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RIDGE LANDFILL

Ridge Landfill Expansion Environmental Assessment

Hydrogeological Work Plan (Final)

September 2018 – 15-2456

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Project and Work Plan Overview

This hydrogeological assessment work plan has been prepared to support the environmental assessment (EA) for the Ridge Landfill expansion and is based on the commitments made in the final amended Terms of Reference (ToR) for the EA that was approved by the Ministry of the Environment and Climate Change (MOECC) in May of 2018.

Waste Connections of Canada (Waste Connections) is proposing an expansion of the Ridge Landfill in order to continue to provide long-term residual disposal capacity for the company's large IC&I customer base and as a regional and inter-regional waste management facility to serve the projected increase in population and economic growth in southern and central Ontario.

The Ridge Landfill has been in operation since 1966 and was previously expanded in 1999. Waste Connections owns 340 hectares (ha) of land at the Ridge Landfill. The existing Landfill Site Area, which is permitted by an ECA from the MOECC for waste management and environmental work purposes, is 262 ha. The area within which waste disposal is permitted, called the Waste Fill Area, is 131 ha or half of the Landfill Site Area. As of December 2017, it is estimated that the existing Waste Fill Area at the Ridge Landfill site will provide waste disposal capacity until approximately 2021 at the current fill rate.

The current approved capacity for the Ridge Landfill is 21 million cubic metres (m^3). The site is approved to accept a maximum of 1,300,000 tonnes of waste per year (the MOECC approved annual waste disposal rate). The EA does not propose to increase the maximum annual fill rate (this would remain as-is); however, Waste Connections is seeking the EA to increase the life of the facility for a 20 year planning period, from 2022-2041.

The waste being landfilled is approximately 98% IC&I waste and 2% residential waste. As part of the EA approval, Waste Connections would agree to reduce their IC&I service area from all of Ontario to just southern and central Ontario, and their residential service area from Chatham-Kent and the neighbouring counties of Essex, Lambton, Middlesex and Elgin, to the just municipality of Chatham-Kent.

This hydrogeological work plan outlines the tasks to support the evaluation of alternative methods, and to undertake an impact assessment once the preferred alternative method is determined. The following paragraphs provide a brief summary of the scope of the hydrogeological work, including protocols and/or standards to be adhered to while work is undertaken.

The purpose of the hydrogeological assessment is to determine whether the site can be developed without causing adverse effects to off-site groundwater.

The hydrogeological discipline is significantly involved in the design of the landfill, particularly in the design of the leachate management system. The assessment will address the requirements of O. Reg. 232/98 Landfilling Sites - in particular, Section 8 of the regulation ("Hydrogeological Assessment"). The assessment will characterize the hydrogeologic setting of the existing landfill site, and predict the potential impacts that could be expected from the landfill expansion.

The work plan includes the following tasks that are required by O.Reg. 232/98:

i. The drilling of boreholes and obtaining samples to characterize soil or bedrock conditions at the site.
ii. The measurement of groundwater levels and pressures to define groundwater flow characteristics.
iii. The collection of groundwater samples to assess groundwater quality.
iv. The interpretation of collected data including the preparation of site and piezometric contour plans, the determination of groundwater flow paths and contaminant attenuation capabilities, and the identification of any unstable soils or geologic conditions.
v. An assessment of the suitability of the site for landfilling with respect to the design, monitoring and contingency plan requirements.

A substantial amount of hydrogeological information is available for the Ridge Landfill. This information has been obtained since the 1980's and on-going monitoring of groundwater monitoring wells has been completed since 1984. The Ridge Landfill is situated on thick, low permeability silty clay till aquitard. Water levels in monitoring wells installed deep within the clay aquitard take many months to reach a static state (i.e., groundwater very slowly fills the monitoring wells after they are installed). As such, it was decided that the drilling program for this work plan be completed concurrently with the development of the ToR. Notwithstanding this, Waste Connections recognizes that the data collected from the wells will need to be discussed with the MOECC to confirm suitability in the context of the larger work plan for hydrogeology for the EA. It is recognized that the EA scope of work (e.g., number of monitoring wells) may evolve as part of this discussion.

The use of groundwater in the vicinity of the site will be documented. The primary source will be the Ministry of the Environment and Climate Change (MOECC) Water Well Record database supplemented with on-site knowledge of groundwater users. As stated in Section 2 of the work plan, the regional aquifer is the basal aquifer found at the interface of the overburden and bedrock. There is a municipal water supply pipeline along both Charing Cross Road and Erieau Road and therefore many residences are no longer on an individual groundwater well supply. The evaluation of alternative methods will also include details of the off-site residential well water quality monitoring that has been completed as part of the overall monitoring program for the existing site since 1998.

A predictive impact assessment will be completed using contaminant transport computer modelling to assess the suitability of the site, and specifically, compliance with the MOECC Reasonable Use Guideline. Predicted impacts will be compared to the Ontario Drinking Water Standards and the Reasonable Use Guideline. The engineered features of the landfill (such as the leachate collection system) will be included in the model and will include an assessment the required service life of the engineered features and an overall assessment of the contaminating life span of the site.

For the site development alternative methods, the "contaminating life span" of the alternative methods will also be qualitatively determined. The contaminating life span will be determined as part of the assessment of potential impacts for the landfill expansion and will depend on primary factors such as tonnes of waste per hectare and leachate generation rate.

A summary of additional commitments for the Hydrogeological Assessment is provided below.

Commitment	Reference to applicable section in EA or supporting document
Waste Connections commits to further development of the hydrogeology EA work plan with the MOECC's Southwest Region Hydrogeologist. As part of these discussions, Waste Connections commits to discussing groundwater sampling parameters and locations.	Hydrogeological Assessment (all). Groundwater sampling parameters are discussed in Section 4.4 and sampling locations are discussed in Section 4.1.
Waste Connections commits to incorporating a section in the EA that describes potential effects to nearby receptors (i.e., private drinking water wells). This section will include discussion on the private drinking water well supplies in the area and will also demonstrate that compliance with the Reasonable Use Guideline is sufficient to show that off-site receptors are not at risk." The methodology to assess potential effects to nearby receptors is to use the results of the predictive contaminant transport and fate modelling that will be completed as part of the Reasonable Use assessment. The travel time to the drinking water aquifer from the surface through the clay aquitard is many hundreds of years and will protect private drinking water wells. Private water well users in the vicinity of the site will be identified via a door-to-door survey	Hydrogeological Assessment Section 4.6. This will also be incorporated into the EA (section TBD).
The leachate contaminating life span for groundwater will be assessed for the alternative methods and the preferred alternative method as follows: The waste loading (tonnes of waste per footprint area) for each alternative method will be determined	Hydrogeological Assessment Section 4.6.1 to 4.6.3. Design and Operations Report (Section TBD).

Commitment	Reference to applicable section in EA or supporting document
Three leachate generation rates will be assumed per alternative method based on a natural cover, low permeability clay cover and a low permeability geosynthetic cover Leachate characteristics used in the contaminating life span estimates will be taken from Table 1, Section 10 of O.Reg. 232/98 The contaminating life span for each alternative method will be estimated adapting the method used by "Barrier Systems for Waste Disposal Facilities, 2nd Edition", by R. Kerry Rowe, Robert M. Quigley, Richard W.I. Brachman & John R. Booker.	
The landfill gas contaminating life span will be determined by modelling landfill gas generation rates for the site development alternative methods. The landfill gas generation model will indicate how long landfill gas will occur (contaminating life span). An assessment of the natural subsurface landfill gas migration potential, which is limited by low permeability soil, a shallow water table and surface water features, will also be included in the landfill gas contaminating life span assessment.	
Potential impacts to nearby receptors such as private drinking water wells will be assessed in the EA using a predictive impact assessment using contaminant transport computer modelling to predict expected concentrations in groundwater in the bedrock aquifer immediately below the landfill. Predicted concentrations will be compared to both the Ontario Drinking Water Standards and the allowable concentrations determined by the Reasonable Use Guidelines.	Hydrogeological Assessment Section 4.6.

1.0 Introduction

An outline of the hydrogeological assessment for the Ridge Landfill expansion was presented in Appendix A of the approved ToR. This work plan provides the details on how this assessment will be carried out. The purpose of the hydrogeological assessment is to determine whether the site can be developed without causing adverse effects to off-site groundwater. The objective of the hydrogeological assessment is to complete the required investigations and analysis of hydrogeological data to support the *Environmental Assessment Act* and the *Environmental Protection Act* approvals required for the expansion of the landfill site.

The hydrogeological discipline is significantly involved in the design of the landfill, particularly in the design of the leachate management system. The assessment will address the requirements of O. Reg. 232/98 Landfilling Sites - in particular, Section 8 of the regulation ("Hydrogeological Assessment"). The assessment will characterize the hydrogeologic setting of the existing landfill site, and predict the potential impacts that could be expected from the landfill expansion.

The detailed assessment of the site required by O.Reg. 232/98 will identify potential effects on the environment from landfill development, and how these potential effects will be mitigated.

1.1 Study Area

For the purpose of the hydrogeological assessment, the investigative Study Area will extend to the limits of the Ridge Landfill property (on-site). The rationale for this study area is that there has been a significant level of previous hydrogeological investigation completed at the site. Major hydrostratigraphic units have been defined and groundwater flow patterns established. Groundwater movement is very slow at the site which also justifies the study area. The assessment area using secondary sources such as water well records and published hydrogeology / geology reports will extend approximately 5 km from the site. Secondary source information is used to summarize regional geology and hydrogeology and groundwater users in the area of the site. A 5 km study is justified by the slow movement of groundwater which limits the area of potential hydrogeological effects from waste disposal from this site.

1.2 Field Work Completed Concurrently with ToR Development

A substantial amount of hydrogeological information is available for the Ridge Landfill. This information has been obtained since the 1980's and on-going monitoring of groundwater monitoring wells has been completed since 1984. A major hydrogeological assessment was completed 1996/1997 in support of the approval process for the existing site (West Landfill and South Landfill) (Dillon, 1997). The Ridge Landfill is situated on thick, low permeability silty clay till aquitard. Static water levels in monitoring wells installed deep within the clay aquitard take many months to reach static water levels (i.e., groundwater very slowly fills the monitoring wells after they are installed). As such, it was decided that the drilling program for this work plan be completed concurrently with the development of the ToR. The drilling program was completed in the fall of 2016 and water levels have been monitored in the new monitoring wells since that time. This approach will improve the quality of data that will be available for the hydrogeological assessment related to the current landfill expansion proposal. Notwithstanding this, Waste Connections recognizes that the data collected from the wells will need to be discussed with the MOECC to confirm suitability in the context of the larger work plan for hydrogeology for the EA. It is recognized that the EA scope of work (e.g., number of monitoring wells) may evolve as part of this discussion.

2.0 Hydrogeological Assessment Criteria

The hydrogeological assessment will be documented following the requirements of Section 8 of O.Reg 232/98. It will include borehole logs, geologic cross-sections and piezometric maps. It will document the suitability of the site for landfilling waste disposal purposes and proposed monitoring and contingency plans. A summary of the hydrogeological assessment will be included in the Environmental Assessment document.

The primary environmental assessment criteria, indicators and data sources for the hydrogeological assessment are provided in **Table 1**. The assessment criteria, indicators, and data sources will be utilized for the evaluation of alternative methods and the assessment of net effects.

Table 1: Hydrogeological Assessment Criteria, Indicators, and Data Sources

Assessment Criteria	Indicators	Data Sources
Contaminating Life span	• Prediction based on tonnes of waste per hectare of footprint area and leachate generation rate.	• Three leachate generation rates: based on a natural cover, low permeability clay cover and a low permeability geosynthetic cover. • Leachate characteristics used in the contaminating life span estimates will be taken from Table 1, Section 10 of O.Reg. 232/98. • Estimated adapting the method used by Rowe et. al (2004).
Potential impacts to groundwater quality	• Concentrations based on predictive contaminant transport modelling (i.e., POLLUTE™) (assessment of net effects).	• Site data collected through intrusive investigations. • Leachate characteristics taken from Table 1, Section 10 of O.Reg. 232/98. • Leachate generation rates (HELP™ modelling). • Landfill design input.
Potential impacts to groundwater quantity	• Reduction in infiltration rate to bedrock aquifer.	• Site data collected through intrusive investigations. • Landfill design input.

Assessment Criteria	Indicators	Data Sources
Potential impacts to water supply wells	• Predictive impact assessment using contaminant transport computer modelling to predict expected concentrations in the bedrock aquifer.	• Water supply well survey. • Site data collected through intrusive investigations. • Leachate characteristics taken from Table 1, Section 10 of O.Reg. 232/98. • Leachate generation rates (HELP™ modelling). • Landfill design input.

Furthermore, the assessment will also address compliance with O.Reg. 232/98 (including the MOECC Reasonable Use Policy). Predicted compliance with O.Reg. 232/98 will infer compliance with the Assessment Criteria.

3.0 Hydrogeological Baseline Conditions

This summary of baseline hydrogeological conditions is based on the existing knowledge of hydrogeological conditions at the Ridge Landfill site, notably the hydrogeological assessment that was completed in support of the approval process for the existing landfill (Dillon, 1997). The Ridge Landfill Site lies within the St. Clair Clay Plain physiographic region. The ground surface has little topographic relief in the area of the Ridge Landfill and slopes slightly to the northwest. Surface drainage is poor and has been enhanced through man-made municipal drains. The clay plain is widespread in the west towards Windsor, but narrows near the landfill, extending from Charing Cross south to Lake Erie. A small rise in the land at Charing Cross (north of the site) marks the location of a minor till moraine.

The clay plain consists of slightly stony, clayey silt Port Stanley Till, which ranges in thickness from 38 m to 44 m. Site investigations indicated that the Port Stanley Till has a weathered and fractured upper surface, characterized by vertical to sub-vertical fractions extending to a depth up to 6 m. The unweathered Port Stanley Till found at the Ridge Landfill is a grey, dense to very dense clayey silt till with traces of sand and fine gravel.

The Port Stanley Till overlies unconsolidated glaciolacustrine sands, silts and clays. Underlying the glaciolacustrine soils is Kettle Point formation black shale bedrock, which is found at an average depth of approximately 46 m below ground surface (mbgs). The surface of the bedrock is highly fractured and weathered. Fracturing in the bedrock decreases with depth.

The hydrogeology of the landfill site has been divided into three main hydrostratigraphic units which are shown on **Figure 1**:

- Layer 1 is the surficial aquifer and consists of a variety of soil types including topsoil, sand, silt and gravel. However, the predominant unit is weathered and fractured Port Stanley Till. Groundwater flow in this hydrostratigraphic unit is horizontal and migrates towards surface water drainage features.
- Layer 2 consists of unweathered Port Stanley Till, which does not have significant discontinuities such as fractures. There is a dominant vertical downward groundwater flow direction but there is a very low groundwater flux due to the very low hydraulic conductivity of the till, which is in the order of 10^{-8} cm/s.
- Layer 3 is the regional aquifer and is made up of a basal overburden sand and gravel unit and/or weathered and fractured bedrock. There is a regionally dominant south-southeast horizontal flow direction in Layer 3. The deposits of sand and gravel, as well as the weathered bedrock surface provide the principal pathway for regional groundwater movement. Layer 3 is relatively heterogeneous and varies in composition, thickness and hydraulic conductivity. The approximate thickness of this layer is 3 m. Water level measurements taken in Layer 3 wells indicate that

horizontal groundwater movement is slow, and occurs under very low hydraulic gradients, in the order of 0.0005 m/m. The hydraulic conductivity of Layer 3 is in the order of 10^{-4} cm/s.

The baseline groundwater quality is well understood and a network of monitoring wells was established in the 1980's. The monitoring program has been expanded throughout the years and consists of groundwater, surface water, and landfill leachate and landfill gas. The monitoring data and assessment are included in the Annual Report documenting site development, operations and monitoring. No groundwater quality issues resulting from the existing landfill have been identified in the monitoring program.

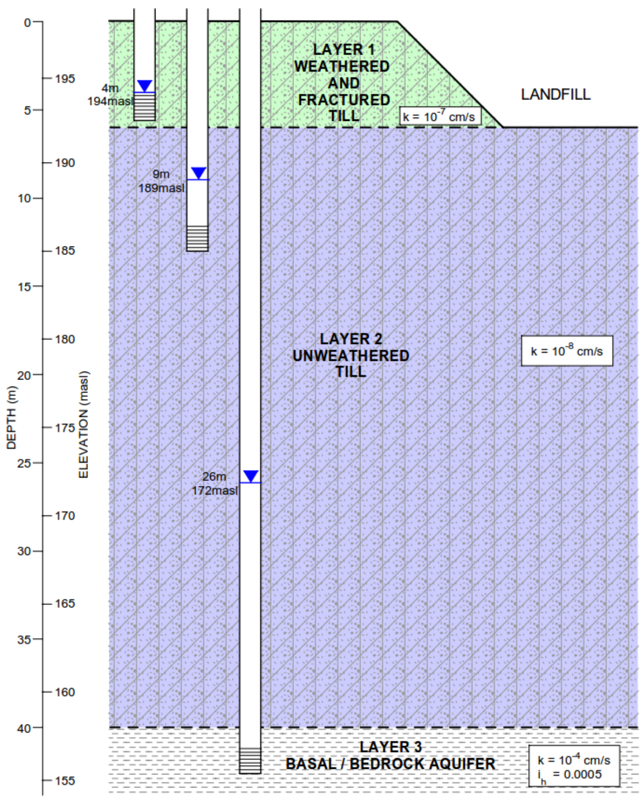

Figure 1 - Conceptual Hydrogeology

4.0 Work Plan Tasks

The hydrogeological work plan has been developed to address the requirements of Ontario Regulation (O.Reg.) 232/98 *Landfilling Sites* and in particular Section 8 of the regulation, "Hydrogeological Assessment". O. Reg. 232/98 under Part V of the *Environmental Protection Act* contains detailed requirements for the design, operation, closure and post-closure care of non-hazardous waste landfills. A detailed assessment of the site is required by O.Reg. 232/98 to identify potential effects on the environment from landfill operations, and how these potential effects can be mitigated.

In addition to O.Reg. 232/98, the MOECC has published a guideline, titled "*Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites*" (MOECC, 2012). These guidelines provide additional technical guidance of the requirements of O.Reg. 232/98.

The guidelines provide the following requirements for the hydrogeological assessment of a landfill site:

i. The drilling of boreholes and obtaining samples to characterize soil or bedrock conditions at the site.
ii. The measurement of groundwater levels and pressures to define groundwater flow characteristics.
iii. The collection of groundwater samples to assess groundwater quality.
iv. The interpretation of collected data including the preparation of site and piezometric contour plans, the determination of groundwater flow paths and contaminant attenuation capabilities, and the identification of any unstable soils or geologic conditions.
v. An assessment of the suitability of the site for landfilling with respect to the design, monitoring and contingency plan requirements. (MOECC, 2012).

4.1 Intrusive Investigation

It is proposed to expand the landfill laterally from the existing west and south mounds, southwards towards Allison Line. The subsurface conditions at the existing landfill site have been investigated and monitored extensively over the past 30 plus years and are well understood. Therefore the focus of the subsurface investigation is in the proposed new landfilling area which is contiguous with the existing landfill area. Six new monitoring well "nests", consisting of a monitoring well installed in each hydrostratigraphic unit (Layer 1, Layer 2 and Layer 3) were installed in the Fall of 2016. These new monitoring well nests are located around the perimeter of the proposed expansion area and will ultimately be incorporated into the monitoring program for the expanded landfill. The locations of the six new monitoring well nests are:

- Two monitoring well nests located along County Line 10 between Allison Line and the former railway track.

- Three monitoring well nests located along Allison Line between County Road 10 and Erieau Road.
- One monitoring well nest located along Erieau Road north of Allison Line.

Approximate locations for the current monitoring well nests are shown on **Figure 2**. It is recognized that as subsurface information is collected, the need for additional, presently unforeseen, subsurface investigation data may be identified. In particular, the monitoring well network that forms the basis of the site groundwater monitoring program may be adjusted based on further investigative results and comments from the Ministry.

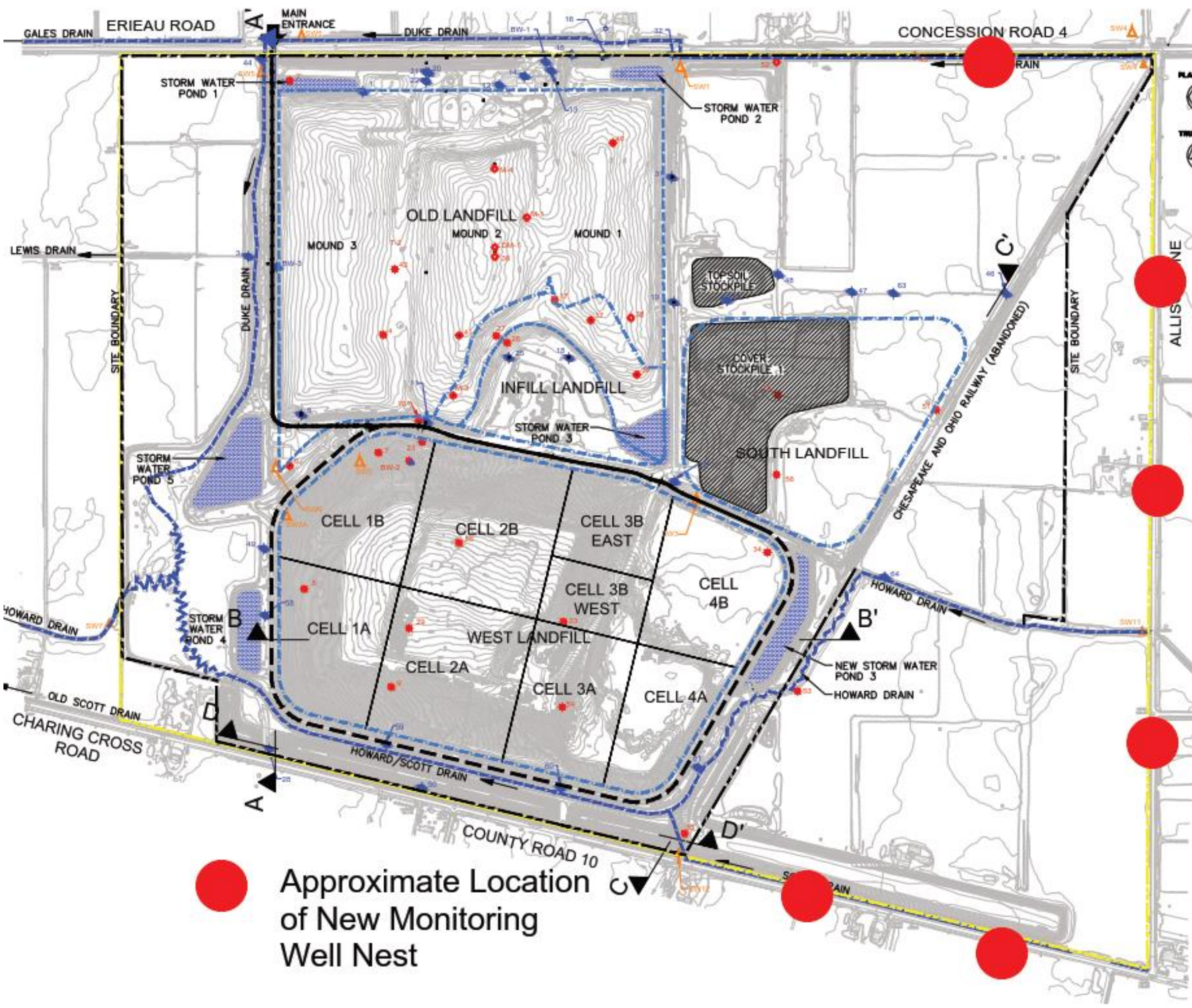

Figure 2 - Approximate New Monitoring Locations

4.1.1 Drilling Program

The new monitoring wells were installed using hollow-stem augers and a continuous soil core sample barrel system, which produces a 1.5 m-long, 65 mm nominal diameter soil core. The continuous-sample barrel is locked inside the lead hollow stem auger, and does not require the use of any drilling fluids (water, drill muds, etc.) to produce soil cores. The soil cores were logged in the field for the deepest monitoring well (bedrock monitoring well) and stored in the core boxes / sleeves. Select soil samples were submitted for laboratory analysis (described below). The deepest borehole at each monitoring well nest extended into the weathered shale bedrock with the augers to a depth of 3 m or refusal.

4.1.2 Monitoring Well Installations – Lateral Expansion Area

At each monitoring well nest location, a monitoring well consisting of a 50 mm diameter, 1.5 m long PVC well screen connected to riser pipe was installed in the deep borehole (a Layer 3 monitoring well). Silica sand was placed in the annulus of the well screen and extends approximately 0.6 m above the top of the screen. A bentonite seal plug was placed above the silica sand, and bentonite grout was placed above the bentonite seal around the PVC riser pipe via a tremie pipe, which was extended to ground surface. Each well is equipped with a protective steel casing, concreted in place at ground surface. The Layer 2 monitoring well was installed in its own borehole at a nominal depth of 15 mbgs (no soil sampling was completed in this borehole). Layer 2 monitoring wells were constructed in a similar fashion as Layer 3 monitoring wells. The shallow Layer 1 monitoring well was installed at a nominal depth of 5 mbgs, and was also installed in its own borehole similar to the Layer 2 wells. The Layer 1 wells have 3.0 m long well screens. As previously stated, soil cores were only obtained from the deep boreholes (i.e., Layer 3 monitoring well borehole).

4.1.3 Leachate Monitoring Wells – Old Landfill Area

As proposed in the ToR, six leachate monitoring wells drilled to the base of fill in the Old Landfill will be used to evaluate leachate quality and leachate levels in the old landfill. The purpose of this work will be to evaluate the potential of both a vertical expansion, or mining of the Old Landfill (Alternative Methods). Leachate level elevations in these wells will be used to evaluate the amount of leachate mounding present in the Old Landfill. The target parameter list for the leachate wells includes metals, inorganics and volatile organic compounds (VOCs).

4.2 Hydraulic Conductivity Testing

Hydraulic conductivity (also referred to as groundwater permeability) is a measure of the ability of geological formation (soil or rock) to transmit water and is the chief hydrogeological characteristic in assessing the natural protection of the groundwater environment. The hydraulic conductivity of the clay till will be assessed using two different methods: in-situ hydraulic conductivity tests and triaxial permeability tests. In-situ hydraulic conductivity tests will be conducted in each of the monitoring wells and consists of removing water from the well and measuring, with time, the rate of recovery of the water level to its static (or baseline) level. Based on the 1996 hydrogeological investigation, the Layer 2 monitoring wells are very slow to establish a static water level and therefore the rate of recovery after well construction will be used to establish an approximate hydraulic conductivity (i.e., a static water level will be assumed in the calculations).

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Triaxial permeability tests were also completed on soil cores. Shelby tubes were taken at two depth intervals at each monitoring well nest location and submitted to a geotechnical laboratory for testing. As well, grain size testing was completed on five soil samples from each monitoring well nest location and submitted to a geotechnical laboratory to determine grain size distribution. The fraction of organic carbon (f_{OC}) was determined in one soil sample taken at an approximate depth of 10 mbgs at each monitoring well nest location.

4.3 Water Level Monitoring

Water levels will be manually monitored in the new monitoring wells periodically after installation. In addition, water level dataloggers were installed in each new well and in two existing monitoring well nests. The top of wells were surveyed to a geodetic benchmark and all water levels converted to geodetic elevations.

4.4 Groundwater Quality

The newly installed monitoring wells were developed and purged. Water samples will be taken once from the new monitoring wells and submitted for laboratory analyses to determine baseline groundwater quality at the new monitoring well nest locations. The target parameter list will be the same as the current groundwater monitoring program:

- pH
- Conductivity
- COD
- BOD
- Chloride
- Phenol
- Sulphate
- Total Kjeldahl Nitrogen
- Calcium
- Volatile organic scan
- Magnesium
- Sodium
- Potassium
- Iron
- Alkalinity
- Total ammonia as N
- Anion scan (nitrate, nitrite, bromide, iodide, fluoride
- Total phosphorus

4.4.1 Groundwater Isotope Assessment

The isotopes of oxygen and hydrogen were used in the 1996 hydrogeological assessment which indicated that the porewater deep in the clay till is many thousands of years old. A similar assessment will be completed at two monitoring well nests where porewater from soil cores and groundwater samples from the monitoring wells will be analyzed for deuterium and oxygen-18.

4.5 Groundwater Use Assessment

The use of groundwater in the vicinity of the site will be documented. The primary source will be the MOECC Water Well Record database supplemented with on-site knowledge of groundwater users. In addition to the MOECC Water Well Record database, a door-to-door well survey will be conducted within a 1,000 m buffer from the site. These property owners / tenants will be asked if there is a water well on the property, if it is actively used and what the water is used for (e.g., lawn watering, livestock, human consumption, etc.). A follow-up, more detailed survey will be completed for those properties that have wells pertaining to such details such as well depth, casing diameter etc.

As stated in Section 2 the regional aquifer is the basal aquifer found at the interface of the overburden and bedrock. There is a municipal water supply pipeline along both Charing Cross Road and Erieau Road and therefore many residences are no longer on an individual well supply. The evaluation will also include details of the off-site residential well water quality monitoring that has been completed as part of the overall monitoring program for the existing site since 1998.

4.6 Predictive Impact Assessment

A predictive impact assessment will be completed using contaminant transport computer modelling to assess the suitability of the site specifically the compliance with the MOECC Reasonable Use Guideline. Impacts to the drinking water aquifer (Layer 3, see Section 2) will be predicted using computer modeling. Predicted impacts will be compared to the Ontario Drinking Water Standards and the Reasonable Use Guideline. The engineered features of the landfill such as the leachate collection system will be included in the model and will include an assessment the required service life of the engineered features and an overall assessment of the contaminating life span of the site.

4.6.1 Contaminating Life span

Ontario Regulation 232/98 defines "contaminating life span of a landfill" as:

(a) in respect of a landfilling site, the period of time during which the site will produce contaminants at concentrations that could have an unacceptable impact if they were to be discharged from the site, and

(b) in respect of a landfilling site and a contaminant or group of contaminants, the period of time during which the site will produce the contaminant or a contaminant in the group at concentrations that could have an unacceptable impact if they were to be discharged from the site.

The three factors that influence the contaminating life span are:

i. The transport pathway (contaminant fate and transport) which will vary from landfill to landfill. The greater the attenuation potential along the transport pathway, the shorter the contaminating life span. At Ridge, the low permeability clay means that it will take many years (in the order of thousands of years) for water to move from the landfill to the underlying bedrock aquifer. Therefore, site development alternatives will not materially affect the influence of the transport pathway on contaminating life span.
ii. The mass of waste per unit area (referred to as "waste loading" in O.Reg. 232/98). The thicker the waste, the more mass of contaminants (and with other factors being equal) the longer the contaminating life span.
iii. The leachate generation rate and initial leachate concentrations. The greater the leachate generation rate, the more contaminants are leached from the waste mound which results in shorter contaminating life spans.

4.6.2 Qualitative Assessment of Contaminating Life Span for Site Development Alternatives

For site development alternatives, the "contaminating life span" of the alternatives will also be qualitatively determined. The contaminating life span will be determined as part of the assessment of potential impacts for the landfill expansion and will depend on primary factors such as tonnes of waste per hectare and leachate generation rate. The contaminating life span for the preferred site development alternative will be quantitatively determined adapting the method used by "Barrier Systems for Waste Disposal Facilities, 2nd Edition" by R. Kerry Rowe et al. (2004).

4.6.3 Landfill Gas Impact Assessment

The landfill gas generation rate and contaminating life span for landfill gas will be assessed by the Design and Operations discipline. The potential for landfill gas to migrate within the subsurface will be included in the hydrogeology impact assessment.

4.7 Monitoring Program and Contingency Planning Development

An expanded monitoring program will be developed that includes new landfill areas and will incorporate the proposed new monitoring well nests located in the southern expansion area of the site. It will also review the existing contingency measures developed for the site and modify these plans as appropriate. The existing triggering mechanism for the contingency plans will also be reviewed and modified as necessary.

5.0 Reporting

The hydrogeological assessment will be documented following the requirements of Section 8 of O.Reg 232/98. It will include borehole logs, geologic cross-sections and piezometric maps. It will document the suitability of the site for landfilling waste disposal purposes and proposed monitoring and contingency plans. The main report will be supported with a set of appendices that will present a thorough description of all elements of the surface water assessment. A summary of the hydrogeological assessment will be included in the Environmental Assessment document.

References

Dillon Consulting Limited, 1997, BFI Ridge Landfill Environmental Assessment, Appendix B – Geology/Hydrogeology Assessment Report.

Rowe, R. K., R.M. Quigley, R.W.I Brachman and J.R. Booker, *Barrier Systems for Waste Disposal Facilities, Second Edition*, Spon Press, 2004.

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