15% methane by volume or between 50,000 and 150,000.

*Ministry Procedure D-4-1 Guideline for Assessing Methane Hazards from Landfill Sites* (Guideline) (MOEE, 1987) considers concentrations greater than 1% methane by volume to be associated with still higher concentrations, potentially exceeding the lower explosive limit (i.e., 5% methane by volume); therefore, methane concentrations at 1% methane by volume or greater should be considered potentially hazardous and gas control systems should be designed to maintain concentrations below this level. Furthermore, Ontario Regulation

(O.Reg.) 232/98 dictates the safety levels for property use based on % by volume of methane. Where there are to be buildings constructed at a site, the % by volume of methane gas must be less than 1.0% in any on-site building or enclosed structure or in the area immediately outside the foundation or basement floor of the structure.

LFG was monitored at all monitoring wells in correlation with the 2020 groundwater monitoring event (Table 6). In 2020, methane was detected at DP07-R and MW106S. Given the location of monitors DP07-R and MW107S and the presence of saturated soils for at least part of the year, it is interpreted the methane at these wells is from the organic soils in the low-lying wet area opposed to from the landfill.

Currently, no active or passive LFG control systems are utilized at the Site. Due to the generally small size of the waste pile and the remote location of the Site, these systems are currently not necessary for LFG management.

## 4.4 Adequacy of Monitoring Program

In an effort to have a refined and concise monitoring program at the Site, the existing monitoring program is reviewed annually to determine if it sufficiently monitors impacts at the Site. Following an assessment of the monitoring program in 2017, several changes were recommended for the monitoring program (Cambium, 2017). An additional recommendation was made for the groundwater monitoring program following the 2018 assessment regarding the prescribed trigger locations for the groundwater compliance assessment (Cambium, 2019).

### Volatile Organic Compounds

VOC concentrations have generally been at or less than the RDLs since being monitored at the Site. VOC analysis should be reduced to once every five years and only be tested at one leachate monitor; piezometer DP13 is recommended. As currently approved, only those VOCs listed in Column 1 of Schedule 5 of the *Landfill Standards* (MOE, 2012) including benzene, 1,4-dichlorobnzene, dichloromethane, toluene, and vinyl chloride should be analyzed (Cambium, 2018).

### Groundwater

With the installation of monitors MW106S/D and MW107S/D, monitor MW05, DP07-R, and DP08-R are no longer required to assess Site compliance; these monitors should be removed from the monitoring program. Similarly, given monitors MW03S/D have not been impacted, are installed significantly deeper than the down-gradient monitors, and any lateral impacts form the landfill will be captured at monitor MW04, monitors MW03S and MW03D should be removed from the monitoring program (Cambium, 2019).

Given that monitor MW02 and drive-point DP11 adequately determine background water quality at the Site, and monitor MW01 is installed deeper than the down-gradient monitors, monitor MW01 should be removed from the monitoring program (Cambium, 2019).

Monitoring wells MW106S, MW106D, MW107S, and MW107D should replace monitors DP06-R, DP07-R, DP08-R, and MW09 as the prescribed trigger locations based on their location in close proximity to the down-gradient property boundary.

As of the date of this report, no comments or approval has been received regarding these recommendations. As per Condition 8 of the ECA, these requested changes will not be implemented until District Manger approval is received and the Director issues an amended ECA.

# 5.0 Site Operations

This section presents a summary of Site operations for 2020 and addresses the following requirements of the ECA as detailed in Condition 6 (7):

- the need to amend the design or operation of the Site, and the adequacy of and need to implement the contingency plans (Section 5.9)
- calculations of the volume of waste, daily and intermediate cover, and final cover deposited or placed at the Site during the reporting period and a calculation of the total volume of Site capacity used during the reporting period (Section 5.8)
- a calculation of the remaining capacity of the Site and an estimate of the remaining Site life (Section 5.8.2)
- a summary of the weekly, maximum daily and total annual quantity (tonnes) of waste received at the Site (Section 5.7 and Table 7)
- a summary of any complaints received and the responses made (Section 5.5)
- a discussion of any operational problems encountered at the Site and corrective action taken (Section 5.2)
- any changes to the Design and Operations Report and the Closure Plan that have been approved by the Director since the last Annual Report (Section 5.9)
- a report on the status of all monitoring wells and a statement as to compliance with R.R.O.1990 Regulation 903: Wells (Reg. 903) (Section 5.6)

## 5.1 Site Access and Security

The Site was well screened by the surrounding forest and thick vegetation. Site access was controlled from Kashwakamak Lake Road by a lockable gate and page wire fencing which was in good repair in 2020. Access was only permitted during operational hours, with the presence of a site attendant.

Signage was posted at the gate, which lists the ECA number, emergency contact information, acceptable wastes types, hours of operation, site rules, and a bear advisory.

The Township utilizes a visual management system through the use of signs to direct residents on how to sort and place divertible materials.

Typically, summer hours would commence on May 15; however, due to the COVID-19 pandemic the hours were delayed to June 15. The hours of operation in 2020 were:

**Winter (October 1 to June 14)**

Sunday, Holiday Monday ..... 12:00 PM to 4:00 PM

**Summer (June 15 to September 30)**

Sunday..... 10:00 AM to 4:00 PM
Holiday Monday ..... 1:00 PM to 6:00 PM
Thursday..... 12:00 PM to 5:00 PM
Saturday ..... 9:00 AM to 1:00 PM

*On Sunday the site was closed from 1:00PM to 1:30PM.*
*All Township Sites are closed on Christmas and New Year's Day.*

All waste disposal and transfer operations were conducted under the supervision and direction of the site attendant in 2020, employed by the Township. The site attendant was responsible for ensuring that the safe and orderly operation and maintenance of the site complied with the requirements of the ECA and the *Environmental Protection Act* and its Regulations as administered by the Ministry. In addition, the site attendant's responsibilities included:

- Controlling admission of authorized vehicles with acceptable wastes
- Ensuring proper daily litter control
- Controlling collection and haulage of materials by a licensed hauler
- Maintaining a daily record of all operations which are available for inspection by the Ministry

## 5.2 Site Operations

As reported by the Township, a log book is kept at the Site in which the site attendant records on each day of operation, the results of daily inspections, any incidents, materials received, and other items, as required by the ECA. Additionally, annual and general monthly inspections

were completed by the Joint Health and Safety Committee and the Waste and Recycling Lead Hand. Details of the inspections included personal protective equipment, daily operational logs, condition of the signage, gates and fences, and other operational features of the Site.

No operational problems were reported by the Township in 2020.

## 5.3 Training

A training plan is used by the Township to ensure that annual health and safety and waste operator training is provided to all landfill attendants. Furthermore, the plan addresses the training requirements for new landfill attendants.

In 2020, all waste and recycling staff completed the Annual Health and Safety training which included the following topics: accessibility (AODA), customer service, Occupation Health and Safety, workplace violence and harassment, Bear wise, and noxious weeds.

In May 2019, Waste Site Attendant Operator training detailing the Litter Control Plan, acceptable waste types, daily operations, etc. was provided by Cambium to all current and new site attendants and other waste/recycling staff as per the requirements of ECA Condition 3 (1) (Cambium, 2020).

Propane in Construction training and Standard First Aid and Cardiopulmonary Resuscitation (CPR) training is provided to all waste site attendants and the waste/recycling hauler on a 3-year renewal basis.

## 5.4 Site Inspections

The following section discusses observations noted by Cambium and reported by the Township in 2020.

### 5.4.1 Aesthetics

The Township conducted regular litter collection programs as necessary throughout 2020. The landfill attendant is responsible for the clean-up of blown litter on a daily basis. Additional help is provided by the Waste and Recycling Maintenance worker and students.

Despite the effort, notable amounts of blown litter east of the active area and into the treeline were noted during both sampling events in 2020 by Cambium staff. Clean-up of the blown litter for this area is recommended as part of the regularly scheduled program.

The Township uses a litter control fence around the active area to aid in reducing the migration of litter. During the 2020 site visits the litter control fence was collapsed in various sections around the active area. The fence should be repaired and maintained to aid in litter reduction.

The intent of good housekeeping practices is to protect the health and safety of site users, to protect the surrounding environment from nuisance effects, and to minimize these nuisance effects by adopting measures as part of the site operations. Regular housekeeping is essential to control such nuisances as:

- Blowing and loose litter
- Odour
- Rodents and insects
- Scavenging birds

### 5.4.2 Drainage

During site inspections in 2020, the waste mound was covered with the exception of the active face and there was no evidence of erosion. The waste mound was graded to promote surface water run-off. No surface water drainage features were created in 2020.

### 5.4.3 Access Road

The access road had sufficient width at the entrance and within the Site to allow unimpeded winter travel and access for emergency and snow removal equipment. The site access roads were well maintained and graded and were regularly cleared of snow with a sand mixture applied by the Township during the winter months.

## 5.5 Complaints and Incidents

The Township reported that there were no formal complaints and no incidents in 2020.

Due to historical incidents at the Site, the Township increased surveillance during non-operating hours. In addition, new locks have been installed for the site entrances, the Township's MHSW Depots, and the Re-Use Centre at the 506 site. A new incident report form has been issued for the waste site attendants for non-Occupational Health and Safety related accidents.

A resident notified the Township about an environmental concern in a waterbody south of the Site in October 2020. Cambium personnel investigated the concern. The area south of the Site was investigated during the autumn sampling event and there were no signs of leachate seeps or adverse impacts occurring down-gradient of the Site. The substances that was observed in the water was either brown algae or iron oxidizing bacteria (not site-related).

## 5.6 Monitoring Well Security

As a part of the 2020 work program, Cambium inspected all monitoring wells as listed in Table 1 for compliance with Reg. 903 and ECA Condition 8 (5). Photographs of the monitoring wells are included in Appendix D.

The following should be completed in 2021:

- The protective casing at monitor MW05 should be re-secured.
- Monitoring well MW03S has a disconnected riser pipe and representative samples can only be collected at this location during times of low water levels. Given this well has been recommended to be removed from the monitoring program, this well should be decommissioned upon approval of the proposed monitoring program.

## 5.7 Materials Summary

The following waste types are approved to be accepted at the Site for disposal and/or diversion; refer to Figure 3 for the collection locations of each material:

- Domestic solid, non-hazardous waste
- Blue Box Recyclables

### 5.7.1 Site Usage

Site usage, as documented by the Township, is summarized in Embedded Table 7. In addition, a monthly breakdown of waste and recyclable materials accepted is in appended Table 7. Although the topographic survey is an accurate representation of the amount of waste and cover material deposited at the Site as discussed in Section 5.8. The Township's records give insight to the sources and nature of the waste received.

**Embedded Table 7 Summary of Site Usage**

| | 2020 | 2019 | 2018 | 2017 | 2016 |
|---|---|---|---|---|---|
| Vehicles – Private | 3,054 | 3,023 | 3,359 | 3,156 | - |
| Bags of Garbage | 4,662 | 3,841 | 3,730 | 1,159 | 3,395 |

Using the number of garbage bags, it is possible to determine the tonnage of residential waste deposited at the Site. Assuming each bag weighs 14 kg, 65 tonnes of residential waste was disposed of in 2020.

### 5.7.2 Site Diversion

The Township reported that 5,850 bags of recycling was accepted at the Site in 2020. Furthermore, as hauling methods vary based on quantities of materials present, Embedded Table 8 provides a summary of diverted materials accepted throughout the Township which includes collection at the Kashwakamak site.

### 5.7.3 Municipal Wide Diversion

Embedded Table 8 provides a summary of the materials diverted from all Township sites in 2020.

**Embedded Table 8 Summary of Diverted Materials - Township**

| Material | tonnes |
|---|---|
| Blue Box | |
| Cardboard | 25.44 |
| Cans and Plastics | 66.31 |
| Glass | 24.00 |
| Paper/Fibre | 30.96 |
| C&D Materials and Bulky Items[1,2] | 71.36 |
| MHSW[1] | 10.49 |
| Scrap Metal[1] | 64.76 |
| Single Use Batteries[1] | 0.28 |
| Tires[1] | 22.69 |
| Waste Electrical and Electronic Equipment (WEEE)[2] | 7.45 |
| White Goods[1] | 3.05 |
| **Total** | **326.79 tonnes** |

Notes:
1. Materials accepted at 506, Mississippi, and Plevna.
2. Hauled off-site by Kimco Steel.
3. WEEE is only accepted at Plevna and 506.

## 5.8 Waste Placement and Cell Development

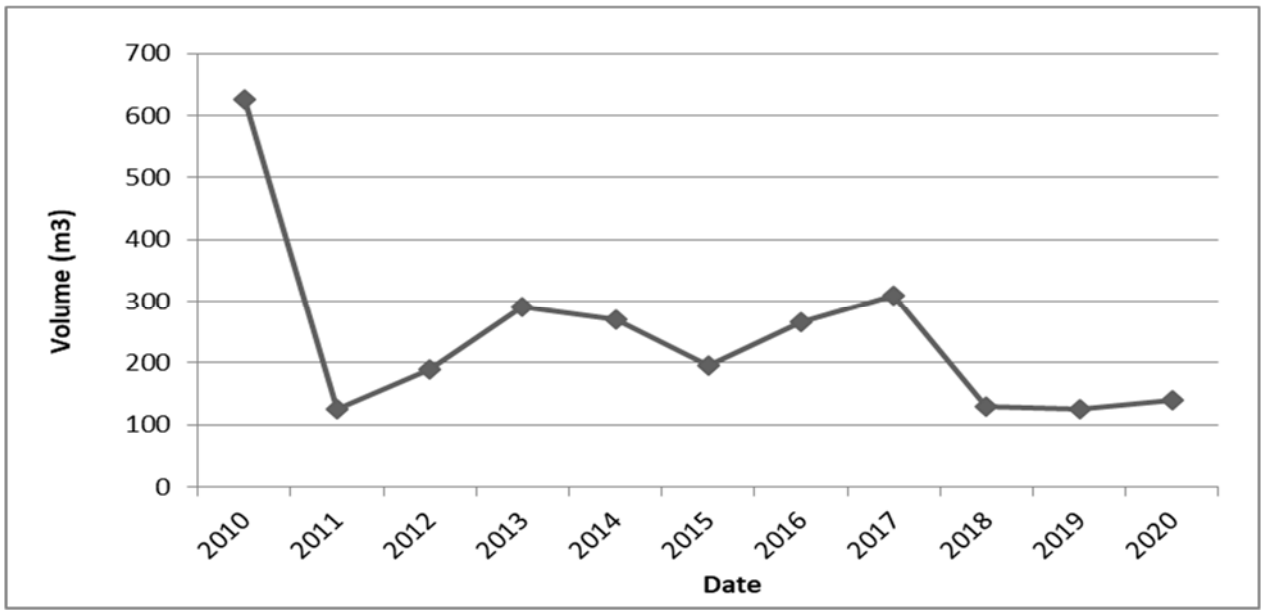
In 2020, the majority of development took place in the eastern portion of the waste mound (Figure 3). Observations of site operations indicated wastes were deposited at the Site using the area method of landfilling (above grade).

On October 8, 2020 Cambium completed a topographical survey of the active landfilling area of the Site. The generated contours are presented on Figure 3.

The approved limit of waste was staked by Cambium staff in May 2020. Locations of the stakes are shown on Figure 3.

This survey was compared to a previous survey completed in October 2019. The volume of material placed in the period between October 2019 and October 8, 2020 and was determined

to be 140 m³. Embedded Figure 1 shows a summary of the annual waste and cover deposition at the Site; a discussion on remaining Site capacity is included in Section 5.8.2.




**Embedded Figure 1 Annual Landfilled Volumes**

The capacity used at the Site includes both cover material and waste. Assuming that 20% of this volume is daily cover, the volume of waste landfilled in 2020 was 110 m³.

Topographic surveys of waste disposal sites can be subject to a large margin of error due to the rough terrain and thin layers of waste involved. For example, an error of only 0.05 m over the active portion of this site represents 125 m³ or about 90% of the measured use. Deposition rates measured over longer periods tend to be more accurate than onetime measurements.

### 5.8.1 Cover Material

Cover must be applied bi-weekly during the summer and monthly during the winter so that no waste is exposed to the atmosphere as per ECA Condition 7. The Township reported that approximately 245 $m^3$ of cover material was used at the Site in 2020.

### 5.8.2 Remaining Site Capacity

Digital Terrain Modelling (DTM) was used to determine the volume increase generated in 2020. To determine the remaining capacity of the Site, the existing volume of waste at the Site was subtracted from the maximum approved capacity including daily and intermediate cover but excluding final cover. Embedded Table 9 provides a summary of the current capacity of the Site.

**Embedded Table 9 Capacity Calculations**

| | |
|---|---|
| Approved Area of Refuse Placement | 0.8 ha |
| Existing Area of Refuse Placement | 0.50 ha |
| Total Site Capacity | 26,200 m³ |
| Volume Added, 2020 | 140 m³ |
| Existing Waste and Cover Placement, Total | 9,085 m³ |
| Remaining Capacity | 17,115 m³ |
| Average Annual Volume, five year | 210 m³ |
| Anticipated Life Span[1] | 81 years |
| Anticipated Closure Date | 2101 |

Notes:

1. Changes in Site usage, compaction and cover practices, and recyclable diversion rates will affect future annual fill volumes and consequently Site life. Annual topographic surveys should be completed to track changes in Site usage.

Additional capacity may become available as the Site develops over time. The removal of on-site berms and roads located within the waste footprint may create the potential for additional capacity depending on the size and scale of the development, which will determine the additional capacity gained in order to reach final approved contours or volumes. In addition, settlement of landfills occurs over time. The rate and magnitude of settlement is dependent on many factors including the time since placement, composition of waste, and thickness of the landfill.

To assist the Township with their long-term waste management planning, Embedded Table 10 provides an update on the current municipal wide available capacity.

**Embedded Table 10 Summary Municipal Wide Capacities**

| | 506 | Kashwakamak | Mississippi | Plevna | Municipality |
|---|---|---|---|---|---|
| Approved waste disposal capacity ($m^3$) | 40,000 | 26,200 | 28,825 | 39,500 | 134,525 |
| Existing volume of capacity used ($m^3$) | 20,485 | 9,085 | 8,680 | 16,560 | 54,810 |
| Annual Volume Used in 2020 ($m^3$) | 40 | 140 | 415 | 845 | 1,440 |
| Remaining volume of capacity ($m^3$) | 19,515 | 17,115 | 20,145 | 22,940 | 79,715 |
| Average annual waste placement ($m^3$) | 530 | 210 | 450 | 810 | 2,000 |
| Remaining site life (years) | 37 | 81 | 45 | 28 | 40 |

Closure activities occurred at the Township's Ardoch waste disposal site in 2016, but the site was closed before reaching its approved total capacity. Embedded Table 11 provides a summary of capacity availability for the Ardoch waste disposal site as of the last survey in November 2015. As per Condition 2.1 of the Ardoch waste disposal site ECA, at least six months prior to resumption of the landfill operation the Township is required to submit for approval from the Ministry, an updated Site Development and Operations Plan to utilize the volume remaining.

**Embedded Table 11 Ardoch - Waste Disposal Remaining Capacity**

| | |
|---|---|
| Approved waste disposal capacity | 30,325 m³ |
| Existing volume of capacity used | 11,895 m³ |
| Remaining volume of capacity | 18,430 m³ |
| Average annual waste placement | 490 m³ |
| Remaining site life | 38 years |

## 5.9 Site Documentation

The document entitled *Kashwakamak Waste Disposal Site Design, Operation and Closure Plan* (AECOM, 2010) is used by the Township for the operation of the Site. No changes were made to this document in 2020.

## 5.10 Compliance with Ministry Approval

As stated in Section 8 Condition (5) of the ECA, all groundwater monitoring wells listed in the monitoring program shall be properly capped, locked, and protected from damage. As mentioned in Section 5.6, monitor MW05 should be repaired and well MW03S should be decommissioned upon approval of the proposed monitoring program.

Other than the minor non-compliance noted above, the Township operated the Site consistent with the ECA in 2020.

# 6.0 Conclusions and Recommendations

Based on the 2020 monitoring program, Cambium offers the following conclusions regarding the Kashwakamak waste disposal site.

- The water level measurements indicated that groundwater flowed toward the southeast with a component to the northwest in the low lying (southeast) portion of the Site.
- Water chemistry data indicated that the leachate plume continued to be generated beneath the waste mound and slightly toward the east; however, the leachate plume was attenuated within a short distance.
- A number of parameter concentrations at monitor MW107D exceeded trigger values; however, as these parameters were not deemed to be the result of leachate impacts, the trigger was not activated and confirmation sampling was not initiated.
- The intent of the RUC (MOEE, 1994a) was met within the property boundary.
- The Township diverted 326.79 tonnes of material from all operational sites in 2020.
- Approximately 140 m³ of waste and cover material was landfilled at the Site between October 2019 and October 2020, resulting in a remaining waste disposal capacity of 17,115 m³. Based on a calculated average annual volume of material of 210 m³, this equates to more than 80 years of Site life remaining.
- Select groundwater monitoring wells require upgrades and/or decommissioning to maintain compliance with Reg. 903 and the ECA.

Based on the results of the 2020 monitoring program, Cambium recommends the following:

- As per Condition 8 of the ECA, the monitoring program should be completed as outlined in Table 1 until the requested changes to the monitoring program are approved by the District Manager and the Director issues an amended ECA.
- Monitor MW03S should be repaired and/or decommissioned to maintain compliance with Reg. 903 and the ECA.

- A thorough litter clean-up should be completed on the areas east of the active area and into the treeline.
- The Township should repair the litter control fence around the active area. This fence should be maintained to prevent the migration of wind-blown litter.

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# Glossary of Terms

**Active Face/Area**
The portion of the landfill facility where waste is currently being deposited, spread and/or, compacted prior to the placement of cover material.

**Adverse Environmental Impact**
Any direct or indirect undesirable effect on the environment resulting from an emission or discharge that is caused or likely to be caused by human activity.

**Annual Report**
Report documenting the results of water quality, environmental quality, and operations monitoring for the year, or for a period as prescribed in the Certificate of Approval.

**Approved Design and Operations Plan**
The design of a landfill site and its facilities which have been submitted along with the application documents for which formal Ministry approval has been issued through the Certificate of Approval.

**Approved Site or Facility**
A landfill site/facility for which there is an existing and current Certificate of Approval.

**Aquifer**
A geologic unit (soil or rock) that contains sufficient saturated permeable material to yield measurable quantities of water to wells and springs.

**Attenuation**
Natural process through which the concentrations of landfill generated contaminants are reduced to safe levels.

**Borehole**
A hole drilled for soil sampling purposes.

**Buffer Area**
An area of land situated within the peripheral area surrounding an active filling area, but limited in extent to the property boundary, assigned to provide space for remedial measures, contaminant control measures, and for the reduction or elimination of adverse environmental impact caused by migrating contaminants.

**Certificate of Approval**
The license or permit issued by the Ministry for the operation of a landfill site. Issued to the owner of the site with conditions of compliance stated therein.

**Contaminant**
A compound, element, or physical parameter, usually resulting from human activity, or found at elevated concentrations that have or may have a harmful effect on public health or the environment.

**Contaminant Migration Path**
Route by which a contaminant will move from the site into adjacent properties or the natural environment. Usually a route that offers the least resistance to movement.

**Contamination Attenuation Zone**
The zone beneath the surface, located beyond the landfill site boundary, where contaminants will be naturally attenuated to predetermined levels. Also, see Reasonable Use Policy.

**Contingency Plan**
A documented plan detailing a co-ordinated course of action to be followed to control and remediate occurrences such as a fire, explosion, or release of contaminants in an uncontrolled manner that could threaten the environment and public health.

**Cover Material**
Material approved by the Ministry that is used to cover compacted solid waste. Usually, a soil with suitable characteristics for specific end-use.

**Site Development Plan and Operations Report**
Development and Operations Plan or Report is a document detailing the planned sequence of activities through the landfill site's active life, the control systems, site facilities and monitoring systems that are necessary. This document is required for obtaining a Certificate of Approval.

**Design Capacity**
The maximum amount of waste that is planned to be disposed of at a landfill site.

**Detection Limit**
Concentration under which a parameter cannot be quantitatively measured.

**EAA or EA Act**
Environmental Assessment Act, Revised Statutes of Ontario, 1990. One of the primary acts of legislation intended to protect, conserve, and wisely manage Ontario's environment through regulating planning and development.

**Environmental Compliance Approval**
The license or permit issued by the Ministry for the operation of a landfill site. Issued to the owner of the site with conditions of compliance stated therein.

**EPA**
Environmental Protection Act, Revised Status of Ontario, 1990. EPA is another of the primary pieces of Provincial legislation governing the protection of the natural environment of the Province.

**Evapotranspiration**
The evaporation of all water from soil, snow, ice, vegetation and other surfaces, including the water absorbed by plants, that is released to the atmosphere as vapour.

**Fill Area**
The area of a landfill site designed and designated for the disposal of waste.

**Final Cover**
Soil material or soil in combination with synthetic membranes, overlain by vegetation in a planned landscape, placed over a waste cell that has reached the end of its active life.

**Groundwater**
Subsurface water that occurs beneath the water table in soils and rocks that are fully saturated.

**Hydraulic Conductivity**
The rate of flow of water through a cross-section under a specific hydraulic gradient. It is a property of the geologic formation and the fluid, in hydrogeologic applications where the fluid is water (Units of m/day or cm/s).

**Hydraulic Gradient**
The head drop per unit distance in the direction of flow, the driving force for groundwater flow.

**Hydrogeology**
The study of subsurface waters and related geologic aspects of surface waters.

**Impermeable Fill**
Soil material that is placed as filling material that is sufficiently cohesive and fine grained to impede and restrict the flow of water through it.

**In situ Testing**
Testing done on-site, in the field, of material or naturally occurring substances in their original state.

**Landfill Gas**
Combustible gas (primarily methane and carbon dioxide) generated by the decomposition of organic waste materials.

**Landfill Site**
A parcel of land where solid waste is disposed of in or on land for the purposes of waste management.

**Leachate**
Water or other liquid that has been contaminated by dissolved or suspended particles due to contact with solid waste.

**Leachate Breakout**
Location where leachate comes to the ground surfaces; a seep or spring.

**Limit of Filling**
The outermost limit at which waste has been disposed of, or approved or proposed for disposal at a landfill.

**Ministry**
Ontario Ministry of the Environment, Conservation and Parks.

**Monitoring**
Regular or spontaneous procedures used to methodically inspect and collect data on the performance of a landfill site relating to environmental quality (i.e., air, leachate, gas, ground or surface water, unsaturated soils, etc.).

**Monitoring Well**
The constructed unit of casing (riser and screen) installed in a borehole.

**Multi-Level Monitoring Well**
More than one monitoring well installed at a given test well location.

**Native Soil**
Soil material occurring naturally in the ground at a location.

**Natural Attenuation**
Where contaminants are reduced to acceptable concentration levels by natural mechanisms (dilution, absorption onto the soil matrix, etc.), biological action, and chemical interaction.

**Occupational Health and Safety Act**
The primary act of legislation enacted by Ontario Ministry of Labour to regulate and control the safety in the workplace; also Occupational Health and Safety Act, Revised Statutes of Ontario, 1990.

**Odour Control**
Minimizing or eliminating the nuisance and undesirable impact of objectionable or unpleasant odours arising from waste disposal operations.

**Open Burning**
Burning any matter whereby the resultant combustion products are emitted directly to the atmosphere without passing through an adequate stack, duct, or chimney.

**Operations Plan**
A document detailing the waste disposal operations in a planned, and if necessary, a staged manner, that ensure compliance with regulatory provisions concerning the operations of a landfill site.

**Operator (Site Operator)/Attendant**
The individual or organization who, through ownership or under contract, manages and operates a landfill site for the purpose of waste disposal.

**Owner**
A person, persons, organization, or municipal authority who own a landfill facility or part of a landfill facility, and in whose name the Certificate of Approval for the site is issued.

**Percolation**
The movement of infiltrating water through soil.

**Permeability**
Often used interchangeable with hydraulic conductivity, but not strictly correct. Permeability is a property of the porous media only. Dependent upon media properties that affect flow, diameter, sphericity, roundness, and packing of the grains.

**Piezometer**
A well that intersects a confined aquifer.

**Provisional Certificate of Approval (Provisional C of A)**
Same as Certificate of Approval.

**Reasonable Use Policy**
A policy developed by the Ministry to stipulate limits to the level of groundwater quality impairment that may be permitted to occur at site property boundaries, to allow the reasonable use of adjacent properties or land without adversely affecting public health and the environment.

**Recharge Zone**
An area where precipitation or surface run-off infiltrates into the ground and then, through natural percolation enters an aquifer.

**Recycling**
Sorting, collecting or processing waste materials that can be used as a substitute for the raw materials in a process or activity for the production of (the same or other) goods. For example, the "Blue Box" system, in-plant scrap handling, or raw material recovery systems. Recycling is also the marketing of products made from recycled or recycled materials.

**Reduction (of waste or component of 3Rs program)**
Those actions, practices, or processes that result in the production or generation of less waste.

**Remedial Action**
Corrective action taken to clean-up or remedy a spill, an uncontrolled discharge of a contaminant, or a breach in a facility or its operations, in order to minimize the consequent threat to public health and the environment.

**Representative Sample**
A small portion of soil, water, etc. which can be subjected to testing and analysis, that is expected to yield results that will reliably represent the identical characteristics of the source of the material or of a larger body of material.

**Reuse (component of 3Rs program)**
The use of an item again in its original form, for a similar purpose as originally intended, or to fulfil a different function.

**Run-off**
The part of precipitation (rainwater, snowmelt) that flows overland and does not infiltrate the surface material (soil or rock).

**Saturated Zone**
The zone of a subsurface soil where all voids are filled with water.

**Sedimentation**
The deposition of fine grained soil in an undesirable location, caused by the scouring, erosion and transportation of earth materials by surface run-off.

**Sensitive Land Use**
A land use where humans or the natural environment may experience an adverse environmental impact.

**Settlement**
The subsidence of the top surface and underlying waste of a landfill or waste cell as a result of densification under its own weight.

**Site Capacity**
The maximum amount of waste that is planned to be disposed (design capacity) or that has been disposed of at a landfill site.

**Site Closure**
The planned and approved cessation or termination of landfilling activities at a landfill site upon reaching its site capacity.

**Site Life**
The period from its inception through active period of waste disposal, to the time when a landfill site reaches its' site capacity, when it ceases to receive any further waste, including and up to closure.

**Solid Waste**
Any waste matter that cannot be characterized by its physical properties as a liquid waste product.

**Solid Waste Disposal Site or Facility**
A site or facility such as a landfill site where solid waste is disposed of.

**Source Separation**
The separation of various wastes at their point of generation for the purposes of recycling or further processing.

**Standpipe**
A monitoring well that intersects the water table aquifer.

**Storm water**
Run-off that occurs as a direct result of a storm event or thaw.

**Storm water Detention**
Control of storm water by the construction of impoundments of structures for the purpose of regulating storm water flows during high intensity rainfall events that would otherwise transport excessive amounts of sediment, cause soil erosion or cause flooding.

**Stratigraphy**
The geologic sub-structuring, usually layered with different distribution, deposition and age.

**Surface Run-off (Drainage)**
See Run-off.

**Surface Water**
Water that occurs at the earth's surface (ponds, streams, rivers, lakes, oceans).

**Sub-Soil**
Soil horizons below the topsoil.

**Test hole**
A hole drilled for soil sampling purposes.

**Topsoil**
The uppermost layer of the soil containing appreciable organic materials in mineral soils. Adequate fertility to support plant growth.

**Unsaturated Zone**
The zone (also vadose zone) in a porous sub-soil, where the voids are not completely water-filled, but contain some air-filled voids. Limited above by the land surface and below by the water table.

**Vector**
A disease carrier and transmitter; usually an insect or rodent.

**VOC**
Volatile organic compounds are those compounds that will readily volatilize (convert from liquid to gas phase) at conditions normally found in the environment.

**Waste**
Ashes, garbage, refuse, domestic waste, industrial waste, or municipal refuse and other used products as are designated or interpreted by the provisions of the Environmental Protection Act.

**Waste Disposal Site (Facility)**
Any land or land covered by water upon, into, in or through which, or building or structure in which, waste is deposited or processed and any machinery or equipment or operation required for the treatment or disposal of waste.

**Waste Management System**
All facilities, equipment and operations for the complete management of waste, including the collection, handling, transportation, storage, processing and disposal thereof, and may include one or more waste disposal sites.

**Water Table**
The water level attained in a monitoring well, which screens the surficial unconfined aquifer.

**Water Balance**
Amounts of water to various components in a system so that water entering the system equals the amount of water contained within and discharged out of a system.

**Water Level**
The level of water in a well.

**Well Casing**
The pipe that is used to construct a well.

**Well Screen**
A filtering device used to keep sediment from entering a well.

**Wetlands**
Areas where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrolytic vegetation, and which have soils indicative of wet conditions.

# Abbreviations

| | | | |
|---|---|---|---|
| **RFP** | Request For Proposal | **ha** | hectare |
| **Ministry** | Ontario Ministry of the Environment, Conservation and Parks | **tonne** | metric ton |
| **MNRF** | Ontario Ministry of Natural Resources and Forestry | **t** | metric tonne |
| **ECA** | Environmental Compliance Approval | **µS** | microSiemens |
| **EPA** | Environmental Protection Act | **ODWQS** | Ontario Drinking Water Quality Standards |
| **EAA** | Environmental Assessment Act | **PC of A** | Provisional Certificate of Approval |
| **MW** | monitoring well | **PWQO** | Provincial Water Quality Objectives |
| **masl** | metres above sea level | **TOC** | Total Organic Carbon |
| **pg** | picogram | **VOC** | Volatile Organic Compound |
| **ng** | nanogram | **BTU** | British Thermal Unit |
| **µg** | microgram | **°C** | temperature in degrees Celsius |
| **g** | gram | **N/A** | not available |
| **kg** | kilogram | **%** | percent |
| **L** | Litre | **cfm** | cubic feet per minute |
| **mg/L** | milligrams per litre | **ppmdv** | part per million by dry volume |
| **mm** | millimetre | **ppmv** | part per million by volume |
| **m** | metre | **ppm** | part per million |
| **km** | kilometre | **min** | minimum |
| **$m^3$** | cubic metre | **max** | maximum |
| **$m^2$** | square metre | | |

# Standard Limitations

Limited Warranty

In performing work on behalf of a client, Cambium relies on its client to provide instructions on the scope of its retainer and, on that basis, Cambium determines the precise nature of the work to be performed. Cambium undertakes all work in accordance with applicable accepted industry practices and standards. Unless required under local laws, other than as expressly stated herein, no other warranties or conditions, either expressed or implied, are made regarding the services, work or reports provided.

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The findings and results presented in reports prepared by Cambium are based on the materials and information provided by the client to Cambium and on the facts, conditions and circumstances encountered by Cambium during the performance of the work requested by the client. In formulating its findings and results into a report, Cambium assumes that the information and materials provided by the client or obtained by Cambium from the client or otherwise are factual, accurate and represent a true depiction of the circumstances that exist. Cambium relies on its client to inform Cambium if there are changes to any such information and materials. Cambium does not review, analyze or attempt to verify the accuracy or completeness of the information or materials provided, or circumstances encountered, other than in accordance with applicable accepted industry practice. Cambium will not be responsible for matters arising from incomplete, incorrect or misleading information or from facts or circumstances that are not fully disclosed to or that are concealed from Cambium during the provision of services, work or reports.

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When preparing reports, Cambium considers applicable legislation, regulations, governmental guidelines and policies to the extent they are within its knowledge, but Cambium is not qualified to advise with respect to legal matters. The presentation of information regarding applicable legislation, regulations, governmental guidelines and policies is for information only and is not intended to and should not be interpreted as constituting a legal opinion concerning the work completed or conditions outlined in a report. All legal matters should be reviewed and considered by an appropriately qualified legal practitioner.

Site Assessments

A site assessment is created using data and information collected during the investigation of a site and based on conditions encountered at the time and particular locations at which fieldwork is conducted. The information, sample results and data collected represent the conditions only at the specific times at which and at those specific locations from which the information, samples and data were obtained and the information, sample results and data may vary at other locations and times. To the extent that Cambium's work or report considers any locations or times other than those from which information, sample results and data was specifically received, the work or report is based on a reasonable extrapolation from such information, sample results and data but the actual conditions encountered may vary from those extrapolations.

Only conditions at the site and locations chosen for study by the client are evaluated; no adjacent or other properties are evaluated unless specifically requested by the client. Any physical or other aspects of the site chosen for study by the client, or any other matter not specifically addressed in a report prepared by Cambium, are beyond the scope of the work performed by Cambium and such matters have not been investigated or addressed.

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Personal Liability

The client expressly agrees that Cambium employees shall have no personal liability to the client with respect to a claim, whether in contract, tort and/or other cause of action in law. Furthermore, the client agrees that it will bring no proceedings nor take any action in any court of law against Cambium employees in their personal capacity.

# Appended Figures

# Appended Tables

## Table Notes

RDL - reported detection limit for the current year

RUC - Reasonable Use Criteria

ODWQS - Ontario Drinking Water Quality Standards, O.Reg. 169/03

PWQO for beryllium, cadmium, copper, and lead depend on hardness

PWQO for aluminum depends on pH and background concentration

NV - No Value

"-" Parameter not analyzed or measured

Unionized ammonia calculated using total ammonia and field data for pH and conductivity

# Appendix A

# Environmental Compliance Approval No. A380203

# Appendix B
# Field and Precipitation Data

# Appendix C

# Laboratory Certificates of Analysis

# Appendix D
# Site Photographs

# Appendix E
# Borehole Logs