POST-CLOSURE
ENVIRONMENTAL MONITORING PLAN

WASTE MANAGEMENT RICHMOND LANDFILL
TOWN OF GREATER NAPANEE, ONTARIO

Prepared for:

Waste Management of Canada Corporation
1271 Beechwood Road
R.R. #6 Napanee, ON K7R 3L1

Prepared by:

BluMetric Environmental Inc.
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The Woolen Mill, The Tower
Kingston, ON K7K 1Z7

Project Number: 240160-01
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1. INTRODUCTION

This document provides the details of the post-closure Environmental Monitoring Plan (EMP) for the Waste Management (WM) Richmond Landfill. This document represents an updated version of the EMP (BluMetric, 2016a), which has been used on an interim basis in accordance with Environmental Compliance Approval (ECA) No. A371203 and was most recently amended on March 19, 2021. It is intended that this EMP will be reviewed and updated periodically, considering any recommendations provided in monitoring reports and subject to review and approval from the Ontario Ministry of the Environment, Conservation and Parks (MECP).

The WM Richmond Landfill Site (the Site) is approved as a 16.2-hectare waste disposal (landfilling) facility within a total area of 138 hectares, located on Part of Lots 1, 2 and 3, Concession IV of the former Township of Richmond, now in the Town of Greater Napanee, Ontario (see Figure 1). The Site has been closed to further waste disposal since June 30, 2011, and the current Site layout is shown on Figure 2.

Hydrogeologic investigations have identified the presence of groundwater impacted by leachate from the landfill extending beyond the current approved Site boundaries. An application to amend ECA No. A371203 to establish a Contaminant Attenuation Zone (CAZ) downgradient from the Site was submitted to MECP. This EMP incorporates the CAZ area and includes a monitoring network to observe the groundwater and surface water conditions on and around the property including within the CAZ.

This document provides a summary of the physical setting of the Site, the rationale and design of the proposed environmental monitoring network (groundwater, surface water, leachate, and landfill gas), monitoring frequencies and parameters for each monitoring location, an appropriate Site-specific method for data evaluation and trigger mechanisms, and contingency plans.

2. SITE CONCEPTUAL MODEL

Background information concerning the Site geology and hydrogeology was described in detail in the Site Conceptual Model (SCM) report (BKA & WESA, 2009) and updated based on results from subsequent hydrogeological investigations (BluMetric 2015, 2016b, 2016c, 2017, 2018 and 2019), and is summarized here. The SCM report describes the groundwater flow conditions at the Richmond Landfill. Based on the results from extensive studies conducted previously at the Site, the basic hydrogeological framework for the facility has been defined as follows:

- The active groundwater flow zone at the Site extends to a depth of approximately 30 m below the top of bedrock;
- The shallow groundwater flow zone is conceptualized as the overburden, the overburden-bedrock contact and the upper one to two metres of bedrock;
- The direction of groundwater flow in the shallow flow zone is strongly influenced by topography;
- The intermediate bedrock flow zone extends from one to two metres below top of bedrock to a depth of approximately 30 m below top of bedrock;
- Groundwater flows through a network of fractures in the upper 30 m of bedrock;
- The dominant fracture orientation is horizontal to sub-horizontal; however, vertical to subvertical fractures are present providing hydraulic connection between horizontal fractures;
- Hydraulic connection of fractures exists in the intermediate bedrock flow zone to the west, south and east of the Site (horizontal and vertical connections);
- Intermediate bedrock flownets show that groundwater flow directions are variable with season and generally flows to the west from the western edge of the landfill, to the southeast from the southern edge of the landfill, to the south along the eastern edge of the landfill, and north to northwest from the northern limit of the landfill;
- The hydraulic conductivity of the intermediate bedrock is lower to the north and east of the landfill compared to other areas of the Site, implying that the rate of groundwater flow is lower than in areas immediately south, southeast and west of the landfill;
- South of the landfill, the intermediate bedrock flow zone has distinct areas of interacting hydrogeological zones which are not isolated from one another, but are distinct based on hydraulic conductivity, water level variations and the rate of response to recharge events; and,
- Groundwater monitoring wells in the southern portion of the CAZ have static groundwater elevations that are similar to each other and much lower than wells further north in the CAZ; these deep groundwater elevations appear to be controlled by karst systems confirmed to exist in the southern portion of the CAZ.

3. GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program includes water elevation measurements and groundwater quality monitoring. The following sections describe the monitoring network for the Site and presents specific assessment parameters with concentration limits to monitor groundwater quality.

The groundwater monitoring network has been developed to monitor hydraulic and chemical conditions in the established flow zones in both vertical and horizontal orientations along the critical flow pathways. The targeted intervals are the Shallow Groundwater Flow Zone and the Intermediate Bedrock Groundwater Flow Zone.

3.1 GROUNDWATER ELEVATION MONITORING

Groundwater elevations have been monitored at the Site on a semi-annual basis since 1991, providing an exhaustive database of groundwater elevations. Groundwater elevations will continue to be recorded semi-annually from hydraulically active locations to monitor the local flow system.

The list of groundwater monitors to be included in the surveys of groundwater elevations is presented in Table 1 and shown on Figures 3(a) & 3(b) (Shallow Groundwater Flow Zone) and Figure 3(c) (Intermediate Bedrock Groundwater Flow Zone). From past investigations, it has been determined that all monitoring wells listed in Table 1 are hydraulically active.

Table 1: Groundwater Elevation Monitoring Locations

Location	Shallow Groundwater Zone (44 locations)	Intermediate Bedrock Groundwater Zone (50 locations)
West of landfill footprint	M27, M67-2, M98, M99-2, M101, M102, OW37-s	M58-3, M72, M74, M82-2, M91-1, M95-1
East of landfill footprint	M23, M47-3, M68-4†, M70-3, M77, M96	M50-3, M52-2
North of landfill footprint	M35, M60-4, M65-2, M66-2, M86, M94-2, M103, M104	M5-3, M6-3, M46-2, M59-4, M60-1, M75, OW1
South/Southeast of landfill footprint and north of Beechwood Road	M14, M18, M41, M53-4, M54-4, M80-2, M81, M87-2, M97	M10-1, M49-1, M53-2, M56-2, M105, M106, M107, M108, M109-1, M109-2, M110-1, M111-1, M112-1, M170, M192*, M193*
South of landfill footprint and south of Beechwood Road (within CAZ)	M114-2, M178R-5, M188-2, M199, M200, M201, M201-DP, M203, M204, M205, M206, M206-DP, M207-DP, M209-DP	M63-2, M64-2, M114-1, M121, M123, M167, M168, M177, M178R-2, M178R-4, M179, M185-1, M185-2, M186, M187, M188-1, M190, M191, M194-2

Note:
† Monitoring well M68-4 is damaged and will be replaced
* Access to monitoring wells M192 and M193 is subject to permission from the property owner

3.2 GROUNDWATER QUALITY MONITORING

The rationale for measuring the groundwater chemistry at any landfill Site is to determine the extent and movement of leachate-impacted groundwater in relation to the Site boundaries. This program is intended to monitor for leachate-impacted groundwater at the Site boundaries and to determine if the observed concentrations of the parameters are adversely impacting neighbouring properties. This EMP presents a consistent approach that involves monitoring at hydraulically active locations within the primary groundwater flow paths from areas of high hydraulic head to low head, defined based on the extensive Site database that includes groundwater elevation and chemistry data collected since 1991. The main criteria used in selecting monitoring locations are:

- monitoring well located within a hydraulically active groundwater zone;
- groundwater flow path within the hydraulically active zone (with flow being from areas of high hydraulic head to low head);
- landfill and property boundary proximity; and
- areas outside of known impacted areas.

3.2.1 Groundwater Quality Monitoring Locations

The groundwater quality monitoring locations are summarized in Table 2 and are illustrated along with pertinent Site features on Figures 3(a) and 3(b) (Shallow Groundwater Flow Zone), and Figure 3(c) (Intermediate Bedrock Groundwater Flow Zone). Representative groundwater contours from April 2019 are also shown on these figures to illustrate the relationship of the monitoring locations to typical groundwater flow patterns on the Site (e.g., background areas, low-head areas, etc.).

Table 2: Groundwater Quality Monitoring Locations

Location	Selected Monitors	Frequency of Sampling
Shallow Groundwater Flow Zone		
Background Locations	M68-4†, M96, M99-2	Once every two years
Known Impacted Areas	M101, M103, M104, M178R-5, M205, M206	Semi-annually
West of Landfill Footprint	M67-2, OW37-s	
North of Landfill Footprint	M86	
South of Landfill Footprint and North of Beechwood Road	M53-4, M80-2	
South of Landfill Footprint and South of Beechwood Road (within Proposed CAZ)	M114-2, M188-2, M199, M200, M203, M204	

Table 2: Groundwater Quality Monitoring Locations *(continued)*

Location	Selected Monitors	Frequency of Sampling
Intermediate Bedrock Groundwater Flow Zone		
Background Locations	M56-2, M58-3, M59-4, M91-1, M95-1	Once every two years
Known Impacted Areas	M6-3, M108, M114-1, M178R-2, M178R-4	Semi-annually
	M167, M170, M192*	
West of Landfill Footprint	M72, M74, M82-2	
North of Landfill Footprint	M5-3, M75, OW1	
South/Southeast of Landfill Footprint and North of Beechwood Road	M52-2, M106, M193*	
South of Landfill Footprint and South of Beechwood Road (within Proposed CAZ)	M168, M177, M179, M185-2, M186, M187, M188-1, M194-2	

Notes:
† Monitoring well M68-4 is damaged and will be replaced
* Access to monitoring wells M192 and M193 is subject to permission from the property owner

3.2.2 Groundwater Quality Monitoring Parameters and Sampling Frequency

Monitoring wells will be sampled semi-annually, with the exception of background locations, which will be sampled once every two years (Table 2).

Groundwater samples will be analyzed for the parameters shown in Tables 3 and 4.

Table 3: Groundwater Quality Monitoring Parameters (Inorganic and General List)

Groundwater Inorganic and General Parameters	
Total dissolved solids	Boron
Alkalinity	Iron
Conductivity	Manganese
Dissolved organic carbon	Ammonia (total)
Calcium	Nitrate
Magnesium	Nitrite
Sodium	Chloride
Potassium	Sulphate

Table 4: Groundwater Quality Monitoring Parameters (VOC List)

Volatile Organic Compounds (VOCs) Monitoring List	
1,4-Dioxane	Chloroethane
Benzene	1,1,2,2-Tetrachloroethane
Toluene	1,1,1,2-Tetrachloroethane
Ethylbenzene	1,1,1-Trichloroethane
m&p-Xylene	1,1,2-Trichloroethane
o-Xylene	1,1-Dichloroethane
Styrene	1,2-Dichloroethane
1,3,5-Trimethylbenzene	1,1-Dichloroethylene
Chlorobenzene	Cis-1,2-Dichloroethylene
1,2-Dichlorobenzene	Trans-1,2-Dichloroethylene
1,3-Dichlorobenzene	Trichloroethylene
1,4-Dichlorobenzene	Tetrachloroethylene
Methylene chloride	Vinyl chloride
Chloromethane	

Monitoring wells M6-3 and M178R-2, located in intermediate bedrock groundwater flow zone impacted areas, will also be sampled for per- and polyfluoroalkyl substances (PFAS) on an annual basis. Samples will be analyzed for the PFAS parameters outlined in Table 5.

Table 5: Water Quality Monitoring Parameters (PFAS)

Parameter	Acronym	Parameter	Acronym
Perfluorobutanoic acid	PFBA	Perfluoroundecanoic acid	PFUnA
Perfluoropentanoic acid	PFPeA	Perfluorodecanesulfonic acid	PFDS
Perfluorohexanoic acid	PFHxA	Perfluorododecanoic acid	PFDoA
Perfluoroheptanoic acid	PFHpA	Perfluorobutanesulfonic acid	PFBS
Perfluorooctanoic acid	PFOA	Perfluorohexanesulfonic acid	PFHxS
Perfluorononanoic acid	PFNA	Perfluorooctanesulfonic acid	PFOS
Perfluorodecanoic acid	PFDA	Perfluorooctane sulfonamide	PFOSA

3.2.3 Groundwater Quality Assessment Limits

Two active flow zones have been identified for groundwater monitoring purposes at the WM Richmond Landfill: i) the Shallow Groundwater Flow Zone; and ii) the Intermediate Bedrock Groundwater Flow Zone. The background groundwater chemistry in these two zones is distinct; therefore, quantitative limits for the purpose of assessing potential groundwater impacts are developed separately for each of the two zones.

The primary indicator that is used to discern impacts from landfill leachate at this Site is 1,4-dioxane. The presence of 1,4-dioxane at detectable concentrations (> 0.001 mg/L) indicates the furthest extent of groundwater impacts. Other parameters that are used to assist in determining leachate impacts, including alkalinity which is generally above 400 mg/L where 1,4-dioxane is detected. and are included in the routine monitoring program are listed in Table 6.

Table 6: Groundwater Indicator Parameters Used in Routine Monitoring Program

Primary Leachate Indicator Parameter	
• 1,4-dioxane	
Other Inorganic and General Indicators	**Volatile Organic Compounds**
• Alkalinity • Total dissolved solids • Conductivity • Chloride • Sodium • Dissolved organic carbon • Ammonia • Iron • Manganese	• Benzene • Toluene • Ethylbenzene • Xylenes • 1,1,1-Trichloroethane • 1,1-Dichloroethane • 1,1-Dichloroethylene • Chloroethane

The median background concentrations in the Shallow Groundwater Flow Zone and Intermediate Bedrock Groundwater Flow Zone for each of the parameters listed in Table 6 are presented in Table 7. Reasonable Use Limits (RULs) have been calculated for parameters that have Ontario Drinking Water Standards (ODWS), and for which concentration limits can be calculated using the procedure outlined in Guideline B-7.

The monitoring wells that were used to define the background dataset for the Shallow Groundwater Flow Zone are as follows:

- M28
- M58-4
- M60-4
- M68-4
- M70-3
- M77
- M96
- M97
- M98
- M99-2

As indicated in Table 2, the following monitoring wells will be used to monitor background groundwater quality in the Shallow Groundwater Flow Zone going forward in the post-closure EMP:

- M68-4
- M96
- M99-2

The monitoring wells that were used to define the background dataset for the Intermediate Bedrock Groundwater Flow Zone are as follows:

- M56-2
- M58-3
- M59-2
- M59-4
- M91-1
- M95-1

The monitoring wells to be used to represent background groundwater quality in the Intermediate Bedrock Groundwater Flow Zone include the following:

- M56-2
- M58-3
- M59-4
- M91-1
- M95-1

Four of these monitoring wells (M56-2, M58-3, M91-1 and M95-1) were selected from locations near the western boundary of WM property along County Road 10, in areas that are hydraulically downgradient from the landfill. The wells have all been classified as responsive wells in the SCM report, and the water quality in these monitoring wells reveals low and stable concentrations of dissolved constituents, not impacted by anthropogenic sources. The use of these wells as background monitors will ensure that the dataset adequately represents natural variations in water quality within the intermediate bedrock across the Site.

Concentration trends in the downgradient background monitoring wells (M56-2, M58-3, M91-1 and M95-1) will be monitored once every four years. If the data remain at low and stable concentrations, then the downgradient monitoring wells will remain in the background dataset. However, if increasing concentration trends are apparent which are indicative of potential impacts, the previous four years of data for the wells (collected since the previous evaluation of RULs) will not be used in the calculation of median background concentrations and RULs.

Table 7: Summary of Indicator Parameters, Background Concentrations and Reasonable Use Limits (RULs)

			Shallow Bedrock Flow Zone			Intermediate Bedrock Flow Zone		
Parameter[1]	ODWS[2]	X[3]	Background Range	Median Background	RUL	Background Range	Median Background	RUL
Primary Leachate Indicators								
1,4-dioxane[4]	---	---	< 0.001	< 0.001	0.001	< 0.001	< 0.001	0.001
Inorganic and General Parameters								
alkalinity	30 - 500	0.5	204 - 440	290	395	234 - 460	303	402
ammonia	---	---	< 0.02 - 1.85	<0.15	---	< 0.02 - 3.41	0.17	---
chloride	250	0.5	1 - 86	11	131	3 - 72	9.9	130
conductivity (µS/cm)	---	---	489 - 1120	652	---	556 - 1100	690	---
DOC	5.0	0.5	< 0.5 - 6.7	2.2	3.6	< 0.5 - 8.2	1.7	3.4
iron	0.3	0.5	< 0.01 - 4.6	< 0.1	0.18	< 0.01 - 2.5	< 0.1	0.18
manganese	0.05	0.5	< 0.002 - 0.31	0.017	0.033	< 0.002 - 0.07	0.01	0.030
sodium	200	0.5	3 - 82	18	109	3 - 123	13	107
TDS	500	0.5	255 - 774	425	462	252 - 696	414	457
Volatile Organic Compounds (VOCs)								
1,1,1-trichloroethane	---	---	< 0.0001 - < 0.0001	< 0.0001	---	< 0.0001 - < 0.0004	< 0.0001	---
1,1-dichloroethane	---	---	< 0.0001 - < 0.0001	< 0.0001	---	< 0.0001 - < 0.0004	< 0.0001	---
1,1-dichloroethylene	0.014	0.25	< 0.0001 - < 0.0001	< 0.0001	0.0035	< 0.00005 - < 0.0002	< 0.0001	0.0035
chloroethane	---	---	< 0.0002 - < 0.001	< 0.0002	---	< 0.0002 - < 0.001	< 0.0002	---
benzene	0.001	0.25	< 0.0001 - 0.0013	< 0.0001	0.0003	< 0.00005 - 0.001	< 0.0001	0.0003
ethylbenzene	0.14	0.5	< 0.0001 - < 0.0016	< 0.0001	0.0700	< 0.00005 - 0.0042	< 0.0001	0.0700
m+p-xylene o-xylene	0.09	0.5	< 0.0001 - 0.0041	< 0.0001	0.0035	< 0.0001 - 0.0031	< 0.0001	0.0035
toluene	0.06	0.5	< 0.0002 - 0.004	< 0.0002	0.0036	< 0.0002 - 0.0022	< 0.0002	0.0036

Notes:

1) All units expressed as mg/L, except where noted.
2) ODWS - Ontario Drinking Water Standards, Objectives and Guidelines.
3) X - denotes the factor used in the Reasonable Use calculations:
   - 0.25 for health-related parameters;
   - 0.5 for aesthetic parameters.
4) Site-specific RUL for 1,4 dioxane (0.001 mg/L) set by ERT Order dated December 24, 2015, to be re-calculated in accordance with procedure document B-7-1 should an ODWS standard be set for 1,4 dioxane

There is no ODWS for 1,4-dioxane, and consequently a RUL cannot be calculated for this parameter. However, owing to its presence in leachate at the Site, and its high aqueous solubility and conservative nature in groundwater, 1,4-dioxane has been identified as a significant and effective parameter to determine the furthest extent of leachate impacts at this Site. In the absence of an ODWS for 1,4-dioxane, a Site-specific RUL of 0.001 mg/L (1 µg/L) is used as required by Condition 8.9 in the current ECA. Should Ontario amend O. Reg. 169/03 to set an ODWS for 1,4-dioxane, or should WM petition the ERT for modification of the mandated, Site-specific RUL for 1,4-dioxane, the RUL will be re-calculated in accordance with procedure document B-7-1, and the EMP shall be amended as necessary to reflect the re-calculated RUL.

There are no existing Ontario groundwater standards for PFAS. Health Canada has developed drinking water screening values for a number of PFAS; however, the guidelines apply to water intended for human consumption and are therefore not applicable for the WM Richmond site.
The RULs shown in Table 7 represent the concentrations that will be used to support the evaluation of whether groundwater quality on properties downgradient from the WM Richmond Landfill and CAZ would be considered acceptable. However, the groundwater geochemistry across the Site is variable, as indicated by the concentration ranges shown in Table 7, reflecting mineralization along the bedrock bedding planes and fractures conveying groundwater and varying amounts of mixing within the fracture network (i.e., water from lower hydraulic conductivity fractures with poor water quality, mixes with fresher water within higher hydraulic conductivity fractures). In essence, background water quality can vary naturally from good to poor (i.e., potable to non-potable). Therefore, the Guideline B-7 (Reasonable Use) assessment for groundwater will be complemented with a review of water quality trends over time at individual wells (an "intra-well analysis") to better evaluate whether the downgradient groundwater is impacted with leachate. The groundwater evaluation method, including the intra-well analysis, is presented in Section 7.1.

3.2.4 Review of Groundwater Monitoring Program

The adequacy of the groundwater monitoring program will be reviewed every year to ensure that the program remains effective and comprehensive. Recommendations for revisions will be developed if appropriate and submitted to the MECP Kingston District Office for review and concurrence.

The RULs listed in Table 7 will be re-calculated once every four years, using the updated background groundwater quality dataset.

4. SURFACE WATER MONITORING PROGRAM

The two watercourses that may receive direct surface water/stormwater runoff, as well as potentially impacted shallow groundwater, from the closed WM Richmond Landfill are Marysville Creek to the north of the waste mound and Beechwood Ditch to the south (Figure 2). Across most of the WM property, Marysville Creek is an intermittent watercourse. However, northerly flowing groundwater discharges to the creek in an area northwest of the landfill. Water is ponded in this area and the surface water is conveyed west of County Road 10 by a culvert beneath the road. Marysville Creek then flows on a continuous basis west of County Road 10.

Groundwater has also been observed to be naturally discharging to ground surface in a diffuse wet low-lying area located in the central portion of the CAZ. A local intermittent receiving water course is present south and downgradient of the groundwater discharge area.

Stormwater runoff from the existing landfill area flows to one of three stormwater management ponds, located to the northeast, northwest and south of the landfill footprint. These ponds are approved under Environmental Compliance Approval No. 1688-8HZNJG issued January 10, 2012. The ponds are located (1) north of the eastern half of the landfill footprint, (2) northwest of the footprint and (3) south of the landfill footprint (see Figure 2).

4.1 Surface Water Elevation Monitoring

Surface water elevations will be monitored at locations within the three inter-connected ponds located south of the landfill footprint, to assist with the interpretation of shallow groundwater elevation contours south of the landfill. These measurements will be used to complement the groundwater elevations to determine the direction of shallow groundwater flow. Surface water elevations will be recorded once per year (at the same time as the groundwater levels) from stream gauges installed at the following locations (refer to Figure 4):

- Westernmost pond in the system (SG1);
- Central pond in the system (SG2); and
- Easternmost pond in the system (SG3).

Additionally, water levels in the North Lagoon will be recorded when the lagoon is used to store leachate as an emergency contingency measure, in accordance with Conditions 4.5 and 4.6 of the ECA.

4.2 Surface Water Quality Monitoring

The purpose of surface water sampling is to monitor the quality of surface water flowing onto and away from the landfill property to evaluate whether the quality of the water is impacted by the closed landfill.

4.2.1 Surface Water Quality Monitoring Locations

A list of surface water quality monitoring locations is provided in Table 8. The respective monitoring points are shown on Figure 4.

Table 8: Surface Water Quality Monitoring Program

Drainage Course	Monitoring Location	Parameters	Monitoring Frequency
Beechwood Ditch	S5, S4R and S8R	Surface Water (Table 9)	Two times each year, in spring and fall
Marysville Creek	S2, S3 and S7	Surface Water (Table 9)	Two times each year, in spring and fall
Unnamed water course in central portion of CAZ	S23	Surface Water (Table 9)	Event based*; maximum quarterly

* Location to be equipped with an alarm to alert sampling staff that surface water is discharging

4.2.2 Surface Water Quality Monitoring Parameters and Sampling Frequency

Surface water will be sampled from all locations included in Table 8 (provided they are not dry) and analyzed for the list of parameters specified below in Table 9. Field measurements of flow rate, temperature, pH, conductivity and dissolved oxygen will be collected at the same time as the sampling for laboratory analysis.

Table 9: Surface Water Quality Monitoring Parameters

Surface Water Parameters	
1,4-Dioxane Total suspended solids Total dissolved solids Biological oxygen demand Chemical oxygen demand Alkalinity Conductivity Hardness Calcium Magnesium Sodium Potassium Boron Cadmium Chromium (total, Cr6+, Cr3+) Cobalt Copper	Iron Lead Nickel Zinc Ammonia (total & un-ionized) Nitrate Nitrite Chloride Sulphate Phenols Total phosphorus Naphthalene <u>Field measurements:</u> pH, temperature, conductivity, dissolved oxygen, estimated flow rate

1,4-Dioxane will be analyzed in samples from all surface water monitoring locations, for five years. If 1,4-dioxane is not detected in any of the samples during the initial five-year period, it will be removed from the monitoring parameter list for surface water upon written notification to the MECP District Manager.

Sampling frequency at all surface water monitoring locations except S23 will be two times per year, in the spring and fall. Surface water sampling at monitoring location S23 will be event-based and will be conducted when flow is occurring, a maximum of once per season as defined below:

- Winter: between December 21 and March 20;
- Spring: between March 21 and June 20;
- Summer: between June 21 and September 20; and
- Fall: between September 21 and December 20.

This location will be instrumented with a pressure transducer or other suitable equipment capable of monitoring active discharge into the nearby karst feature that will trigger an alarm when flow is occurring. The flow monitoring equipment will be connected to a battery or solar powered real-time logger telemetry system accessible via cellular modem communication.

The following surface water locations will also be sampled for PFAS on an annual basis, in spring:

- S3
- S8R
- S23
- S24 (MECP sampling location "SW5")

Samples will be analyzed for the PFAS parameters outlined in Table 5.

4.2.3 Surface Water Quality Assessment Limits

Representative indicator parameters for surface water monitoring were chosen based on leachate indicators, shallow groundwater and surface water concentrations, and Provincial Water Quality Objectives (PWQO) values. The surface water parameters to be assessed are listed in Table 10 with their respective PWQO values, where applicable. Upstream and downstream concentrations will be compared to each other and to PWQO to observe whether concentrations of surface water indicator parameters increase across the landfill property and whether they meet the MECP water quality objectives.

Table 10: Surface Water Assessment Parameters and PWQO

Parameter	PWQO (µg/L)
1,4-Dioxane	20
Alkalinity	Should not be decreased by more than 25% of the natural concentration
Ammonia (unionized)	20
Boron*	1,500
Chloride	----
Chromium	1.0 for hexavalent chromium (Cr VI) 8.9 for trivalent chromium (Cr III)
Cobalt	0.9
Conductivity	----
Copper	5.0 (revised Interim PWQO)
Iron	300
Lead	5.0 (revised Interim PWQO)
Naphthalene	7.0
Nickel	25
Phenols (4-AAP)	1.0
Total phosphorus	30
Zinc	20 (revised Interim PWQO)
PFAS	N/A

Note:
* The assessment limit for boron is based on the CCME guidelines for the protection of aquatic life (CCME, 2009)[1]

4.2.4 Groundwater-Surface Water Interaction

Shallow groundwater discharge occurs in an area along Marysville Creek northwest of the landfill. As a result, groundwater quality may influence surface water chemistry.

As noted in Section 3.1 above, water levels in shallow and intermediate bedrock wells will be monitored to continue to observe and evaluate groundwater flow directions and hydraulic gradients in the vicinity of Marysville Creek.

Surface water downstream from the area of groundwater discharge in the central area of the CAZ will be monitored to assess the water quality of the groundwater discharge to surface water and assess any potential impacts to surface water along the local water course.

4.2.5 Review of Surface Water Monitoring Program

The surface water monitoring program will be re-evaluated every year to ensure the program remains effective and comprehensive. Recommendations for revisions will be developed if appropriate and submitted to the MECP Kingston District Office for review and concurrence.

[1] https://ccme.ca/en/res/boron-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf

5. LEACHATE MONITORING PROGRAM

Considerable information has been gathered on the quality of leachate that is generated at the WM Richmond Landfill. This understanding of leachate quality has allowed the selection of Site-specific indicator parameters that are used to monitor the groundwater and surface water environments. Leachate monitoring will continue during the post-closure period of the landfill.

5.1 LEACHATE QUALITY MONITORING

The purpose of leachate sampling is to monitor for any changes in the leachate parameter concentrations as the waste in the closed landfill gradually decomposes over time.

5.1.1 Leachate Quality Monitoring Locations

Leachate samples will be collected from the South Chamber (PS1) and North Chamber (PS2) leachate sumps, shown on Figure 4. Sampling ports installed in a pumping station (PS3) associated with the leachate holding tank will be used for leachate sampling.

5.1.2 Leachate Quality Monitoring Parameters and Sampling Frequency

The leachate samples will be collected from the above locations once every three years (concurrent with calculation of contaminating lifespan) and will be analyzed for the list of parameters specified in Table 11.

Table 11: Leachate Quality Monitoring Parameters

Leachate Inorganic and General Parameters		
Total dissolved solids	Boron	Ammonia (total)
Conductivity	Cadmium	Total Kjeldahl nitrogen
Alkalinity	Chromium (total)	Nitrate
pH	Cobalt	Nitrite
Hardness	Copper	Chloride
Calcium	Iron	Sulphate
Magnesium	Lead	Total phosphorus
Sodium	Manganese	Phenols
Potassium	Nickel	Naphthalene
Biological oxygen demand	Zinc	N-nitrosodimethylamine (NDMA)
Chemical oxygen demand		
Dissolved organic carbon		

Table 11: Leachate Quality Monitoring Parameters *(continued)*

Leachate Inorganic and General Parameters	
Leachate VOC List	
1,4-Dioxane	1,1,2,2-Tetrachloroethane
Benzene	1,1,1,2-Tetrachloroethane
Toluene	1,1,1-Trichloroethane
Ethylbenzene	1,1,2-Trichloroethane
m&p-Xylene	1,1-Dichloroethane
o-Xylene	1,2-Dichloroethane
Styrene	Chloroethane
1,3,5-Trimethylbenzene	1,1-Dichloroethylene
Chlorobenzene	Cis-1,2-Dichloroethylene
1,2-Dichlorobenzene	Trans-1,2-Dichloroethylene
1,3-Dichlorobenzene	Trichloroethylene
1,4-Dichlorobenzene	Tetrachloroethylene
Methylene chloride	Vinyl chloride
Chloromethane	

6. LANDFILL GAS MONITORING PROGRAM

WM has an odour monitoring and abatement program at the closed Site, approved under Condition 8.7 of Amended ECA No. A371203 dated March 19, 2021.

Continuous gas sensors and alarms are installed in all on-Site buildings within 30 metres of the landfill. Buildings that are not vented or equipped with methane detectors are monitored using a portable gas detector, with readings recorded on a quarterly basis. These facilities are, therefore, not included in the landfill gas migration EMP.

The landfill gas collection and flaring system has been taken offline because methane gas generated by the landfill is insufficient to keep the flare lit. Six gas monitoring probes are installed around the perimeter of the landfill (denoted GM1, GM3, GM4-1, GM4-2, GM5 and GM6; see Figure 4) and are included in the EMP. The six gas probes will be monitored annually using a portable combustible gas detector to measure the concentration of methane.

The recorded measurements of landfill gas from the monitoring locations identified above will be compared to the assessment limits shown in Table 12.

Table 12: Landfill Gas Assessment Concentrations

Landfill Gas Probes
Concentrations must be less than 2.5% methane by volume (50% LEL).

7. DATA EVALUATION AND CONTINGENCY PLANS

This section outlines the evaluation methods that will be used if observed concentrations at the groundwater, surface water or landfill gas monitoring locations exceed the Reasonable Use Limits (RULs) and other assessment limits specified above (Tables 7, 10 and 12 for groundwater, surface water and landfill gas, respectively).

7.1 GROUNDWATER EVALUATION METHODS AND TRIGGER MECHANISMS

The groundwater monitoring program is summarized in Table 2. Monitoring wells within the low-head areas of the WM Richmond Landfill, at or proximal to the downgradient boundaries, in both the Shallow Groundwater and Intermediate Bedrock Groundwater Flow Zones will be evaluated following the procedures outlined below. These monitoring wells, denoted trigger wells, are listed in Table 13.

The trigger wells were selected on the basis of their locations in the groundwater flow paths within the hydraulically active flow zones, in a low-head region either in proximity to a downgradient property boundary, or for the trigger wells on the CAZ, immediately downgradient of the known extent of leachate impacts.

Table 13: Summary of Groundwater Trigger Wells

Shallow Flow Zone (see Figure 3(a,b))		Intermediate Bedrock Flow Zone (see Figure 3(c))	
North and West	OW37-s	North and West	M56-2‡, M58-3‡, M91-1‡, M95-1‡, M82-2
South	M200	South and Southeast	M170, M177, M179, M185-2, M186, M187 and M188-1

Notes:
‡ denotes a background monitoring well. The chemistry from these wells will be used to determine background water quality; unless increasing concentration trends indicate potential impacts (refer to Section 3.2.1).

Data evaluation for the trigger wells will focus on the list of leachate indicators outlined in Section 3.2.3. The laboratory analytical results obtained from each sampling event will be compared to the RULs derived for the Shallow Groundwater and Intermediate Bedrock Groundwater Flow Zones (Table 7). Any new detection of 1,4-dioxane above the RUL or any new exceedance of the RULs will trigger the evaluation procedures described below. The approach will include a confirmation step whereby observations of concentrations above the compliance limits will be verified through re-sampling. This approach improves the accuracy of the detection monitoring program by eliminating potential false positives from cross-contamination, laboratory error, or other possible causes. For any new exceedances, an intra-well trend analysis will be conducted. This will consist of an examination for significant geochemical trends using the results

of the laboratory analyses in time-series graphs and using Piper and Stiff geochemical diagrams, where appropriate. A significant trend will be noted when the inorganic chemistry of a monitor shifts progressively towards the geochemical signature typical of leachate or other potential source for two consecutive monitoring events. A minimum of five baseline events must exist prior to the beginning of the trend evaluation. Following the verification re-sampling procedure, if a geochemical trend is documented, an alternate source evaluation will be completed to ascertain the source of the trend or exceedance.

The specific steps to water quality evaluation and trigger mechanisms are as follows:

Step 1 – Water Quality Conformance Assessment and Confirmation Re-sampling

If there is a documented new exceedance of the groundwater RULs (Table 7), complete a comprehensive water quality assessment within 90 days of receiving the laboratory analysis that indicates an exceedance. The major ion chemistry, VOCs and other tools such as time-series graphs, Piper and Stiff diagrams will be used, as appropriate, with the current and historical monitoring program results to further evaluate any changes in leachate indicator concentrations. If the water quality assessment indicates that leachate may be the source of the observed exceedance and increasing concentrations, proceed to Step 2.

Confirmation sampling will occur within 15 days of the determination of a new RUL exceedance in a groundwater trigger well. If the initial exceedance or trend is verified and the water quality assessment indicates that leachate may be the source, begin accelerated monitoring and proceed to Step 2.

Accelerated monitoring will consist of the following procedure. The monitoring frequency of the monitor(s) with the elevated concentrations is increased to quarterly for one year and groundwater is sampled for all parameters included in the Groundwater Inorganic and General list (Table 3) and VOC list (Table 4).

Step 2 – Alternate Source Evaluation

The geochemical results from the accelerated monitoring program will be used with the interpretative tools described above (time-series graphs, Piper and Stiff diagrams, etc.) to evaluate the source(s) of the observed exceedance or increasing trend in leachate indicator concentration. This will be completed within 90 days of receiving the laboratory analysis from the last quarterly sampling round. If leachate is confirmed as the source, proceed to Step 3. If the source is not confirmed to be leachate, adjust the program if warranted to prevent re-occurrence (i.e., review sampling procedures, re-evaluate limits) and return to routine monitoring.

Step 3 – Development and Implementation of Corrective Action Plan (CAP)

At this point a CAP will be developed, reviewed and approved by the MECP, and implemented to prevent exceedance of groundwater assessment parameter concentrations at the WM property boundary. The CAP will be prepared and submitted to the MECP within 90 days of leachate being identified as the source of water quality exceedances (i.e., 90 days from completion of Step 2).

Data evaluation according to the aforementioned methods will be completed after receipt of results from each monitoring event and submitted as part of the routine reporting.

7.2 Surface Water Evaluation

The applicable objectives for surface water monitoring are based on PWQO for the indicator parameters listed in Table 10. The surface water monitoring locations at the downstream boundaries of the WM Richmond Landfill (S3, S4R and S8R), as well as the downstream sampling location along the unnamed surface water course within the CAZ (S23), will be evaluated as described above for the low-head groundwater monitoring wells. Comparisons will first be made to PWQO and to upstream concentrations. If there are new occurrences of downstream concentrations higher than the PWQO and higher than upstream concentrations, further evaluation will be conducted, as described above for groundwater. This will begin with an assessment of water chemistry using the interpretive tools described above for groundwater (time-series graphs, Piper and Stiff diagrams, etc.). If the water quality assessment indicates that leachate could be a potential source of the observed exceedance and increasing concentrations, the accelerated monitoring program will commence along with Step 2, *Alternate Source Evaluation*. For surface water monitoring, the accelerated monitoring program will take place at a weekly frequency for a maximum of eight weeks, rather than quarterly as described for groundwater monitoring.

7.3 Landfill Gas Evaluation

Landfill gas migration monitoring is completed in subsurface gas probes located around the landfill footprint (GM1 to GM6). If the methane concentration exceeds the criterion listed in Table 12, then the source of the gas will be determined. The steps that will be followed for this process are as follows:

Step 1 – Landfill Gas Assessment

Compare results to criterion in Table 12; if concentration exceeds criterion, report to WM immediately and proceed to Step 2.

Step 2 – Confirmation Monitoring

Conduct another round of monitoring within one week. If the initial exceedance is verified, proceed to Step 3. If unverified, return to routine monitoring. If confirmed, ensure that health and safety procedures are in place through active temporary means until further steps are completed, and further data indicate that no problem exists or a permanent solution is put into place.

Step 3 – Alternate Source Evaluation

Conduct investigation to determine the source of the gas within 30 days of the confirmation of the exceedance. If landfill gas is confirmed as the source, proceed to Step 4. If the source is not confirmed to be of landfill origin (in the case of background sources), identify the sources and consider these sources or adjust the program if warranted to prevent re-occurrence (i.e., review sampling procedures, re-assess limits) and return to routine monitoring.

Step 4 – Development and Implementation of Corrective Action Plan (CAP)

At this point a CAP will be developed, reviewed, and approved by the MECP, and implemented. The CAP will be prepared and submitted to the MECP within 90 days of the landfill being identified as the source of the gas migration exceedances (i.e., 90 days from completion of Step 3).

7.4 CONTINGENCY PLANS

Contingency plans for leachate, groundwater and surface water are outlined below. Within the scope of this report, contingency plans are defined as general procedures that will be followed to respond to potential future environmental impacts associated with the closed WM Richmond Landfill. These plans typically include assessing the scope of a potential problem, additional investigation to determine the precise extent of a problem, assessing the feasibility of implementing potential remedial alternatives ("contingency measures") and the installation of any additional engineered facilities not originally part of the landfill design, or the implementation of other mitigative action.

A flow chart illustrating the process of implementing a Contingency Plan is presented on Figure 5. Contingency plans would be implemented as part of Step 4 of the Data Evaluation procedures as described above in Section 7.0. Note that the contingency plans for landfill gas are beyond the scope of this document and are described in the report entitled *"Richmond Sanitary Landfill Site – Landfill Gas Collection System Contingency Plan"*, prepared by Genivar Inc., dated June 25, 2010.

Brief descriptions of the contingency measures that potentially could be implemented as part of the Contingency Plans are provided below.

7.4.1 Leachate Contingency Plan

This section deals with a contingency plan for leachate breakout or seepage from the closed landfill toe or side slopes. Additional information regarding the contingency plan for the leachate collection system is presented in the report entitled *"Richmond Sanitary Landfill Site – Leachate Collection System Contingency Plan"*, prepared by Genivar Inc. and dated June 25, 2010.

The main concerns associated with potential leachate impacts include visible breakouts or seepage through the final cap of the closed landfill. Inspection, maintenance and monitoring programs will continue during the post-closure period and will assist WM in detecting any future leachate breakouts or seepage faces. The proposed contingency to address these failures is to repair the seepage locations as required.

Typical approaches to repair areas of leachate break-out involve excavating into the waste and backfilling with clear stone to improve drainage or drilling into the waste to promote vertical drainage. In some situations, subsurface drainage (French drains) can be installed along the landfill slope to promote drainage to the leachate collection system. The final clay cap is then placed and re-compacted over the repaired area.

7.4.2 Groundwater Contingency Plan

Groundwater monitoring programs will continue during the post-closure period, with the data evaluation methods and trigger mechanisms in place, as described in Section 7.1. In the event it is necessary, the planned contingency for addressing groundwater impacts will be to first evaluate the degree of impact (in consultation with the MECP District Office) and the need to carry out additional subsurface investigation, as per Step 2 of the Groundwater Data Evaluation Method (Section 7.1).

The results of any additional investigations will be used to determine the extent of off-Site migration and to develop a Corrective Action Plan (CAP), as described in Step 3 of the Groundwater Data Evaluation Method (Section 7.1). Following approval of the CAP by MECP, a comparative evaluation of various remedial alternatives will be completed. This will include an assessment of the feasibility of implementing various remedial alternatives. The remedial alternatives, or "contingency measures", will be evaluated on the basis of several criteria, such as:

- Technical feasibility in a fractured bedrock context;
- Potential advantages and disadvantages;
- Effectiveness in achieving remedial objectives;
- Implementation time and scheduling constraints; and
- Required resources and costs (capital, O&M, etc.).

Potential remedial activities to be implemented, also known as contingency measures will depend on the scope and extent of groundwater impacts. For example, impacts to the Shallow Groundwater Zone may be addressed using different contingency measures than impacts to the Intermediate Bedrock Zone. Also, localized impacts of limited scope (e.g., shallow chlorinated aliphatic hydrocarbons from a well-defined source) may be managed differently than extensive impacts from a broad range of parameters.

The selected remedial approach will represent the most viable technical and economic option.

7.4.3 Surface Water Contingency Plan

The main concerns associated with potential surface water impacts relate to the discharge of leachate from surface seeps or the discharge of shallow impacted groundwater into Beechwood Ditch or Marysville Creek. Routine visual inspections and surface water sampling will be carried out to identify leachate seeps, characterize the surface water chemistry at the discharge locations in relation to background chemistry, and determine if contingency measures are warranted. The data evaluation methods and trigger mechanisms for contingency action are described in Section 7.2.

The planned contingency measure for potential non-groundwater impact will be to divert leachate-impacted water from entering the surface water receptor (Marysville Creek or Beechwood Ditch), and to repair any leachate seeps or areas of break-out. The diverted impacted water will be collected in one of the on-Site stormwater management ponds where it will be contained for treatment and disposal. Treatment of the impacted water is available at the Town of Greater Napanee wastewater treatment plant, subject to the discharge agreement with Waste Management. While this contingency measure is in place, the feasibility of on-Site treatment and polishing of surface water discharge will be investigated. Any shallow impacted groundwater that is contributing to the need for contingency action will be addressed as described above in Section 7.4.2.

The current status of contingency plans will be reviewed as required. Proposed contingency actions will be implemented if necessary, in consultation with the MECP District Office.

8. REPORTING REQUIREMENTS

Reporting requirements related to the environmental monitoring program are specified in ECA No. A371203. Proposed updates to the reporting requirements for this Environmental Monitoring Program are outlined below.

8.1 ANNUAL MONITORING REPORT

A report describing the results of the monitoring program for the preceding period is to be prepared on an annual basis and submitted to the MECP District Office by February 15 for the period ending December 31 of the previous year. The report will also be posted on a publicly accessible website. The report is to include the components outlined in Condition 14.1 of Notice No. 1 of ECA No. A371203. The recommended components of the annual reports are listed below:

a) The results in tabular form and an interpretive analysis of the results from the leachate, groundwater, surface water, and landfill gas monitoring programs approved by the ECA, including:
   i. an assessment of the need to amend the monitoring programs;
   ii. an evaluation of any observations of saline upwelling in the groundwater;
   iii. an estimation of the leachate generated at the Site;
   iv. an evaluation of leachate quality, levels, and mounding within the landfill;
   v. figure(s) showing the landfill Site and contaminant attenuation zone;
   vi. figures delineating the extents of impacted groundwater (1-4 dioxane exceeding the RUL) in the Shallow and Intermediate Bedrock Groundwater Flow Zones;
   vii. figure(s) showing the off-Site properties suspected or confirmed of being impacted by leachate from the landfill;
   viii. a complete inventory of the groundwater monitoring well locations;
   ix. detailed analysis on groundwater quality trends on downgradient groundwater wells which have been impacted or are suspected of being impacted by leachate from the landfill; and
   x. trend analysis for leachate indicator parameters in surface water.
b) An assessment with regards to the compliance of the groundwater quality at the property boundary and compliance points with regards to Guideline B-7 Reasonable Use Concept;
c) A report on the status of any monitoring wells required to be tested pursuant to the EMP and a statement as whether those wells are in compliance with Ontario Regulation 903;

d) An Annual Summary section which describes the results from the current calendar year and notable data quality changes identified from previous years, or through the current year. The Annual Summary section will also include a listing and summary of any hydrogeologic investigations carried out during the current calendar year that were beyond the scope of the Environmental Monitoring Plan; and
e) All surface and groundwater analytical results reported in Annual Monitoring Reports shall be reported by groups of substances (i.e., VOCs, PAHs, inorganics, etc.) and by numeric location, and shall be posted by WM on a publicly accessible website, with the data being posted on such website being updated annually.

Respectfully submitted,
BluMetric Environmental Inc.

François Richard, Ph.D. P.Geo.
Senior Hydrogeologist

9. REFERENCES

BluMetric, 2015: *Supporting Document, Application to Amend Environmental Compliance Approval No. A371203*, Waste Management Richmond Landfill Site, prepared by BluMetric Environmental Inc., March 2015

BluMetric 2016a: *Revised Interim Environmental Monitoring Plan v. 05, WM Richmond Landfill, Town of Greater Napanee, Ontario*, BluMetric Environmental Inc., Report dated April 2016.

BluMetric, 2016b: *Site Conceptual Model Update and Contaminant Attenuation Zone Delineation, Waste Management Richmond Landfill Site*, prepared by BluMetric Environmental Inc., Report dated January 2016.

BluMetric, 2016c: *Addendum to Site Conceptual Model Update and Contaminant Attenuation Zone Delineation, Waste Management Richmond Landfill Site*, prepared by BluMetric Environmental Inc., Report dated April 2016.

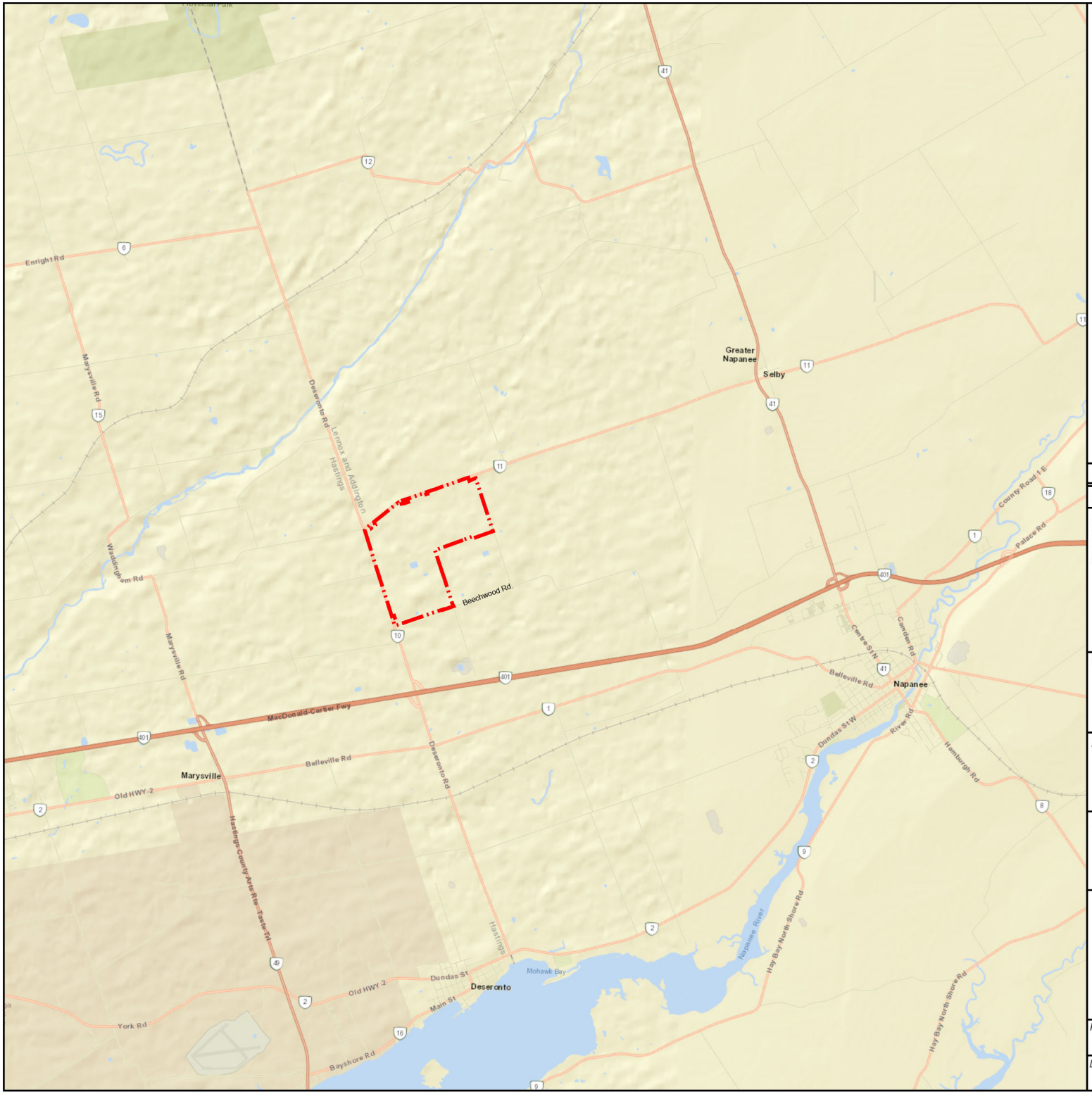
BluMetric, 2017: *Site Conceptual Model Update and Contaminant Attenuation Zone Delineation, Waste Management Richmond Landfill Site*, prepared by BluMetric Environmental Inc., Report dated July 2017.

BluMetric, 2018: *Site Conceptual Model Update and Contaminant Attenuation Zone Delineation, Waste Management Richmond Landfill Site*, prepared by BluMetric Environmental Inc., Report dated October 2018.

BluMetric, 2019: *Addendum to Site Conceptual Model Update and Contaminant Attenuation Zone Delineation, Waste Management Richmond Landfill Site*, prepared by BluMetric Environmental Inc., Report dated May 2019.

BKA and WESA 2009: Site Conceptual Model Report, WM Richmond Landfill, B. Kueper & Assoc. Ltd. and WESA Inc., Report dated October, 2009.

FIGURES



LEGEND

Property Boundary

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REFERENCES

N W E S

0 2 4 Kilometers

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CLIENT

WM

PROJECT

Waste Management Richmond Landfill Environmental Monitoring Plan

TITLE

Site Location

BluMetric™ Environmental

The Tower - The Woolen Mill,
4 Cataraqui St.,
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TEL: (613) 531-2725
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PROJECT #	DATE
240160-01	**April 24, 2024**

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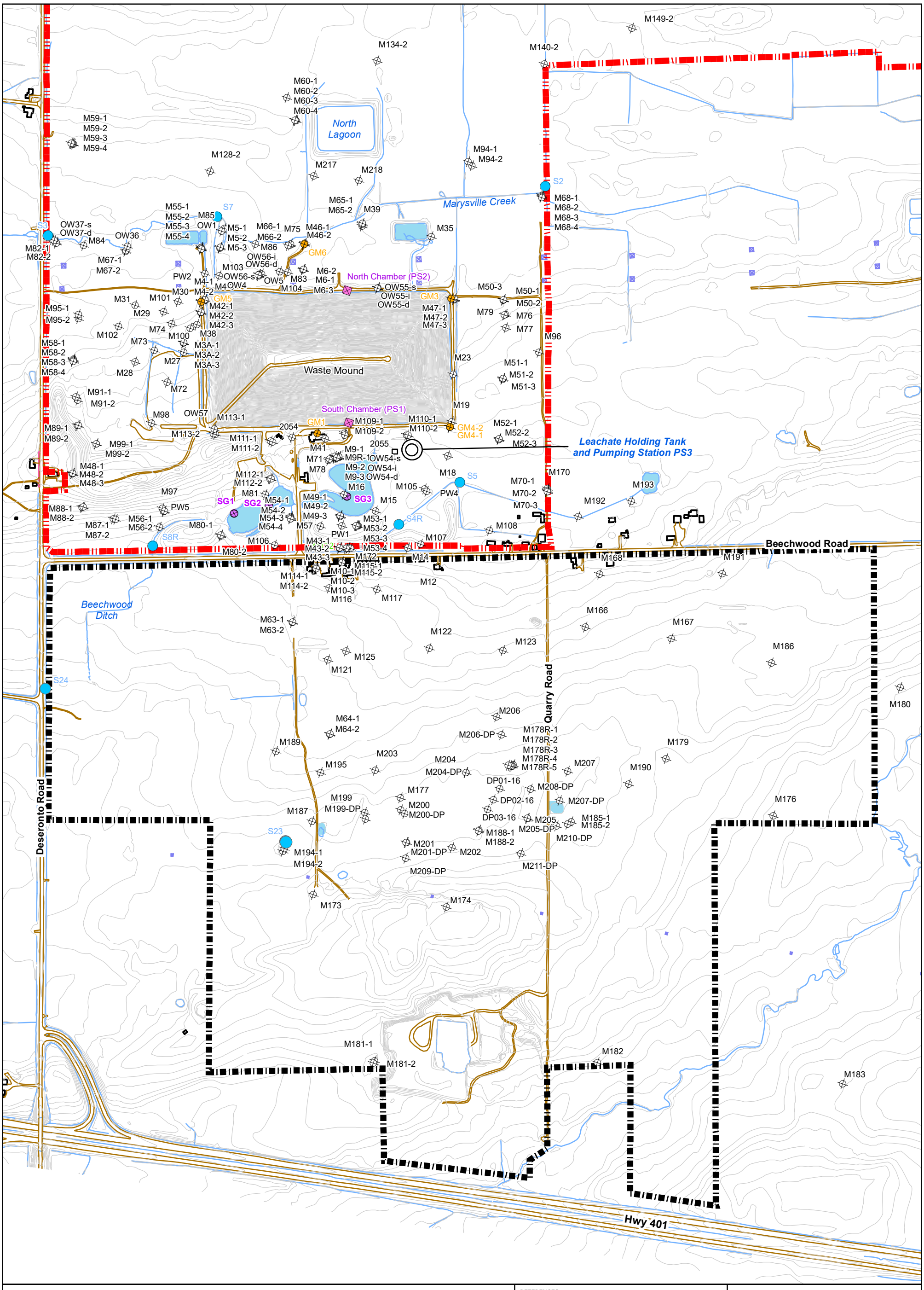

LEGEND

- Topographic Contour Lines
- Surface Water
- Property Boundary
- Contaminant Attenuation Zone
- M35 — Groundwater Monitoring Well
- GM1 — Gas Monitoring Well
- Leachate Sump
- S2 — Surface Water Monitoring Location
- Stream Gauge

REFERENCES

DO NOT SCALE DRAWING.
THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.
-UNITS: METERS
-PROJECTION: UTM NAD83 ZONE 18
-DATA SOURCE: WM CANADA, BLUMETRIC, MNRO, NRCAN

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Metres
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CLIENT: WM

PROJECT: **WASTE MANAGEMENT RICHMOND LANDFILL ENVIRONMENTAL MONITORING PLAN**

TITLE: **SITE PLAN**

PROJECT #	DATE
240160-01	April 24, 2024

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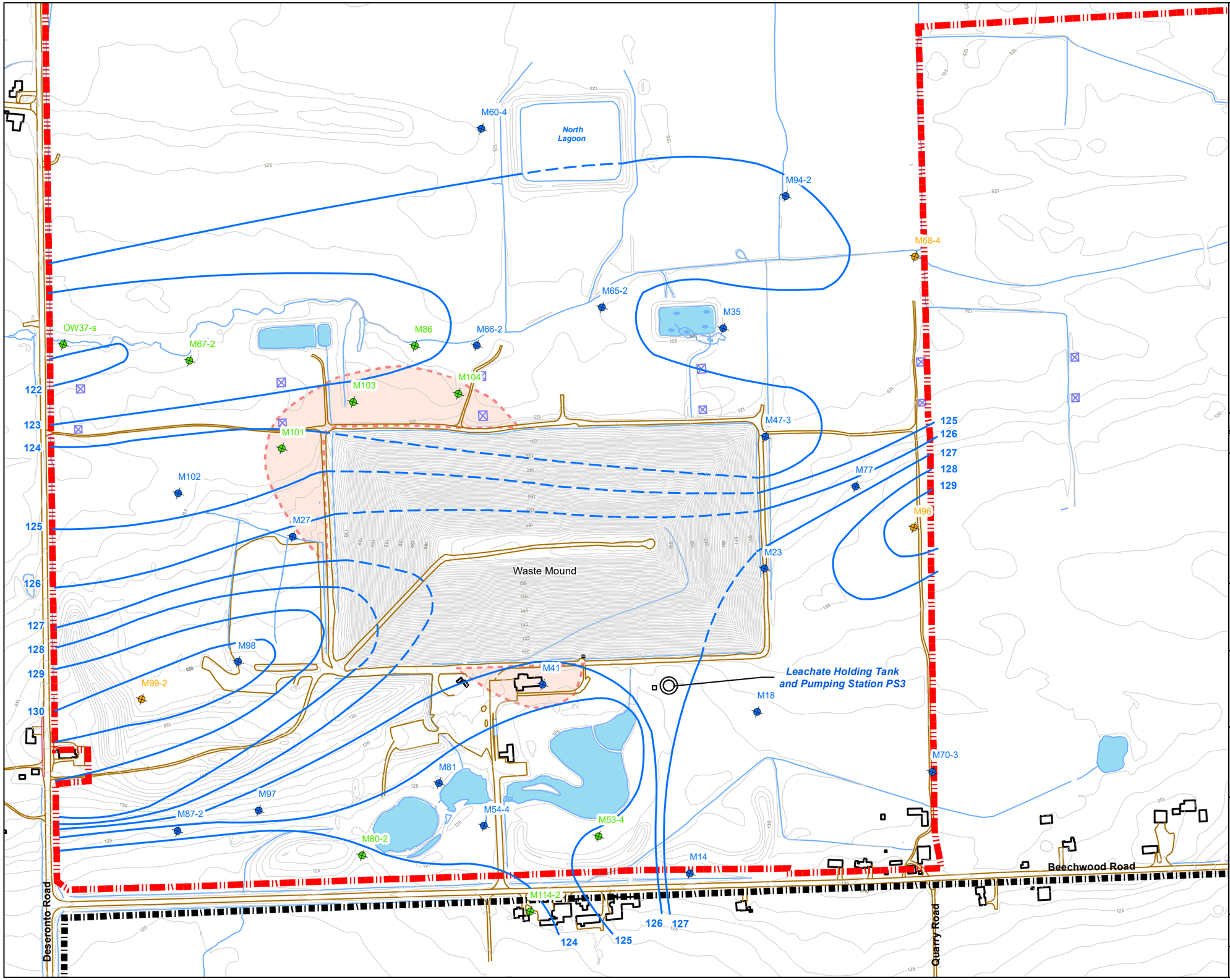

LEGEND

- Monitoring Well - Water level only (not sampled)
- Monitoring Well - Water level and chemistry (semi-annual)
- Monitoring Well - Water level and chemistry (every 2 years)
- Potentiometric Surface (Interpolated)
- Potentiometric Surface (Inferred)
- 1,4 Dioxane Impacted Area
- Topographic Contour Lines
- Surface Water
- Property Boundary
- Contaminant Attenuation Zone

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REFERENCES

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CLIENT

WM

PROJECT

WASTE MANAGEMENT RICHMOND LANDFILL ENVIRONMENTAL MONITORING PLAN

TITLE

Groundwater Monitoring Locations – Shallow Groundwater Flow Zone (North of Beechwood Road)

BluMetric™ Environmental

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PROJECT #	DATE
240160-01	April 24, 2024

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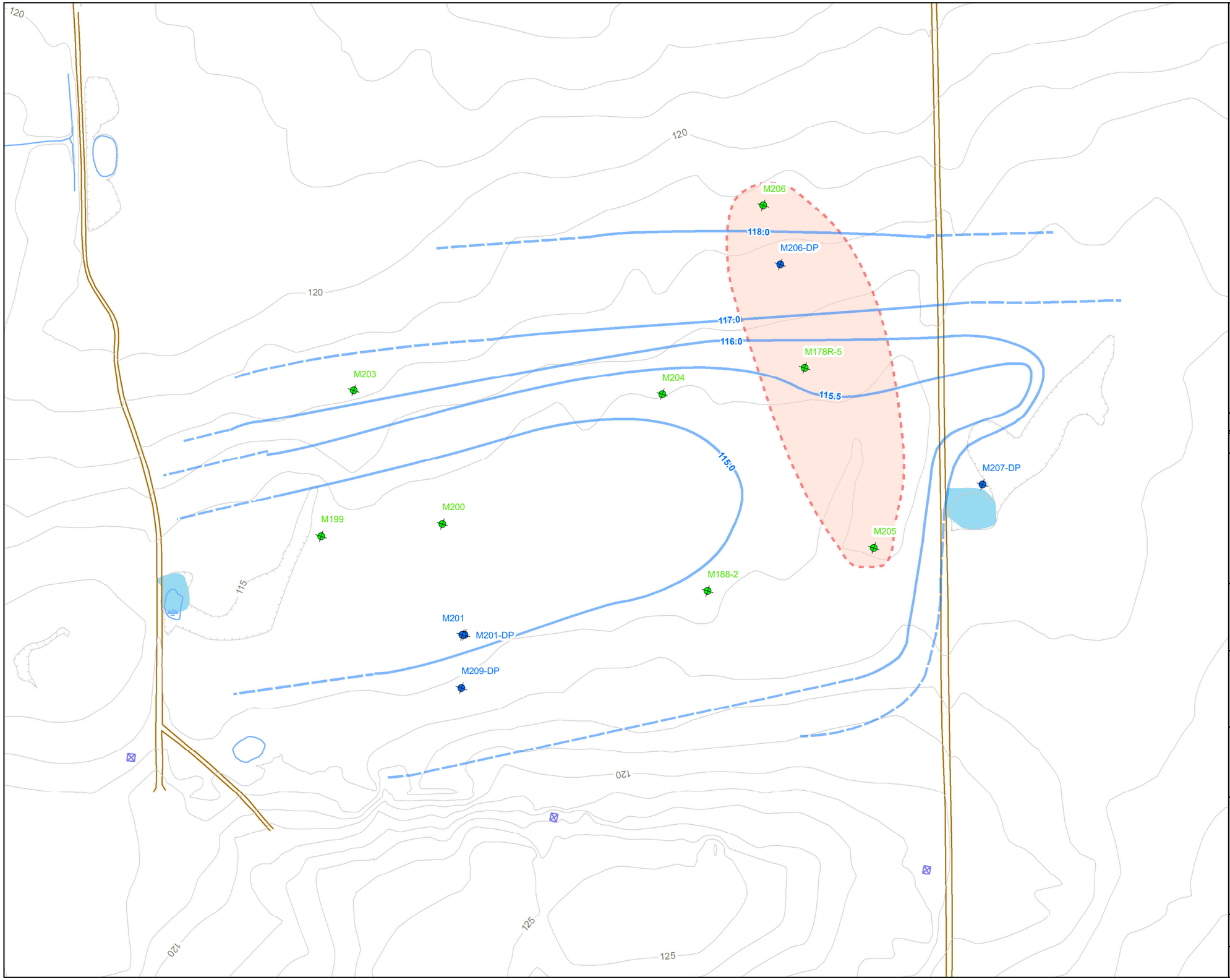

LEGEND

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- Monitoring Well - Water level and chemistry (semi-annual)
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- Potentiometric Surface (Inferred)
- Extents of 1,4 Dioxane Impacted Area
- Topographic Contour Lines
- Surface Water

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
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CLIENT

PROJECT

WASTE MANAGEMENT RICHMOND LANDFILL ENVIRONMENTAL MONITORING PLAN

TITLE

Monitoring Locations – Shallow Groundwater Flow Zone (Central CAZ)

BluMetric™ Environmental
The Tower - The Woolen Mill,
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PROJECT #	DATE
240160-01	April 24, 2024

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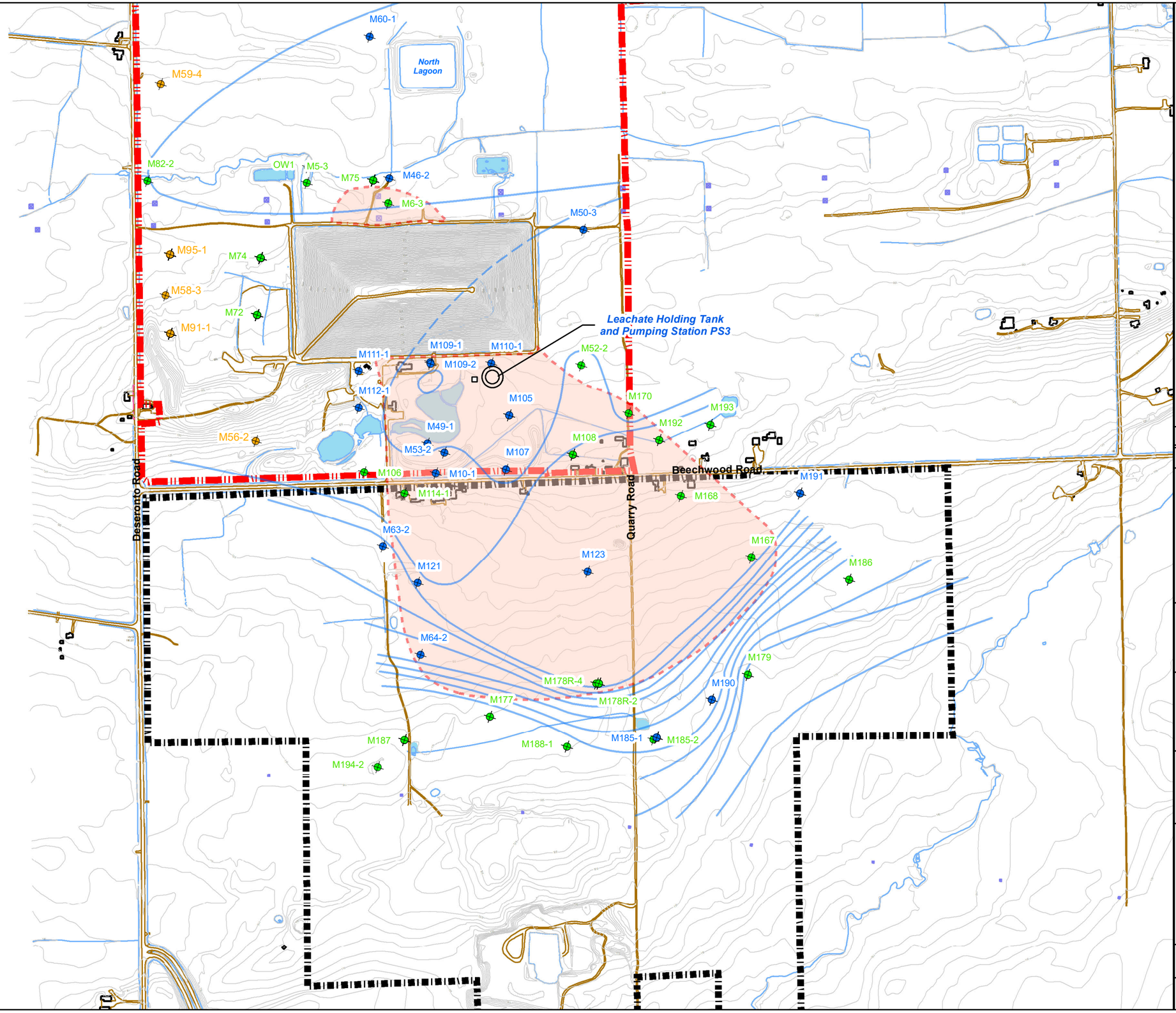

LEGEND

- Monitoring Well - Water level only (not sampled)
- Monitoring Well - Water level and chemistry (semi-annual)
- Monitoring Well - Water level and chemistry (every 2 years)
- Potentiometric Surface (Inferred)
- Potentiometric Surface (Interpolated)
- 1,4 Dioxane Impacted Area
- Topographic Contour Lines
- Surface Water
- Property Boundary
- Contaminant Attenuation Zone

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CLIENT

PROJECT

WASTE MANAGEMENT RICHMOND LANDFILL ENVIRONMENTAL MONITORING PLAN

TITLE

Monitoring Locations – Intermediate Bedrock Groundwater Flow Zone

The Tower - The Woolen Mill,
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PROJECT #	DATE
240160-01	April 24, 2024

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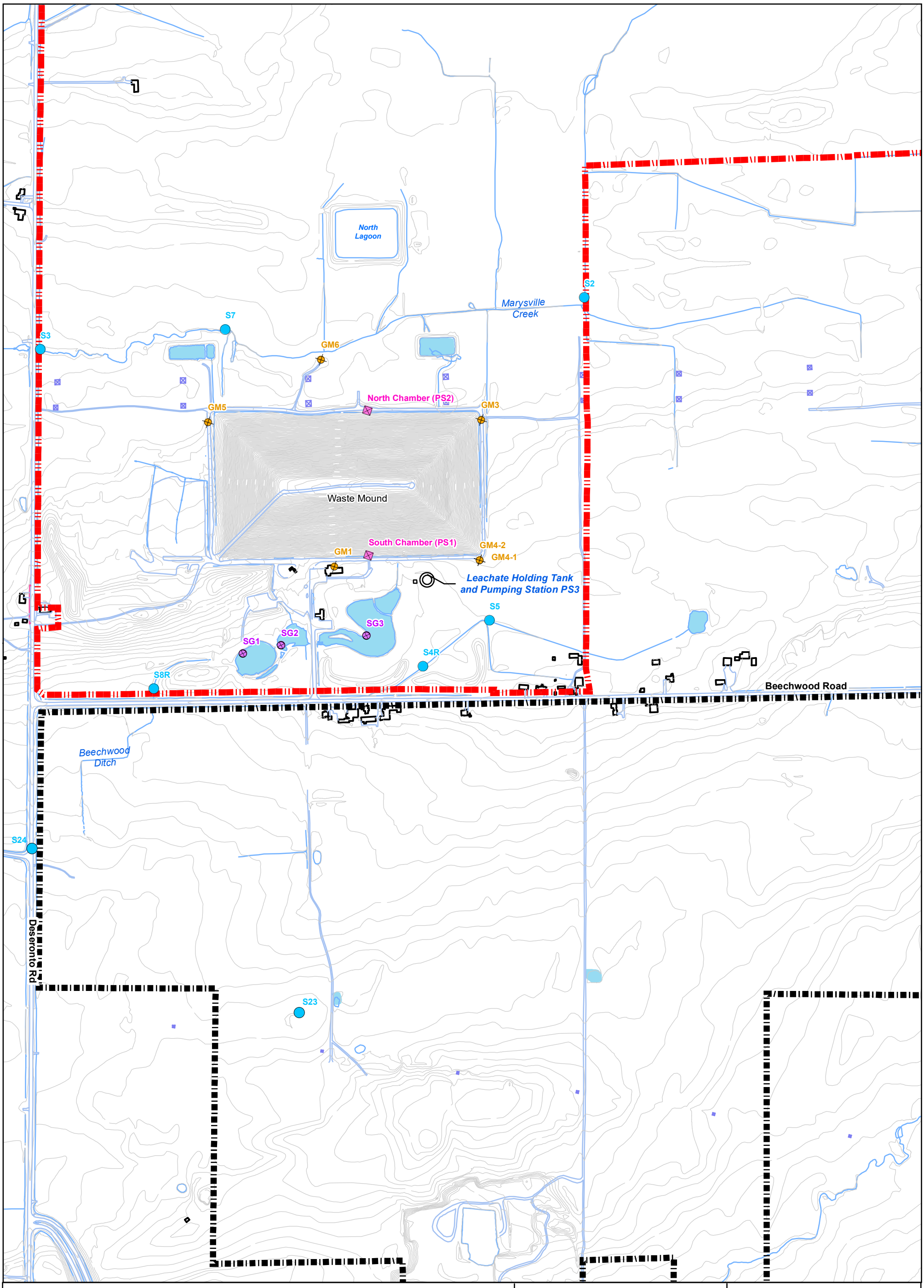

LEGEND

- M100 — Gas Monitoring Well
- Leachate Monitoring Location
- S2 — Surface Water Monitoring Location
- Stream Gauge
- Topographic Contour Lines
- Surface Water
- Property Boundary
- Contaminant Attenuation Zone

REFERENCES

THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.
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-PROJECTION: UTM NAD83 ZONE 18
-DATA SOURCE: WM CANADA, BLUMETRIC, MNRO, NRCAN

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Meters

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CLIENT: WM

PROJECT: WASTE MANAGEMENT RICHMOND LANDFILL ENVIRONMENTAL MONITORING PLAN

TITLE: SURFACE WATER, LEACHATE AND LANDFILL GAS MONITORING LOCATIONS

PROJECT #	DATE		
240160-01	April 24, 2024		
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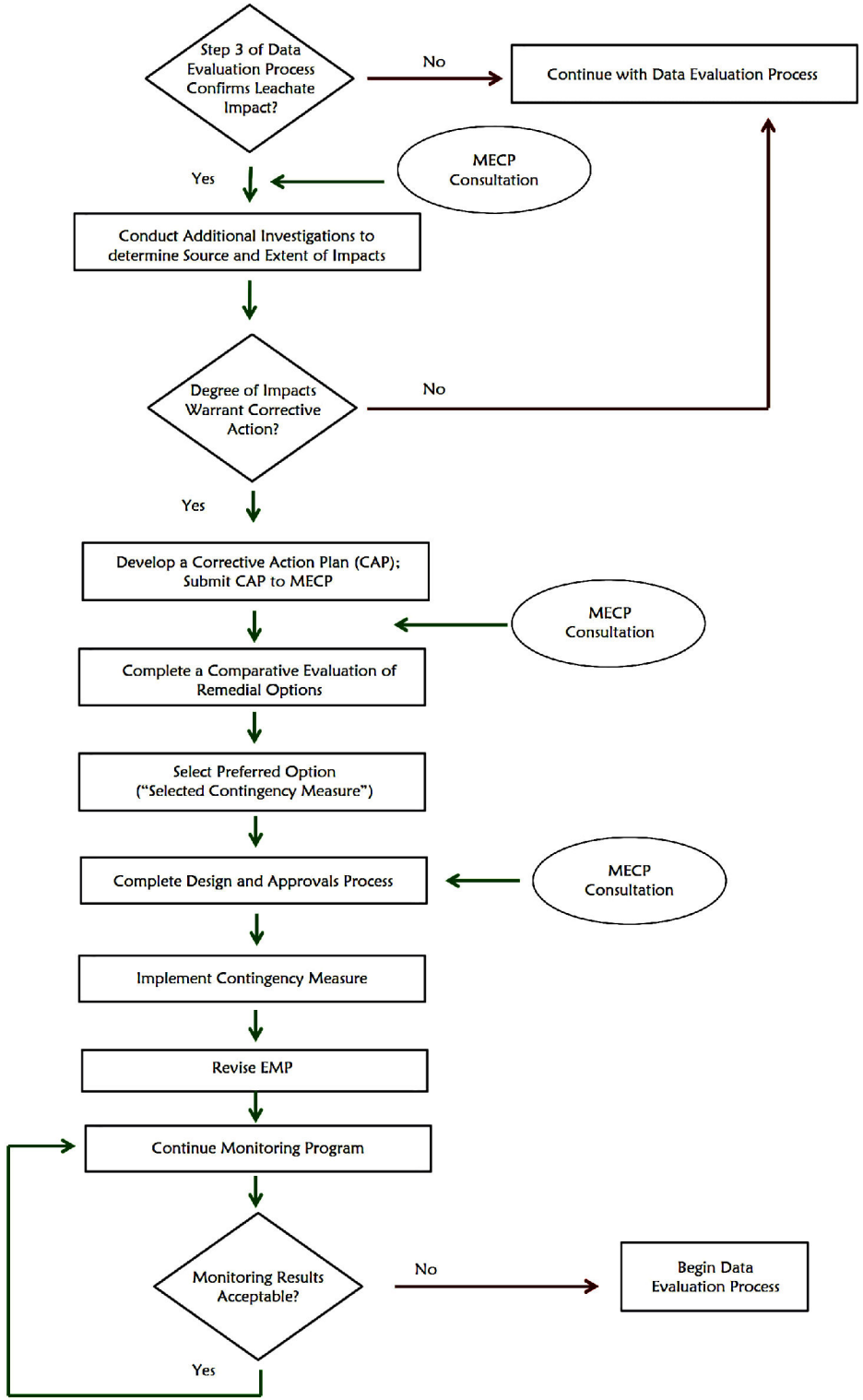

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REFERENCES

CLIENT

WM

PROJECT

Waste Management Richmond Landfill Environmental Monitoring Plan

TITLE

Contingency Plan Process

BluMetric™ Environmental

The Tower - The Woolen Mill,
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PROJECT #	DATE
240160-01	**April 24, 2024**

DRAWN	CHECKED	FIG NO.	REV
EB	**FR**	**05**	**0**

C:\SP\BluMetric Environmental\Geomatics - GIS (1)\GIS_PROJECTS\PROJECTS\WM\Richmond\240160\APRX\2024-04-24\240160-01 - WM Richmond.aprx

APPENDIX A

Post-Closure EMP Monitoring Well Construction Details

Waste Management Richmond Landfill

Post-Closure EMP Monitoring Well Construction Details

Monitoring Well Location	Easting	Northing	Dip Angle	Date Drilled	Monitor Type	Reference Elevation (masl)	Ground Elevation (masl)	Bedrock Elevation (masl)	Overburden Thickness (m)	Monitored Interval		
										Top Elevation (masl)	Bottom Elevation (masl)	Mid-Point Elevation (masl)
Shallow Groundwater Flow Zone												
M14	335625	4902637	90	04-Jun-91	Single Screen	127.71	127.38	124.59	2.79	125.08	124.68	124.88
M18	335648	4902866	90	05-Jun-91	Single Screen	128.32	127.81	126.34	1.47	126.81	126.51	126.66
M23	335602	4903049	90	05-Jun-91	Single Screen	128.48	127.82	123.45	4.37	124.22	123.42	123.82
M27	334997	4902908	90	19-Jun-91	Single Screen	127.85	127.16	122.13	5.03	122.86	122.26	122.56
M35	335458	4903336	90	18-Jun-91	Single Screen	124.83	124.49	122.89	1.60	123.20	122.89	123.04
M41	335368	4902818	90	21-Jun-91	Single Screen	127.22	126.68	121.78	4.90	122.09	121.78	121.94
M47-3	335552	4903215	90	n/a	Multilevel	127.74	126.82	121.82	5.00	123.82	121.82	122.82
M53-4	335496	4902649	90	17-Feb-98	Single Screen	126.69	125.89	123.91	1.98	124.39	124.09	124.24
M54-4	335348	4902618	90	18-Feb-98	Single Screen	125.71	124.06	119.95	4.11	122.08	120.56	121.32
M60-4	335077	4903494	90	17-Mar-98	Single Screen	126.71	125.87	122.67	3.20	124.07	121.87	122.97
M65-2	335298	4903316	90	29-May-98	Multilevel	124.41	123.83	122.03	1.80	120.58	119.23	119.91
M66-2	335155	4903219	90	29-May-98	Multilevel	124.41	123.54	122.04	1.50	122.24	121.54	121.89
M67-2	334799	4903090	90	01-Jun-98	Multilevel	123.81	123.11	121.61	1.50	121.61	120.91	121.26
M68-4	335672	4903499	90	03-Jun-98	Single Screen	125.24	124.43	122.30	2.13	124.43	122.93	123.68
M70-3	335891	4902858	90	29-Jun-98	Single Screen	128.26	127.12	124.68	2.44	126.12	125.82	125.97
M77	335685	4903188	60	22-Jun-00	Single Screen	129.22	128.27	123.94	4.33	123.59	121.34	122.47
M80-2	335206	4902534	90	06-Oct-04	Single Screen	125.97	123.34	118.64	4.70	119.77	116.74	118.25
M81	335275	4902654	90	06-Oct-04	Single Screen	125.90	125.05	120.05	5.00	121.30	118.24	119.77
M86	335077	4903195	90	08-Oct-04	Single Screen	123.99	123.18	122.48	0.70	121.35	119.83	120.59
M87-2	334965	4902495	90	09-Jun-05	Single Screen	126.38	125.29	117.78	7.51	120.72	117.67	119.19
M94-2	335486	4903526	90	24-Oct-06	Single Screen	125.05	124.31	122.18	2.13	120.95	117.90	119.42
M96	335774	4903158	90	26-May-08	Single Screen	130.59	129.61	125.40	4.21	126.87	122.29	124.58
M97	335059	4902551	90	26-May-08	Single Screen	127.55	126.65	118.42	8.23	119.95	115.38	117.66
M98	334976	4902730	90	27-May-08	Single Screen	131.13	130.23	120.78	9.45	122.30	117.73	120.01
M99-2	334869	4902646	90	04-Jun-08	Single Screen	131.37	130.51	120.76	9.75	122.21	117.63	119.92
M101	334949	4903015	90	28-May-08	Single Screen	125.30	124.35	122.03	2.32	122.37	119.02	120.69
M102	334836	4902919	90	28-May-08	Single Screen	125.52	124.72	122.03	2.68	122.69	119.03	120.86
M103	335021	4903101	90	17-Jun-08	Single Screen	125.30	124.42	122.31	2.10	122.59	119.54	121.06
M104	335150	4903152	90	17-Jun-08	Single Screen	124.46	123.57	122.05	1.52	122.20	119.15	120.68
M114-2	335439	4902528	90	10-Feb-11	Single Screen	125.36	124.41	122.41	2.00	123.34	122.12	122.73
M178R-5	335997	4902232	90	14-Nov-16	Single Screen	117.33	116.49	114.74	1.75	115.27	114.05	114.66
M188-2	335978	4902068	90	14-Nov-16	Single Screen	116.53	115.71	115.18	0.53	114.19	112.36	113.28
M200	335793	4902059	90	17-Apr-18	Single Screen	116.02	115.40	114.97	0.43	113.58	112.05	112.81
M201-DP	335828	4901991	90	18-Apr-18	Drive Point Piezometer	116.20	115.21	113.52	1.69	114.18	113.72	113.95
M203	335709	4902128	90	18-Apr-18	Single Screen	118.91	118.18	117.11	1.07	116.66	115.13	115.90
M204	335910	4902186	90	17-Apr-18	Single Screen	116.92	116.06	114.54	1.52	113.01	111.49	112.25
M205	336077	4902128	90	17-Apr-18	Single Screen	116.58	115.83	114.92	0.91	113.85	112.32	113.08
M206	335938	4902329	90	17-Apr-18	Single Screen	119.70	118.89	117.98	0.91	117.21	115.69	116.45
M206-DP	335961	4902294	90	24-Apr-18	Drive Point Piezometer	118.95	117.79	116.35	1.44	117.01	116.55	116.78
M207-DP	336135	4902191	90	24-Apr-18	Drive Point Piezometer	117.71	116.36	115.22	1.14	115.88	115.42	115.65
M209-DP	335838	4901957	90	04-May-18	Drive Point Piezometer	117.38	116.20	113.66	2.54	114.32	113.86	114.09
OW37-s	334634	4903062	90	29-Jan-78	Open Borehole	122.93	121.89	120.49	1.40	120.19	118.84	119.51

Waste Management Richmond Landfill

Post-Closure EMP Monitoring Well Construction Details

Monitoring Well Location	Easting	Northing	Dip Angle	Date Drilled	Monitor Type	Reference Elevation (masl)	Ground Elevation (masl)	Bedrock Elevation (masl)	Overburden Thickness (m)	Monitored Interval		
										Top Elevation (masl)	Bottom Elevation (masl)	Mid-Point Elevation (masl)
Intermediate Bedrock Groundwater Flow Zone												
M5-3	335003	4903163	90	12-Mar-91	Multilevel	124.02	123.20	122.44	0.76	117.20	115.70	116.45
M6-3	335201	4903174	90	08-Mar-91	Multilevel	124.39	123.73	122.23	1.50	118.73	117.23	117.98
M10-1	335494	4902596	90	18-Mar-91	Multilevel	127.04	126.47	123.47	3.00	98.47	96.27	97.37
M46-2	335185	4903232	90	n/a	Multilevel	125.03	123.96	123.66	0.30	117.66	116.16	116.91
M49-1	335454	4902658	90	26-Aug-96	Multilevel	125.75	125.47	122.77	2.70	99.97	98.37	99.17
M50-3	335660	4903248	90	26-Aug-96	Multilevel	125.85	125.25	122.00	3.25	116.25	114.75	115.50
M52-2	335748	4902940	90	27-Aug-96	Multilevel	129.36	128.78	126.88	1.90	115.98	114.78	115.38
M53-2	335499	4902650	90	17-Feb-98	Single Screen	126.70	125.89	123.91	1.98	98.94	95.89	97.42
M56-2	335065	4902545	90	23-Nov-05	Single Screen	127.15	126.12	118.20	7.92	112.32	109.32	110.82
M58-3	334761	4902812	90	18-Mar-98	Single Screen	126.04	125.32	121.21	4.11	116.32	113.32	114.82
M59-4	334604	4903287	90	19-Mar-98	Single Screen	125.13	124.63	124.02	0.61	117.63	115.43	116.53
M60-1	335044	4903538	60	17-Mar-98	Single Screen	125.70	124.71	122.82	1.89	98.30	96.13	97.21
M63-2	335425	4902394	90	02-Apr-98	Multilevel	122.61	121.71	119.81	1.90	113.71	111.71	112.71
M64-2	335585	4902176	90	07-Apr-98	Multilevel	121.60	120.95	120.05	0.90	112.45	109.95	111.20
M72	334981	4902831	60	15-Jun-00	Single Screen	129.22	128.39	122.50	5.89	112.37	110.20	111.29
M74	334950	4902962	60	19-Jun-00	Single Screen	126.13	125.04	121.92	3.12	117.68	115.51	116.60
M75	335151	4903215	60	21-Jun-00	Single Screen	124.44	123.57	122.53	1.04	118.98	116.64	117.81
M82-2	334641	4903058	90	06-Oct-04	Single Screen	123.19	122.33	121.13	1.20	117.33	114.33	115.83
M91-1	334798	4902729	60	25-Sep-06	Single Screen	130.40	129.80	121.45	8.35	109.80	107.15	108.47
M95-1	334743	4902908	60	04-Oct-06	Single Screen	124.13	123.42	122.11	1.31	108.91	106.26	107.59
M105	335620	4902778	90	30-Mar-09	Single Screen	127.48	126.81	125.21	1.60	109.50	106.15	107.83
M106	335331	4902549	90	16-Aug-10	Single Screen	124.73	124.03	119.61	4.42	100.35	97.00	98.67
M107	335650	4902654	90	17-Aug-10	Single Screen	128.71	127.98	124.32	3.66	103.11	99.76	101.44
M108	335791	4902733	90	19-Aug-10	Single Screen	128.39	127.69	125.31	2.38	103.40	100.05	101.73
M109-1	335405	4902844	90	03-Feb-11	Single Screen	127.42	126.62	122.40	4.22	108.52	105.62	107.07
M109-2	335407	4902840	90	11-Mar-11	Single Screen	127.49	126.72	122.19	4.53	117.03	113.68	115.35
M110-1	335543	4902883	90	07-Feb-11	Single Screen	127.55	126.82	123.80	3.02	107.86	104.82	106.34
M111-1	335250	4902774	90	09-Feb-11	Single Screen	128.95	128.21	120.40	7.81	100.84	97.81	99.33
M112-1	335274	4902692	90	11-Feb-11	Single Screen	126.38	125.65	120.45	5.20	99.63	96.58	98.11
M114-1	335437	4902530	90	23-Feb-11	Single Screen	125.36	124.41	122.50	1.91	97.25	94.21	95.73
M121	335529	4902337	90	17-May-12	Single Screen	121.78	120.97	119.75	1.22	96.99	94.00	95.50
M123	335905	4902479	90	23-May-12	Single Screen	123.60	122.92	122.46	0.46	101.00	97.96	99.48
M167	336266	4902624	90	06-Mar-13	Single Screen	120.68	119.98	119.60	0.38	96.91	94.07	95.49
M168	336063	4902714	90	06-Mar-13	Single Screen	126.29	125.29	124.22	1.07	100.25	97.24	98.74
M170	335889	4902865	90	07-Mar-13	Single Screen	128.21	127.51	125.18	2.33	104.11	101.30	102.70
M177	335784	4902084	90	13-Nov-13	Single Screen	116.60	115.90	115.75	0.15	112.90	109.90	111.40
M178R-2	336008	4902233	90	19-Aug-15	Single Screen	117.51	116.52	114.90	1.62	102.82	96.72	99.77
M178R-4	336002	4902232	90	15-Aug-15	Single Screen	117.34	116.54	114.86	1.68	112.94	111.04	111.99
M179	336338	4902357	90	11-Nov-13	Single Screen	117.67	117.04	116.89	0.15	102.04	99.04	100.54
M185-1	336175	4902152	90	17-Jun-14	Single Screen	117.33	116.57	116.14	0.43	87.57	84.57	86.07
M185-2	336169	4902145	90	28-Aug-14	Single Screen	117.38	116.68	115.99	0.69	103.18	100.18	101.68
M186	336502	4902641	90	17-Jun-14	Single Screen	121.34	120.58	120.38	0.20	111.08	108.08	109.58
M187	335607	4901972	90	27-Jan-15	Single Screen	116.31	115.76	115.25	0.51	90.53	87.53	89.03
M188-1	335979	4902069	90	28-Jan-15	Single Screen	116.37	115.81	115.05	0.76	86.81	83.81	85.31
M190	336274	4902275	90	27-Jan-15	Single Screen	118.00	117.32	116.56	0.76	103.24	100.24	101.74
M191	336332	4902802	90	27-Jan-15	Single Screen	123.31	122.81	121.95	0.86	94.29	91.29	92.79
M192	335976	4902826	90	04-Dec-15	Single Screen	128.09	127.28	125.25	2.03	102.08	99.08	100.58
M193	336082	4902896	90	04-Dec-15	Single Screen	128.13	127.44	123.86	3.58	114.44	111.44	112.94
OW1	334995	4903200	90	01-Jan-78	Single Screen	123.60	122.96	122.66	0.30	117.71	117.21	117.46

APPENDIX B

Groundwater Monitoring Well Logs

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12e, mississauga, ontario (416) 624 - 9308

OW1/78

CLIENT Sutcliffe Sanitation Services Ltd. FILE NO. 90-781

PROJECT LANDFILL LOCATION RICHMOND TOWNSHIP

GEOLOGIST/ENGINEER JWW DATE COMPLETED

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
GROUND ELEVATION122.96							
TOPSOIL: dark brown, clayey,partly organic						C	
	1						
		5				A	
	2						
LIMESTONE: grey,dense							
	3	10				B	
	4						
		15				C	
	5					D	
						E	
	6	20					
E.O.H.							
	7						
		25					
	8						
	9	30					

10 20 30 40 50 60 70 80 90

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12e, mississauga, ontario (416) 624 - 9508

OW4/78

CLIENT Sutcliffe Sanitation Services Ltd. FILE NO. 90-781

PROJECT LANDFILL LOCATION RICHMOND TOWNSHIP

GEOLOGIST/ENGINEER JWW DATE COMPLETED

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
GROUND ELEVATION 123.96							
TILL: light brown, clayey, silt, boulders	1	5				C, A, C	
LIMESTONE: grey, dense	2, 3, 4, 5	10, 15				B, C, D, E	
E.O.H.	6, 7, 8, 9	20, 25, 30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		W 5	March 12, 1991

PROJECT Richmond Township Landfill
PROJECT NO. 2300

DRILLING METHODS Cable Tool
SUPERVISOR J. Meadows
DRILLING CONTRACTOR Jack Knox Well Drilling

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING INTERVAL
0	123.20			Lockable well cap; W5-1, W5-2, W5-3; 0.83m stickup	
	122.44	0.76m CLAY TILL: with silt, gravel & sand			
2		LIMESTONE: blue-grey, fine to medium crystalline, thin to medium bedded with shaly partings		16.5 cm diameter steel casing; bentonite seal 1.5m, 2.5cm I.D., 10 slot PVC screen 5.5m; 8.0m	
4					
6					
8					
		9.75m		2.5cm I.D., PVC Pipe	
10		LIMESTONE: brown-grey, fine to medium crystalline, thin to medium bedded with shaly partings			
12				bentonite seal	
14					
16					
18					
20				19.5m 3m sand pack 3.0m, 2.5cm I.D., 10 slot PVC screen	
22					
24	99.23			24.5m bentonite seal 26.1m	
26					
28				3m sand pack 3.0m, 2.5cm I.D., 10 slot PVC screen	
30	92.60	END OF HOLE at 30.6m			
32					
34					

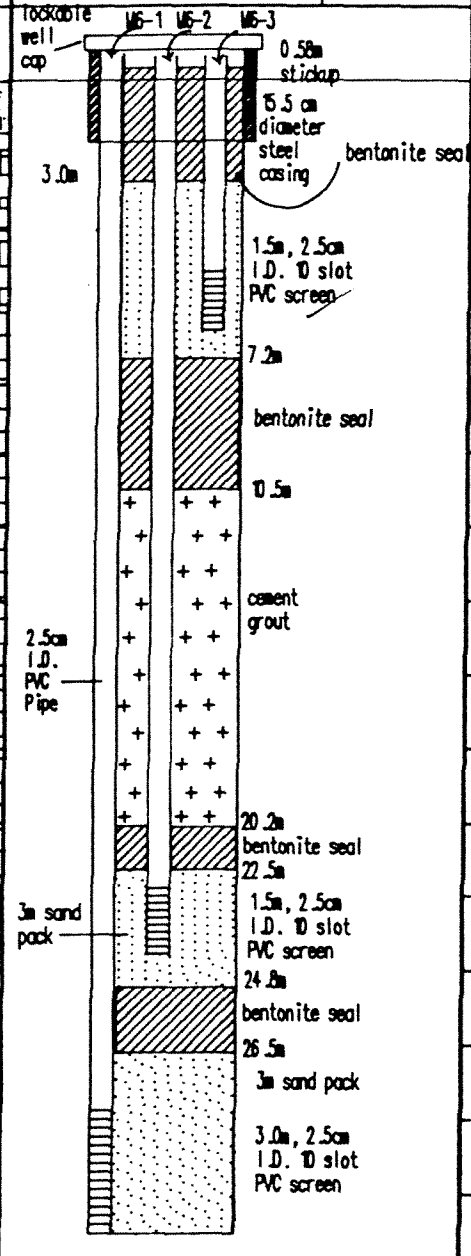
*Measurements in piezometer construction details referenced from ground surface

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		M 6	March 8, 1991

PROJECT Richmond Township Landfill
PROJECT NO. 2300
DRILLING METHODS Cable Tool
SUPERVISOR
DRILLING CONTRACTOR Jack Knox Well Drilling

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING INTERVAL
0	123.73				
	122.23	CLAY TILL: with silt, gravel & sand 1.5m			
2		LIMESTONE: blue-grey fine to medium crystalline, thin to medium bedded with shaly partings			
4	117.25				
6					
8					
10					
12					
14		Water-bearing fracture at 14.0 m Gas at 14.0 m			
16					
18					
20					
22	99.65				
24					
26					
28					
30					
	93.01	END OF HOLE AT 30.8m			
32					
34					



*Measurements in piezometer construction details referenced from ground surface

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE

RECORD OF TEST HOLE

DESIGNATION: M 10

COMPLETION DATE: March 18, 1991

PROJECT: Richmond Township Landfill

PROJECT NO.: 2300

DRILLING METHODS: Cable Tool

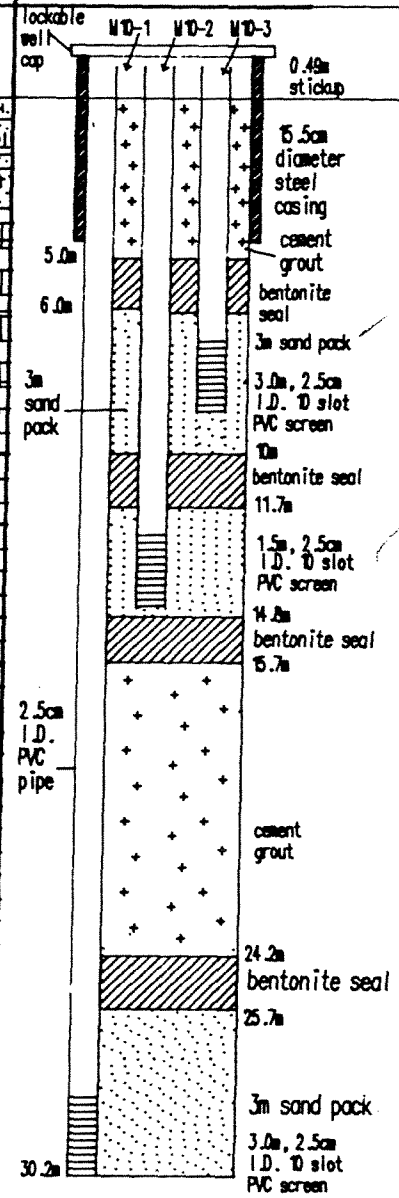
SUPERVISOR: J. Meadows

DRILLING CONTRACTOR: Jack Knox Well Drilling

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY
0	126.47	
2	123.47	CLAY TILL: with silt, gravel & sand with some cobbles
		3.0m
4		LIMESTONE: blue-grey, fine to medium crystalline, thin to medium bedded with shaly partings
6		
8	117.10	
10		
12		
14	112.26	
16		
18		
20		20.1m
22		LIMESTONE: brown-grey fine to medium crystalline, thin to medium bedded with shaly partings
24		
26		
28		
30	96.26	Water-bearing fracture at 29.3m
		END OF HOLE AT 30.2m
32		
34		

LOG

INSTRUMENTATION



SAMPLING

INTERVAL

GS

GS

*Measurements in piezometer construction details referenced from ground surface

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE

RECORD OF TEST HOLE

DESIGNATION: M 14

COMPLETION DATE: June 4, 1991

PROJECT: LAIDLAW - Richmond Township Landfill
PROJECT NO.: 2300

DRILLING METHODS: Hollowstem Auger
SUPERVISOR: R. Winters
DRILLING CONTRACTOR: All-Terrain Drilling

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	N VALUE
0				Locking well cap			
		0 - 0.76: Light brown, sandy SILT TILL with trace of boulders and rounded cobbles		cement grout	G1	0.0 0.31	
					G2	0.31 1.52	
1.0		0.76 - 1.52: Light grey, sandy SILT TILL with trace rounded gravels			SS1	1.52 1.98	
		1.52 - 2.29: Dark brown grey, sandy SILT TILL with some subangular to subrounded boulders & cobbles		bentonite seal	G3	1.98 2.29	
2.0				3m sand pack	G4	2.29 2.82	
		2.29 - 2.82: Buff brown grey, sandy SILT TILL with some subangular to subrounded gravel & cobbles		1" ID, 10 slot screen			
3.0		2.82: Bedrock/Refusal, LIMESTONE					
4.0							
5.0							
6.0							
7.0							
8.0							
9.0							
10.0							
12.0							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	**RECORD OF TEST HOLE**	DESIGNATION MW 18	COMPLETION DATE June 5, 1991
PROJECT LAIDLAW - Richmond Township Landfill PROJECT NO. 2300		DRILLING METHODS Hollowstem Auger SUPERVISOR R. Winters DRILLING CONTRACTOR All-Terrain Drilling	

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		Surface: Grassed		Locking well cap			
		0 - 0.3m Dark brown sandy silty clay (organic) topsoil		cement grout	GS1	0.0 0.3	
		0.3 - 1.2m Grey/brown silty clay TILL with some sand & a trace of gravel, dry to damp		bentonite seal	GS2	0.3 0.7	
1.0		1.2 - 1.4m Dense, grey/brown silty clay TILL with some sand & gravel dry to damp		3m sand pack	GS3	0.7 1.2	
		1.4m Auger/Refusal		0.3m, 10 slot, 1" I.D. screen	SS1	1.2 1.4	
2.0							
3.0							
4.0							
5.0							
6.0							
7.0							
8.0							
9.0							
10.0							
12.0							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE

RECORD OF TEST HOLE

DESIGNATION W 23

COMPLETION DATE June 5, 1991

PROJECT LAIDLAW - Richmond Township Landfill

PROJECT NO. 2300

DRILLING METHODS Hollowstem Auger

SUPERVISOR R. Winters

DRILLING CONTRACTOR All-Terrain Drilling

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	N VALUE
0		SURFACE: Grassed		Locking well cap			
		0 - 0.8m - Grey/brown silty CLAY with a trace of sand, dry		cement grout	GS1	0.0 0.3	
1.0		0.8 - 2.0m - Grey silty clay TILL with some sand & gravel, dry		1" I.D. PVC pipe	GS2	0.3 0.76	
2.0		2.0 - 2.3m Grey silty clayey TILL with some gravel (subrounded) dry		Bentonite seal			
		2.3 - 3.0m Grey silty clayey sand TILL with some gravel (subrounded), wet					
3.0		3.0 - 3.5m - Grey sandy silt TILL with some clay and gravel, moist		3m sand pack			
		3.5 - 4.4m - Grey clayey silt TILL with some sand & gravel, very wet at 3.8 - 4.4m					
4.0		4.4m Bedrock/Refusal, LIMESTONE		0.60m, 1" I.D. PVC 10 slot screen			
5.0							
6.0							
7.0							
8.0							
9.0							
10.0							
12.0							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION M 27	COMPLETION DATE June 19, 1991
PROJECT LAIDLAW - Richmond Township Landfill PROJECT NO. 2300		DRILLING METHODS Hollowstem Auger SUPERVISOR R. Winters DRILLING CONTRACTOR All-Terrain Drilling	

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		SURFACE: Grassed		Locking well cap			
		0 - 0.6m Light brown sand TILL with some gravel and cobbles and a trace of silt		cement grout	GS1	0.0 - 0.6	
1.0		0.6 - 2.0m Grey, silty and TILL with some gravel (rounded), wet, dense		1" I.D. PVC pipe	GS2	0.6 - 1.5	
2.0		2.0 - 3.4m Grey sandy silt TILL with some gravel and cobbles (rounded) and a trace of clay, dense			SS1	1.5 - 2.0	
3.0					GS3	2.0 - 3.0	
				bentonite seal	SS2	3.0 - 3.4	
4.0		3.4 - 4.6m Grey sandy silt TILL with some gravel (rounded), very dense			GS4	3.4 - 4.6	
				3m sand pack			
		4.6 - 5.0m Grey sandy silty TILL with some gravel and cobbles, moist, very dense			SS3	4.6 - 5.0	
5.0		5.0m Bedrock/Refusal: LIMESTONE		0.60m, 1" I.D. 10 slot screen			
6.0							
7.0							
8.0							
9.0							
10.0							
12.0							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	**RECORD OF TEST HOLE**	DESIGNATION M 35	COMPLETION DATE June 18, 1991

PROJECT LAIDLAW - Richmond Township Landfill
PROJECT NO. 2300
DRILLING METHODS Hollowstem Auger
SUPERVISOR M. Grinnell
DRILLING CONTRACTOR All-Terrain Drilling

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	N VALUE
0		Ground Surface: Grass		Locking well cap; 0			
	0.15	TOPSOIL: Dark brown, organic silty sand with clay		cement grout	GS1	0.15	
					GS2	0.76	
1.0		Mottled dark greenish grey brown, SILTY CLAY TILL, with trace sands and subrounded gravels. Some organics (rootlets) present. Unit is stiff with high plasticity.		0.93; sand pack; 1.29	SS1		
	1.60				GS3	1.24	
					GS4	1.55	
		1.60m Bedrock/Refusal LIMESTONE				1.60	
2.0							
3.0							
4.0							
5.0							
6.0							
7.0							
8.0							
9.0							
10.0							
12.0							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE	RECORD OF TEST HOLE	DESIGNATION MW 41	COMPLETION DATE June 21, 1991
PROJECT LAIDLAW - Richmond Township Landfill PROJECT NO. 2300		DRILLING METHODS Hollowstem Auger SUPERVISOR R. Winters DRILLING CONTRACTOR All-Terrain Drilling	

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY & HYDROSTRATIGRAPHY	LOG	INSTRUMENTATION	SAMPLING TYPE	SAMPLING INTERVAL	SAMPLING N VALUE
0		Surface: Granular 'B' gravel fill		Locking well cap			
	0.47	FILL: Sand and angular gravels Gravels have oil staining		cement grout	SS1	0.47	
1.0		FILL: coarse grained gravel with some sand. Unit is damp. Gravel particles are angular, 2.5 to 15cm in dia. Fill is contaminated			GS1		
	1.55				SS2	1.55 2.02	
2.0		Greyish-brown, CLAYEY SILT TILL with some sand and trace subrounded gravels and cobbles. Unit is damp.			GS2		
3.0				3.28 bentonite seal	SS3	3.20 3.57	
4.0				4.19 sand pack	GS3		
				4.59	SS4	4.85	
5.0		4.90m Bedrock/Refusal LIMESTONE					
6.0							
7.0							
8.0							
9.0							
10.0							
12.0							

WATER AND EARTH SCIENCE ASSOCIATES LTD.

FIGURE:

RECORD OF TEST HOLE

DESIGNATION	COMPLETION DATE
M46	

PROJECT: RICHMOND LANDFILL

PROJECT NO.: 3759

DRILLING METHODS: AIR ROTARY

SUPERVISOR: EMMANUEL SAYDEH

DRILLING CONTRACTOR: CHALK DRILLING NAPANEE

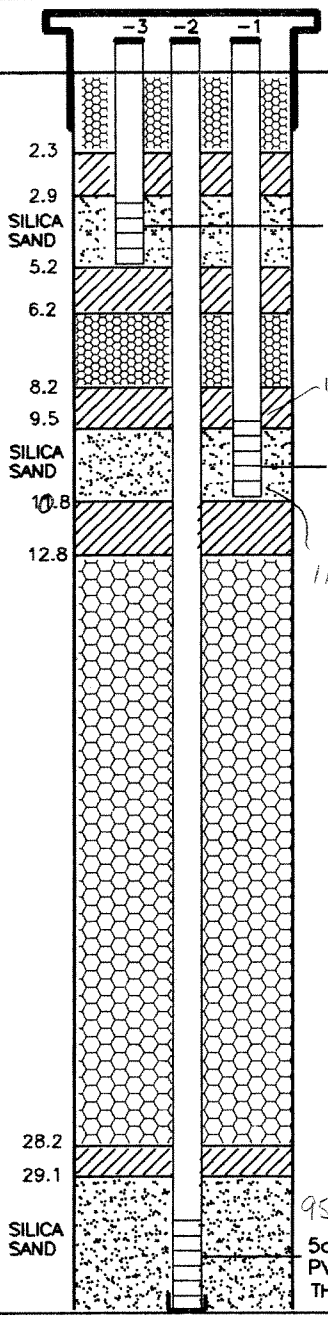
DEPTH METRES	ELEVATION METRES	STRATIGRAPHY	LOG	INSTRUMENTATION	TYPE	INTERVAL	N VALUE
0				.91m CASING STICK-UP			
1				.18m CASING BENTONITE SEAL			
				1.3	CLEAN PEA GRAVEL		
2					BENTONITE		
				2.4			
3					CLEAN PEA GRAVEL		
4							
				4.8			
5					BENTONITE		
6				6.0			
7					SAND		
					1.5m SCREEN		
8				8.2			
					BENTONITE		
9				9.1			
10					CLEAN PEA GRAVEL		
11							
12				12.1			
					BENTONITE		
13				13.4			
14					SAND		
					1.5m SCREEN		
15		15.2			BELL END CAP		
16							
17							
18							
19							
20							

WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O.BOX 430 CARP, ONTARIO. KOA 1L0

FIGURE:	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		M47	

PROJECT: RICHMOND LANDFILL
PROJECT NO.: 3759
DRILLING METHODS: AIR ROTARY
SUPERVISOR: EMMANUEL SAYDEH
DRILLING CONTRACTOR: CHALK DRILLING NAPANEE

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY
0	126.82	
		SILTY SAND (BACKFILL) – PEBBLES & COBBLES 1.8 LIGHT BROWN COLOUR
2		SILTY CLAY (BACKFILL) – DARK BROWN – PEBBLES & COBBLES
		3.6
4		SILTY SAND WITH SOME CLAY 4.45 LIGHT BROWN COLOUR – MOIST – SOME WATER
		5.0
6	121.82	BEDROCK – SOFT – LIMESTONE – DARK GREY
8		CASING SET TEMPORARILY @ 5.0m UNTIL HOLE IS INSTRUMENTED – NO GROUT
		10.0
10		10.2 SAND, MEDIUM
		10.3
12		10.8 FRACTURE – <1.0 GPM WATER – LIGHT BROWN COLOUR, SAND
14	▽	
16		SHALE, SOFT – VISIBLE TEXTURAL STRUCTURES I.E. LAMINATION RIPPLE STRUCTURES
18		
20		
22		
24		
26		
28		BEDROCK LIMESTONE – NO WATER
30		
32	93.68	33.14 END OF HOLE
34		– OBSERVED GASES COMING OUT @ WELL HEAD WHEN COMPLETED DRILLING. – DRILL RODS WERE BLACK
36		
38		
40		



INSTRUMENTATION	TYPE	INTERVAL	N VALUE

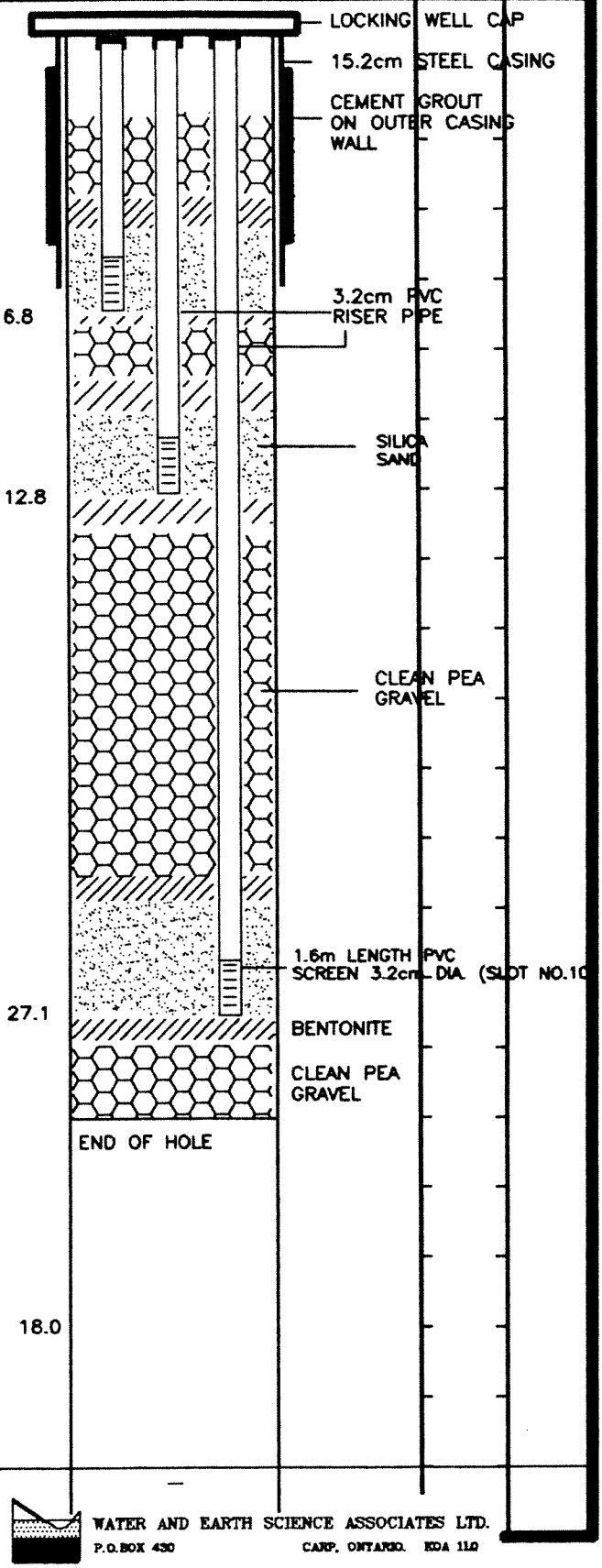
WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O.BOX 430 CARP, ONTARIO. K0A 1L0

FIGURE:	**RECORD OF TEST HOLE**	DESIGNATION M49	COMPLETION DATE AUGUST 26, 1996
PROJECT:	RICHMOND LANDFILL	DRILLING METHODS:	AIR ROTARY
PROJECT NO.:	A276	SUPERVISOR:	EMMANUEL SAYDEH
		DRILLING CONTRACTOR:	CHALK DRILLING NAPANEE

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY
0		
		SAND AND GRAVEL TILL
2		
		LIMESTONE
4		
		FRACTURE @ 5.80m
6		
8		
10		
12		FRACTURE @11.8m
14		
16		
18		
20		
22		
24		FRACTURE @ 24.0m
		FRACTURE @ 25.9m
26		FRACTURE @ 26.8m
		GROUNDWATER : < 1GPM
28		
		END OF HOLE
30		

LOG

INSTRUMENTATION



TYPE	INTERVAL	N VALUE

WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O.BOX 430 CARP, ONTARIO. KOA 1LO

FIGURE:

RECORD OF TEST HOLE

DESIGNATION	COMPLETION DATE
M50	AUGUST 26, 1996

PROJECT: RICHMOND LANDFILL

PROJECT NO.: A276

DRILLING METHODS: AIR ROTARY

SUPERVISOR: EMMANUEL SAYDEH

DRILLING CONTRACTOR: CHALK DRILLING NAPANEE

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY	LOG	INSTRUMENTATION	TYPE	INTERVAL	N VALUE
0			~0.6		LOCKING WELL CAP		
		SAND AND GRAVEL TILL			15.2cm STEEL CASING		
2					CEMENT GROUT ON OUTER CASING WALL		
		WEATHERED LIMESTONE/SHALE					
4		LIMESTONE					
6					3.2cm PVC RISER PIPE		
8							
10		FRACTURE ● 9.45m		10.9	SILICA SAND		
12							
14				15.5			
16							
18					CLEAN PEA GRAVEL		
20							
22		FRACTURE ● 21.9m					
24							
26							
		FRACTURE ● 26.5m			1.6m LENGTH PVC SCREEN 3.2cm DIA. (SLOT NO.10		
28				28.0	BENTONITE		
		END OF HOLE					
30					END OF HOLE		
		STRONG ORGANIC ODOUR NOTICED IN GROUNDWATER ● 26.8 m		18.0			

WATER AND EARTH SCIENCE ASSOCIATES LTD.

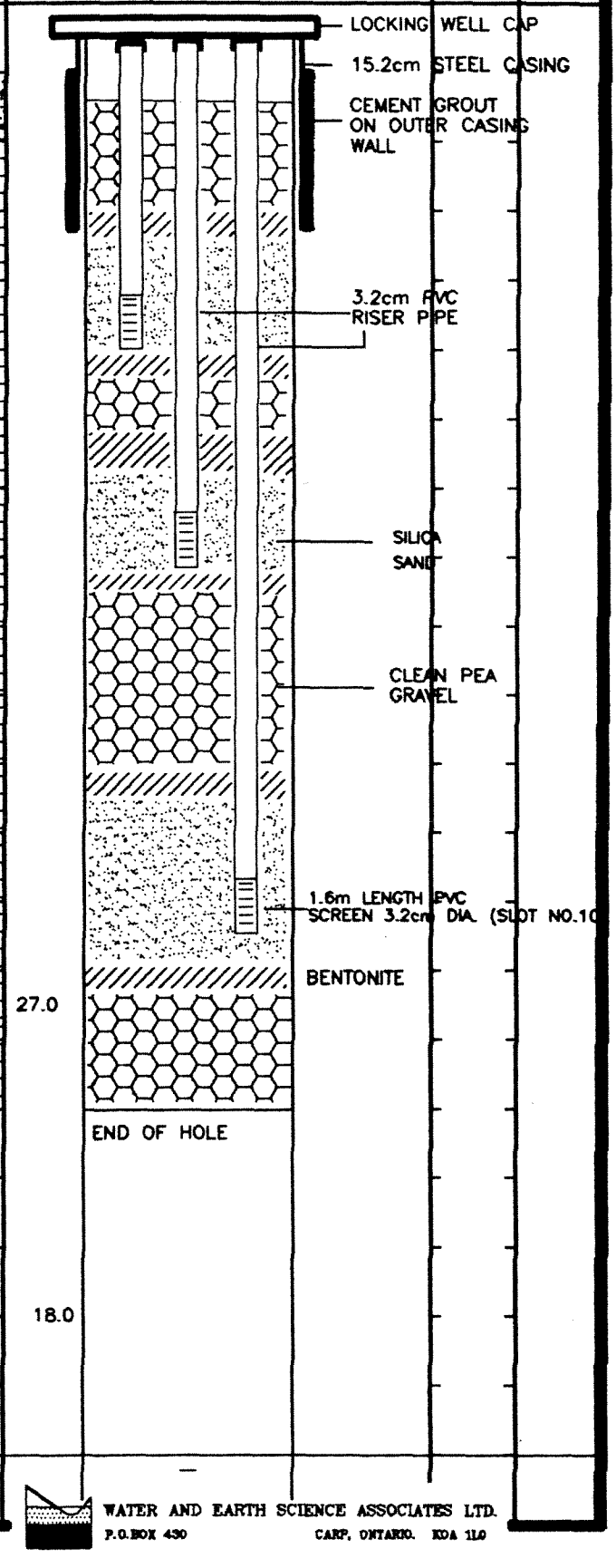
P.O.BOX 430 CARP, ONTARIO. KOA 1L0

FIGURE:	RECORD OF TEST HOLE	DESIGNATION	COMPLETION DATE
		M52	AUGUST 27, 1996
PROJECT:	RICHMOND LANDFILL	DRILLING METHODS:	AIR ROTARY
PROJECT NO.:	A276	SUPERVISOR:	EMMANUEL SAYDEH
		DRILLING CONTRACTOR:	CHALK DRILLING NAPANEE

DEPTH METRES	ELEVATION METRES	STRATIGRAPHY
0		
		SAND AND GRAVEL TILL
2		LIMESTONE
4		
6		FRACTURE @ 6.7m
8		
10		
12		FRACTURE @ 12.8m
14		
16		
18		FRACTURE @ 19.8m
20		
22		
24		FRACTURE @ 24.4m
26		
28		
30		END OF HOLE

NOTES:

NOTICED GAS PRESSURE AT 13.0 m



WATER AND EARTH SCIENCE ASSOCIATES LTD.
P.O.BOX 430 CARP, ONTARIO. KOA 1L0

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Inc.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary / Cable Tool

Well ID: M53

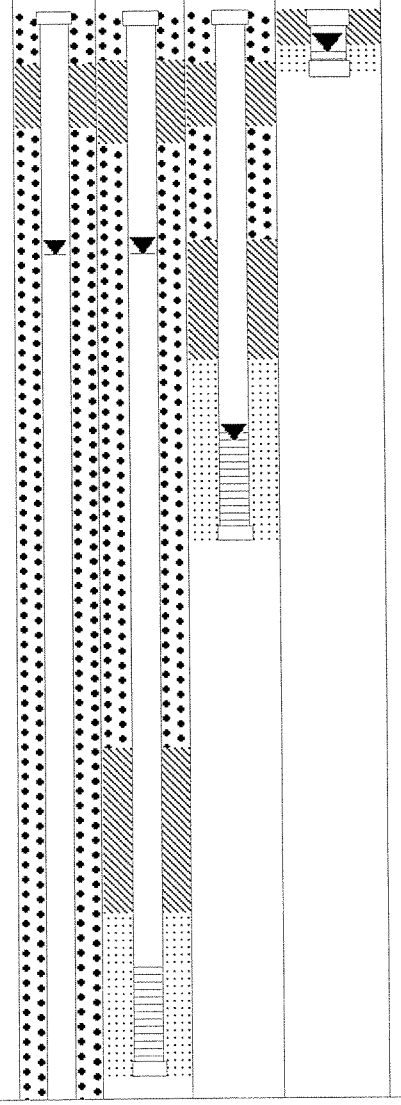
Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures
0		Ground Surface	125.92	
1		***CLAY*** brown		
2		***CLAY TILL*** with gravel and sand, brown	124	
3			123	x
4		***LIMESTONE*** grey	122	
5			121	
6			120	x
7			119	
8			118	
9			117	
10			116	
11			115	
12			114	x
13			113	
14			112	
15			111	
16			110	
17			109	
18			108	x
19			107	x
20			106	
21			105	
22			104	
23			103	
24			102	x
25			101	x
26			100	x
27			99	
28			98	x
29			97	
30			96	
			95	

Well Construction



Comments

elev. TOC/ground (m):
53-1 126.55/125.92
53-2 126.56/125.89
53-3 126.81/125.87
53-4 126.46/125.89

Hole Size: 15.9 cm diameter

Datum: 125.92 m (at M53-1)

Drill Date: February 16-17, 1998

Sheet: 1 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Inc.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary / Cable Tool

Well ID: M53

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE					Well Construction				Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	3	4	
31		***LIMESTONE*** grey	94	x					blue-green colour from 48.5 to 49.7 m
32			93						
33			92						
34			91						
35			90						
36			89	x					
37			88						
38			87						
39			86						
40			85	x					
41			84						
42			83						
43			82	x					
44			81						
45			80						
46			79						
47			78						
48			77						
49			76						
50			75						
51			74						
52			73						
53			72						
54			71						
55			70						
56			69						
57			68						
58			67						
59			66						
60		***EOH at 60.96 m depth***	65						
61									

Hole Size: 15.9 cm diameter

Datum: 125.92 m (at M53-1)

Drill Date: February 16-17, 1998

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Inc.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary / Cable Tool

Well ID: M54

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	2	3	4	Comments
0		Ground Surface	124.02						elev. TOC/ground (m):
1		*CLAY* brown, becoming dense							54-1 124.47/124.02
2			122						54-2 124.74/123.97
3			121						54-3 124.51/123.99
4		*CLAY TILL* with gravel and sand, brown	120						54-4 124.61/124.06
5		*LIMESTONE* grey	119						
6			118						
7			117						
8			116						
9			115						
10			114	x					
11			113						
12			112						
13			111						
14			110						
15			109						
16			108						
17			107						
18			106						
19			105	x					
20			104						
21			103						
22			102						
23			101	x					
24			100						
25			99						
26			98						
27			97						
28			96						
29			95						
30			94						
			93						

Hole Size: 15.9 cm diameter

Datum: 124.02 m (at M54-1)

Drill Date: February 17-18, 1998

Sheet: 1 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Inc.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary / Cable Tool

Well ID: M54

Enclosure:
Field Personnel: BA

SUBSURFACE PROFILE					Well Construction				Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	3	4	
31		*LIMESTONE* grey	92						
32									
33			91	x					
34			90						
35			89						
36			88						
37			87						
38			86						
39			85	x					
40			84						
41			83						
42			82	x					
43			81						
44			80						
45			79						
46			78						
47			77	x					blue-green colouring from 46.9 to 47.9 m
48			76						
49			75						
50			74						
51			73						
52			72						
53			71						
54			70						
55			69						
56			68						
57			67						
58			66						
59			65						
60		*EOH at 60.96 m depth*	64						blue green colouring from 59.1 to 61.0 m
61			63						

Hole Size: 15.9 cm diameter

Datum: 124.02 m (at M54-1)

Drill Date: February 17-18, 1998

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A757-7

Project: Additional Wells - SW Quadrant

Client: WM - Richmond Landfill

Location: Napanee

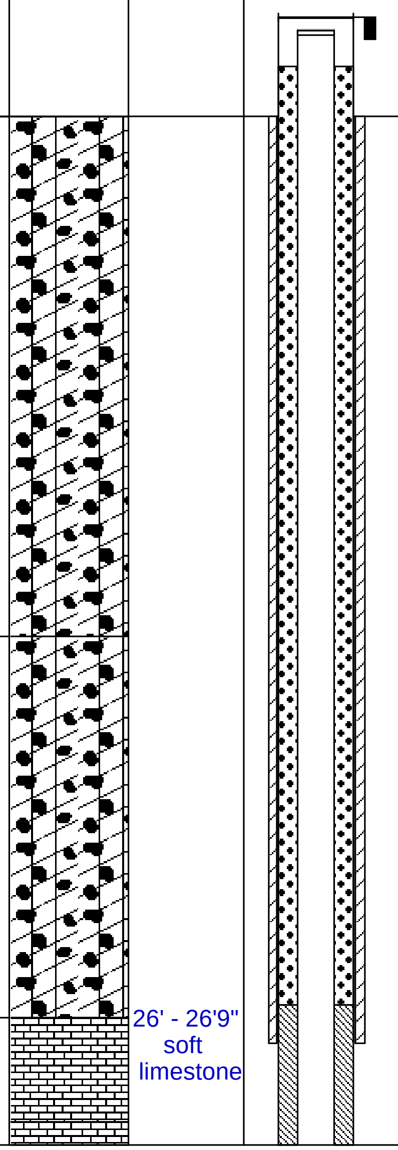
Well ID: M56-2

Log File: M56-2
Tem. File: WESA-Bedrock

Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
ft -3, -1 / m	126.12	Ground Surface				
1, 3, 5, 7 (2 m), 9, 11, 13 (4 m)		***Clay TILL*** Brown Clayey TILL with small gravel and trace sand.				Drilled through overburden with 8" Tricone. Drilled through bedrock with 6" air hammer. 6" steel casing grouted in place with 20% solids bentonite quickgrout from bedrock to surface using tremie pipe and grout pump.
15, 17, 19 (6 m), 21, 23, 25	121.55	***Clay TILL*** Grey Clayey TILL with gravel and trace sand.				Clean pea gravel from top of holeplug to surface inside steel casing.
27 (8 m), 29	118.20	***LIMESTONE BEDROCK***		26' - 26'9" soft limestone		3/8" Bentonite Holeplug from top of filter pack to up inside steel casing.
	117.28					



Drilled By: Chalk Well Drilling

Drill Method: Air Rotary

Drill Date: November 23, 2005

Hole Size: 6"

Datum: Top of Casing Elevation - 126.991 masl

WESA A Better Environment For Business

Project No: A757-7

Project: Additional Wells - SW Quadrant

Client: WM - Richmond Landfill

Location: Napanee

Well ID: M56-2

Log File: M56-2
Tem. File: WESA-Bedrock

Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
31		***LIMESTONE BEDROCK***				
33 – 10						3/8" Bentonite Holeplug
35						
37						
39 – 12						
41						
43				Water Producing fracture 43' 44'		
45						
47 – 14						
49						10' Slot 10 PVC Screen with #3 Silica Sand Filterpack
51						
53 – 16				Water Producing fracture 52' -53'		
55	109.05					Limestone Cuttings (fall in)
57		End of Borehole				
59 – 18						
61						

Drilled By: Chalk Well Drilling

Drill Method: Air Rotary

Drill Date: November 23, 2005

Hole Size: 6"

Datum: Top of Casing Elevation - 126.991 masl

WESA
A Better Environment For Business

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Dilling Ltd.
Drill Method: Cable Tool / Air Rotary

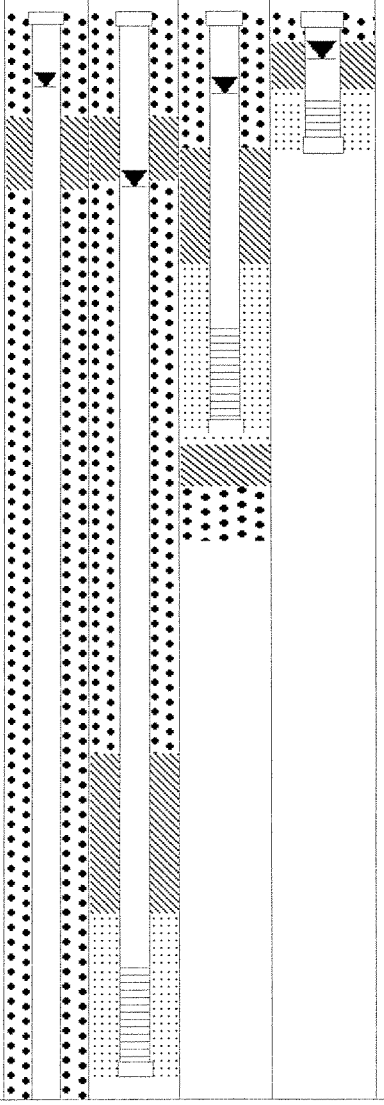
Well ID: M58

Enclosure:
Field Personnel: BA / ES

SUBSURFACE PROFILE

Depth	Description	Elevation (m)	Fractures
0	Ground Surface	125.34	
1	***CLAY*** brown		
2	***CLAY TILL*** brown, with sand and gravel	123	
3		122	
4	***SAND AND GRAVEL*** brown	121	x
5	***LIMESTONE*** grey	120	x
6		119	
7		118	
8		117	x
9		116	x
10		115	x
11		114	x
12		113	
13		112	
14		111	
15		110	
16		109	
17		108	
18		107	
19		106	
20		105	x
21		104	
22		103	
23		102	
24		101	
25		100	
26		99	
27		98	
28		97	x
29		96	
30		95	

Well Construction: 1, 2, 3, 4



Comments

elev. TOC/ground (m):
M58-1 126.05/125.34
M58-2 125.96/125.30
M58-3 125.96/125.32
M58-4 125.91/125.46

Hole Size: 15.9 cm diameter

Datum: 125.34 m (at M58-1)

Drill Date: March 17-18, 1998

Sheet: 1 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Dilling Ltd.
Drill Method: Cable Tool / Air Rotary

Well ID: M58

Enclosure:

Field Personnel: BA / ES

SUBSURFACE PROFILE					Well Construction				Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	3	4	
31		*LIMESTONE* grey	94						
32			93						
33			92						
34			91						
35			90						
36			89						
37			88						
38			87						
39			86						
40			85	x					
41			84						
42			83						
43			82						
44			81						blue-green colour from 44.5 to 45.7 m
45			80	x					
46			79						
47			78	x					
48			77						
49			76						
50			75						
51			74						
52			73						
53			72						
54			71						
55			70						
56			69						
57			68						
58			67						blue-green colour from 58.2 to 59.4 m
59			66						
60		*EOH at 60.96 m depth*	65						
61			64						

Hole Size: 15.9 cm diameter

Datum: 125.34 m (at M58-1)

Drill Date: March 17-18, 1998

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Dilling Ltd.
Drill Method: Cable Tool / Air Rotary

Well ID: M59

Enclosure:

Field Personnel: BA / ES

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	2	3	4	Comments
0		Ground Surface	124.62						elev. TOC/ground (m):
0		***CLAY***							M59-1 125.19/124.62
1		brown							M59-2 125.32/124.67
2		***LIMESTONE***	123						M59-3 125.32/124.69
3		grey	122						M59-4 125.16/124.63
4			121						
5			120						
6			119						
7			118						
8			117	x					
9			116						
10			115						
11			114						
12			113						
13			112						
14			111	x					
15			110						
16			109						
17			108	x					
18			107	x					
19			106						
20			105						
21			104	x					
22			103						
23			102	x					
24			101	x					
25			100						
26			99	x					
27			98						
28			97						
29			96						
30			95	x					
			94						

Hole Size: 15.9 cm diameter

Datum: 124.62 m (at M59-1)

Drill Date: March 18-19, 1998

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Dilling Ltd.
Drill Method: Cable Tool / Air Rotary

Well ID: M59

Enclosure:

Field Personnel: BA / ES

SUBSURFACE PROFILE					Well Construction				Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	3	4	
31		*LIMESTONE* grey	93						
32			92						
33			91	x					
34			90						
35			89						
36			88						
37			87						
38			86						
39			85	x					
40			84	x					
41			83						
42			82						
43			81						
44			80						blue-green colour from 44.5 to 45.7 m
45			79						
46			78						
47			77						
48			76						
49			75						
50			74						
51			73						
52			72						
53			71						
54			70						
55			69						
56			68						
57			67	x					
58			66						
59			65						
60		*EOH at 60.96 m depth*	64						
61									

Hole Size: 15.9 cm diameter

Datum: 124.62 m (at M59-1)

Drill Date: March 18-19, 1998

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Inc.
Location: Napanee, Ontario

Drilled By: Downing Drilling/Chalk Drilling
Drill Method: LF70 Core Drill, Air Rotary

Well ID: M60

Enclosure:

Field Personnel: BA

Depth	Symbol	Description	Elevation (m)	Well Construction 1	2	3	4	Rock Quality Designation % 20 60	Fracture Frequency (/m)	Comments
0		Ground Surface	124.71							elev. TOC/ground (m): M60-1 125.33/124.71 M60-2 126.30/125.80 M60-3 126.38/125.86 M60-4 126.67125.87
1		***CLAY*** brown								
2		***CLAY TILL*** brown, some sand present								
3		***LIMESTONE*** medium to dark grey, fine to medium grained limestone interbedded with fine to medium grained calcarenite, occasional brachiopods and crinoids (Lower Bobcaygeon Formation)	123						11.4	
4			122							
5			121						5.1	PACKER TEST: 25 psi for 1 hour depth: 6.6-9.2 m avg. 0.025 gal/min range 0.018-0.035
6			120							
7			119							
8			118						6.6	
9			117							
10			116							
11			115							
12			114						4.9	
13			113							
14		***LIMESTONE*** medium to dark brown lithographic to sub-lithographic limestone, minor amounts of argillaceous, bioclastic, calcarenitic and oolitic limestone present (Gull River Formation, Upper Member)	112						6.1	PACKER TEST: 25 psi for 1 hour depth 14.5-17.2 m no flow
15			111							
16			110							
17			109						5.7	
18			108							
19			107							
20			106						4.5	
21			105							
22			104						4.5	
23			103							
24			102							Note: bedrock elev. at M60-2, 60-3, 60-4 is 122.64 m (3.2 m below surface)
25			101						1.9	
26			100							
27			99							
28			98						2.1	
29			97							
30			96						2.3	
			95							
			94							

Hole Size: 15.9 cm diameter

Datum: 124.71 m (at M60-1)

Drill Date: 98/03/13,16-17

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Inc.
Location: Napanee, Ontario

Drilled By: Downing Drilling/Chalk Drilling
Drill Method: LF70 Core Drill, Air Rotary

Well ID: M60

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE				Well Construction				Rock Quality Designation	Fracture Frequency (/m)	Comments
Depth	Symbol	Description	Elevation (m)	1	2	3	4	% 20 60		
31			93						3.4	PACKER TEST: 18.5 psi for 1 hour depth 30.9-33.5 m avg. 6.2 gal/min range 5.3-7.7 g/min
32			92							
33			91						3.4	
34			90							
35			89							
36			88						3.0	
37			87							
38			86						2.7	
39			85							
40			84							
41			83						3.8	
42			82							
43			81							
44		***LIMESTONE*** interbedded pale green to buff finely crystalline dolomitic limestone and medium to dark brown lithographic limestone (Gull River Formation, Middle Member)	80						2.7	
45			79							
46			78							
47			77						1.9	
48			76							
49			75							
50			74						0.8	
51			73							
52		***EOH at 52.3 m depth***	72						2.3	
53		End of Borehole	71							
54			70							
55			69							
56			68							
57			67							
58			66							
59			65							
60			64							
61										

Hole Size: 15.9 cm diameter

Datum: 124.71 m (at M60-1)

Drill Date: 98/03/13,16-17

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Cable Tool

Well ID: M63

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE					Well Construction	Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1 2	
0		Ground Surface	121.71			elev. TOC: 122.61 m Note: water level in M63-1 is 0.25 m above ground surface
1		***CLAY*** brown				
2		***LIMESTONE*** grey	120			
3			119	x		
4			118			
5			117			
6			116	x		
7			115			
8			114			
9			113			
10			112	x		
11			111			
12			110			
13			109			
14			108			
15			107			
16			106			
17			105			
18			104			
19			103			
20			102			
21			101			
22			100			
23			99	x		H2S gas encountered at 22.6 m depth
24			98			
25			97			
26			96			
27			95			
28			94			
29			93			
30			92			
			91			

Hole Size: 15.9 cm diameter

Datum: 121.71 m

Drill Date: April 2, 1998

Sheet: 1 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Cable Tool

Well ID: M63

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE					Well Construction		Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	
31			90				
32			89				
33			88				
34			87				
35			86				
36		*EOH at 36.5 m depth*	85				
37		End of Borehole	84				
38			83				
39			82				
40			81				
41			80				
42			79				
43			78				
44			77				
45			76				
46			75				
47			74				
48			73				
49			72				
50			71				
51			70				
52			69				
53			68				
54			67				
55			66				
56			65				
57			64				
58			63				
59			62				
60			61				
61							

Hole Size: 15.9 cm diameter

Datum: 121.71 m

Drill Date: April 2, 1998

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary

Well ID: M64

Enclosure:
Field Personnel: BA

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	Well Construction 2	Comments
0		Ground Surface	120.95				elev. TOC: 121.56 m
1		***CLAY*** brown					
2		***CLAY TILL*** brown, with sand and gravel	119				
3			118	x			
4		***LIMESTONE*** grey	117				
5			116	x			
6			115				
7			114				
8			113				
9			112				
10			111				
11			110	x			
12			109				
13			108				
14			107				
15			106				
16			105				
17			104	x			
18			103				
19			102				
20			101				
21			100				
22			99				
23			98	x			
24			97				
25			96				
26			95				
27			94				
28			93				
29			92				
30			91				
			90				

Hole Size: 15.9 cm diameter

Datum: 120.95 m

Drill Date: April 7, 1998

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary

Well ID: M64

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE					Well Construction		Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	
31			89				
32			88	x			
33			87				
34			86				
35			85				
36		*EOH at 36.5 m depth*	84				
37		End of Borehole	83				
38			82				
39			81				
40			80				
41			79				
42			78				
43			77				
44			76				
45			75				
46			74				
47			73				
48			72				
49			71				
50			70				
51			69				
52			68				
53			67				
54			66				
55			65				
56			64				
57			63				
58			62				
59			61				
60			60				
61							

Hole Size: 15.9 cm diameter

Datum: 120.95 m

Drill Date: April 7, 1998

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Cable Tool

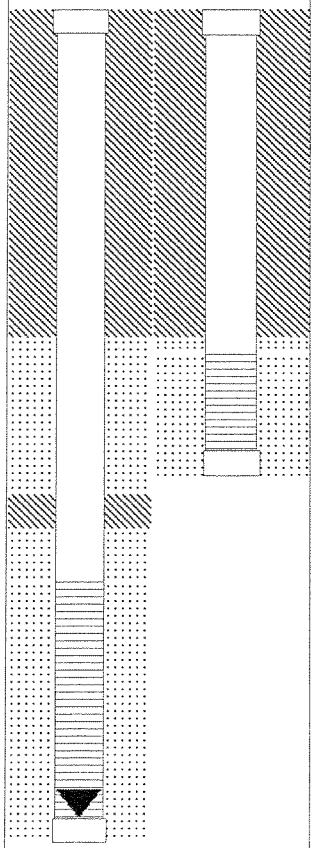
Well ID: M65

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	Well Construction 2	Comments
0		Ground Surface	123.83				elev. TOC: 124.28 m
		CLAY brown					
1			123				
		LIMESTONE grey	122				
2							
			121				
3							
			120				
4		***EOH at 4.8 m depth***					
			119				
5		End of Borehole					
			118				
6							



Hole Size: 15.9 cm diameter

Datum: 123.83 m

Drill Date: May 29, 1998

Sheet: 1 of 1

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Cable Tool

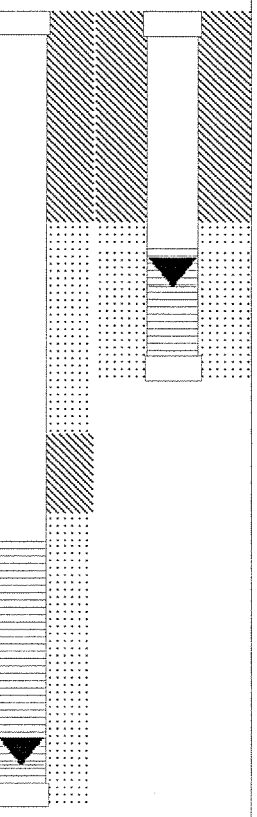
Well ID: M66

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	Well Construction 2	Comments
0		Ground Surface	123.54				elev. TOC: 124.40 m
		CLAY brown					
1			123				
		LIMESTONE grey	122				
2							
			121				
3							
			120				
4		***EOH at 4.5 m depth***					
		End of Borehole	119				
5							
			118				
6							



Hole Size: 15.9 cm diameter

Datum: 123.54 m

Drill Date: May 29, 1998

Sheet: 1 of 1

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Cable Tool

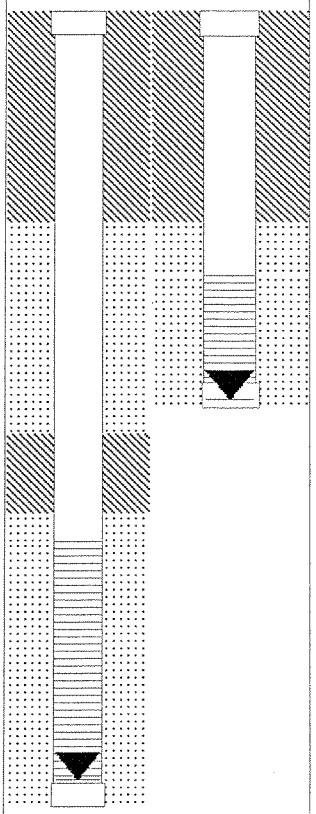
Well ID: M67

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	Well Construction 2	Comments
0		Ground Surface	123.11				elev. TOC: 123.75 m
0		***CLAY*** brown					
1			122				
1		***LIMESTONE*** grey					
2			121				
3			120				
4			119				
4		***EOH at 4.5 m depth***					
		End of Borehole					
5			118				
6			117				



Hole Size: 15.9 cm diameter

Datum: 123.11 m

Drill Date: June 1, 1998

Sheet: 1 of 1

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary

Well ID: M68

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE

Depth	Description	Elevation (m)	Fractures	Well Construction 1	2	3	4	Comments
0	Ground Surface	124.29						elev. TOC/ground (m):
0	*TOPSOIL*							M68-1 124.91/124.29
1	*CLAY TILL* greyish brown, trace of sand and gravel							M68-2 124.92/124.39
2		122						M68-3 124.93/124.41
3		121						M68-4 125.13/124.43
4	*SAND TILL* silty, light brown, some gravel and boulders present	120						
5		119	x					
6	*LIMESTONE* grey	118						
7		117	x					
8		116	x					
9		115						
10		114	x					
11		113						
12		112						
13		111	x					
14		110						H2S gas present
15		109	x					at 14.6 m
16		108						
17		107						
18		106						
19		105						
20		104						
21		103						
22		102	x					
23		101	x					
24		100						
25		99						
26		98	x					
27		97						
28		96						
29		95						
30		94						

Hole Size: 15.9 cm diameter

Datum: 124.29 m (at M68-1)

Drill Date: June 2-3, 1998

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary

Well ID: M68

Enclosure:

Field Personnel: BA

SUBSURFACE PROFILE					Well Construction				Comments
Depth	Symbol	Description	Elevation (m)	Fractures	1	2	3	4	
31		***LIMESTONE*** grey	93						
32			92	x					
33			91						
34			90	x					
35			89	x					
36			88						
37			87						
38			86	x					
39			85						
40			84	x					
41			83						
42			82						
43			81						
44			80						blue-green colour from 44.5 to 44.8 m
45			79	x					
46			78						
47			77						
48			76						
49			75	x					
50			74						
51			73						
52			72						
53			71						
54			70						
55			69						
56			68	x					
57			67						blue-green colour from 56.4 to 59.7 m
58			66						
59			65						
60		***EOH at 60.96 m depth***	64						
61			63						

Hole Size: 15.9 cm diameter

Datum: 124.29 m (at M68-1)

Drill Date: June 2-3, 1998

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754
Project: Richmond Landfill Expansion
Client: Canadian Waste Services Ltd.
Location: Napanee, Ontario

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary

Well ID: M70

Enclosure:

Field Personnel: BA/BM

Depth	Symbol	Description	Elevation (m)	Fractures	Well Construction 1	Well Construction 2	Well Construction 3	Comments
0		Ground Surface	127.2					elev. TOC/ground (m):
1		***CLAY*** brown						M70-1 127.60/127.20
2		***CLAY TILL***	125					M70-2 127.52/127.05
3		brown, with sand and gravel	124	x				M70-3 127.87/127.12
4		***LIMESTONE*** grey	123					
5			122					
6			121					
7			120	x				
8			119					
9			118	x				
10			117	x				
11			116					
12			115	x				
13			114	x				
14			113					
15			112					
16			111					
17			110					
18			109					
19			108	x				
20			107					
21			106					
22			105	x				
23			104					
24			103					
25			102	x				
26			101					
27			100					
28			99					
29			98	x				
30		***EOH at 30.9 m depth***	97					
31			96					

Hole Size: 15.9 cm diameter

Datum: 127.20 m (at M70-1)

Drill Date: June 29, 1998

Sheet: 1 of 1

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M72 Angle Hole

File: cwsm72d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
			129.21					
0		Ground Surface						
0			128				S/U 0.83m	
1			127				50mm PVC riser and 20 slot screen	
2			126					
3		***Clay Till*** brown, with sand and gravel, boulders and cobbles present.	125					
4			124					
5			123				HQ casing grouted in bedrock	
6			122					
7			121			4	23'4" weathered shale	
8						4		
9			120			9		
10			119			6	31'2" weathered fract. 32'6"-36'6" Highly fractured	2.E-09
11			118			6	34'6" vert. fract.	
12		***Limestone*** Light grey lithographic fossiliferous limestone with undulatory shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.	117			4	38'4"-40'9" fract.	3.E-11
13			116			5		
14			115			4		
15			114			3		5.E-11
16			113			0		
17			112			4		
18			111			3		1.E-10
19			110			2		
			109			3		

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 14, 15/2000

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M72 Angle Hole

File: cwsm72d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
19							64'2" fracture	
20			108			4		1.E-05
21			107			5		
22			106			1		4.E-07
23			105			2		
24		***Limestone*** *Light grey lithographic fossiliferrous limestone with undulating shale partings. Styolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.*	104			2		
25			103			1		3.E-11
26			102			4		
27			101			2		
28			100			3		2.E-06
29			99			3		
30			98			0		
31		End of Borehole	97					
32			96					
33			95					
34			94					
35			93					
36			92					
37			91					
38			90					
39								

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 14, 15/2000

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M74 Angle Hole

File: cwsm74d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
			126.02					
0		Ground Surface					S/U 0.98m	
1		***Clay Till*** brown, with sand and gravel, boulders and cobbles present.	124				50mm PVC riser and 20 slot screen	
2			123				*HQ casing grouted* in bedrock	
3			122			5	11'8"-19'6" highly fractured	
4			121			3		
5			120			6		5.E-09
6			119			2		
7			118			3		6.E-07
8			117			3		
9			116			1	27'8" clay lense 1" thick	
10		***Limestone*** Light grey lithographic fossiliferous limestone with undulatory shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.	115			1		7.E-07
11			114			1		
12			113			3		
13			112			0	38'6" vert. frac.	3.E-09
14			111			1		
15			110			1		
16			109			2		6.E-11
17			108			0		
18			107			2		
19			106			2	58'3" calcite filled vug	6.E-11
						0		

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 19, 2000

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M74 Angle Hole

File: *cwsm74d.log*
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
19						0		
20			105			1		6.E-11
21			104			1		
22			103			0		
23			102			0		3.E-09
24		***Limestone*** Light grey lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.	101			0		
25			100			0		
26			99			1	84'1" calcite filled vug	6.E-11
27			98			1	87'4" pyrite filled vug	
28			97			0		
29			96			0		8.E-11
30			95			1		
31		End of Borehole	94			0		
32			93					
33			92					
34			91					
35			90					
36			89					
37			88					
38			87					
			86					

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 19, 2000

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M75 Angle Hole

File: cwsm75d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
			124.39					
0		Ground Surface					S/U 0.82	
1		***Clay Till*** brown, with sand and gravel, boulders and cobbles present.	123				HQ casing grouted in bedrock	
2			122			3		
3			121			3	50mm PVC riser and 20 slot screen	
4			120			3	1'8" weathered shale frac	7.E-08
5			119			3		5.E-09
6			118			4		
7			117			4		
8			116			4	22'6" clay lense	4.E-07
9		***Limestone*** Light grey lithographic fossiliferous limestone with undulatory shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.	115			5		
10			114			6	28'7" 2nd. mineralization	
11			113			3		2.E-09
12			112			1		
13			111			2		3.E-11
14			110			1		
15			109			2		
16			108			2		3.E-11
17			107			3		
18			106			4		
19			105			4		4.E-11
						2		
						1		
						0		

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 20, 21/2000

Sheet: 1 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M75 Angle Hole

File: cwsm75d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
19			104			4		2.E-10
20			103			3	68'5" weathered frac.	
21			102			1		
22			101			2		5.E-11
23			100			2		
24		***Limestone*** Light grey lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.	99			1		
25			98			0		1.E-09
26			97			1		
27			96			1		
28			95			0		7.E-11
29			94			0		
30			93			3		
31		End of Borehole	92					
32			91					
33			90					
34			89					
35			88					
36			87					
37			86					
38			85					
39								

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 20, 21/2000

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M77 Angle Hole

File: cwsm77d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
-1			129.32				S/U 1.05m	
0		Ground Surface						
1			128					
2		***Sand Till***	127				HQ casing grouted in bedrock	
3		brown, with silt and gravel, boulder and cobbles present.	126					
4			125					
5			124				50mm PVC *riser and 20 slot screen*	
6			123			5	16'5"-23'10" highly frac.	
7			122			5		2.E-07
8			121			3		6.E-08
9			120			2		
10			119			2	26'10" weathered shale	
11		***Limestone***	118			2		3.E-09
12		Light grey lithographic fossiliferous limestone with undulatory shale partings.	117			5		
13		Stylolites are common. Numerous calcite stringers throughout.	116			1		
14		Occasional coarse crystalline zones approximately 6" thick.	115			0		
15			114			3		5.E-08
16			113			2	41'6" weathered 2nd. mineralization	5.E-08*
17			112			2		
18			111			0		3.E-11
19			110			0		
						2		3.E-11
						1	60'10" fracture	

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 22, 2000

Sheet: 1 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: A754-2-29
Project: Angle Wells Installations
Client: Canadian Waste Systems
Location: Richmond Landfill, Napanee, Ont.

Drilled By: Downing Drilling
Drill Method: Diamond Drilling

Well ID: M77 Angle Hole

File: cwsm77d.log
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency (per meter)	Comments	K (m/sec)
19			109			1	64'1" frac. 2nd. mineral.	
20			108			2		1.E-07
21			107			0		
22			106			1		
23			105			1		3.E-11
24		***Limestone*** Light grey lithographic fossiliferous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones approximately 6" thick.	104			3		
25			103			1		3.E-11
26			102			2		
27			101			2	87'3" clay lense 2" thick, stiff, moist	
28			100			1		
29			99			0		9.E-09
30			98			1		
31		End of Borehole	97			0		
32			96					
33			95					
34			94					
35			93					
36			92					
37			91					
38			90				* Duplicate test	

Hole Size: HQ 3.75" (95mm) OD

Datum: Geodetic

Drill Date: June 22, 2000

Sheet: 2 of 2

W.E.S.A.
WATER & EARTH SCIENCE ASSOCIATES LTD.

Project No: C-B3618-00

Project: 2004 Drilling Program

Client: Waste Management

Location: Richmond Landfill

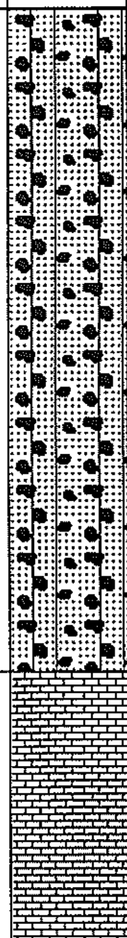
Well ID: M80-2

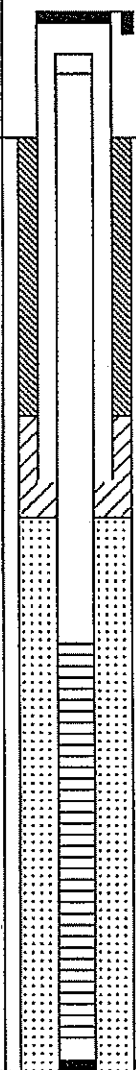
Log File: B3618-M80-2
Tem. File: WESA-Bedrock

Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
ft / m: -3, -1	123.3	Ground Surface				
1, 3, 5, 7 (2 m), 9, 11, 13 (4 m), 15	118.6	***OVERBURDEN*** Brown and Grey Clay Till				6" Steel protective casing with locking cap; Quick Grout Bentonite Seal inside and outside casing to surface; 3/8" Bentonite Holeplug; 2" Schedule 40 PVC risor pipe; 10' Scedule 40 Slot 10 PVC Screen
17, 19 (6 m), 21	116.7	***LIMESTONE BEDROCK*** Grey Limestone				#3 Silica Sand Filter pack
23		End of Borehole				





Drilled By: Chalk Well Drilling

Drill Method: Air Rotary

Drill Date: October 6, 2004

Hole Size: 6"

Datum: Elevation TOC - 124.260

Sheet: 1 of 1

Project No: C-B3618-00

Project: 2004 Drilling Program

Client: Waste Management

Location: Richmond Landfill

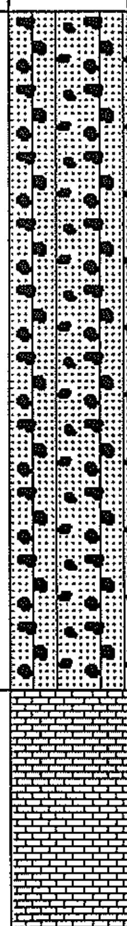
Well ID: M81

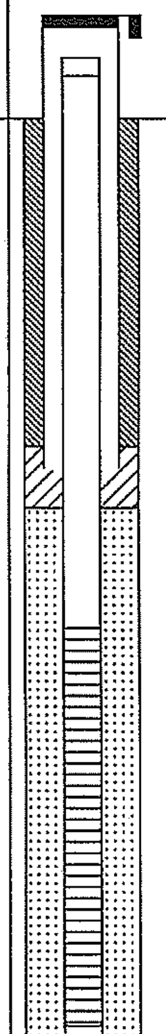
Log File: B3618-M81
Tem. File: WESA-Bedrock

Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
	125.0	Ground Surface				
		OVERBURDEN Brown and Grey Clay Till				
	120.0	***LIMESTONE BEDROCK*** Grey Limestone				
	118.2	End of Borehole				





Comments:

6" Steel protective casing with locking cap

Quick Grout Bentonite Seal inside and outside casing to surface

2" Schedule 40 PVC risor pipe

3/8" Bentonite Holeplug

10' Scedule 40 Slot 10 PVC Screen

#3 Silica Sand Filter pack

Drilled By: Chalk Well Drilling

Drill Method: Air Rotary

Drill Date: October 6, 2004

Hole Size: 6"

Datum: TOC Elevation - 125.792

Sheet: 1 of 1

Project No: C-B3618-00

Project: 2004 Drilling Program

Client: Waste Management

Location: Richmond Landfill

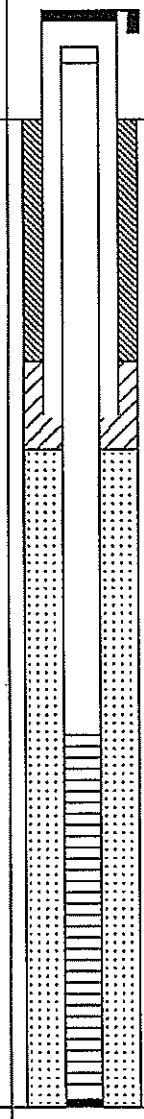
Well ID: M82-2

Log File: B3618-M82-2
Tem. File: WESA-Bedrock

Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
ft / m: -3 / -1	122.3	Ground Surface				
1		***OVERBURDEN*** Brown Clay				6" Steel protective casing with locking cap
3	121.1					Quick Grout Bentonite Seal inside and outside casing to surface
5		***LIMESTONE BEDROCK*** Grey Limestone				
7 / 2						3/8" Bentonite Holeplug
9						2" Schedule 40 PVC risor pipe
11						
13 / 4						
15						10' Scedule 40 Slot 10 PVC Screen
17	117.1	-water bearing fracture				#3 Silica Sand Filter pack
19 / 6						
21						
23	115.0					
25		-water bearing fracture				
8	114.2					
27		End of Borehole				



Drilled By: Chalk Well Drilling

Drill Method: Air Rotary

Drill Date: October 7, 2004

Hole Size: 6"

Datum: Elevation TOC - 123.100

Project No: K-A756

Project: Drilling Program

Client: Waste Management

Location: Richmond Landfill

Well ID: M86

Log File: M86
Tem. File: WESA-Bedrock

Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
ft / m: -3 / -1	123.2	Ground Surface				
1		***OVERBURDEN*** Brown Clay				Portland Cement with bentonite at surface and inside casing
	122.5					
3		***LIMESTONE BEDROCK*** Grey Limestone				3/8" Bentonite Holeplug
5						Schedule 40 PVC risor pipe
7 / 2						5' of schedule 40 Slot 10 PVC screen
9						#3 Silica sand filterpack
11	119.3					
13 / 4		End of Borehole				

Drilled By: Chalk Well Drilling

Drill Method: Air Rotary

Drill Date: October 8, 2004

Hole Size: 6"

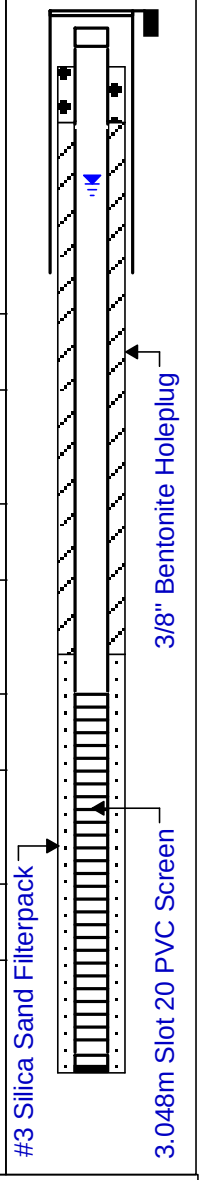
Datum: Elevation TOC - 124.024

Log of Borehole: M87-2

WESA
A Better Environment For Business

Project No.: A756-8
Project: Empey Hill Drilling
Client: WM - Richmond
Location: Richmond Landfill
Enclosure: W/L 2.36 m TPVC
Logged By: B.M.

SUBSURFACE PROFILE				SAMPLE				
Depth (ft / m)	Symbol	Description	Elevation (m)	Number	Type	Recovery	N-Value	Monitor Details
		Ground Surface	125.25					
0 – 1		Grassy surface underlain by Brown TOPSOIL and Silty TILL with gravel. (auger observation)	123.73					
1 – 2		Brown Silty TILL with small gravel. Tight, Dry.	122.20	1		8	25	
2 – 3		Brown Silty TILL with small gravel. Trace sand. Possibly trace clay. Tight, Dry.	120.68	2		20	63	
3 – 4		Brownish Grey Silty Clay TILL with gravel. Trace sand. Bottom 2" brownish grey Sandy TILL. Tight, Dry.	119.15	3		20	52	
5 – 6		Grey Silty CLAY with trace fine sand. Trace small gravel upper 2". Tight, Moist.	118.54	4		6	50	
6 – 7		Auger Sample Grey Silty CLAY with sand and trace gravel. Wet, Sticky.	117.63					
7 – 8		**Auger Refusal on Bedrock at 7.62m**						



Drilled By: CME 75 Track
Drill Method: Hollow Stem Auger
Drill Date: June 9, 2005

Hole Size: 8"
Datum: TOC Elevation 1126.207 masl
Northing: 4902490
Easting: 334966

Sheet: 1 of 1

Project No: K-A756-5

Project: 2006 Angle Well Installations

Client: Waste Management

Location: Napanee, Ontario

Well ID: M91-1 Angle Hole

Easting: 4902730
Northing: 334798
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth* (ft / m)	Stratigraphy	Description	Elev.* (masl)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
0 / 0		Ground Surface	129.80					
		Silty Sand Till Light brown, silty sand Till, encountering boulders at 6.5m.					M91-1 elev. 130.40m TPVC steel protective casing with locking cap 50mm PVC riser within bentonite grout seal	
27 / 8			121.45					
		Limestone Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones.				7	bottom of HW casing	1.4E-06
33 / 10								

Drilled By: Downing Drilling
Drill Method: Diamond Drill
Hole Size: HW(4.5")/HQ3(3.78")
Drill Date: Sept. 25,26, 2006

Drill Angle: 60 degrees from horiz.
Azimuth: 344 degrees clockwise from north
Datum: m.a.s.l.
Checked By: FAR

* Depth and Elevation corrected to vertical

WESA
A Better Environment For Business

Project No: K-A756-5

Project: 2006 Angle Well Installations

Client: Waste Management

Location: Napanee, Ontario

Well ID: M91-1 Angle Hole

Easting: 4902730
Northing: 334798
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth*	Stratigraphy	Description	Elev.* (masl)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency/Run	Comments	K (m/sec)
34		- 10.3m (33.8') weathered fracture	119.50			4		
35								
36	11							1.0E-11
37								
38						4		
39			117.79					
40	12	-12m (39.4') clay seam						
41								
42						5		
43	13							2.03E-08
44								
45								
46	14	-14m (46') fracture	115.78			5		
47								
48		-14.6m (48') fracture	115.17					
49	15							
50								
51						1		
52	16							1.0E-11
53								
54		-16.5m (54') wide fracture	113.34					
55						3		
56	17							
57								
58								
59	18					4		
60								1.0E-11
61								
62	19						#1 silica sand	
63								
64						2		
65								
66	20							
67		-20.3m (66.7') weathered fracture	109.47					
68						4		1.0E-07

Drilled By: Downing Drilling
Drill Method: Diamond Drill
Hole Size: HW(4.5")/HQ3(3.78")
Drill Date: Sept. 25,26, 2006

Drill Angle: 60 degrees from horiz.
Azimuth: 344 degrees clockwise from north
Datum: m.a.s.l.
Checked By: FAR

WESA
A Better Environment For Business

* Depth and Elevation corrected to vertical

Project No: K-A756-5

Project: 2006 Angle Well Installations

Client: Waste Management

Location: Napanee, Ontario

Well ID: M91-1 Angle Hole

Easting: 4902730
Northing: 334798
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth*	Stratigraphy	Description	Elev.* (masl)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency/Run	Comments	K (m/sec)
69–103							50mm slot 20 PVC screen within a #3 silica sand pack	
21–22						5		
22–23						1	#1 silica sand	1.0E-11
23–25						3		
25–26		-25.4-26.7m (83-87.5') fracture, vertical fracture	103.89			6		4.0E-09
26–27						2	20% solids bentonite grout	
27–28		-27.4m (90') weathered fracture	102.37			3		1.0E-11
28–30						3		
30–31			99.16					
31		End of Borehole						

Drilled By: Downing Drilling
Drill Method: Diamond Drill
Hole Size: HW(4.5")/HQ3(3.78")
Drill Date: Sept. 25,26, 2006

Drill Angle: 60 degrees from horiz.
Azimuth: 344 degrees clockwise from north
Datum: m.a.s.l.
Checked By: FAR

* Depth and Elevation corrected to vertical

WESA
A Better Environment For Business

Project No: K-A756-5

Project: 2006 Vertical Well Installations

Client: Waste Management

Location: Napanee, ON

Well ID: M94-2

Easting: 4903527
Northing: 335486

Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (m)	Elevation (m)	Description	Stratigraphy	Fractures	Well	Comments
ft / m						
-2 / 0	124.31	Ground Surface				
0 – 2 – 4 – 6 / 2	122.18	***Silty Sand Till*** Light brown, silty sand Till, encountering boulders at 6.5m.				15cm protective steel casing casing s/u 0.74m M94-2 elev. 125.05m TOC bentonite gravel seal
8 – 10 – 12 – 14 – 16 – 18 – 20 / 4 – 6	117.91	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale parting.				50mm slot 20 PVC screen within #3 silica sand pack
22		End of Borehole				

Drilled By: MPI Drilling Ltd.
Drill Method: Air Hammer
Drill Date: Oct.24, 2006
Hole Size: 10cm/4"

Datum: m.a.s.l.
Checked by: FAR

Project No: K-A756-5

Project: 2006 Angle Well Installations

Client: Waste Management

Location: Napanee, Ontario

Well ID: M95-1 Angle Hole

Easting: 4902910
Northing: 334742
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth* (ft / m)	Stratigraphy	Description	Elev.* (masl)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
0 / 0		Ground Surface	123.42					
0–4 / 0–1		***Silty Sand Till*** Light brown, silty sand Till, with cobbles and boulders.	122.11				M95-1 elev. 124.13m TOC steel protective casing with locking cap	
4–13 / 1–4		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occasional coarse crystalline zones. -1.1-2.9m(5.2-9.5') highly fractured	120.07				- 1.6m bottom of HW casing	
13–16 / 4–5		-3.4-4.9m(11.2-16') highly fractured	119.21					6.0E09
16–20 / 5–6								2.0E-08
20–27 / 6–8							50mm PVC riser within bentonite grout seal	3.0E-07
27–32 / 8–9								

Rock Quality Designation: % (20, 60)

Fracture Frequency/Run: 4, 12, 8, 6, 3, 2, 4

Drilled By: Downing Drilling
Drill Method: Diamond Drill
Hole Size: HW(4.5")/HQ3(3.78")
Drill Date: Oct.4,5, 2006

Drill Angle: 60 degrees from horiz.
Azimuth: 19 degrees clockwise from north
Datum: m.a.s.l.
Checked By: FAR

* Depth and Elevation corrected to vertical

WESA
A Better Environment For Business

Project No: K-A756-5

Project: 2006 Angle Well Installations

Client: Waste Management

Location: Napanee, Ontario

Well ID: M95-1 Angle Hole

Easting: 4902910
Northing: 334742
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth*	Stratigraphy	Description	Elev.* (masl)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency/Run	Comments	K (m/sec)
33 – 10						2		
34								
35								
36 – 11			112.23					4.0E-07
37		- 11.2m(36.7) vertical fracture				6		
38								
39 – 12								
40								
41								
42						3		
43 – 13							#1 silica sand	
44								5.0E-06
45								
46 – 14						4		
47								
48			108.48					
49 – 15		-14.9m (49') broken rock						
50								
51						6		
52			107.57					
53 – 16		-15.8m (52')fracture, lost water circulation for the remainder of hole.					50mm slot 20 PVC screen within a #3 silica sand pack	2.0E-05
54			106.78					
55		-16.6m (54.6') vertical fracture	106.41			7		
56 – 17		-17m (55.8') broken rock						
57								
58							#1 silica sand	
59 – 18						3		
60								2.0E-06
61								
62								
63 – 19						2		
64								
65								
66 – 20								
67								

Drilled By: Downing Drilling
Drill Method: Diamond Drill
Hole Size: HW(4.5")/HQ3(3.78")
Drill Date: Oct.4,5, 2006

Drill Angle: 60 degrees from horiz.
Azimuth: 19 degrees clockwise from north
Datum: m.a.s.l.
Checked By: FAR

* Depth and Elevation corrected to vertical

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Project No: K-A756-5

Project: 2006 Angle Well Installations

Client: Waste Management

Location: Napanee, Ontario

Well ID: M95-1 Angle Hole

Easting: 4902910
Northing: 334742
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth*	Stratigraphy	Description	Elev.* (masl)	Well Construction	Rock Quality Designation (%, 20 – 60)	Fracture Frequency/Run	Comments	K (m/sec)
68 – 69	21					5		3.0E-07
70 – 72	22					5		
73 – 76	23					3		6.0E-08
77 – 80	24						20% solids bentonite grout	
81	25					1		
82 – 85	26					1		5.0E-08
86 – 89	27					2		
90 – 93	28							1.0E-11
94	29					1		
95 – 98	30					3		
99 – 100			92.80					
101 – 102	31	End of Borehole						

Drilled By: Downing Drilling
Drill Method: Diamond Drill
Hole Size: HW(4.5")/HQ3(3.78")
Drill Date: Oct.4,5, 2006

Drill Angle: 60 degrees from horiz.
Azimuth: 19 degrees clockwise from north
Datum: m.a.s.l.
Checked By: FAR

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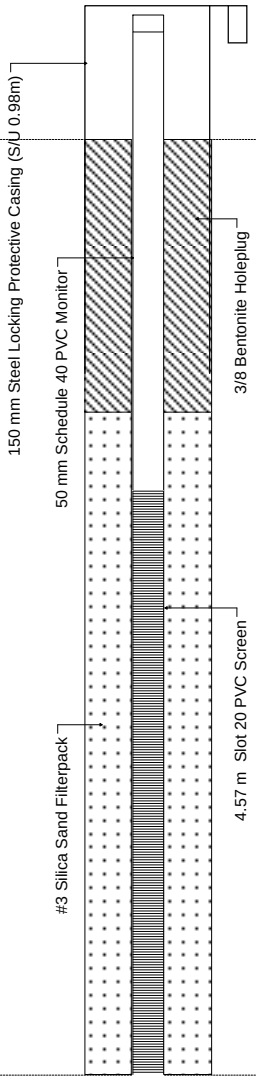
* Depth and Elevation corrected to vertical

Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M96

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario
Northing: 4903158
Easting: 335774
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Well Completion Details
-3		Ground Surface	129.609			
2		CLAY *TILL*				
7			126.256			
12		Sandy *CLAY*	125.403			
17 / 5		Limestone *BEDROCK*				
		Soft Zone (5.79 - 6.1 m)	123.818			
22			122.294			
		End of Borehole				



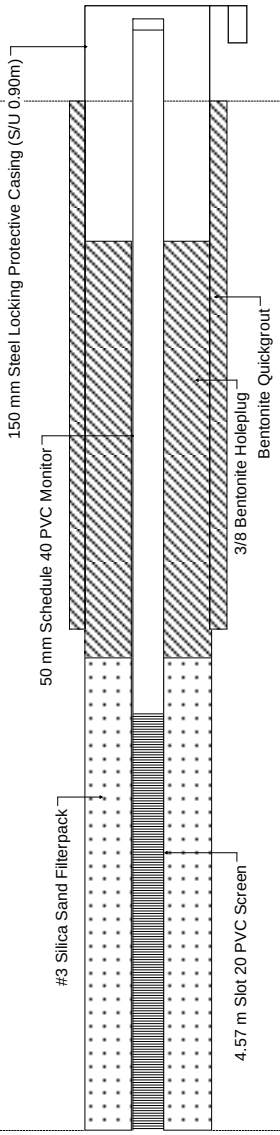
Drilled By: Chalk Well Drilling
Drill Method: 6" Air Hammer
Drill Date: May 26, 2008
Hole Size: 6"
Datum: Elevation TOC - 130.589
Template: Water Supply Well - Kingston
Sheet: 1 of 1

Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M97

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario
Northing: 4902551
Easting: 335059
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Well Completion Details
-3		Ground Surface	126.653			
2		Brown CLAY *TILL* Dry				
7						
12			122.691			
17 / 5		Grey CLAY *TILL* Saturated				
22						
27			118.423			
32 / 10		Limestone *BEDROCK*				
37			115.375			
		End of Borehole				



Drilled By: Chalk Well Drilling
Hole Size: 6"
Drill Method: 10" Tricone / 6" Air Hammer
Datum: Elevation TOC - 127.553
Drill Date: May 26, 2008
Template: Water Supply Well - Kingston
Sheet: 1 of 1

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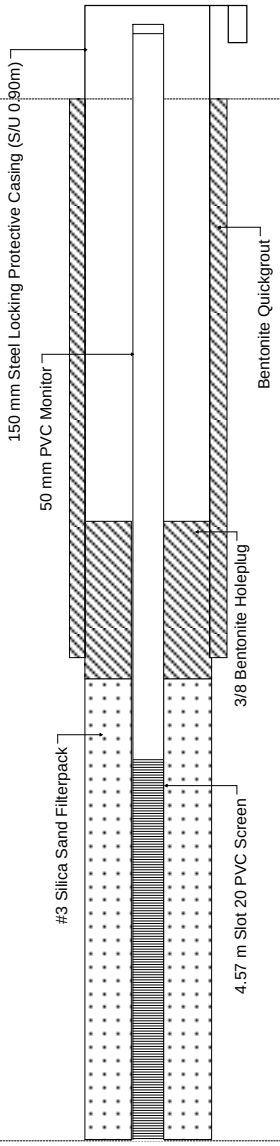
Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M98

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario

Northing: 4902730
Easting: 334976
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Well Completion Details
-4		Ground Surface	130.225			
1		Brown CLAY *TILL*				
			128.396			
6		Brown *SAND* and *GRAVEL*	128.091			
		Brown *CLAY TILL* with Boulders				
			126.872			
11 / 4		Grey *CLAY TILL* Saturated				
16						
21						
26 / 9						
			120.776			
31		Limestone *BEDROCK*				
36						
			117.728			
41		End of Borehole				



Drilled By: Chalk Well Drilling
Hole Size: 6"
Drill Method: 10" Tricone, 6" Air Hammer
Datum: Elevation TOC - 131.125
Drill Date: May 27, 2008
Template: Water Supply Well - Kingston
Sheet: 1 of 1

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Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

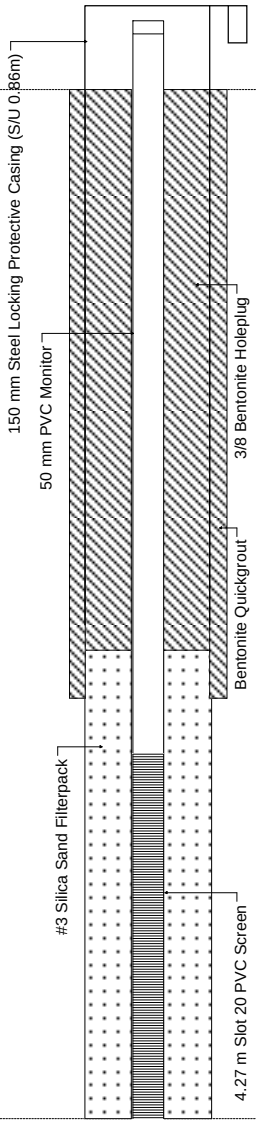
Well ID: M99-2

Project No.: KB5691-10 ***Northing:*** 4902646

Client: Waste Management - Richmond ***Easting:*** 334869

Location: Napanee, Ontario ***Project Manager:*** Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Well Completion Details
-3		Ground Surface	130.511			
2		*SAND and GRAVEL. Some Clay*				
27		Flowing *SAND*	122.281			
32 / 10		Limestone *BEDROCK. Soft*	120.757 120.453			
37		Limestone *BEDROCK*				
42		End of Borehole	117.618			



Drilled By: Chalk Well Drilling ***Hole Size:*** 6"

Drill Method: Cable Tool ***Datum:*** Elevation TOC - 131.371

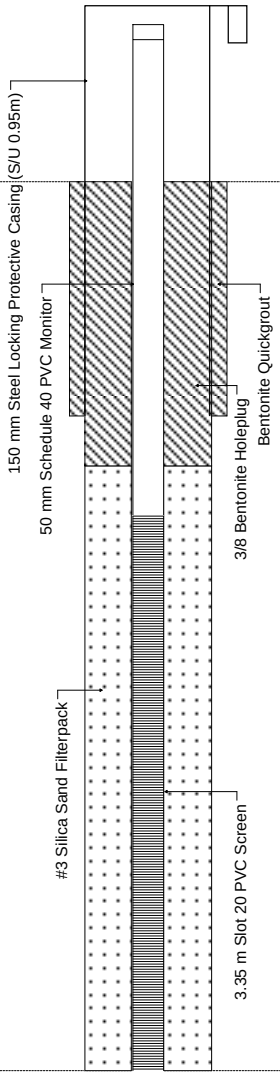
Drill Date: June 4, 2008 ***Template:*** Water Supply Well - Kingston ***Sheet:*** 1 of 1

Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M101

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario
Northing: 4903015
Easting: 334949
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Well Completion Details
-3		Ground Surface	124.351			
2		Brown *CLAY* Wet	122.827			
7		Brown *CLAY TILL* Wet	122.035			
12		Limestone *BEDROCK*	119.017			
17		End of Borehole				



Drilled By: Chalk Well Drilling
Drill Method: 6" Air Hammer
Drill Date: May 28, 2008
Hole Size: 6"
Datum: Elevation TOC - 125.301
Template: Water Supply Well - Kingston
Sheet: 1 of 1

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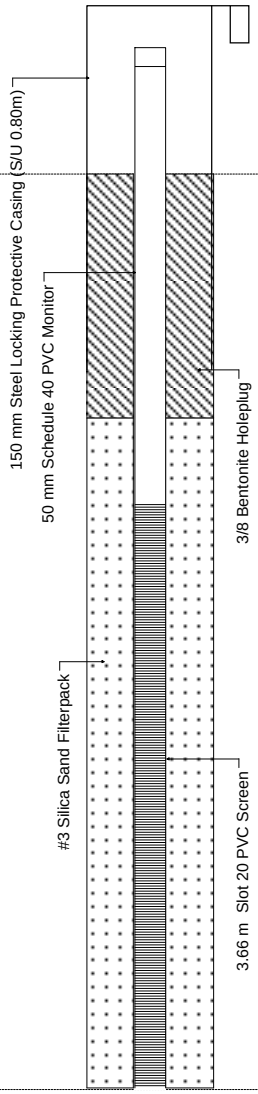
Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M102

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario

Northing: 4902919
Easting: 334836
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth	Symbol	Description	Elevation	Number	Type	Well Completion Details
ft / m						
-3		Ground Surface	124.715			
2		Brown *CLAY*	123.191			
7		Brown *CLAY TILL*	122.033			
12		Limestone *BEDROCK*	118.985			
17 / 5		End of Borehole				



Drilled By: Chalk Well Drilling
Drill Method: 6" Air Hammer
Drill Date: May 28, 2008

Hole Size: 6"
Datum: Elevation TOC - 125.515
Template: Water Supply Well - Kingston

Sheet: 1 of 1

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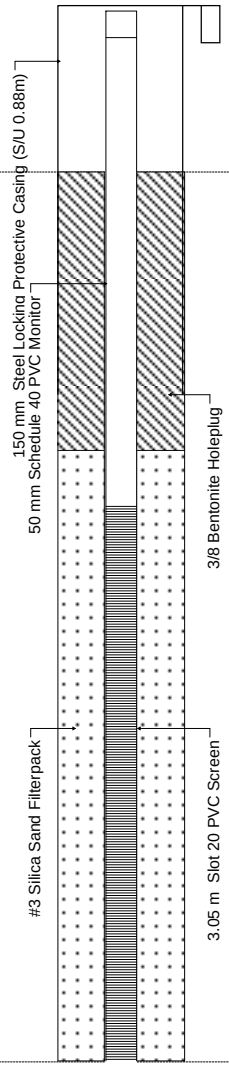
Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M103

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario

Northing: 4903101
Easting: 335021
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		Well Completion Details
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	
-3		Ground Surface	124.416			
2		Brown *CLAY TILL*				
7		Limestone *BEDROCK*	122.313			
12			119.539			
17 / 5		End of Borehole				



Drilled By: Chalk Well Drilling
Drill Method: 6" Air Hammer
Drill Date: June 17, 2008

Hole Size: 6"
Datum: Elevation TOC - 125.296
Template: Water Supply Well - Kingston

Sheet: 1 of 1

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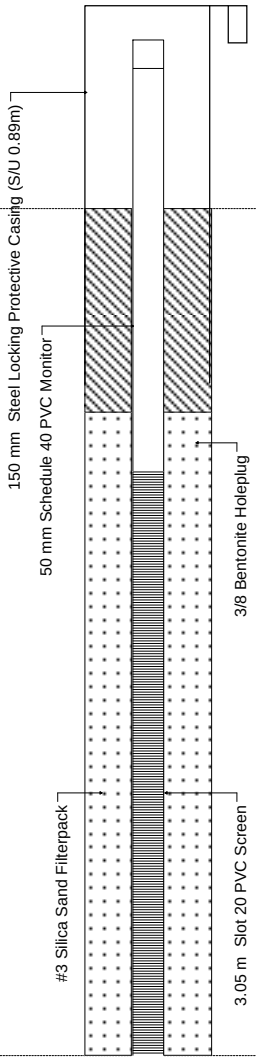
Water and Earth Sciences Associates Ltd.
The Woolen Mill, 4 Cataraqui Street
Kingston, Ontario, Canada K7K 1Z7

Well ID: M104

Project No.: KB5691-10
Client: Waste Management - Richmond
Location: Napanee, Ontario

Northing: 4903152
Easting: 335150
Project Manager: Phil Tibble

SUBSURFACE PROFILE				SAMPLE		
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Well Completion Details
-3		Ground Surface	123.572			
2		Brown *CLAY TILL*	122.048			
7		Limestone *BEDROCK*	119.152			
12		End of Borehole				
5						



Drilled By: Chalk Well Drilling
Drill Method: 6" Air Hammer
Drill Date: June 17, 2008

Hole Size: 6"
Datum: Elevation TOC - 124.462
Template: Water Supply Well - Kingston

Sheet: 1 of 1

Project No: K-B5691-11

Project: Spring 2009 Drilling Program

Client: Waste Management

Location: Richmond Landfill

Well ID: PW3/M105

Easting: 335620
Northing: 4902778
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-2 ft / m		Ground Surface	126.81				- PW3/M105 Elev. 127.48m TOC TOC s/u 0.67m	
0 – 2 ft		***Silty Sand Till*** Light brown, moist to wet, silty sand till with trace clay, cobbles and boulders.	126.00			2	Hollow stem augered to refusal 4'1""(1.24m) HW casing grouted into bedrock 5'3" (1.6m)	
2 – 4 ft			124.00			16	- clay seam 9'10" - 10' (2.99-3.05m)	1.0E-06
4 – 6 ft			122.00			9		4.7E-07
6 – 8 ft		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	120.00			9		4.4E-07
8 – 10 ft			118.00			7		
10 – 12 ft			116.00			7	- 33'3" (10.1m) weathered fracture	8.3E-06
12 – 14 ft			114.00			6	- 40' (12.2m) weathered shale fracture - 40'6" (12.34m) broken rock layer	
14 – 16 ft			112.00			4	- 47'7" (14.5m) weathered fracture	8.7E-09
16 – 18 ft						0		
18 – 20 ft						1		

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: March 30,31, 2009

Drill Angle: Vertical (90)
Azimuth: n.a.
Datum: NAD 83 Zone 18A
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B5691-11

Project: Spring 2009 Drilling Program

Client: Waste Management

Location: Richmond Landfill

Well ID: PW3/M105

Easting: 335620
Northing: 4902778
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
51							- Bentonite grout 20% solids	
53	16					0		
55			110.00					1.0E-05
57						0		
59	18							
61			108.00				3.05 (10') x 51mm dia. slot 10 PVC screen within #3 silica sand pack	6.0E-05
63						2		
65	20							
67			106.00					
69						1		1.6E-08
71		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.						
73	22					0		
75			104.00					3.6E-04
77								
79	24					3	- 78'2" (22m) weathered fracture	
81			102.00					
83						0		
85	26						- Bentonite gravel seal	
87								
89			100.00			1		3.8E-04
91	28							
93						2		
95			98.00					1.7E-07
97						0		
99	30	End of Borehole						

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: March 30,31, 2009

Drill Angle: Vertical (90)
Azimuth: n.a.
Datum: NAD 83 Zone 18A
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9132

Project: EMP Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M106

Easting: 335330
Northing: 4902550
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
0 / 0		Ground Surface	123.97				- Elev. M106 124.67m TOC - TOC s/u 0.70m	
0 / 0		***Fill*** Grey, moist, sand and gravel fill.	124.00					
4 / 1		***Silty Sand Till*** Light brown, moist to wet, silty sand till with a trace of clay, cobbles and boulders.	122.00				- Pressure grout mixture of cement and bentonite from 0-5 ft. (0-1.5m) - HW casing pressure grouted with cement 5 ft. - 15.83ft. (1.5-4.82m). - Hollow stem augered to refusal 14.5 ft. (4.42m).	
14 / 4			120.00					
16 / 5						3	- Set HW casing 1'4" into bedrock to a depth of 15.83' (4.82m).	
18 / 5						9	- 17'7" - 18'8"(17.58 - 18.66m) thin high angle fracture with secondary mineralization	4.32E-07
20 / 6			118.00					
24 / 7						7	- 23'4" (7.19m) weathered fracture.	1.30E-08
26 / 8			116.00					
28 / 9						2		
30 / 9						1		1.04E-08
32 / 10		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	114.00					
36 / 11						3		6.89E-07
38 / 12			112.00					
42 / 13						2	- 42'5" - 42'10" (12.93 - 13.05m) high angle fracture with partial secondary mineralization.	
46 / 14			110.00					1.05E-08
48 / 15						0		
52 / 16			108.00					
54 / 16						1		
56 / 17								

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: August 16, 17, 2010

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9132

Project: EMP Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M106

Easting: 335330
Northing: 4902550
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
58–62			106.00			1	- 59'4"(18.08m) weathered shale fracture with thin mud seam.	
62–64	19							3.78E-05
64–66						3		
66–68			104.00					
68–70	21					1	- Bentonite grout 20% solids	
70–72								
72–74			102.00			1		
74–76	23							
76–78						1		
78–80			100.00					
80–82						1		
82–84	25	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.					- 3.05m (10') slot 10 PVC screen within #3 silica sand pack	1.52E-05
84–86								
86–88			98.00			2		
88–90	27							
90–92								
92–94			96.00			0	- 93'5" - 95'3" (28.47-29.03m) light grey brown, very fine homogeneous, chert layer.	3.83E-07
94–96	29							
96–98						1		
98–100			94.00					
100–102								
102–104	31					0	- Beatonite gravel seal	
104–106								
106–108			92.00					
108–110	33					1		
110–112								
112–114			90.00			0		
114–116	35	End of Borehole						

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: August 16, 17, 2010

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9132

Project: EMP Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M107

Easting: 335651
Northing: 4902655
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2 / 0		Ground Surface	127.98				- Elev. M107 128.71m TOC - TOC s/u 0.73m	
0 / 2 / 4 / 6 / 8 / 10 / 12 / 14 / 16 / 18 / 20 / 22 / 24 / 26 / 28 / 30 / 32 / 34 / 36 / 38 / 40 / 42 / 44 / 46 / 48 / 50 / 52 / 54 (1 / 3 / 5 / 7 / 9 / 11 / 13 / 15)		***Silty Sand Till*** Light brown, moist to wet, silty sand till with a trace of clay, cobbles and boulders.	128.00 126.00 124.00 122.00 120.00 118.00 116.00 114.00 112.00		20 – 60 %	11 11 8 6 8 8 7 10 10	- Pressure grout mixture of cement and bentonite from 0-5 ft. (0-1.5m) - HW casing pressure grouted with cement 5 ft. - 13.25ft. (1.5-4.04m). - Hollow stem augered to refusal 12 ft. (3.66m). - 12'7"-12'9" (3.83-3.89m) broken rock - Set HW casing 1'3" into bedrock to a depth of 13.25' (4.03m). - fracture, broken rock 16'*" (5.08m) - 17'2" (5.23m) broken rock, weathered shale fracture. - weathered fractured bedrock 16'-30' (4.87-9.14m) - 28'9" (8.76m) broken rock - 35'4"-35'9" (10.76-10.9m) high angle fracture with oxidation staining and secondary mineralization. - 38'7"-40'1" (11.76-12.22m) high angle fracture with secondary mineralization - 44'4" (13.5m) broken rock. - 46'5" (14.14m) high angle fracture, secondary mineralization - 55'2"-55'7" (16.81-16.94m) wide fracture, lost	6.95E-07 1.45E-06 2.54E-06 3.77E-07
		Limestone Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.						

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: August 17, 18, 2010

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9132
Project: EMP Drilling Program
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M107

Easting: 335651
Northing: 4902655
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20, 60)	Fracture Frequency/Run	Comments	K (m/sec)
18			110.00			4	- 57'6" wide fracture with rounded weathered rock fragments.	3.36E-04
						5	- 63' 6" (19.35m) fracture above calcite filled vug.	
20			108.00					3.95E-09
						1	- Bentonite grout 20% solids	
22			106.00			1		1.34E-06
							- 76'4" (23.26m) weathered fracture	
24			104.00			2		1.54E-06
		Limestone Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.				3		
26			102.00				- 85'6" (26m) weathered fracture.	
						1	- 3.05m (10') slot 10 PVC screen within #3 silica sand pack	3.61E-05
28			100.00				- 92'2" (28m) weathered fracture.	
						1		3.29E-04
30			98.00			2	- Bentonite gravel seal	
						1		2.12E-04
32			96.00				- 105'5" (32.13m) top of very fine, chert layer	
						1	- water circulation did not return.	6.45E-09
34		End of Borehole	94.00					

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: August 17, 18, 2010

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9132

Project: EMP Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M108

Easting: 335792
Northing: 4902733
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							- Elev. M108 128.37m TOC - TOC s/u 0.7m	
0		Ground Surface	128.00 127.67					
0 – 10 / 0 – 3		***Silty Sand Till*** Light brown, moist to wet, silty sand till with a trace of clay, cobbles and boulders.				7 5	- Pressure grout mixture of cement and bentonite from 0-5 ft. (0-1.5m) - HW casing pressure grouted with cement 5 ft. - 12ft. (3.65m). - Hollow stem augered to refusal 7'10" ft. (2.38m). - Set HW casing 4' into bedrock to a depth of 12' (3.65m).	
10 – 22 / 3 – 7			126.00 124.00 122.00			4 3		
22 – 30 / 7 – 9		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	120.00			3	- 28'6" (8.68m) broken rock	
30 – 36 / 9 – 11			118.00			0		
36 – 42 / 11 – 13			116.00			2	- 41' (12.4m) broken rock	
42 – 50 / 13 – 15			114.00			2 0		3.37E-07
50 – 54 / 15			112.00			4	- 54'-54'11" (16.4-16.74m) high angle fracture	6.84E-07

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: August 19, 20, 2010

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9132

Project: EMP Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M108

Easting: 335792
Northing: 4902733
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
56			110.00			0		
58	18							1.43E-08
60							- 61'-61'5" (18.75m) high angle fracture	
62								
64			108.00			3	- Bentonite grout 20% solids	
66	20							1.99E-07
68						0		
70								
72	22		106.00			1		
74								1.03E-06
76								
78			104.00			3		
80	24	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.					- 80'7"-80'9" (24.56-24.61m) broken rock and mud seam.	
82							- 3.05m (10') slot 10 PVC screen within #3 silica sand pack	2.67E-05
84			102.00			2		
86	26						- 84'10" (25.86m) weathered fracture.	
88						1	- 88'5" (26.95m) weathered fracture	
90								2.94E-04
92	28		100.00			0		
94								
96								
98	30		98.00			0	- 99' (30.17m) pyrite intrusion.	
100								
102							- Bentonite gravel seal	
104	32		96.00			0		2.63E-09
106								
108						0		
110		End of Borehole	94.00					
112	34							

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78" (96mm)
Drill Date: August 19, 20, 2010

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: D.H.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M109-1

Easting: 335405
Northing: 4902844
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2 / 0		Ground Surface	126.62				MOE Well tag #A109371 - Elev. M109-1 127.42m TOC - Elev. M109-1 127.28m TPVC - TOC s/u 0.8m	
0 – 4 / 1		***Fill*** Brown, moist to wet, fine to medium grained sand with some gravel	126.00					
4 – 10 / 1 – 3		***Fill*** Brown, wet, sand and gravel.					- Bentonite gravel backfill 0-5 ft. (0-1.5m)	
10 – 14 / 3		***Fill*** Grey, wet, crushed rock.	124.00				- HW casing pressure grouted with cement 5-18'8" (1.5-5.7m)	
14 – 16 / 5		***Clayey Sand*** Light brown, wet, clayey sand.	122.00				- Hollow stem auger refusal 14'2" (4.3m)	
16 – 18 / 5						10	- Set HW casing 4'6" into rock to a depth of 18'8"(5.7m)	
18 – 22 / 5 – 7						2		1.E-07
22 – 24 / 7			120.00			1		
24 – 26 / 7								5.E-07
26 – 28 / 7 – 9								4.E-07
28 – 30 / 9			118.00			4		
30 – 34 / 9						2	- 34'1" (10.4m) weathered fracture.	3.E-09
34 – 36 / 11		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	116.00					
36 – 38 / 11						5	- 39'1"(11.9m) and 39'4" (11.98) weathered rounded burrow fragments within fracture.	
38 – 42 / 11 – 13			114.00					3.E-07
42 – 44 / 13						0		
44 – 48 / 13 – 15			112.00			3	- 49'1"(14.96m) fracture	4.E-07
48 – 54 / 15 – 17			110.00			3		
54 – 58 / 17						1		8.E-007

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 3,4,7, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M109-1

Easting: 335405
Northing: 4902844
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
60			108.00					
62	19					2	- 10ft. (3m) slot 10 PVC screen within 3m silica sand pack.	7.E-06
64								
66								
68			106.00			1	- 67' (20.42m) fracture with weathered broken rock.	
70	21						- 71'3" (21.7m)fracture.	7.E-06
72						6		
74			104.00					
76	23							
78						4	- 78'7" (24m) thin mud seam before fracture with broken rock.	3.E-06
80								
82	25		102.00					
84						2	- 84'9" (25.8m) mud seam witin broken shale pating.	1.E-06
86								
88	27	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	100.00			1	- bentonite gravel seal	
90								
92								7.E-09
94			98.00			0		
96	29							
98						0	- 97'8" - 100' (29.76 - 30.48m) light grey, microcrystalline chert, with trace stylolites.	
100								9.E-09
102	31		96.00					
104						0		
106								
108	33		94.00					1.E-08
110						0		
112								2.E-06
114	35		92.00			0		
116		End of Borehole						
118								
120			90.00					

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 3,4,7, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M109-2

Easting: 335407
Northing: 4902839
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2 / 0		Ground Surface	126.70				MOE Well tag #A101284 - Elev. M109-2 127.49m TOC - Elev. M109-2 127.44m TPVC - TOC s/u 0.79m	
0–4 / 1		Gravel Fill	126.00					
4–10 / 1–3		Crushed Limestone Fill	124.00				- Well casing pressure grouted with cement 0-17' (0-5.18m)	
10–14 / 3–5		Clay Till	122.00					
16–54 / 5–15		Limestone Bedrock	120.00 118.00 116.00 114.00 112.00				- Bentonite gravel backfill 0-31'5"(0-9.6m) - 10ft. (3m) slot 10 PVC screen within 3m silica sand pack. - Bentonite gravel backfill	4.E-06 3.E-06 6.E-06 8.E-06 4.E-06
54		End of Borehole	110.00					

Drilled By: Chalk Well Drilling Ltd.
Drill Method: Air Rotary
Hole Size: 6" (150mm)
Drill Date: March 31, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M110-1

Easting: 335543
Northing: 4902883
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2 / 0		Ground Surface	126.82				MOE Well tag #A109372 - Elev. M110-1 127.55m TOC - Elev. M110-1 127.49m TPVC - TOC s/u 0.73m	
0 – 10 / 0 – 3		***Sandy Silt*** Brown, moist to wet, sandy silt with some gravel.	126.00 124.00				- Bentonite gravel backfill 0-5 ft. (0-1.5m) - HW casing pressure grouted with cement 5-13'4" (1.5-4.06m) - Hollow stem auger refusal 10'3" (3.1m)	
10 – 16 / 3 – 5			124.00 122.00			6 4	- 13' (3.96m) mud seam within weathered - Set HW casing 2'10" into rock to a depth of - 14'5" 14' 11" weathered fractures.	5.E-07
16 – 22 / 5 – 7			122.00 120.00			13 3	- 18'7" (5.66m) weathered fracture. - 19'10" (6.04m) mudseam	8.E-08
22 – 30 / 7 – 9			120.00 118.00			1 0		2.E-08
30 – 36 / 9 – 11		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	118.00 116.00			3	- 39'9"-39'11" (12.11-12.16m) mud seam with weathered shale layer.	6.E-06
36 – 42 / 11 – 13			116.00 114.00			2		2.E08
42 – 48 / 13 – 15			114.00 112.00			1	- 47'2"-49'9" (14.37-15.16m) thin re-cemented high angle fracture.	
48 – 54 / 15 – 17			112.00 110.00			0	- 55'10"-58'4" (17.01-17.77m) thin re-cemented high angle fracture.	2.E-08

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 7-9, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M110-1

Easting: 335543
Northing: 4902883
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
58						0		6.E-06
60								
62	19		108.00			2	- 63'2" weathered fracture	
64								
66								1.E-05
68	21		106.00			1	- 10ft 3.0m) slot 10 PVC screen within 3m silica sand pack.	
70								
72						0		
74			104.00					1.E-05
76	23							
78						2	- 79'5"-79'6" (24.29m) mud seam	
80								
82	25	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	102.00			0	- Bentonite gravel seal	1.E-05
84								
86								
88	27		100.00			0		3.E-08
90								
92								
94	29		98.00			0		2.E-08
96								
98						0	- 98'5"-100'(30m) light greyish brown, mycrocrystalline, chert like.	
100								
102	31		96.00			0	- limestone cuttings.	1.E-08
104								
106								
108	33		94.00			0		1.E-08
110								
112		End of Borehole						
114	35		92.00					
116								

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 7-9, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M111-1

Easting: 335250
Northing: 4902774
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2		Ground Surface	128.21				MOE Well tag #A109373 - Elev. M111-1 128.95m TOC - Elev. m111-1 128.80m TPVC - TOC s/u 0.74m	
0 / 0		***Sandy Silt*** Granular fill overlying light brown sandy silt.	128.00					
10 / 3		***Sandy Silt Till*** Light brown, to grey, sandy silt till, with a trace of clay and cobbles.	126.00 124.00 122.00				- Bentonite gravel backfill 0-5 ft. (0-1.5m) - HW casing pressure grouted with cement 5-28'3" (1.5-8.61m)	
26 / 8		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	120.00 118.00 116.00 114.00 112.00 110.00			2 9 3 0 3 0 1 1	- Hollow stem auger refusal 25'6" (7.77m) - 27' (8.22m) fracture with broken rock. - Set HW casing 2'9" into rock to a depth of 28'3" (8.61m). - 32'3" (9.83m) weathered fracture. - 44'10" (13.66)Fracture zone, washed out mud seam.	4.E-08 4.E-08 3.E-07 4.E-08 4.E-08

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 9,10, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M111-1

Easting: 335250
Northing: 4902774
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
64–66						0		
66–68	20		108.00			0		9.E-08
68–70								
70–72						0		
72–74	22		106.00					1.E-07
74–76							-77'2"(23.52m) fracture.	
76–78						1		
78–80	24		104.00					9.E-08
80–82						0		
82–84								
84–86	26		102.00			0		3.E-07
86–88								
88–90		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.						
90–92						0		
92–94	28		100.00			1	- 92'8" (28.24m) thin weathered fracture.	
94–96								
96–98							- 10ft. (3.0m) slot 10 PVC screen within 3m silica sand pack.	1.E-06
98–100	30		98.00			0		
100–102							- 102'7" (31.26m) pyrite intrusion.	
102–104							- 102'9"-106' (31.3m) light greyish brown, mycrocrystalline, chert like.	
104–106	32		96.00			0		4.E-08
106–108								
108–110						0		
110–112	34		94.00					2.E-07
112–114						0	- Bentonite gravel seal.	
114–116								
116–118	36		92.00			0		2.E-07
118–120								
120–122								
122–124						0		1.E-07
124–126	38		90.00					
126–128		End of Borehole						

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 9,10, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M112-1

Easting: 335274
Northing: 4902692
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2		Ground Surface	126.00 / 125.69				MOE Well tag #A109374 - Elev. M112-1 126.38mTOC - Elev. M112-1 126.31m TPVC - TOC s/u 0.73m	
0 – 16 / 1 – 5		***Sandy Silt*** Light brown, moist to wet, sandy silt.	124.00 – 120.00			7	- Bentonite gravel backfill 0-5 ft. (0-1.5m) - HW casing pressure grouted with cement 5-18'7" (1.5-5.661m) - Hollow stem auger refusal 16'11" (5.15m) - Set HW casing 1'8" into rock to a depth of 18' 7" (5.66m). - 18' (5.48m) fracture zone.	3.E-07
16 – 36 / 5 – 11		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	120.00 – 118.00			5	- 25'11" (7.9m) weathered broken shale seam.	4.E-08
			118.00 – 116.00			2	- 29'8" (9.04m) weathered fracture.	
			116.00 – 114.00			0		4.E-08
						3	- 38'1" (11.6m) weathered fracture. - 38'5"-38'8" (11.7-11.78m) mud seam with rock fragments, weathered burrowed surface.	2.E-06
36 – 48 / 11 – 15			114.00 – 112.00			0		
						3	- 48'9"-50' (14.86-15.24) high angle fracture.	2.E-07
48 – 58 / 15 – 17			112.00 – 108.00			1	- 52' (15.85m) fracture above re-mineralized high angle fracture.	2.E-07
						1		

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 11, 14, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M112-1

Easting: 335274
Northing: 4902692
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
60–62								3.E-07
62–64 (19)						2		
64–66			106.00					
66–68						1	- 67'-67'10" (20.42-20.67m) high angle fracture.	4.E-08
68–70 (21)								
70–72			104.00			0		
72–74								4.E-08
74–76 (23)								
76–78			102.00			0		
78–80								
80–82						0		1.E-07
82–84 (25)			100.00					
84–86		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.				1	- 10ft. (3.0m) slot 10 PVC screen within 3m silica sand pack	4.E-06
86–88								
88–90 (27)			98.00			0		
90–92								
92–94							- 96'1" pyrite intrusion above light greyish brown, microcrystalline , chert like.	9.E-08
94–96 (29)			96.00			0		
96–98								
98–100						0		
100–102 (31)			94.00					4.E-08
102–104						0		
104–106								
106–108							- Bentonite gravel seal.	
108–110 (33)			92.00			0		
110–112								
112–114								4.E-08
114–116 (35)								
116–118		End of Borehole	90.00					
118–120								

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 11, 14, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M114-1

Easting: 335437
Northing: 4902530
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2 / 0		Ground Surface	124.41				MOE Well tag #A109377 - Elev. M114-1 125.36m TOC - Elev. M114-1 125.30m TPVC - TOC s/u 0.95m	
0 – 4 / 1		***Sandy Silt*** Brown, moist to wet, sandy silt overlying sandy silt till.	124.00				- Hollow stem auger refusal 6'2" (1.88m) - HW casing pressure grouted with cement 4'-8'11" (1.22-2.72m).	
6 – 10 / 2 – 3			122.00			5	- Set HW casing 2'9" into bedrock to a depth of 8'11" (2.72m). - Mud seams 8'4", 9'8", and 10'.	2.E-07
12 – 14 / 4						11	- intensely fractured zone 10'10"- 15'5".	
16 / 5			120.00				- 15'5" (4.7m) mud seam.	2.E-09
18						7	- intensely fractured zone 15'10"- 20'10". - fracture	
20 – 24 / 6 – 7			118.00					2.E-09
24		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.				3		
26 – 28 / 8			116.00			0		4.E-12
30 / 9								
32 – 34			114.00			0		
36 / 11							- 36' (10.97m) fracture. - 36'6"-36'9" (11.12-11.2m) broken rock, trace mud.	3.E-08
38						4		
40 – 42 / 12 – 13			112.00					
44						1		3.E-09
46 – 48 / 14			110.00					
50 / 15						0		
52								3.E-10

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 23, 24, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M114-1

Easting: 335437
Northing: 4902530
Field Personnel: B.A.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
54–56			108.00			0		
56–58	17					0		1.E-08
58–60			106.00					
60–62						0		
62–64	19							4.E-11
64–66			104.00			0		
66–68								
68–70	21					0		4.E-07
70–72			102.00					
72–74						0		
74–76	23	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.					- weathered fracture.	
76–78						1		
78–80			100.00				- 81' (24.7m) weathered fracture.	4.E-07
80–82	25					1		
82–84								
84–86								4.E-10
86–88			98.00			0	- 88'11" (27.1m) pyrite intrusion above light grey, microcrystalline, chert like rock.	
88–90	27							
90–92								
92–94			96.00			4	- 92'11" and 93' weathered limesone layer - 93'6" - 96'6" (28.42- 29.42m) microcrystalline texture - 95'4" (29.06m) mud seam.	
94–96	29							2.E-05
96–98								
98–100			94.00			0	- 10ft. (3.0m) slot 10 PVC screen within 3m silica sand pack	
100–102	31							
102–104						0		4.E-12
104–106							- Bentonite gravel seal	
106–108		End of Borehole	92.00					

Drilled By: Aardvark Drilling Inc.
Drill Method: Diamond Drilling
Hole Size: HQ3 3.78 (96mm)
Drill Date: February 23, 24, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504

Project: 2011 Hydrogeo Drilling Program

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M114-2

Easting: 335438
Northing: 4902527
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag #A109142 - Elev. M114-2 125.36m TPVC - TOC s/u 0.95m	
0		Ground Surface	124.41					
0		Topsoil, Sand and Gravel						
2		Coarse soil Silt/Clay	124.00				- bentonite gravel seal 0-4'6" (0-1.37m)	
4 (1)		Clay/Silt						
6		Clay/Silt						
8		Limestone Bedrock	122.00				- 10ft. (3m) slot 10 PVC screen within 3m silica sand pack.	
10 (3)		End of Borehole						

Drilled By: GET Drilling Ltd.
Drill Method: Auger/Air Hammer
Hole Size: 4" (100mm)
Drill Date: February 10, 2011

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA
A Better Environment For Business

Project No: K-B9504-00-08

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M121

Easting: 335529
Northing: 4902337
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2 / 0		Ground Surface	120.97				MOE Well tag #A130074 - Elev. M121 121.78m TOC - Elev.121 121.73m TPVC - TOC (HW) s/u 0.81m	
0 / 2 / 4 / 1		Brown, sandy silty Clay.	121.00 120.00				- Hollow stem auger refusal 4' (1.22m)	
6 / 8 / 10 / 3			119.00 118.00				- HW casing pressure grouted with cement to 9' (2.74m)	
12 / 14 / 16 / 5			117.00 116.00					
18 / 20 / 22 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	115.00 114.00					
24 / 26 / 28 / 9			113.00 112.00				- Bentonite pressure grouted to surface.	
30 / 32 / 34 / 11			111.00 110.00					
36 / 38 / 40 / 13			109.00 108.00					
42 / 44 / 46 / 15			107.00 106.00					3.E-08
48 / 50								

Drilled By: Aardvark Drilling Inc.
Drill Method: Rotary Tri-cone
Hole Size: 3.78" (96mm)
Drill Date: May 17, 2012

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-00-08

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M121

Easting: 335529
Northing: 4902337
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency/Run	Comments	K (m/sec)
53			105.00					9.E-08
55								
57	17		104.00					
59			103.00					
61								3.E-08
63	19		102.00					
65			101.00					
67								
69	21		100.00					
71			99.00					
73								
75	23	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	98.00					9.E-08
77								
79			97.00					
81								
83	25		96.00				- 10ft. (3.0m) slot 10 PVC screen within 3m silica sand pack.	1.E-06
85			95.00					
87								
89	27		94.00					
91			93.00					2.E-07
93								
95	29		92.00					
97								
99			91.00				- Bentonite gravel seal.	7.E-08
101								
103	31		90.00					
105		End of Borehole	89.00					

Drilled By: Aardvark Drilling Inc.
Drill Method: Rotary Tri-cone
Hole Size: 3.78" (96mm)
Drill Date: May 17, 2012

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-00-08

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M123

Easting: 335905
Northing: 4902479
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag #A130073 - Elev. M123 123.60m TOC - Elev. M123 123.54m TPVC - TOC (HW) s/u 0.68m	
0		Ground Surface	122.92					
0		Brown, sandy silty Clay.	123.00					
2 / 1			122.00				- Hollow stem auger refusal 1'6" (0.46m)	
6			121.00					
8 / 10 / 3			120.00				- HW casing pressure grouted with cement to 8' (2.44m)	
12			119.00					
16 / 5			118.00					8.9E-09
18			117.00					
22 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	116.00					2.3E-08
26			115.00					
28 / 30 / 9			114.00				- Bentonite pressure grouted seal.	2.4E-08
34			113.00					
36 / 11			112.00					3.5E-07
38			111.00					
42 / 13			110.00					4.7E-08
46			109.00					
48			108.00					
50 / 15								

Drilled By: Aardvark Drilling Inc.
Drill Method: Rotary Tri-cone
Hole Size: 3.78" (96mm)
Drill Date: May 23, 2012

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-00-08

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M123

Easting: 335905
Northing: 4902479
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
53			107.00					7.3E-07
55	17		106.00					
57			105.00					1.0E-06
59			104.00					
61	19		103.00				- water bearing fracture 63'4"(19.32m)	1.8E-07
63			102.00					
65			101.00					2.2E-07
67	21		100.00					
69		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	99.00				- 10ft. (3.0m) slot 10 PVC screen wothin 3M silica sand pack.	4.2E-04
71			98.00					
73	23		97.00					1.3E-07
75			96.00				- water bearing fracture 87'9" (26.75m)	
77			95.00					
79	25		94.00				- Bentonite gravel seal.	3.7E-07
81			93.00					
83			92.00					2.3E-06
85	27							
87								
89								
91	29							
93								
95								
97	31							
99								
101		End of Borehole	91.00					
103								
105								

Drilled By: Aardvark Drilling Inc.
Drill Method: Rotary Tri-cone
Hole Size: 3.78" (96mm)
Drill Date: May 23, 2012

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-11

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M167

Easting: 336266
Northing: 4902624
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag #A133065 - Elev. M167 120.68m TOC - Elev. M167 120.62m TPVC - TOC s/u 0.70m	
0		Ground Surface	119.98					
0		Brown-grey, silty Clay with gravel.	120.00					
2 / 1			119.00				- Hollow stem auger to 5' (1.5m)	
4							- 4" (10mm) steel casing pressure grouted with cement to 5' (1.5m)	
6			118.00				- fractures 7', 7.5', 10' and 14' (2.13, 2.28, 3.05 and 4.26m)	
8								
10 / 3			117.00					
12								1.E-07
14			116.00					
16 / 5			115.00				- fractures 17' and 20' (5.18 and 6.1m)	
18								
20			114.00					
22 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	113.00					1.E-07
24								
26			112.00				- fracture 27' (8.23m)	
28								
30 / 9			111.00					
32								
34			110.00				- 20% soliids bentonite grout seal	1.E-06
36 / 11			109.00				- fractures 35'6", 36' 39'6" and 44' (10.8, 11, 12 and 13.4m)	1.E-06
38								
40			108.00					
42 / 13			107.00					
44								
46			106.00					1.E-08
48								
50 / 15			105.00				- moderately wide fracture 51' (15.55m)	

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: March 6, 11, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-11

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M167

Easting: 336266
Northing: 4902624
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95 97 99 101	17 19 21 23 25 27 29	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	104.00 103.00 102.00 101.00 100.00 99.00 98.00 97.00 96.00 95.00 94.00 93.00 92.00 91.00 90.00		20 60		- moderately wide water bearing fracture 57' (17.37m) - Bentonite gravel seal - water bearing fracture 71' (21.64m) - fracture 78' (23.77m) - moderately wide fracture 79' (24.08m) - 3.0m (10ft.) slot 10 PVC screen with 3M silica sand pack - fracture 84' (25.6m) - Bentonite gravel seal	3.E-08 4.E-07 1.E-04 1.E-08 3.E-07
101 103 105	31	End of Borehole	89.00 88.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: March 6, 11, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™ a BluMetric™ company

Project No: K-B9504-11

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M168

Easting: 336063
Northing: 4902714
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag #A133059 - Elev. M168 126.29m TOC - Elev. M168 126.21m TPVC - TOC s/u 1.0m	
0		Ground Surface	125.29					
0 – 2		Light brown, fine to medium grained, silty Clay with gravel.	125.00				- Hollow stem auger to 4'6" (1.37m)	
4 / 1			124.00				- 6" tri-cone to 6'6" (1.98m) and cemented grouted 4" steel casing.	
8			123.00				- fractures 8', 10', 13', 14'6", 15, and 17' (2.43, 3.05, 3.96, 4.42, 4.57 and 5.18m)	
10 / 3			122.00					
12 – 14			121.00					5.E-09
16 / 5			120.00					
18							- moderately wide fracture 18' (5.49m) - fracture 19' (5.79m)	
20 – 22			119.00					
24 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	118.00				- fractures 24' and 24'6" (7.31 and 7.47m)	2.E-09
26 – 28			117.00					
30 / 9			116.00				- moderately wide fracture 30' (9.14m) - fracture 31' (9.45m)	
32 – 34			115.00					
36 / 11			114.00					5.E-07
38 – 40			113.00				- 20% solids bentonite grout seal	
42 / 13			112.00				- fractures 43' and 46' (13.1 and 14m)	
44 – 46			111.00					
48 / 15								4.E-09
50			110.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: March 6, 12, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-11

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M168

Easting: 336063
Northing: 4902714
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
53			109.00					
55	17		108.00					
57							- moderately wide fracture 58'6" (17.83m)	4.E-09
59			107.00					
61								
63	19		106.00					
65								
67			105.00					
69	21						- fracture 68' (20.72m)	
71			104.00					7.E-08
73								
75	23	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	103.00				- fracture 75' (22.86m)	
77			102.00					
79							- Bentonite gravel seal	
81			101.00					9.E-06
83	25							8.E-06
85			100.00				- fracture 84' (25.6m)	
87			99.00					
89	27							
91			98.00				- 3.0m (10ft) slot 10 PVc screen within 3M silica sand pack	
93			97.00					3.E-08
95	29							6.E-08
97			96.00					
99			95.00				- moderately wide fracture 99' (30.17m)	
101	31						- Bentonite gravel seal	
103			94.00					
105		End of Borehole	93.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: March 6, 12, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-11

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M170

Easting: 335889
Northing: 4902865
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2		Ground Surface	127.51				MOE Well tag #A077021 - Elev. M170 128.21m TOC - Elev M170 elev. 128.14m TPVC - TOC s/u 0.70m	
0 / 2 / 4 / 1		Brown, wet, clay till.	127.00 126.00					
6 / 8 / 10 / 3			125.00 124.00				- Hollow stem auger to 9'9" (2.97m) - 4" (100mm) steel casing pressure grouted with cement to 9' 9" (2.97m)	
12 / 14 / 16 / 5			123.00 122.00				- fracture 14' (4.27m)	
18 / 20 / 22 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	121.00 120.00				- moderately wide fracture 20'6" (6.24m) - fractures 23' and 24' (7.01 and 7.32m)	2.E-09
24 / 26 / 28 / 9			119.00 118.00				- fractures 28' and 30' (8.53 and 9.14m) - 20% solids bentonmnite gravel seal	1.E-09
30 / 32 / 34 / 11			117.00 116.00				- moderately wide fracture 33'6" (10.21m)	
36 / 38 / 40 / 42 / 13			115.00					1.E-05
44 / 46 / 48 / 15			114.00 113.00				- moderately wide water bearing fracture 44' (13.41m) - moderately wide fracture 46' (14.02m)	
50 / 52			112.00				- fracture 50' (15.24m)	2.E-09

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: March 7, 14, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-11

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M170

Easting: 335889
Northing: 4902865
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
55			111.00					
57			110.00					
59	18		109.00					
61								3.E-08
63			108.00				- moderately wide water bearing fracture 64' (19.5m)	
65	20		107.00					
67								
69			106.00				- Bentonite gravel seal	
71							- fracture 72' (21.95m)	
73	22		105.00					1.E-09
75								
77		***Limestone***	104.00					
79	24	Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.						
81			103.00				- fracture 80' (24.38m)	
83							- 3.0m (10ft) slot 10 PVC screen within 3M silica sand pack	
85	26		102.00				- moderately wide fracture 85' (25.9m)	6.E-07
87								7.E-07
89			101.00					
91			100.00					
93	28						- fracture 93' (28.3m)	
95			99.00					
97			98.00					3.E-08
99	30						- Bentonite gravel seal	3.E-08
101			97.00					
103							- fracture 102' (31.08m)	
105	32		96.00					
107			95.00					
109		End of Borehole	94.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: March 7, 14, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-12

Project: South Property Investigation

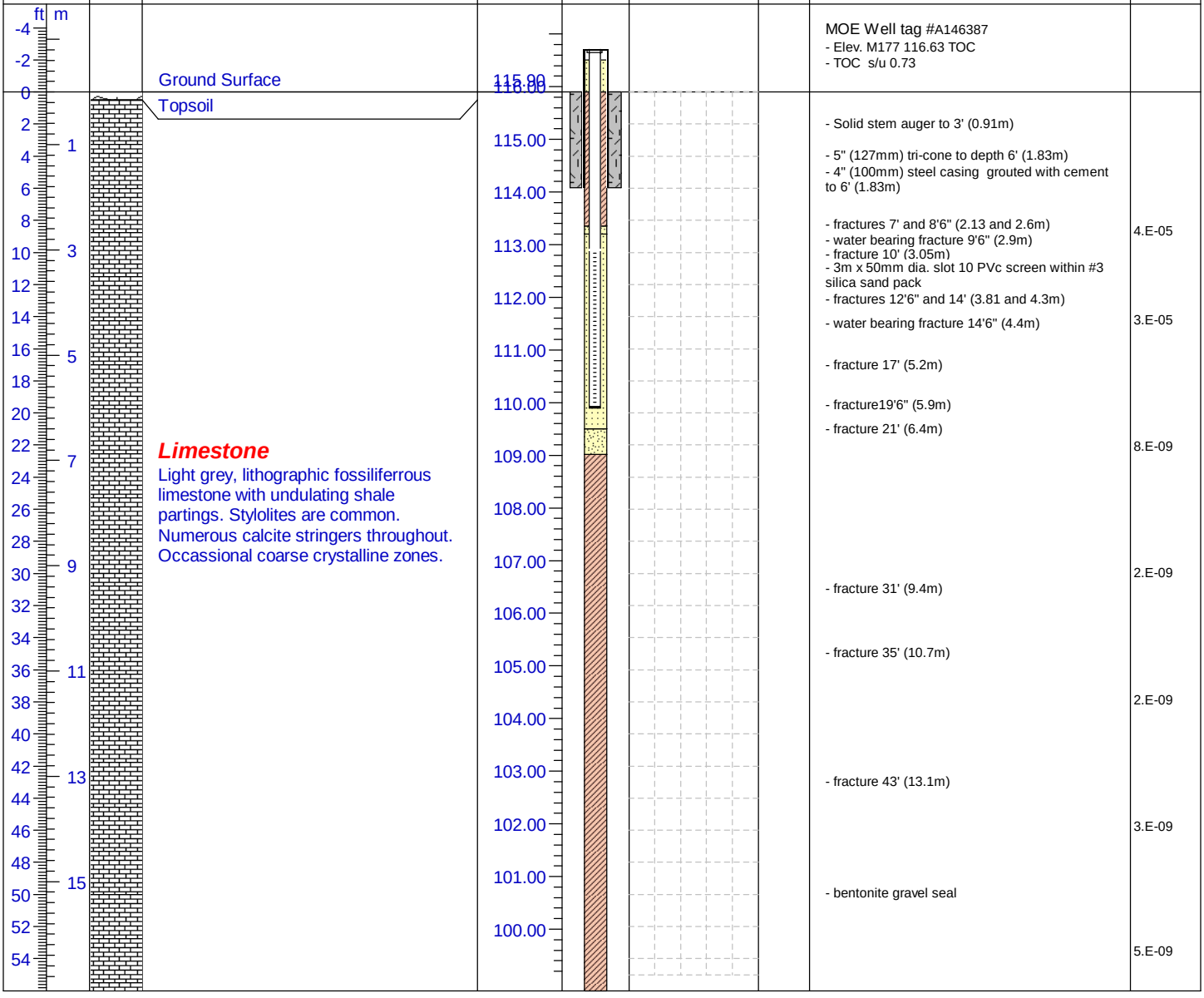
Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M177

Easting: 335784
Northing: 4902084
Field Personnel: M.L.

SUBSURFACE PROFILE



Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: November 13, December 5, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-12

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M177

Easting: 335784
Northing: 4902084
Field Personnel: M.L.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
57–113		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	98.00 to 83.00				- fracture 61' (18.6m) - bentonite gravel seal - fracture 81' (24.7m) - fracture 82'6" (25.1m) - bentonite gravel seal	5.E-09 1.E-08 1.E-08 2.E-08 4.E-08 4.E-08 6.E-08 6.E-08
111–113	34	End of Borehole	82.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: November 13, December 5, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™ a BluMetric™ company

Project No: K-B9504-19

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M178R-2

Easting: 336008
Northing: 4902233
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
0 / 0		Ground Surface	117.00 116.52				MOE Well tag # A175231 - Elev. M178R-2 117.24 m TOC - Elev. M178R-2 117.20 m TPVC - TOC s/u 0.72m	
0 / 0 – 4 / 1		***Sandy Clay*** Brown, cobbles at bedrock surface	116.00					
4 / 1 – 36 / 9		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	115.00 114.00 113.00 112.00 111.00 110.00 109.00 108.00 107.00 106.00				-10" dia. (254mm) tri-cone to depth 43'6" (13.25m) - 6" dia. (152mm) steel casing grouted with cement to 43'6" (13.25m) - water bearing fractures 11'6", 12' (3.5, 3.65m) - fracture 14' (4.26m) - bentonite gravel seal - fracture 28' (8.53m)	

Drilled By: Aardvark Drilling Ltd.
Drill Method: Mud Rotary Tri-cone
Hole Size: 6" (152mm)
Drill Date: Aug. 19, 21, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-19

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M178R-2

Easting: 336008
Northing: 4902233
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
38				105.00				- fracture 37' (11.28m)	
40	12								
42				104.00				- #1 Silica sand pack	
44				103.00					
46	14								4.5E-06
48				102.00				- water bearing fracture 47' (14.3m)	
50				101.00					
52	16							- water bearing fracture 52' (15.8m)	8.5E-05
54			***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	100.00				3.0m x 50mm Slot 10 PVC screen within #3 silica sand pack.	
56									
58				99.00					
60	18								4.5E-08
62				98.00					
64				97.00				- water bearing fracture 64' (19.5m)	
66	20							- fracture, artesian, sulfur odour present 65'6" (20m)	2.5E-02
68				96.00					2.0E-03
70				95.00				- bentonite gravel seal	
72	22								
74			End of Borehole	94.00					
76									

Drilled By: Aardvark Drilling Ltd.
Drill Method: Mud Rotary Tri-cone
Hole Size: 6" (152mm)
Drill Date: Aug. 19, 21, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-19

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M178R-4

Easting: 336002
Northing: 4902232
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2			117.00				MOE Well tag # A175229 - Elev. M178R-4 117.34 m TOC - Elev. M178R-4 117.30 m TPVC - TOC s/u 0.80m	
0		Ground Surface	116.52				- Water level elev. 116.55m recorded Nov. 20, 2015	
2 / 1		***Sandy Clay*** Brown, cobbles at bedrock surface	116.00					
4			115.00				-10" dia. (254mm) tri-cone to depth 8'8" (2.64m) - 6" dia.(152mm) steel casing grouted with cement to 8'8" (2.64m)	
6								
8			114.00				- bentonite gravel seal	
10 / 3							- #1 Silica sand pack - water bearing fractures 10'6", 11' (3.2, 3.35m)	
12		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	113.00					6.2E-03
14			112.00				1.9m x 50mm Slot 10 PVC screen within #3 silica sand pack.	2.3E-03
16 / 5							- water bearing fracture 16' (4.9m)	1.4E-03
18			111.00				- fracture 18' (5.5m)	
20							- fracture 20' 9 (6.1m)	
22 / 7			110.00					
		End of Borehole						

Drilled By: Aardvark Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 6" (152mm)
Drill Date: Aug. 15,17, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: 160143-11

Project: Complementary CAZ Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M178R-5

Easting: 335997
Northing: 4902232
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag # A193460 - Elev. M178R-5 117.33 m TPVC - TOC s/u 0.84m	
			117.00					
0		Ground Surface	116.49				- Water level elev. 116.51m recorded Apr. 21, 2017	
2			116.00				- 4" steel protective casing - bentonite gravel seal	
4 / 1		***Sandy Clay*** Brown, trace gravel at bedrock surface						
			115.00					
6		***Limestone*** (2.29m) water bearing fracture.					1.22m x 50mm Slot 10 PVC screen within #3 silica sand pack.	
8		Auger refusal (2.44m) End of Borehole	114.00					

Drilled By: GET Drilling Ltd.
Drill Method: Solid Flight Augers
Hole Size: 6" (152mm)
Drill Date: November 15, 2016

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-12

Project: South Property Investigation

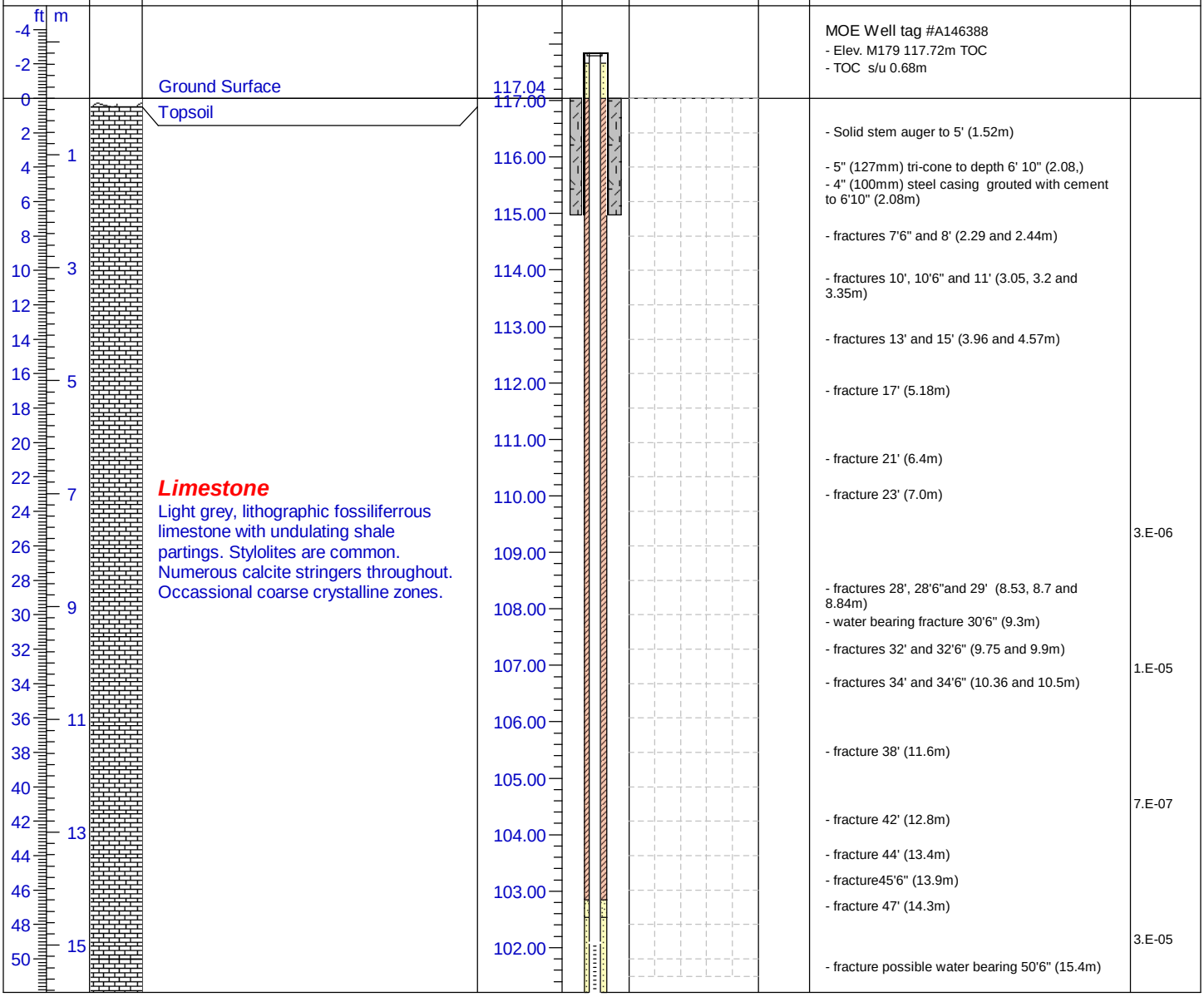
Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M179

Easting: 336338
Northing: 4902356
Field Personnel: B.M.

SUBSURFACE PROFILE



Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: November 11, 13, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-12

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M179

Easting: 336338
Northing: 4902356
Field Personnel: B.M.

SUBSURFACE PROFILE

Depth (m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
53			101.00				- fractures 53' and 53'6" (16.2 and 16.3m) - 3m x50mm dia. slot 10 PVC screen within #3 silica sand pack	
55								
57	17		100.00				- fracture 57' (17.4m)	3.E-05
59			99.00					
61								
63	19		98.00				- fracture possible water bearing, sulphur odour - fracture 64' (19.5m)	
65			97.00					9.E-06
67								
69	21		96.00					
71								
73			95.00					2.E-07
75	23	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	94.00				- fracture 75' (22.9m)	
77								
79			93.00					4.E-08
81	25		92.00				- fracture 81' (24.7m)	3.E-08
83								
85			91.00				- bentonite gravel seal	
87								
89	27		90.00					4.E-08
91							- fracture 91' (27.7m)	
93			89.00					
95	29		88.00				- fracture 95' (29m)	4.E-08
97								3.E-08
99			87.00					
101	31		86.00					
103								
105		End of Borehole	85.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: November 11, 13, 2013

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD 83 Zone 18
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-14

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M185-1

Easting: 336175
Northing: 4902152
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
							MOE Well tag # A163300 - Elev. M185 117.33 m TOC - TOC s/u 0.76m	
0 / 0		Ground Surface	117.00 116.57					
0 / 0		Topsoil overlaying brown clay.						
2 / 1			116.00					
4 / 1							- 5.75" (146mm) tri-cone to depth 6'6" (1.98m) - 4" (100mm) steel casing grouted with cement to 6'6" (1.98m)	
6 / 2			115.00					
8 / 2								
10 / 3			114.00					
12 / 4								
14 / 4			113.00					
16 / 5							- fracture 16'5" (5m)	
18 / 5			112.00					
20 / 6							- bentonite gravel seal	2.E-08
22 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	111.00					
24 / 7								
26 / 8			110.00				- fracture 26'2" (8m)	
28 / 9								1.E-09
30 / 9			109.00					
32 / 10							- fracture 32'9" (10m)	
34 / 10			108.00				- fracture 34'5" (10.5m)	
36 / 11							- fracture 36' (11m)	
38 / 12			107.00					
40 / 12							- fracture 39'5" (12m)	7.E-09
42 / 13			106.00					
44 / 13								
46 / 14			105.00					
48 / 15								
50 / 15			104.00				- fracture trace water 49'2" (15m)	1.E-06
52 / 16							- fracture 50'9" (15.5m)	
			103.00					
			102.00					
			101.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: June 17, 18, 2014

Drill Angle: Vertical
Azimuth: n.a.
Datum: M178-1 Elev. 116.65m TOC
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-14

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M185-1

Easting: 336175
Northing: 4902152
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency/Run	Comments	K (m/sec)
55			100.00					
57							- bentonite gravel seal	
59	18		99.00					1.E-06
61			98.00					
63								
65	20		97.00				- water bearing fracture 64'7" (19.7m) - fracture 65'7" (20m)	
67								
69			96.00					1.E-07 1.E-07
71	22		95.00					
73								
75			94.00				- fracture 75'6" (23m)	
77		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.						
79	24		93.00					3.E-08
81								
83			92.00					
85	26		91.00					
87			90.00					3.E-08
89								
91	28		89.00					
93								
95			88.00				- fracture 94'9" (28.9m)	
97			87.00					4.E-08
99	30						- 3m x 50mm dia. slot 10 PVC screen within #3 silica sand pack	
101			86.00					2.E-08
103			85.00					
105	32							
107			84.00					
109		End of Borehole	83.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: June 17, 18, 2014

Drill Angle: Vertical
Azimuth: n.a.
Datum: M178-1 Elev. 116.65m TOC
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-14

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M185-2

Easting: 336175
Northing: 4902152
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag # A163304 - Elev. M185 117.38 m TOC - TOC s/u 0.70m	
0		Ground Surface	117.00 116.65					
0		Topsoil overlaying brown clay.						
2 / 1			116.00					
4			115.00				- 5.75" (146mm) tri-cone to depth 7' (2.11m) - 4" (100mm) steel casing grouted with cement to 7' (2.11m)	
6								
8			114.00					
10 / 3			113.00					
12								
14			112.00					
16 / 5							- bentonite gravel seal	
18			111.00					
20							- water bearing fracture 20' (6.1m))	
22 / 7			110.00				- water bearing fracture 23' (6.1m)	
24								
26		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	109.00					
28								
30 / 9			108.00					
32			107.00				- fracture 32'9" (10m)	
34								
36 / 11			106.00					
38								
40			105.00					
42 / 13			104.00					
44								
46			103.00				- water bearing fracture 47' (14.3m)	
48 / 15			102.00				- 3m x 50mm dia. slot 10 PVC screen within #3 silica sand pack	
50								
52			101.00					
54			100.00					
56 / 17		End of Borehole						

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: August 28, 29, 2014

Drill Angle: Vertical
Azimuth: n.a.
Datum: M178-1 Elev. 116.65m TOC
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-14

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M186

Easting: 336502
Northing: 4902641
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2							MOE Well tag # A163301 - Elev. M186 121.34 m TOC - TOC s/u 0.76m	
0		Ground Surface	121.00 120.58					
0		Topsoil with brown clay.						
2 / 4 / 6 / 8 / 10 / 12 / 14 / 16 / 18 / 20 / 22 / 24 / 26 / 28 / 30 / 32 / 34 / 36 / 38 / 40 / 42 / 44 / 46 / 48 / 50 / 52 / 54 / 56		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	120.00 119.00 118.00 117.00 116.00 115.00 114.00 113.00 112.00 111.00 110.00 109.00 108.00 107.00 106.00 105.00 104.00				- 5.75" (146mm) tri-cone to depth 4'6' (1.37m) - 4" (100mm) steel casing grouted with cement to 4'6" (1.37m) - bentonite gravel seal - fracture 24'7" (7.5m) - fracture 25'3" (7.7m) - fracture trace water 31'1" (9.5m) - 3m x 50mm dia. slot 10 PVC screen within #3 silica sand pack - fracture 39'5" (12m) - fracture 49'2" (15m) - fracture 54'6" (16.6m)	1.E-09 1.E-09 1.E-07 4.E-09 2.E-08 4.E-08

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: June 17, 19, 2014

Drill Angle: Vertical
Azimuth: n.a.
Datum: M166 Elev. 123.19m TOC
Checked By: P.T.

WESA™
a BluMetric™ company

Project No: K-B9504-14

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M186

Easting: 336502
Northing: 4902641
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
59–117		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	102.00 to 86.00				- bentonite gravel seal - fracture 83'6" (25.5m) - fracture 85'3" (26m) - bentonite gravel seal	7.E-09 6.E-10 1.E-08 2.E-09 6.E-09 1.E-08
19, 21, 23, 25, 27, 29, 31, 33, 35								
115–117		End of Borehole	86.00 to 85.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: June 17, 19, 2014

Drill Angle: Vertical
Azimuth: n.a.
Datum: M166 Elev. 123.19m TOC
Checked By: P.T.

WESA™ a BluMetric™ company

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M187

Easting: 335607
Northing: 4901972
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	115.76				MOE Well tag # A163222 - Elev. M187 116.31 m TOC - Elev. M187 116.20 m TPVC - TOC s/u 0.55m	
1		***Clay*** Brown, some silt and gravel. - 0.5m gravel till.	115.00					
3							- 5.75" dia. (146mm) tri-cone to depth 8'6" - 4" dia. (100mm) steel casing grouted with cement to 8'6" (2.59m)	
5								
7 / 2			114.00					
9			113.00				- fracture 10'6" (3.2m)	
11								
13 / 4			112.00				- fractures 13'6", 14', 15' (4.1,4.3, 4.6m)	
15								
17			111.00				- fracture 16'5 (5m)	
19 / 6			110.00					
21							- fracture 21' (6.4m)	
23			109.00					
25		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	108.00					
27 / 8							- bentonite gravel seal	
29			107.00					
31								
33 / 10			106.00				- fractures 33'6", 37', 37'8", 38'4" (10.2,11.3, 11.5, 11.7m)	
35			105.00					
37								
39 / 12			104.00				- fractures 39'5", 40'8", 41'8" (12,12.4, 12.7m)	
41								
43			103.00					
45 / 14			102.00					
47							- fracture 47'7" (14.5m)	
49			101.00					
51			100.00				- fractures 50'6", 51'9", 52'6" (15.4, 15.8, 16m)	

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan 27, Feb. 2, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M187

Easting: 335607
Northing: 4901972
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (% 20 60)	Fracture Frequency/Run	Comments	K (m/sec)
54			99.00					
56	17							
58			98.00				- fracture 57'5" (17.5m)	
60								
62	19		97.00				- bentonite gravel seal	
64							- Water level elev. 96.17m recorded Nov. 20, 2015	
66			96.00					
68	21							
70			95.00					
72								
74			94.00					
76	23	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	93.00					
78								
80			92.00				- #1 Silica sand pack	
82	25							
84			91.00					
86								
88	27		90.00				- water bearing fracture 86'3" (26.3m)	
90								
92			89.00				3.0m x 38mm Slot 10 PVC screen within #3 silica sand pack.	
94								
96	29		88.00				- fracture 92'6" 28.2m)	
98								
100			87.00					
102	31							
104			86.00					
			85.00				- bentonite gravel seal	
			84.00					
106		End of Borehole						

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan 27, Feb. 2, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: South Property Investigation

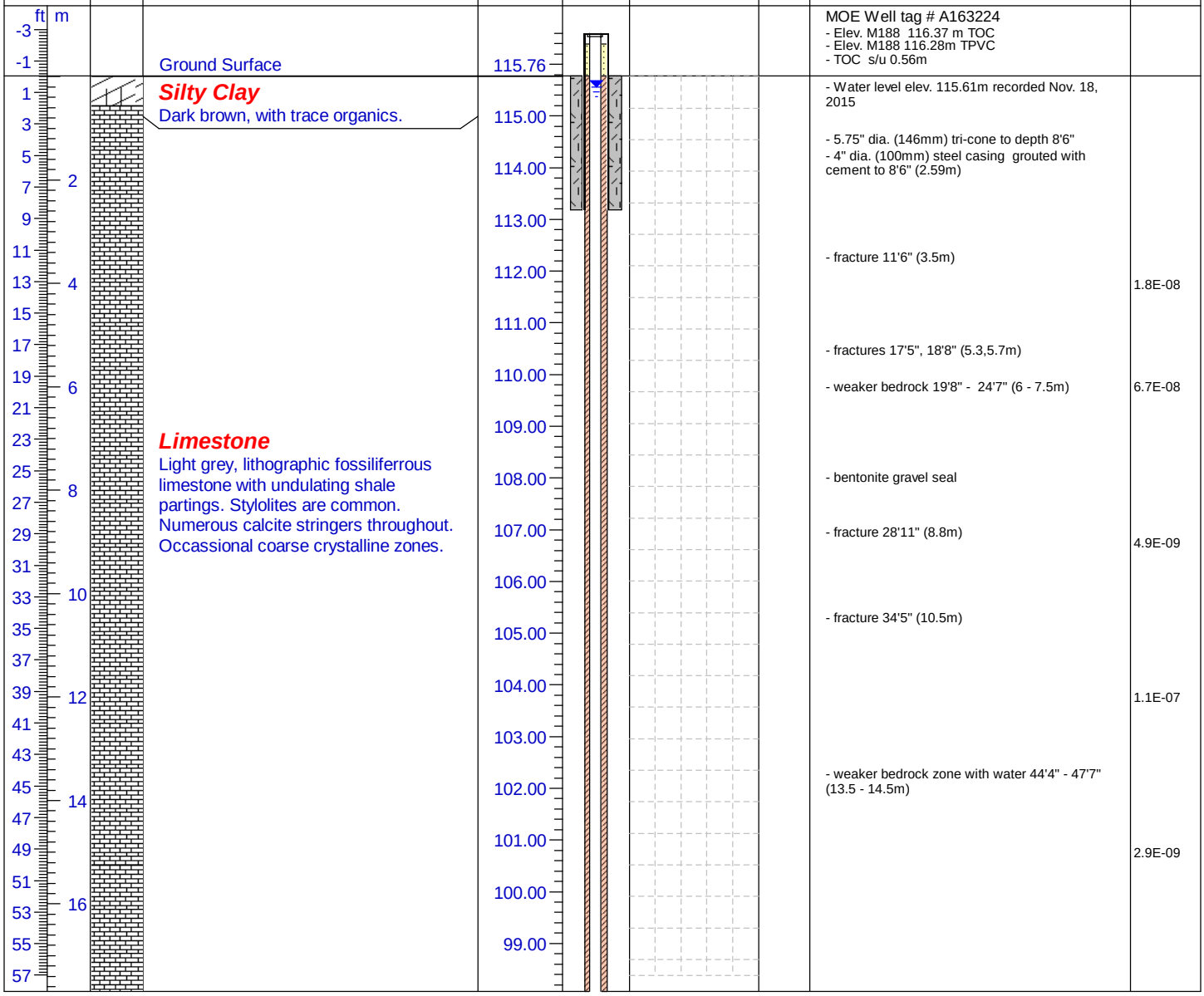
Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M188-1 (was M188)

Easting: 335979
Northing: 4902069
Field Personnel: B.McC.

SUBSURFACE PROFILE



Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan 28, Feb. 4, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M188-1 (was M188)

Easting: 335979
Northing: 4902069
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
59–107	19–33	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	98.00–83.00				- fracture 60'4" (18.4m) - bentonite gravel seal - fracture 70'11" (21.6m) - #1 Silica sand pack - #1 silica sand - water bearing fracture 100' (30.5m) 3.0m x 38mm Slot 10 PVC screen within #3 silica sand pack.	4.1E-09 6.5E-09 3.8E-09 2.2E-08 7.1E-06 4.8E-06
109–117	33–35	End of Borehole	82.00–80.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan 28, Feb. 4, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: 160143-11

Project: Complementary CAZ Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M188-2

Easting: 335978
Northing: 4902068
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1			116.00				- Elev. M188-2 116.53 m TPVC - TOC s/u 0.82m	
		Ground Surface	115.71					
1		***Silty Clay*** Dark brown, with trace organics.					- Water level elev. 115.75 m recorded Apr. 21, 2017 - 4" dia. (100mm) protective steel casing	
3			115.00				- bentonite gravel seal	
5							- 5.25" dia. (133mm) tri-cone to depth 11' (3.35m) -weak bedrock5' (1.52m)	
7 (2)		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	114.00				2.43m x 50mm Slot 10 PVC screen within #3 silica sand pack.	
9			113.00				- weak bedock 10' and 10'6" (3.05, 3.2m)	
11		End of Borehole						

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 5.25" (133mm)
Drill Date: November 14, 2016

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M190

Easting: 336274
Northing: 4902275
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
							MOE Well tag # A163225 - Elev. M190 118.00 m TOC - Elev. M190 117.90m TPVC - TOC s/u 0.68m	
0 ft / 0 m		Ground Surface	117.90				- Surface elev. 117.90m	
2 ft		***Clay*** Brown, some silt.						
4 ft / 1 m		***Sand Till*** Grey, some gravel.	117.00				- Water level elev. 115.81m recorded Nov. 20, - 5.75" dia. (146mm) dia. tri-cone to depth 8'6" - 4" dia. (100mm) steel casing grouted with cement to 8'6" (2.59m)	
6 ft			116.00					
8 ft								
10 ft / 3 m			115.00					
12 ft							- fracture 13'1" (4m)	
14 ft			114.00				- fracture 14'10" (4.5m) Centralizer	
16 ft / 5 m			113.00					
18 ft								
20 ft			112.00					1.1E-09
22 ft								
24 ft / 7 m			111.00				- fracture 22'7" (6.9m)	
26 ft		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	110.00					
28 ft							- bentonite gravel seal	
30 ft / 9 m			109.00				- fracture 29'6" (9m)	2.9E-08
32 ft								
34 ft			108.00					
36 ft / 11 m			107.00					
38 ft								
40 ft			106.00					2.4E-05
42 ft								
44 ft / 13 m			105.00				- #1 Silica sand pack	
46 ft							- water bearing fracture 44'4" (13.5m)	
48 ft			104.00				Centalizer	
50 ft / 15 m			103.00					2.5E-03
52 ft							3.0m x 38mm Slot 10 PVC screen within #3 silica sand pack. - water bearing fracture 51'6" (15.7m)	
			102.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan. 27, Feb.5, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M190

Easting: 336274
Northing: 4902275
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
54			101.00					
56	17							
58			100.00					3.1E-06
60								
62	19		99.00				- fracture 61'5" (18.7m)	
64								
66			98.00					
68								
70	21		97.00					5.9E-09
72								
74			96.00					
76	23	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	95.00				- fracture 74'10" (22.8m)	
78								3.0E-06
80			94.00					
82	25							
84			93.00					
86								
88	27		92.00					1.3E-06
90								
92			91.00				- bentonite gravel seal	
94								
96	29		90.00					
98								7.9E-09
100			89.00					1.3E-08
102	31							
104			88.00					
106								
108		End of Borehole	87.00					
			86.00					
			85.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan. 27, Feb.5, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M191

Easting: 336332
Northing: 4902802
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	122.81				MOE Well tag # A163226 - Elev. M191 123.31 m TOC - Elev. M191 123.21m TPVC - TOC s/u 0.50m	
1 / 3 / 5 / 7 / 2 / 9 / 11 / 13 / 4 / 15 / 17 / 19 / 6 / 21 / 23 / 25 / 27 / 8 / 29 / 31 / 33 / 10 / 35 / 37 / 39 / 12 / 41 / 43 / 45 / 14 / 47 / 49 / 51 / 53 / 16 / 55 / 57		***Clay*** Dark to light brown, some silt trace organics. ***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	122.00 121.00 120.00 119.00 118.00 117.00 116.00 115.00 114.00 113.00 112.00 111.00 110.00 109.00 108.00 107.00 106.00		20 – 60 %		- 5.75" dia. (146mm) tri-cone to depth 8'9" - 4" dia. (100mm) steel casing grouted with cement to 8'9" (2.67m) - fracture trace water 13' (4m) - fractures 16'9", 17'8" (5.1, 5.4m) - weaker bedrock 19' - 19'8" (5.8 - 6m) - fracture 22' (6.7m) - bentonite gravel seal - fracture 44' (13.4m) - fracture 52'2" (15.9m)	4.5E-07 4.0E-07 3.5E-08 3.5E-09 4.8E-09 3.7E-09 3.7E-11

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan. 27, Feb. 6, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: South Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M191

Easting: 336332
Northing: 4902802
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
59–107	19–31	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	105.00–91.00				- bentonite gravel seal	3.4E-09
							- fracture 73'2" (22.3m)	7.7E-09
							- fracture 80'4" (24.5m)	7.1E-09
							- fracture 84'4" (25.7m)	
							- #1 silica sand	1.5E-08
							3.0m x 38mm Slot 10 PVC screen within #3 silica sand pack.	2.0E-06
								8.3E-07
107–117	33–35	End of Borehole	90.00–88.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Jan. 27, Feb. 6, 2015

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: Martin Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M192

Easting: 335976
Northing: 4902826
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	127.37				MOE Well tag # A163239 - Elev. M192 128.085 m TOC - Elev. M192 127.98m TPVC - TOC s/u 0.72m	
1 / 3 / 5 / 7 / 2 / 9 / 11 / 13 / 4 / 15 / 17 / 19 / 6 / 21 / 23 / 25 / 8 / 27 / 29 / 31 / 33 / 10 / 35 / 37 / 39 / 12 / 41 / 43 / 45 / 14 / 47 / 49 / 51 / 53 / 16 / 55 / 57		***Silt and Sand*** Topsoil over laying brown, moist to wet, some clay, trace gravel. - some coarse gravel, wet. ***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	127.00 126.00 125.00 124.00 123.00 122.00 121.00 120.00 119.00 118.00 117.00 116.00 115.00 114.00 113.00 112.00 111.00 110.00				- 8" dia. (203mm) HSA to depth 9'8" (2.94m) - 4" dia. (100mm) steel casing grouted with cement to 9'8" (2.94m) - w/l elev. 121.92m recorded March 4, 2016 - fracture or weak rock 7m - bentonite gravel seal - fractures 8.2 and 8.5m - weaker bedrock or fracture 10.5m - water bearing fracture 12.44m. - fracture or weaker rock 13.5m	7.E-10 5.E-06 2.E-09

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Dec. 4, 10, 2015, Feb. 22, 2016

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

Project No: K-B9504-18

Project: Martin Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M192

Easting: 335976
Northing: 4902826
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%, 20–60)	Fracture Frequency/Run	Comments	K (m/sec)
59–117	19–35	***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	109.00–93.00				- bentonite gravel seal - #1 silica sand - fracture or weaker rock 24m. - fracture or weak rock 24.5m - fracture or weak rock 26m 3.0m x 38mm Slot 10 PVC screen within #3 silica sand pack. - bentonite gravel seal	2.E-08 2.E-09 2.E-09 5.E-06 7.E-06 9.E-09
113–117	35	End of Borehole	93.00–92.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Dec. 4, 10, 2015, Feb. 22, 2016

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: Martin Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M193

Easting: 336082
Northing: 4902896
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Comments	K (m/sec)
-3 / -1		Ground Surface	127.52	MOE Well tag # A163240 - Elev. M193 128.17 m TOC - Elev. M193 127.07m TPVC - TOC s/u 0.65m	
1 / 3		Grey Clay	127.00		
5 / 7 / 2		***Silty Sand Till*** Brown, damp to moist, some well graded gravel.	126.00 125.00	- 8" dia. (203mm) HSA to depth 14' (4.27m) - 4" dia. (100mm) steel casing grouted with cement to 14' (4.27m)	
9 / 11 / 13 / 4			124.00 123.00		
15 / 17 / 19 / 6			122.00 121.00	- fracture or weak rock 5m. - fracture 5.5m - w/l elev. 122.03m recorded March 4, 2016	
21 / 23 / 25 / 8		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	120.00	- bentonite gravel seal	
27 / 29 / 31 / 33 / 10			119.00 118.00	- weaker bedrock or fracture 8.4m. - water bearing fracture 8.6	2.E-09
35 / 37 / 39 / 12			117.00 116.00	- #0 silica sand	2.E-09
41 / 43 / 45 / 14			115.00 114.00	- fracture or weaker rock 14m.	
47 / 49 / 51 / 16			113.00 112.00	- fracture 14.5m. 3.0m x 38mm Slot 10 PVC screen within #3 silica sand pack.	8.E-07
53 / 55 / 57			111.00 110.00		

Well Construction

Rock Quality Designation (%: 20, 60)

Fracture Frequency/Run

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Dec. 4, 9, 2015, Feb. 22, 2016

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: K-B9504-18

Project: Martin Property Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M193

Easting: 336082
Northing: 4902896
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
60			109.00					2.E-09
62	19						- bentonite gravel seal	
64			108.00					
66								
68			107.00					
70	21						- fracture or weaker rock 21m.	4.E-09
72			106.00					
74								
76	23		105.00					
78								4.E-09
80			104.00					
82	25							
84		***Limestone***	103.00					
86		Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.					- fracture or weak rock 26.5m.	
88	27		102.00					4.E-09
90								
92			101.00					
94								
96	29		100.00				- fracture or weak rock 29.5m.	
98								
100			99.00					
102	31						- fracture or weaker rock 31.5m.	
104			98.00				- bentonite gravel seal	
106								1.E-09
108	33		97.00				- water bearing fracture 33m.	
110								
112			96.00				- fracture or weaker rock 34m.	
114	35							
116			95.00					
118		End of Borehole	94.00					
			93.00					
			92.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Tri-cone
Hole Size: 3.87" (98mm)
Drill Date: Dec. 4, 9, 2015, Feb. 22, 2016

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: P.T.

BluMetric™ Environmental

Project No: 180150-02

Project: Complementary CAZ Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M200

Easting: 335796
Northing: 4902060
Field Personnel: B.Mc.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	116.00 / 115.40				MOE Well tag # A228384 - Elev. M200 116.02m TPVC - s/u 0.62m	
1 / 3 / 5 / 7 / 9 / 11		**Clay** Brown. **Limestone** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	115.00 / 114.00 / 113.00				- 150mm solid flight auger to 0.91m - 100sqmm steel casing with bentonite gravel seal - Fracture trace water 1.37m - Fracture trace water 1.82m - 1.5m x 50mm slot 10 PVc screen within #3 silica sand pack - weak bedrock, water bearing fractures, sulfur odour 2.44 - 3.05m	
13		End of Borehole	112.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Air Hammer
Hole Size: 5" (127mm)
Drill Date: April 17, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

BluMetric™ Environmental

Project No: 180150-02
Project: Complementary CAZ Investigation
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M201-DP

Easting: 335828
Northing: 4901991
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
ft / m					20 – 60			
-4 / -2			116.00				- Elev. M201-DP 116.20m TOC - TOC s/u 0.99m	
0		Ground Surface	115.21					
2		***Till*** Brown, clayey Sand.	115.00				- bentonite gravel seal	
4 / 1			114.00				- 0.5m x 32mm Steel screen	
6		End of Borehole						

Drilled By: BluMetric Environmental Inc.
Drill Method: Drive Point
Hole Size: 1.25" (32mm)
Drill Date: April 18, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

Project No: 180150-02

Project: Complementary CAZ Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M202

Easting: 335929
Northing: 4902013
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	117.00 / 116.48				MOE Well tag # A228379 - Elev. M202 117.22m TPVC - s/u 0.75m	
1 / 3 / 5 / 7 / 9 / 11		Overburden ***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones. End of Borehole	116.00 / 115.00 / 114.00 / 113.00				- 150mm solid flight auger to 1.37m - 100sqmm steel casing with bentonite gravel seal - weak bedrock, multiple fractures, trace water 1.68 - 2.29m - weak bedrock 2.37m - weak bedrock zones 2.5 - 2.74m - weak bedrock 3.05m	

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Air Hammer
Hole Size: 5" (127mm)
Drill Date: April 18, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

BluMetric™ Environmental

Project No: 180150-02
Project: Complementary CAZ Investigation
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M203

Easting: 335708
Northing: 4902128
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	118.18				MOE Well tag # A228386 - Elev. M203 118.91m TPVC - s/u 0.73m	
1 / 3 / 5 / 7 / 9		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	118.00 117.00 116.00				- 150mm solid flight auger to 1.07m - 100sqmm steel casing with bentonite gravel seal - weak bedrock 2.13m - 1.5m x 50mm slot 10 PVc screen within #3 silica sand pack - fracture trace water 2.59m	
11		End of Borehole	115.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Air Hammer
Hole Size: 5" (127mm)
Drill Date: April 18, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

BluMetric™ Environmental

Project No: 180150-02
Project: Complementary CAZ Investigation
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M204

Easting: 335912
Northing: 4902187
Field Personnel: B.Mc.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	116.06				MOE Well tag # A228385 - Elev. M204 m TPVC - s/u 0.86m	
1 / 3		***Sandy Clay*** Brown, wet to saturated.	116.00 115.00				- 150mm solid flight auger to 1.5m - 100sqmm steel casing with bentonite gravel seal	
5 / 2 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	114.00				- weak bedrock 2.19m	
9 / 11 / 13 / 4			113.00 112.00				- 1.5m x 50mm slot 10 PVc screen within #3 silica sand pack - weak bedrock trace water 4.11 - 4.42m	
15		End of Borehole						

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Air Hammer
Hole Size: 5" (127mm)
Drill Date: April 17, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: F.R.

BluMetric™ Environmental

Project No: 180150-02

Project: Complementary CAZ Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M205

Easting: 336078
Northing: 4902129
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1							MOE Well tag # A228367 - Elev. M205 116.58m TPVC - s/u 0.75m	
		Ground Surface	116.00 115.83					
1 / 3		***Sandy Clay*** Brown, wet to saturated.	115.00				- 150mm solid flight auger to 1.07m - 100sqmm steel casing with bentonite gravel seal	
5 / 2 / 7		***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	114.00				- weak bedrock, fracture, water bearing 2.07m - water bearing fracture 2.59m	
9 / 11			113.00				- 1.5m x 50mm slot 10 PVc screen within #3 silica sand pack - fracture trace water 3.17m - water bearing fracture 3.29m	
13 / 4		End of Borehole	112.00					

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Air Hammer
Hole Size: 5" (127mm)
Drill Date: April 17, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

BluMetric™ Environmental

Project No: 180150-02
Project: Complementary CAZ Investigation
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M206

Easting: 335939
Northing: 4902329
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-3 / -1		Ground Surface	119.00 118.89				MOE Well tag # A228368 - Elev. M206 119.70m TPVC - s/u 0.82m	
1 / 3 / 5 / 7 / 9 (2)		Overburden ***Limestone*** Light grey, lithographic fossiliferrous limestone with undulating shale partings. Stylolites are common. Numerous calcite stringers throughout. Occassional coarse crystalline zones.	118.00 117.00 116.00				- 150mm solid flight auger to 1.07m - 100sqmm steel casing with bentonite gravel seal - weak bedrock, fracture, water bearing 2.13m - 1.5m x 50mm slot 10 PVc screen within #3 silica sand pack	
11		End of Borehole						

Drilled By: GET Drilling Ltd.
Drill Method: Rotary Air Hammer
Hole Size: 5" (127mm)
Drill Date: April 17, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: F.R.

BluMetric™ Environmental

Project No: 180150-02
Project: Complementary CAZ Investigation
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M206-DP

Easting: 335960
Northing: 4902295
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
0		Ground Surface	118.00 117.79				- Elev. M206-DP 118.95m TOC - TOC s/u 1.16m	
0 – 4		Overburden.	117.00				- bentonite gravel seal - 0.5m x 32mm Steel screen	
6		End of Borehole	116.00					

Drilled By: BluMetric Environmental Inc.
Drill Method: Drive Point
Hole Size: 1.25" (32mm)
Drill Date: April 24, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

Project No: 180150-02

Project: Complementary CAZ Investigation

Client: Waste Management

Location: Richmond Landfill, Napanee, ON

Well ID: M207-DP

Easting: 336138
Northing: 4902190
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
-4 / -2			117.00				- Elev. M207-DP 117.71m TOC - TOC s/u 1.35m	
0		Ground Surface	116.36					
0			116.00				- bentonite gravel seal	
2 / 1		Overburden, brown, clayey.					- 0.5m x 32mm Steel screen	
4		End of Borehole	115.00					

Drilled By: BluMetric Environmental Inc.
Drill Method: Drive Point
Hole Size: 1.25" (32mm)
Drill Date: April 24, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

Project No: 180150-02
Project: Complementary CAZ Investigation
Client: Waste Management
Location: Richmond Landfill, Napanee, ON

Well ID: M209-DP

Easting: 335840
Northing: 4901958
Field Personnel: B.McC.

SUBSURFACE PROFILE

Depth (ft / m)	Stratigraphy	Description	Elevation (m)	Well Construction	Rock Quality Designation (%)	Fracture Frequency/Run	Comments	K (m/sec)
0		Ground Surface	116.20				- Elev. M209-DP 117.38m TOC - TOC s/u 1.17m	
0 – 8	1	Overburden, brown, clayey.	116.00 – 114.00				- bentonite gravel seal - 0.5m x 32mm Steel screen	
		End of Borehole						

Drilled By: BluMetric Environmental Inc.
Drill Method: Drive Point
Hole Size: 1.25" (32mm)
Drill Date: May 4, 2018

Drill Angle: Vertical
Azimuth: n.a.
Datum: NAD83
Checked By: M.C.

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