2024 Annual Monitoring Report East Luther Landfill

Township of Grand Valley

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1.0 Introduction

This report summarizes the operational and hydrogeological conditions at the East Luther Landfill site and presents the results of the annual surface and groundwater quality analyses. All figures referred to in the text are found at the end of the report. A copy of the Certificate of Approval, borehole logs, landfill standard operating procedures, laboratory certificates of analysis, hydraulic gradients and groundwater elevations, historic water quality tables, water quality graphs, and Landfill Annual Report Checklist are included in Appendices A through H respectively.

1.1 Location

The former Township of East Luther Grand Valley (now the Town of Grand Valley) operates a municipal solid waste disposal site located in Part Lot 21, Concession 4, former Township of East Luther Grand Valley, County of Dufferin (Figure 1). The East Luther Landfill (hereinafter referred to as "the Site") was licensed to operate by the Ministry of the Environment, Conservation and Parks (MECP) to receive municipal solid waste. The MECP was formerly known as the Ministry of the Environment (MOE), as shown on several documents provided in the appendices, and is referred to as such when referencing publications issued under the previous Ministry title.

The front gate of the Site is located at Easting 549395 Northing 4860715 Zone 17T, NAD83. These coordinates were established using a geo-referenced air-photo and have an accuracy of 10 m. A more detailed map of the Site is shown on Figure 2. The Site is located approximately 6 km northwest of the community of Grand Valley adjacent to the Luther Marsh, a significant headwaters area managed under the jurisdiction of the Grand River Conservation Authority (GRCA).

1.2 Ownership and Key Personnel

Figure 2 shows the originally licensed lease area and a 30 m buffer zone around the licensed area. The Town operates the Site on land leased from the GRCA. The CEP for both groundwater and surface water for the Site is David Hopkins, B.Sc., P.Geo., of R.J. Burnside & Associates Limited (Burnside). If there are environmental issues at the Site Mr. Matthew Bos should be contacted. Contact information is listed below:

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1.3 Description and Development of the Waste Disposal Site

The Site is licensed by the MECP to receive municipal solid waste and operates under Certificate of Approval (C of A) No. A180601 (Appendix A). The Site was first opened for waste collection in 1976; however, the Town has not used the landfill since December 31, 2005 and has since completed the process of closure construction as described in a letter report submitted to the MOE on January 4, 2010. As requested, a supplemental application to alter the requirement for additional site fencing was also prepared and submitted to the MOE on February 11, 2010. The Town signed an access agreement with the GRCA dated April 25, 2006, which allows access to the Site for the purposes of monitoring and maintenance.

The Site was originally approximately 4 ha in size (Figure 2). In 1988, approximately 100 m of additional buffer lands to the north, west, and south of the original site were leased from the GRCA. With the inclusion of these additional lands, the Site is currently approximately 11.5 ha in size (Figure 2), with the actual fill area occupying about 2.5 ha (22 %) of the 11.5 ha site. All areas of the Site have received final closure cover.

There are no additional permits or control instruments associated with the Site. There are no storm water management facilities, sewage works or leachate collection systems at the Site.

There were no developments on the Site or within the vicinity of the Site in 2024.

The environmental baseline investigations for the East Luther landfill site include a hydrogeological study conducted by Dames and Moore, Canada (DMC) in 1987. The study included the installation of 12 groundwater observation wells and the sampling and testing of groundwater and surface water. The study suggested that the shallow groundwater flow from the landfill area was north and west into the surrounding Luther Marsh. Leachate was produced in the fill area; however, the study concluded that dilution and attenuation of the leachate within the shallow groundwater / surface water system reduced the concentration to levels acceptable to the MECP.

A conceptual landfill design and operating plan was developed, and a routine monitoring program was recommended. Site monitoring was subsequently conducted semi-annually by DMC in 1989, 1990 and 1991, and annually in 1992.

The development of the monitoring network included the installation of groundwater monitoring wells. Between August 10 and August 12, 1987, Trow, Dames and Moore (TDM) drilled monitoring wells OW1 to OW7 using a combination of solid stem and hollow stem auguring equipment. Monitoring wells OW8 and OW10 were completed on September 24, 1987 using manual auguring equipment in the marsh north and west of the fill area. TDM had also installed a monitoring well labeled OW9, but this well was replaced by OW9R on September 2, 1994 by Burnside. Burnside also installed OW11 and OW12 on the same day as OW9R. All monitoring wells are installed into the overburden material. Borehole logs can be found in Appendix B.

In 1993, the Site monitoring was conducted in the spring and fall by Burnside. In the spring of 1994, Burnside collected groundwater samples from the existing wells. In September of 1994, three new groundwater observation wells were installed, and the monitoring program was expanded in October 1994 to include these new wells. Annual monitoring reports have been produced since 1995.

On March 15, 2000, a new monitoring well labelled OW13 was installed in the fill area at the south end to monitor the extent of groundwater mounding in the waste. This well was extended through the entire thickness of the fill until the underlying silt layer was encountered at a depth of 8.23 m. The total depth of the monitoring well is 8.99 m. This well was included in water level monitoring in the spring of 2003 and groundwater was sampled at this well during the spring sampling event. The well was subsequently damaged and was inaccessible until recently. OW14 was installed in February 2005 to provide additional information along the southern edge of the fill area.

In addition, two gas probes (GP1 and GP2) were installed in March 2000 in the area between the fill and the Site office.

Table 1 summarizes the construction details for these monitoring wells. Locations are shown on Figure 2.

The conceptual site model was developed and produced from the DMC hydrogeological study.

A report titled “Development, Operation and maintenance Plan for the East Luther Landfill Site” dated November 10, 2004 was prepared for the township of East Luther Grand Valley. In addition, a report entitled “Township of East Luther Grand Valley-East Luther Landfill Site-Closure Plan” was prepared by Burnside dated October 14, 2005.

A May 2005 report entitled “Hydrogeological Assessment Township of East Luther Grand Valley Landfill” was prepared. The report includes additional surface water sampling, predicted impacts, identification of a Contaminant Attenuation Zone (CAZ) along with groundwater quality trigger levels and contingency plans.

A request to reduce the Monitoring and reporting requirements was made to the MECP in a letter dated August 26, 2020. The request is currently under consideration by the MECP.

1.4 Monitoring and Reporting Program Objectives and Requirements

At the request of the Town, Burnside conducted the 2024 annual monitoring program at the East Luther waste disposal site to assess the Site's impact on nearby groundwater and surface water resources. This annual report has been completed to satisfy Condition No. 10 of the amended provisional Certificate of Approval (C of A) No. A180601 (included in Appendix A), under which the Site currently operates.

1.5 Assumptions and Limitations

Burnside has conducted this study in accordance with generally accepted standard practices. The conclusions and recommendations in this report are professional opinions based upon visual observations and limited analytical results for the Site conditions existing at the time of our assessment. Burnside does not guarantee the accuracy and reliability of the information provided by other persons or agencies and does not claim responsibility for undisclosed or non-visible environmental concerns. The results of an investigation of this nature should in no way be construed as a warranty that the Site is free from all contamination from past or current practices.

This report was prepared for the exclusive use of the Town of Grand Valley. Any use of reliance on or decisions based on this report by a third party are the responsibility of such third parties. Burnside accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. Reports or memoranda resulting from this assignment are not to be used, in whole or in part, outside the client's organization without prior written permission.

2.0 Physical Setting

This section describes the physical features of the area where the landfill is located. This physical setting information will be used to interpret the monitoring data.

2.1 Geology and Hydrogeology

The landfill Site is located within a till plain composed predominantly of fine-grained, dense silty clay- till to -silty sand till (Tavistock and Catfish Creek Tills). The till is very compact and contains abundant clasts. Some sand and gravel lenses were noted south of the landfill area (DMC, 1988) and silty sand and gravel was also observed north of the fill area at the location of OW12 (Burnside, 1994). The overburden thickness in the study area is approximately 30 m. The bedrock underlying the Site is dolostone of the Guelph Formation.

To the west and northwest of the landfill the land becomes marshy, and the surficial soil is saturated loose peat and organic material. At OW11, over 1.5 m of peat was observed (Burnside, 1994). To the south and east of the landfill, the surficial soil is firm, dry and dense.

Surface Water Features

The landfill is located in the southeast corner of the Luther Marsh complex (Figure 3) about 1 km southeast of the open water portion of the Marsh. Luther Lake is located further to the northwest. The landfill "juts out" into a portion of the marsh that has been reclaimed by vegetation. As a result, the land to the south, west and north of the fill area (Figure 2) is very flat with water very close to or at the surface. The surface water sampling locations are open areas of water within the wetland vegetation. As can be seen on Figure 2, there is what appears to be a municipal drain running southwards from OW11R towards the south and southeast. This area is not readily identifiable in the field. There are areas of intermittent water ponding throughout the area. As a result of the low relief, it is very difficult to identify surface water flow direction and there has never been measurable flow at any of the surface water sampling locations.

3.0 Description of Monitoring Program

The monitoring program for groundwater and surface water will be described in this section. This description will include information about the monitoring locations, frequency of monitoring and standard operating procedures for monitoring at the Site.

3.1 Monitoring Locations

The monitoring well construction details are shown in Table 1. The UTM coordinates, NAD, Zone, elevation, condition, depth and screen information are included in this table.

Further information on the hydrostratigraphy of each well location can be found in the borehole logs (Appendix B).

The surface water monitoring locations are shown on Figure 2.

3.2 Monitoring Frequency

The monitoring frequency of groundwater and surface water is not identified in the C of A for the Site. In light of this, monitoring of surface water locations and groundwater observation wells is completed twice annually, once in the spring and once in the fall. This monitoring frequency is based on the historical monitoring program established for the Site.

3.3 Field and Laboratory Parameters and Analysis

The C of A for the Site specifies that the sampling program for the groundwater and surface water should include the parameters listed in Schedule 5 of Regulation 232/98 at a minimum. These parameters have been replaced with Schedule 5 from *Landfill Standards, A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites*.

The groundwater samples that were collected in 2024 were analyzed at the laboratory for all parameters outlined in Column 1 of Schedule 5 except for biochemical oxygen demand. Volatile organic compounds were measured in the sample from OW13 as it is considered to represent leachate quality. Temperature, pH, dissolved oxygen, and oxidation reduction potential were measured in the field.

The surface water samples were analyzed for all parameters outlined in Column 3 of Schedule 5. Temperature, pH, dissolved oxygen, and oxidation reduction potential were also measured in the field. There was no discernible or measurable flow at any of the surface water sample locations.

3.4 Certificate of Approval Requirements

The C of A for the Site does not specify groundwater and surface water monitoring and sampling frequency and location but requires that a monitoring report must be prepared based on the monitoring and sampling at the Site, and that a visual inspection of the final cover, integrity of the slopes, vermin and vectors must be performed at the Site. The C of A requires that trigger mechanisms and levels be identified for the Site. At this Site chloride, DOC, hardness, conductivity, and alkalinity were identified as trigger mechanisms in the 2005 hydrogeological study.

The monitoring and sampling program is based on the historical program. The monitoring locations, frequency of monitoring and parameters in 2024 remained similar to 2023.

3.5 Monitoring Procedures and Methods

Monitoring and sampling at the Site were conducted in accordance with the Burnside Standard Operating Procedures (SOP) for Landfill Sampling. A copy of the SOP is included in Appendix C.

Samples for analysis of general chemical parameters and metals were collected in appropriate sample bottles supplied by the laboratory. All samples were stored in an ice packed cooler until delivery to the laboratory. A chain of custody form was completed detailing the samples taken and the analysis required. Laboratory certificates of analysis are provided in Appendix D.

Surface water samples were collected for general chemical analysis and total suspended solids in sample bottles provided by the laboratory. The surface water samples were not filtered in the field. The samples were stored in an ice packed cooler until delivery to the laboratory.

Notes were kept in a site designated field book in the spring and fall.

3.6 Standard Operating Procedures

The SOP “Landfill Sampling Standard Operating Procedures” was prepared by Burnside in March 2012. The document outlines the groundwater and surface water sampling procedures to be followed at the East Luther site (Appendix C). The field water quality parameters were measured with a Horiba U51 Multiparameter Meter and Probe. The surface water flow measurements were below the sensitivity of the Marsh-McBirney Flo-Mate Model 2000 Portable Velocity Meter. The concentrations of landfill gas were measured with the GEM 2000 Landfill Gas Meter.

Historical water levels can be found in Table 2 and Appendix E and historical water quality data can be found in Appendix F.

Water levels in groundwater wells were measured with a downhole electronic water level meter. Prior to sampling, the wells were either purged until dry or at least three well volumes of water were removed to ensure that representative groundwater samples were obtained. The field parameters were measured as purging was completed and were recorded in the field notes. The purge water was discharged to the ground near the purged well. Groundwater samples to be analyzed for metals were filtered in the field using Waterra© 0.45-micron in-line filters.

3.7 Record Keeping and Field Notes

Notes were taken in the field to document the following:

- Date and time of monitoring
- Field staff

- Well and casing conditions
- Purge water conditions
- Field measurements
- Sample information
- Sample preparation methods

Photos were taken when required and appropriate. Sample bottle numbers and IDs were recorded in the field book and on the Chain of Custody form submitted to the laboratory.

The instruments were rented and were calibrated by the rental company. They were tested by Burnside staff prior to leaving for the field.

3.8 Quality Assurance for Sampling and Analysis

Since there are no quality control measures outlined in the C of A, the quality control measures that were taken to ensure that accurate samples were taken and delivered to the lab are outlined in the Landfill Standard Operating Procedures (Appendix C). There was one duplicate sample taken for each 10 samples of surface water and groundwater. The duplicate bottles were filled partially and in sequence with the sample bottles for the selected groundwater or surface water sample location. There were no travel blanks, or spiked travel blanks used at this Site.

As outlined in Section 3.6 the samples were kept below the temperature acceptable by the lab. The temperature of the samples was recorded upon arrival at the lab. The lab performs matrix spike, spiked blank, and method blank tests for quality assurance.

3.9 Supplemental Monitoring

To date there has been no benthic, sediment or toxicity monitoring performed, as there have been no known concerns associated with these parameters at the Site.

3.10 Operational Monitoring

The operational monitoring at this Site consists of annual inspections of the cover, integrity of the slopes, vegetation and vermin and vector presence during monitoring, twice each year. The cover was in good condition in 2024 with no slumping of the side slopes observed. No leachate seeps were observed in 2024. The Site does not have a leachate collection system or extraction wells. No vermin or vectors were observed during the Site visits.

4.0 Monitoring Results, Assessment, Interpretation and Discussion

Historical data and data from the 2024 monitoring event at the Site will be evaluated and described in this section. The water levels in the groundwater monitoring wells were measured on April 16, 2024, and on September 18, 2024. Groundwater and surface water sampling locations were sampled where possible on both occasions.

4.1 Historical Data

Burnside began monitoring, sampling and reporting on water quality in the spring of 1993. Additional wells were installed in the fall of 2007.

Generally, there are two total monitoring and sampling events per year per location: one in the spring and one in the fall. All the monitoring event dates, and water level elevations are found in Table 2.

OW1 to OW7, OW8 and OW10 were installed in 1987 by TDM. TDM had previously installed OW9, but it was replaced by Burnside in 1994 with a new monitoring well, OW9R. OW11 and OW12 were also installed in 1994. OW13 was installed in 2000, but it was damaged in 2003. It was repaired and sampling resumed at OW13 in the fall of 2005. OW10R replaced OW10, and OW11R replaced OW11 in 2005.

There are three surface water sampling locations (SW1 to SW3) that have been monitored and sampled consistently since June 2003. There were additional surface water locations measured and sampled in November 2004 and April 2005 (SW4, SW5, SW6 and SW7).

4.2 Data Quality and Evaluation

Quality Assurance of samples was completed in accordance with Section 3.9. The laboratory results and Certificates of Analysis are included in Appendix D, and the laboratory quality assurance was deemed to meet acceptability criteria by laboratory personnel.

4.3 Groundwater Flow Monitoring and Interpretation

The April 2024 and September 2024 site visits included the measurement of static water levels. The wells were observed to be in good condition with protective casings and surface seals intact during our site visits.

Precipitation data was obtained from Environment Canada’s Climate Data and Information Archive for the Fergus Shand Dam weather station. There was 47.8 mm of precipitation during the week prior to the April 16, 2024 sampling event. There was 0 mm of precipitation during the week prior to the September 18, 2024 sampling event.

The groundwater elevation with respect to the local datum for the 2024 monitoring events and historical events is shown in Table 2. Hydrographs (Figures E-1 and E-2 in Appendix E) illustrate the water level fluctuations through time. The Groundwater Study (GWS) well is a deep bedrock well that was drilled as part of a groundwater management study for the Township.

Groundwater elevation contours interpreted from the elevation of the water in the groundwater monitoring wells are shown on Figure 4 (April 2024) and Figure 5 (September 2024). The groundwater elevations in all the monitoring wells in 2024 were within the historical range.

Figure E-1 displays water levels for the wells along the eastern boundary of the Site farthest from the marsh. The water levels in April 2024 for the upgradient wells were on average 0.43 m higher than the water levels measured in May 2023. The September 2024 water levels were on average 0.02 m higher than October 2023 water levels in the upgradient wells.

Figure E-2 shows water levels in the downgradient wells located closest to the marsh. Fluctuations in these wells appear to be buffered by water levels in the marsh and are less than those measured in upgradient wells. The levels recorded in April 2024 are on average 0.16 m higher than those measured in May 2023. The September 2024 water levels were on average 0.14 m lower than those recorded in October 2023.

Figure 4 shows the interpreted groundwater flow pattern based on the April 16, 2024, groundwater elevation data. The elevation data suggests there is a slight groundwater mound beneath the fill area. This occurs because the downward migration of infiltrating water is restricted by the relatively impermeable till material underlying the waste. The shallow groundwater flow from the landfill appears to move horizontally through the surficial soils in a semi-radial pattern outward to the north, west and south (Figure 4). There was a difference of 2.19 m in groundwater elevation measured across the Site from a high of 481.92 masl (OW7) to a low of 479.73 masl (OW5).

The interpreted groundwater flow pattern based on the groundwater elevation data obtained on September 18, 2024, is shown on Figure 5. The shallow groundwater flow appears to move horizontally in a radial pattern outward from the eastern edge of the landfill to the north, west, and south (Figure 4). During the fall monitoring event, groundwater elevations varied from a high of 481.00 masl (OW13) to a low of 478.84 masl (OW5). This represents a 2.16 m difference from the highest to lowest groundwater elevation measured at the Site. As can be seen on Table 2, the water levels in OW8 and OW11R are usually very similar, suggesting that the water levels away from the fill are controlled primarily by the water levels in the marsh.

Calculations of hydraulic gradients are presented in Table E1. The water levels used to calculate both sets of gradients were measured in April and September 2024 during the sampling events. In both the spring and the fall, slight downward vertical gradients were calculated in the OW1 well nest. Upwards gradients were calculated in the spring at the OW6 well nest. The shallow well was dry in the fall and a gradient could not be calculated. Horizontal gradients calculated from elevations obtained in April vary from 0.0069 to 0.0124. Gradients calculated from data obtained in September using the same wells varied from 0.0061 to 0.0090. The most significant differences in gradients were noted between OW7 and OW8 and OW7 and OW4 where the gradients were much lower in the fall than in the spring.

Hydraulic conductivity (K) describes the ability of soil or rock to transmit water. Based on the observed conditions at this landfill, the horizontal hydraulic conductivity (Kh) of the overburden is estimated to be about 2.73×10^{-8} m/sec. The vertical hydraulic conductivity (Kv) is generally lower than the horizontal conductivity and is estimated as 3.58×10^{-9} m/sec.

Assuming an effective porosity of 0.3 for the Site soils, the groundwater velocity can be calculated using the equation:

$$V = Ki/n$$

Where:

V = groundwater velocity
K = hydraulic conductivity
i = hydraulic gradient
n = effective porosity

Using an average horizontal gradient of 0.01 (based on spring and fall gradients), the horizontal groundwater velocity would be about 0.90 m/year. The vertical groundwater velocity for the Site using the average 2024 downward vertical gradient (0.04) is calculated to be about 0.047 m/year. The above observations and calculations indicate that horizontal flow predominates over vertical flow at this Site.

4.4 Groundwater Quality Monitoring and Interpretation

The water quality data collected from 1993 to 2002 are provided in Appendix F. The 2003 to 2024 data is found in Table 3. The results are compared to the Ontario Drinking Water Quality Standards (ODWQS). It should be noted that the ODWQS are used for comparative purposes or screening criteria. Water quality at the landfill is not required to meet this standard. Parameters that exceed their respective ODWQS values are highlighted. Results are provided graphically as concentration vs time plots on Figures G-1 to G-22 (Appendix G).

Background Water Quality

OW5 is located over 60 m south of the fill area and the water quality at the well is considered representative of background water quality for the Site. Due to the semi-radial flow pattern of the groundwater, it may be possible for leachate impact to be noted at this well at which time it will no longer be suitable for use as the background well. OW3 and OW13 are in the center of the fill area and samples taken from these wells are considered representative of leachate quality.

Historically, the range of levels for the selected indicator parameters at the background well OW5 are much lower than in the leachate well and have been reported within the following ranges:

2024 Background Quality Sample Results

Parameter	Historical Range	Spring 2024 Concentration	Fall 2024 Concentration
Chloride (mg/L)	0.08-17	4.6	3.8
Alkalinity (mg/L)	250-460	360	400

Iron and manganese levels in the background well have been reported at concentrations ranging from below detection limits up to 0.70 mg/L and 0.31 mg/L, respectively. In both the spring and fall iron concentrations were measured at 0.20 mg/L (below the ODWQS criteria of 0.30 mg/L).

Manganese was reported at concentrations of 0.059 and 0.083 mg/L in the spring and fall, respectively. The spring and fall concentrations were above the ODWQS of 0.05 mg/L. Manganese has exceeded the ODWQS in 39 of 59 samples, whereas iron has exceeded the ODWQS only 17 times.

Concentrations of other metals have always been below the ODWQS and are typically either below the laboratory detection limits or present at very low concentrations. Generally, results for all parameters measured in 2024 are within historical ranges. Dissolved organic carbon (DOC) had exceeded the ODWQS of 5 mg/L at OW5 until the fall of 2009 when concentrations dropped below the ODWQS. In the fall of 2024, the concentration of DOC was below the ODWQS, at 2.4 mg/L.

4.5 Landfill Impacts

There are two primary long-term effects common to all landfills: i) impacts due to leachate production in the waste, and ii) impacts due to methane gas generation in the waste. Leachate continues to be produced from waste materials for many years. Methane is a by-product of waste decomposition and will be present in the landfill until all the organic matter is decayed.

The long-term impact of primary concern for the Site is the potential impact of the production and the migration of leachate. Methane, while it is a potential explosion hazard, is not a major concern as no inhabited buildings are on site, nor are there any nearby structures on adjacent properties. In addition, the fill area is raised above the surrounding area and, as a result, it is expected that much of the methane will vent out of the above grade sides of the fill.

4.6 Leachate Generation

Leachate is produced by vertical infiltration of water down through the refuse. The annual infiltration into the landfill depends on site conditions such as amount of precipitation, surface grading, cap materials and vegetation. The Site grading and cover at the East Luther landfill was improved as part of the Site closure and will help to reduce infiltration and subsequent leachate generation.

4.7 Leachate Migration

Figure 2 shows the originally licensed lease area and a 30 m buffer zone around the licensed area. Leachate movement from the landfill will occur horizontally in a semi-radial direction following the direction of groundwater flow (Figures 4 and 5). The downward migration of leachate is restricted by the relatively low permeability of the silty clay till material that underlies the Site. The presence of this low permeability layer is confirmed by the groundwater mounding observed in the fill.

The groundwater quality data at OW2, OW8, and OW14 suggests landfill leachate has impacted the area only within about 20 m to 30 m directly downgradient of the fill (i.e., the buffer zone around the Site appears to attenuate contaminants in the groundwater to acceptable levels relatively close to the landfill area).

There is no evidence of leachate impact to wells further from the fill area. Surface water locations continue to have low chloride concentrations. There is no evidence to suggest the leachate has migrated off-site via ground or surface water. The thick, relatively low permeability till unit beneath the Site is expected to provide adequate contaminant attenuation to protect the underlying bedrock aquifer. This data suggests the natural setting of the Site provides a substantial degree of environmental protection.

Reasonable Use Criteria

The MECP Reasonable Use Policy for existing landfills specifies that an existing landfill cannot degrade the water quality on an adjacent property by more than 50 % of the difference between background and the water quality required for use of that property (for non-health related parameters, 25% for health-related parameters). This can be represented by the formula:

$$Cm = Cb + X(Cr - Cb)$$

Where:

Cm = The maximum concentration of a particular contaminant that would be acceptable in the groundwater beneath the adjacent property.

Cb = The background concentration of the particular contaminant in the groundwater before affected by man.

Cr = The maximum concentration of the particular contaminant that should, according to provincial water management policy, be present in the groundwater.

X = 25% for health-related parameters, 50% for non-health related parameters.

Chloride is a conservative ion in groundwater and is considered a good indicator of the extent of leachate contamination. Therefore, using chloride as an example:

- The background concentration (OW5) generally ranges from approximately 0.08 to 17 mg/L. The chloride concentration during the September 2024 sampling was 3.8 mg/L (Cb).
- The reasonable use of the groundwater beneath the adjacent properties has been determined to be domestic supplies. The ODWQS for chloride is 250 mg/L (Cr).
- Chloride is a non-health related parameter and therefore X would be 50%.

Cm = Cb + X(Cr - Cb)
= 3.8 + 0.5*(250-3.8)
= 126.9 mg/L

Therefore, the maximum allowable concentration of chloride beneath the adjacent property is calculated to be 126.9 mg/L. Table 6 shows the comparison of the May and September 2024 sampling results with the Reasonable Use Criteria (RUC).

Since the landfill is the only anticipated source of chloride, the chloride concentration at the Site boundary (about 100 m away from the most impacted wells) is expected to be much less than the calculated RUC of 126.9 mg/L.

In 2024, the highest concentrations of chloride (not including results from OW3 or OW13) were found in samples from wells OW2, OW8, OW9R and OW14 which are downgradient of the landfill.

The highest chloride concentration in 2024 was 110 mg/L measured at OW9R in September. A concentration of 83 mg/L of chloride was observed at OW9R in the spring. Chloride concentrations at OW9R had shown a gradual increasing trend from the fall of 2007 until the fall of 2019 but now appear to be stabilizing. OW9R is within 20 m of the landfill footprint, and over 100 m away from the property boundary (Figure 2).

Chloride levels at OW8 (downgradient of the fill and just inside the buffer zone) were 66 mg/L, and 70 mg/L in the spring and fall of 2024 respectively. A gradual decreasing trend in chloride at this well can be seen over the past 10 years.

OW14 had a chloride concentration of 66 mg/L in the spring of 2024 and 81 mg/L in the fall 2024. The 2024 concentrations of chloride are in line with historical values dating back through 2006 and appear to be stable. OW5 (background well) is downgradient of

OW14 with respect to groundwater flow (see Figure 4) and is closer to the property boundary. In 2024, the April chloride concentration in OW5 was 4.6 mg/L while it was 66 mg/L in OW14 during the same sampling period which confirms that attenuation is occurring in the shallow groundwater flow system.

Chloride concentrations at OW2 were 27 mg/L in April and 42 mg/L in September 2024, consistent with the stable trend observed at this well since 2015. Concentrations also show a seasonal pattern with highest values in the fall.

In 2024, chloride levels at OW11R (downgradient of the fill and outside the buffer zone) were reported as <20 mg/L in April and <10 mg/L in September. Laboratory notes indicate that due to colour interference the samples required dilution and the detection limit was adjusted accordingly. Since 2002, chloride levels at this well have been measured at concentrations less than 10 mg/L, which suggests the 2024 results are consistent with historical concentrations.

The April and September chloride level at OW10R (which is downgradient of the fill and within the buffer zone) was reported as < 20 mg/L. The laboratory note indicated that due to the sample matrix the sample required dilution and the detection limit was adjusted accordingly. The concentrations observed during 2024 reflect historical chloride levels at this well.

Chloride concentrations at OW1S (just outside of the buffer zone) are reported as <1 mg/L in both the spring and fall. The water quality results indicate that chloride is being attenuated with distance from the landfill and will not exceed the RUC at the property boundary. Since the Site is now closed and covered, concentrations of indicator parameters will continue to decrease over time.

In addition to the background and leachate wells, there are ten groundwater observation wells around the landfill (Figure 2). These wells have been divided into four groups for discussion as noted below:

Group I	OW1S/1D OW2 OW4 OW8 OW14	Wells located downgradient from the landfill less than 20 m from the toe of the fill area.
Group II	OW5 OW6S/6D	Wells downgradient from the landfill - farther from the fill area than the Group 1 wells (>20 m) and not within the marsh limits.

Group III	OW9R OW10R OW11R OW12	Wells downgradient from the landfill - farther from the fill area than the Group 1 wells (>20 m) and located within the marsh.
Group IV	OW7	Upgradient well located relatively close to the fill area (<20 m) - not on a direct flow path from the landfill.

Each of the graphs in Appendix G include the data from OW3 (leachate well), OW13 (leachate well) and OW5 (background well) for comparison purposes. Water quality from all wells is compared to the quality at OW13 (the most impacted well).

Group I – OW1S / 1D, OW2, OW4, OW8, OW14

OW4 and OW8 have historically shown signs of leachate impacts. OW4 was not monitored between the fall of 2008 and the fall of 2012 due to issues with the integrity of the well. During that time OW14 was used to examine the effects of leachate on the water quality in this group of wells.

The levels of the leachate indicator parameters in samples from these four Group 1 wells (OW2, OW4, OW8, and OW14) have historically been about 20% to 35% of those found in OW13. The chloride concentrations in these wells have generally peaked between 100 and 300 mg/L in comparison to 400 and 810 mg/L in OW13 and have generally decreased since 2014. Chloride levels at OW8 increased from about 100 mg/L in 2001 to a peak of about 302 mg/L in May 2011 but have since decreased and are now consistently below 100 mg/L. 63 mg/L in October 2023. Chloride concentrations in OW13 have generally decreased from 767 mg/L in 2006 to 440 mg/L in September 2024.

Fall 2024 Sampling Results

Parameter	OW13	OW2	OW8	OW4	OW14	Average Percent of OW13 Concentrations
Chloride (mg/L)	620	42 (7)	70 (11)	24 (4)	81 (13)	9%
Alkalinity (mg/L)	2300	620 (27)	780 (34)	430 (19)	710 (31)	28%

Note: Percent of parameter concentration compared to OW13 shown in brackets.

The values for these parameters obtained from the sampling in September 2024 are generally within the historical range.

The water chemistry at OW1S and OW1D has typically been similar to wells considered to represent background conditions.

Fall 2024 Sampling Results

Parameter	OW13	OW1S	OW1D	Average Percent of OW13 Concentrations
Chloride (mg/L)	620	<1 (0.16)	2.4 (0.39)	0.3 %
Alkalinity (mg/L)	2300	340 (14.8)	270 (11.7)	13.3 %

Note: Percent of parameter concentration compared to OW13 shown in brackets.

As can be seen, indicator parameters at OW1S and OW1D are typically at lower concentrations than those observed at OW2, OW4, OW8. Except for chloride, there is little variation in chemistry between the deep and shallow wells. Chloride is the only parameter to have historically varied between the deep and shallow wells, which is seen again in 2024 Chloride in OW1D has remained steady since 2002. Chloride concentrations in OW1S slowly increased from 1 mg/L in 2004 to a high of 14.0 mg/L in April 2010 suggesting possible landfill impact. Since then, chloride concentrations at OW1S have been decreasing and were measured at <1 mg/L in September 2024.

Figures G-1, G-4, G-7, G-10, and G-13 show chloride, alkalinity, conductivity, hardness, and DOC levels over time for Group I wells. The 2024 results indicate that OW14 has the highest chloride concentration (110 mg/L) of Group I Wells. Chloride levels at OW4 show seasonal variations with levels highest in the fall but are well below the ODWQS. Figure G-1 indicates that OW1S and OW1D chloride concentrations are similar to background (OW5) results. Chloride concentrations in the Group I wells were much below levels in OW13 during the 2024 sampling events.

2024 results from several Group I wells exceeded the ODWQS: iron concentrations greater than 0.30 mg/L were reported at OW2 and OW8 (spring and fall) and OW4 in fall; manganese concentrations greater than 0.05 mg/L were observed at OW2, OW4, OW8 and OW14 in the spring and fall; alkalinity concentrations were greater than 500 mg/L at OW2, OW8 and OW14 (spring and fall); and, DOC was greater than 5 mg/L at OW2 and OW8 in the spring and fall and OW14 in the fall.

Group II – OW5, OW6S / 6D

Group II includes monitoring wells OW5 and OW6S / 6D. These wells are downgradient from the landfill, greater than 20 m from the fill area and not within the limits of the marsh.

Chloride levels at OW6S and OW6D between 1999 and 2006 were consistently higher in the fall than in the spring. Concentrations gradually increased in both wells from about 10 mg/L in the fall of 1999 to about 100 mg/L in 2006. This seemed to indicate that these wells were beginning to be impacted by landfill leachate. However, since 2006, chloride levels at both wells decreased to less than 10 mg/L by May 2014. In 2024, chloride levels at OW5, OW6S and OW6D remained stable with concentrations less than 10 mg/L, and the results are comparable to or lower than concentrations seen in wells from Group I. OW6S was not sampled during the fall 2024 monitoring event because it was dry.

Fall 2024 Sampling Results

Parameter	OW13	OW6D	OW6S	OW5	Average Percent of OW13 Concentrations
Chloride (mg/L)	620	2.5 (0.4)	Not Sampled	3.8 (0.6)	0.5 %
Alkalinity (mg/L)	2300	320 (14)	Not Sampled	400 (17)	15 %

Note: Percent of parameter concentration compared to OW13 shown in brackets.

The conductivity and alkalinity indicator parameter results for OW6D are similar to those seen at the OW5 background well, indicating minimal landfill impact is occurring at this location. The concentration of iron measured at OW6D during the fall 2022 exceeded the ODWQS value at 1 mg/L. This is the first exceedance for iron at this location since 2006. The Spring and Fall 2024 concentration for iron was below the reporting detection limit. Figures G-2, G-5, G-8, G-11, and G-14 show long-term chloride, alkalinity, conductivity, hardness, and DOC levels for Group II wells.

The only exceedances of ODWQS in 2024 among Group II wells occurred at OW5, where manganese concentrations exceeded 0.05 mg/L, reaching 0.059 mg/L in the spring and 0.083 mg/L in the fall.

Group III

OW9R, OW10R, OW11R, and OW12 are located within the marsh and are over 20 m away from the fill area. The 2024 water chemistry data from OW10R, OW11 and OW12 show no significant increases in leachate indicators.

Fall 2024 Sampling Results

Parameter	OW13	OW9R	OW10R	OW11R	OW12	Average Percent of OW13 Concentrations
Chloride (mg/L)	620	110 (18)	<20* (3)	<10* (2)	5.8 (1)	6%
Alkalinity (mg/L)	2300	290 (13)	140 (6)	87 (4)	350 (15)	9.5%

Note: * Value represents detection limit.

Percent of parameter concentration compared to OW13 shown in brackets.

After July 2008, the concentration of chloride at OW9R began to increase and in September 2019 the concentration peaked at 140 mg/L. Since that peak, the concentration of chloride gradually declined to 63 mg/L in September 2021. In 2024, the spring and fall chloride concentrations were 83 mg/L and 110 mg/L respectively which falls in line with recent years. Iron, manganese and DOC tend to be elevated at this location. In 2024, iron, manganese, and DOC were all above the ODWQS.

OW10R was installed in 2005 and indicator parameter levels have remained similar to or below, background levels. The level of DOC in OW10R has been elevated above the level in OW5 since sampling of this well began. In 2024, iron (spring and fall), manganese (fall), and DOC (spring and fall) were above the ODWQS.

Samples from OW11R have historically had concentrations of iron and DOC that are above their respective ODWQS values, and the same exceedances were observed in 2024. The September 2024 reported pH value at OW11R was slightly lower than the ODWQS value at 6.49 pH units.

At OW12, the chloride concentration peaked at 15 mg/L in May 2011. In 2024, the chloride concentration remained stable with values of 5.8 mg/L in May and October. Iron concentrations at OW12 exceeded the ODWQS with values of 2.6 mg/L in the spring and 2.5 mg/L in the fall. DOC concentrations at OW12 exceeded the ODWQS with values of 6.4 in the fall. The April and September 2024 concentration of arsenic exceeded the ODWQS at 0.035 mg/L and 0.045 mg/L respectively.

Figures G-3, G-6, G-9, G-12, and G-15 show long-term chloride, alkalinity, conductivity, hardness, and DOC levels for Group III.

Group IV

OW7 is the only well in Group IV. This group is defined as the upgradient wells located relatively close to the fill area (<20 m), but not on a direct flow path from the landfill. Concentrations of indicator parameters at OW7 are shown on Figures G-16 and G-17. Variable chloride concentrations up to 41 mg/L in OW7 occurred between 2003 and 2008 (Figure G-16). Apart from a spike to 26 mg/L in October 2012, the chloride concentration declined and was 4.1 mg/L in September 2024.

Conductivity, hardness, and alkalinity generally declined from the peak levels recorded in 2008 until September 2014 when concentrations began to rise, with September 2017 values near the 2008 peaks. These indicator parameter concentrations have historically tended to be slightly higher than background levels since 1993 and that trend has continued. Iron concentrations are variable, ranging from <0.1 mg/L to a maximum of 4.1 mg/L in October 2015 and September 2024. Iron (spring and fall) and manganese (spring and fall) exceeded their ODWQS values in 2024 which is typical of water quality at this location.

4.7.1 Volatile Organic Compounds Characterization and Interpretation

Samples from OW13 have been analyzed for the volatile organic compounds (VOCs) listed in Column 1, Schedule 5 of the Landfill Standards Guideline since 2011.

Ethylbenzene appears to have stabilized since a peak concentration of 40 µg/L in May 2017. Ethylbenzene was above the ODWQS of 2.4 µg/L in the spring (26 µg/L) and in the fall (27 µg/L). No other VOCs exceeded the applicable ODWQS in 2024. 2024 VOC results are summarized in Table 4.

4.7.2 Leachate Characterization and Interpretation

Parameters such as chloride, conductivity, and alkalinity are considered typical landfill leachate indicators. Chloride is a conservative ion in groundwater and is generally a good indicator of the extent of leachate impacts. A summary of the concentration of leachate indicator parameters from the spring 2024 sampling event is provided below.

Summary of Indicator Parameters in Groundwater 2024

Monitoring Well	Chloride (mg/L) Spring 2024	Conductivity (µmhos/cm) Spring 2024	Alkalinity 4.2 (mg $CaCO_3$/L) Spring 2024
OW1S	<1	530	310
OW1D	1.6	530	270
OW2	27	1100	580
OW3	170	1800	680
OW4	3.6	540	350
OW5	4.6	610	360
OW6S	<1	420	230
OW6D	1.1	460	250
OW7	2.1	660	390
OW8	66	1300	790
OW9 R	83	860	260
OW10 R	<20	140	87
OW11 R	<20	130	64
OW12	5.8	560	330
OW13	470	3900	1900
OW14	66	1300	630

Concentrations of landfill leachate indicator parameters in samples from OW3 and OW13 have been reported within the following ranges:

2024 Leachate Sample Results

	OW13			OW3		
Parameter	**Historical Range**	**2024 Spring**	**Trend**	**Historical Range**	**2024 Spring**	**Trend**
Chloride (mg/L)	100-807	470	Variable	0.1-1,130	170	Decreasing
Conductivity (umhos/cm)	2,500-6,738	3,900	Variable	620 - 5,740	1,800	Variable
Hardness (mg/L)	740-1,531	1,400	Variable	280-1,430	490	Stable
Alkalinity (mg/L)	1,200-2,200	1,900	Variable	330 - 1,790	680	Variable

The 2024 concentrations of landfill leachate indicator parameters for OW3 and OW13 are generally considered to be typical. Chloride concentrations at OW3 and OW13 have shown a decreasing trend since 2010. Since 2014 Chloride concentrations at OW3 have been lower in the spring.

Parameters such as iron, chloride, sodium, manganese, conductivity, hardness, and alkalinity are typically elevated at both wells when compared to background concentrations.

4.8 Surface Water Quality

The surface water sample results from 2003 to 2024 are compared to the Provincial Water Quality Objectives in Table 5. Any parameter that exceeds the respective PWQO is shaded. The table below provides concentrations of leachate indicator parameters for the 2024 sampling events. SW1 did not have sufficient water to obtain samples during the fall 2024 sampling event.

Summary of Indicator Parameters in Surface Water in April 2024

Monitoring Location	Chloride (mg/L)	Conductivity (µmhos/cm)	Hardness (mg/L)	Alkalinity 4.2 (mg $CaCO_3$/L)
SW1	<20	31	3.8	2.6
SW2	1.7	410	260	220
SW3	<20	95	66	53

Summary of Indicator Parameters in Surface Water in September 2024

Monitoring Location	Chloride (mg/L)	Conductivity (µmhos/cm)	Hardness (mg/L)	Alkalinity 4.2 (mg $CaCO_3$/L)
SW2	3.8	560	300	300
SW3	<20	74	45	33

Unionized ammonia is calculated using field pH and temperature, as well as the ammonia concentration as measured by the laboratory. No samples were calculated to be above the PWQO for unionized ammonia in 2024. As can be seen on Figure 3, the surface locations are part of a large boggy area associated with Luther Marsh and Luther Lake. The area is very flat with a water table at or near surface and as a result, there are no well-defined streams or creeks. The three surface water stations are open areas within the boggy deposits and are considered representative of the surrounding surface water. The open water portion of Luther Marsh is about 1 km to the northwest of the landfill (Figure 3) with Luther Lake further to the northwest. Figures G-18 to G-21 show long-term concentration vs time plots of alkalinity, conductivity, hardness, and chloride for surface water locations SW1, SW2 and SW3.

Aluminum exceeded the PWQO at SW1 (spring), SW2 (fall) and SW3 (spring and fall). The interim PWQO of 0.075 mg/L is valid for pH between 6.5 and 9.0. At pH 4.5 to 5.5, the interim PWQO is reduced to 0.015 mg/L. In spring and fall of 2024, the ODWQS criteria for aluminum of 0.075 mg/L was exceeded at SW1 (spring- 0.24 mg/L), SW2 (fall- 0.22 mg/L) and at SW3 (spring-0.23 mg/L and fall-2 mg/L).

A review of the pH data at SW1 indicates the water is acidic (the lowest lab measured pH is 5.2 pH units) which may be resulting in some leaching of metals from soil and vegetation. Due to the presence of surficial peat deposits in the Luther Marsh area, acidic surface water conditions can be expected. A variety of metals were present at concentrations above the PWQO during sampling events from 2003 to 2007 including cadmium, cobalt, copper, lead, vanadium and zinc. Since 2007, only aluminum and zinc have consistently exceeded the PWQO. It is possible that the closure of the landfill has reduced impacts at this location by reducing erosion and sediment loading to the surface water. SW1 is in the marsh, within 30 m of the landfill area (Figure 2). Alkalinity, chloride and conductivity have all decreased over time at SW1. DOC concentrations are typically the highest measured in the surface water samples and have been variable with no well-defined trend apparent.

SW2 is located approximately 75 m south of the property line near the access road. Historically, the concentration of aluminum is typically above the PWQO, and has ranged from 0.037 mg/L to 5.1 mg/L. Aluminum was measured to be at a concentration of 0.033 mg/L in April 2024 and 0.4 mg/L in September 2024. The aluminum concentration of 6.9 mg/L observed in October 2023 was the highest concentration recorded. Hardness and conductivity have both decreased since 2008. Chloride concentrations have remained stable with values of 1.7 mg/L in the spring and 3.8 mg/L in the fall.

SW3 is a monitoring location on the edge of the marsh approximately 100 m north of the fill area on the property boundary (Figure 2). SW3 had water available for sampling in both the spring and fall of 2024. Aluminum has always exceeded the PWQO of 0.075 mg/L. In spring of 2024 the aluminum concentration was 0.25 mg/L and in the fall was 2 mg/L. SW3 also exceeded the PWQO for lead (0.005 mg/L) and zinc (0.02 mg/L) during the fall sampling event with concentrations of 0.01 mg/L and 0.037 mg/L respectively.

Overall, the landfill does not appear to have resulted in any measurable surface water impacts.

4.9 Gas Pressures and Composition

Methane gas (CH_4) is a by-product of waste decomposition and is generated in waste until all the organic matter has completely decayed. Methane is a potential explosion hazard, but the shallow water table and surrounding marsh environment at this site prevent significant migration of methane. In addition, the fill area is above grade and therefore, any gas produced is expected to vent naturally to the atmosphere through the sides of the fill.

Methane is typically not a major concern unless buildings are located within 30 m of the fill area as nearby buildings could accumulate methane gas to dangerous levels. The operator’s shed (the only building at the Site) has been removed.

Two methane probes, GP1 and GP2, were installed in the former area of the operators shed (Figure 2). The methane probes and the water monitoring wells were monitored in 2024 for methane concentrations. Methane was only detected in during the September 2024 monitoring event at SW3 at 1.6 % volume in air. A summary of gas readings is presented in Table 7.

5.0 Summary and Conclusions

Based on the information supplied by the Town of Grand Valley and review of the results from the 2024 monitoring program, Burnside concludes that:

- The East Luther landfill site is located on a parcel of land owned by the Grand River Conservation Authority (GRCA) within the Luther Marsh on Lot 21, Concession 4. The Site has historically been operated by the Township of Grand Valley under the MOE Provisional Certificate of Approval No. A180601. The Town (formerly the Township of East Luther Grand Valley) discontinued use of the Site as of December 31, 2005 and has completed closure construction.
- The filled area of this site is approximately 2.5 ha.
- The Site is located on a parcel of land that encroaches on the low boggy area associated with the Luther Marsh and Luther Lake.
- Shallow groundwater moves in a semi-radial pattern from the fill area through the surficial soils. There is evidence of a slight groundwater mound within the landfill area as the downward migration of groundwater is restricted by the low permeability till material that underlies the Site.
- Landfill leachate impacts are evident in the shallow groundwater within about 20 m of the landfill toe of slope (Group I), as well as in the marsh area as observed in OW9R (Group III).
- The low permeability environment provides adequate contaminant attenuation, protecting the underlying bedrock aquifer.
- Based on Reasonable Use calculations, the dilution and attenuation of the leachate within the shallow groundwater / surface water system reduces the leachate concentrations to levels acceptable to the MECP.
- Surface sample locations have elevated levels of aluminum which are likely naturally occurring. Concentrations of other metals have been above the PWQO in the past, but the PWQO exceedances have decreased in frequency over time.
- Methane, while it is a potential explosion hazard, is not a major concern providing no buildings are onsite. The shallow water table and surrounding marsh environment at this site will prevent significant migration of methane, therefore, any gas produced is expected to vent naturally to the atmosphere.
- Concentrations of indicator parameters will continue to decrease since the Site is now inactive and the final cover should reduce infiltration and leachate production.

- Burnside has submitted a request (along with supporting rationale) to the MECP for a reduction in the monitoring requirements.

6.0 Recommendations

Based on review of the 2024 monitoring and historical data, and information from the Town it is recommended that:

- Sampling for VOCs listed in Schedule 5 of “Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites” (January 2012) should continue at OW13.
- The current monitoring program should continue until the proposed changes are approved by the MECP.

7.0 Bibliography

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