Stantec

1999 ANNUAL MONITORING REPORT VILLAGE OF CASSELMAN LANDFILL SITE

Prepared for:

The Corporation of the Village of Casselman

Prepared by:

Stantec Consulting Ltd.
871 Victoria Street North
Kitchener, Ontario
N2B 3S4

634-46550
February 2000

Table of Contents

List of Appendices

List of Figures

Appendix A

List of Tables

Appendix B

1.0 Introduction

Stantec Consulting Ltd. (Stantec) has prepared this report for the Corporation of the Village of Casselman (Casselman) to document the 1999 environmental monitoring program performed by Stantec at the Casselman Municipal Landfill Site (the Site). The Site is located approximately 4 km northwest of the Village of Casselman along the south bank of the South Nation River. Specifically, the Site occupies an area of 7.0 ha on a portion of the west half of Lot 14, Concession 5, Township of Cambridge, within the United Counties of Prescott-Russell in Eastern Ontario (refer to Figure 1). The east side of the Site shares a common boundary with the Nation (formerly Township of Cambridge) Municipal Landfill.

The Casselman Municipal Landfill was initially opened in 1972 to receive waste from residential and commercial sources at a rate of approximately 2 tons per week (McNeely, 1997). Waste disposal consists primarily of dumping (modified area method) solid waste over the bank of a gully approximately 10 m deep (Figure 2). The present areal extent of the disposal footprint is 2.8 ha and contains approximately 60,000 m^3 of waste. The theoretical capacity of the landfill is 304,800 m^3 (Stantec, 2000). The Environmental Protection Act regulated by the Ministry of the Environment (MOE) states that all landfills with a total waste volume of more than 40,000 m^3 must have a groundwater and surface water monitoring program. The results of the 1999 environmental monitoring program for the Site are presented in this report.

1.1 MONITORING REQUIREMENTS

The Casselman Municipal Landfill Site was initially registered with the Waste Management Branch of the MOE on 29 November 1971 under Provisional Certificate of Approval (CofA) No. A 471106. The MOE reissued CofAs for the Site on 5 July 1972, 24 July 1972, 20 July 1973 and 16 June 1980. Waste disposal was permitted provided that some basic engineering requirements were followed. These requirements included control of site access and manner of dumping, site grading to promote surface water runoff and waste compaction and covering. No stipulations were made at that time regarding an environmental monitoring program.

In May 1996, Casselman was advised that two Site inspections had been completed by the Cornwall District Abatement Section of the MOE and that an Inspection Report dated 16 May 1996 had been prepared. The Inspection Report required that certain deficiencies at the Site be corrected. Stantec (formerly McNeely Engineering Consultants Limited) was retained to address the concerns raised in the Inspection Report. Beatty Franz and Associates Ltd. (BFA) was subcontracted to conduct a hydrogeological assessment at the Site. BFA presented their findings in a report

entitled *Hydrogeological Assessment of the Village of Casselman Landfill* (BFA, 1997). It was recommended that seasonal monitoring of the groundwater levels, and groundwater and surface water chemistry be performed to establish seasonal trends. 1999 was the first year that an environmental monitoring program was carried out at the Site.

In addition to the monitoring at the Site, Golder Associates Ltd. (Golder) have performed the 1999 annual monitoring at the adjacent Nation Municipal Landfill. Since the Nation Municipal Landfill shares a common boundary with the Site, a number of shared surface water sampling locations have been identified. Golder has made surface water quality data available to Stantec to assist in the evaluation of the landfill leachate impacts on neighbouring properties (Golder, 2000). The MOE has provided surface water quality data that was collected by the South Nation River Conservation Authority (SNRCA) at a location upstream of both the Site and the Nation Municipal Landfill. This data has been used in conjunction with some of the Golder data to establish background water quality conditions for the South Nation River.

1.2 MONITORING OBJECTIVES

The environmental monitoring program was developed and implemented at the Site to evaluate temporal trends:

- in water levels at the Site; and,
- in groundwater and surface water quality at the Site.

The primary objective of the monitoring program is to ensure that there are no unacceptable impacts to human health or the environment related to chemicals originating from the Site. This is assessed by: (1) reviewing hydraulic monitoring data and historical water quality data to evaluate the likely future compliance status of the Site; and, (2) evaluating the current compliance status of groundwater and surface water quality relative to the applicable MOE policies and guidelines.

1.3 APPLICATION OF OBJECTIVES AND GUIDELINES

The groundwater component of the environmental monitoring program was evaluated by applying the groundwater quality data to:

- Ontario Drinking Water Objectives (ODWOs; MOE, 1994a); and,
- Reasonable Use Concept (Reasonable Use; MOE, 1994b and 1994c).

The ODWOs prescribe standards of quality for all drinking water supplies to protect public health. While most of the objectives have been adopted from the Canadian Drinking Water Guidelines, the Province of Ontario has set some health related and

aesthetic objectives. Groundwater quality data were compared with ODWOs, where established, and exceedences of the ODWOs are discussed in this report. The Reasonable Use Concept of water quality management establishes procedures for the determination of what constitutes reasonable use of groundwater on property adjacent to potential sources of contamination. Groundwater quality data were also applied to the Reasonable Use Concept and exceedences of calculated Reasonable Use concentrations are discussed.

The surface water component of the environmental monitoring program was evaluated by applying the surface water quality data to:

- Policies, Guidelines and Provincial Water Quality Objectives (PWQOs; MOE, 1994d)

The PWQOs are a set of narrative and numerical criteria designed for the protection of aquatic life and recreation in and on the water. They represent a desirable level of water quality that the MOE strives to maintain in surface waters. Surface water quality data were compared with PWQOs, where established, and exceedences of the PWQOs are discussed in this report.

1.4 REPORT ORGANIZATION

The remainder of this report is divided into sections that present:

- The Site setting describing Site drainage, geology, and hydrogeology, (Section 2.0);
- The scope of the 1999 environmental monitoring program (Section 3.0);
- Descriptions of the methods used to collect the groundwater and surface water, and implement quality assurance and quality control (Section 4.0);
- Assessments of the groundwater elevations, and groundwater and surface water quality data collected in 1999 (Section 5.0);
- Conclusions (Section 6.0); and
- Recommendations (Section 7.0); and,
- References (Section 8.0).

Figures and tables are presented in Appendices A and B, respectively. Field forms and laboratory certificates of analysis are presented in Appendices C and D, respectively.

2.0 Site Setting

Observations made during the 1999 monitoring program and the description of site drainage presented in the Leachate Treatment Options Report (Stantec, 2000) are used to describe Site drainage. Geologic and hydrogeologic data from the BFA report (BFA, 1997) are used to describe the geology and hydrogeology of the Site.

The physical components of surface water flow and Site topography are used to discuss the drainage at the Site. A brief description of the Site geology based on the Site borehole information and a literature review is presented. The physical components of groundwater, including flow direction and velocity, hydraulic gradients and conductivity, are discussed in the characterization of the Site hydrogeology.

2.1 SITE DRAINAGE

The Site is likely a local discharge zone based on the local relief and surficial drainage patterns. On-site drainage ditches and the deep gully, and the South Nation River act as the local and regional groundwater flow discharge points, respectively.

A significant portion of the surface water runoff, the result of precipitation and groundwater exfiltration from the south end of the Site, is diverted around the landfill by a perimeter cutoff ditch constructed in 1998 (refer to Figure 2). Precipitation over the central part of the landfill area infiltrates the waste placed within the deep gully where it likely discharges to the South Nation River.

The deep gully that shares the western boundary of the adjacent Nation Municipal Landfill provides a near-continuous flow of water to the South Nation River. There are two other smaller ravines incised into the riverbank at the north end of the property, but discharge of water from these ravines is intermittent.

2.2 GEOLOGY

The Site geology consists of a surficial brown, silty fine sand up to 3.0 m thick (observed in BH96-1, BH96-2 and BH96-4), underlain by a light grey, silty clay (BFA, 1997). The sand forms part of the Russell and Prescott sand plains and the clay forms part of the Ottawa Valley clay flats physiographic regions, respectively (Chapman and Putnam, 1984). The silty clay unit was observed at ground surface in BH96-3 and extends to a depth of at least 5.3 m below ground surface. Water well records from nearby domestic wells indicate that the silty clay unit is typically 10 m to 25 m in thickness. Both of these units are thought to be fluvial sedimentary deposits from the former Champlain Sea. Water well records indicated that the silty clay is

underlain by a sand and gravel unit and limestone bedrock. The bedrock, part of the Trenton and Black River Groups, also known as the Simcoe Group (or Ottawa Group in the Ottawa area), is encountered between 20 m and 30 m below grade in the vicinity of the Site (OGS, 1979).

2.3 HYDROGEOLOGY

The water table is encountered in the silty sand unit and the waste is thought to be controlled by seasonal recharge (precipitation events) (BFA, 1997). The water table is likely perched above the silty clay unit, which was interpreted to be an aquitard. As noted above, the silty sand unit does not extend to BH96-3, which is located north of the gully.

Water well records indicated that most domestic water is drawn from the sand and gravel unit, which represents a deeper aquifer above the bedrock.

Hydraulic conductivities were calculated using the Hvorslev method (Hvorslev,1951) from recovery test data collected from slug tests performed by BFA at each monitoring well. Based on the hydraulic conductivities calculated by BFA from the wells instrumented in the silty sand unit [BH96-2 (I), BH96-2 (II) and BH96-4] (BFA, 1997), the geometric mean hydraulic conductivity was 2×10^{-6} m/s. BFA calculated a hydraulic conductivity of 2.0×10^{-8} m/s from well BH96-3, instrumented in the silty clay.

The average linear groundwater velocity (v) flowing through the subsurface is calculated from the equation:

$$v = \frac{Ki}{n}$$

Where K is the hydraulic conductivity, i is the hydraulic gradient and n is the porosity.

BFA grouped the landfill waste material, which is a relatively transmissive hydraulic unit, with the silty sand unit to calculate a range of groundwater velocities. This paired unit was interpreted by BFA to contribute a higher percentage of groundwater into the deep gully and the South Nation River than the silty clay unit. Using the geometric mean hydraulic conductivity of 2×10^{-6} m/s, a hydraulic gradient of 0.008 m/m, and an assumed porosity of 0.30 for the silty sand unit, and a hydraulic conductivity of 1×10^{-5} m/s, a hydraulic gradient of 0.05 m/m, and a porosity of 0.35 assumed representative of the landfill waste, groundwater velocity was calculated to range from between 2 metres/year to 45 metres/year for the silty sand unit and the waste, respectively. A groundwater velocity of 0.02 metres/year was calculated for the silty clay unit using a hydraulic conductivity of 2×10^{-8} m/s, a hydraulic gradient of 0.008 m/m, and an assumed porosity of 0.30.

3.0 Scope of 1999 Monitoring Activities

The 1999 environmental monitoring program comprised the following elements:

- Groundwater level monitoring;
- Groundwater quality monitoring; and
- Surface water quality monitoring.

Groundwater and surface water monitoring was carried out in two semi-annual monitoring events. The spring semi-annual monitoring event occurred on 15 and 16 May 1999. The fall semi-annual monitoring event occurred on 21 and 22 October 1999. Table 1 presents a summary of the 1999 monitoring program and sampling schedule. Highlights of the monitoring program are summarized below.

Water levels were measured in all wells sampled in the spring and fall, as scheduled. A water level was not encountered in monitoring well BH96-2 (II) for either monitoring event and the well was noted as "dry" on the field forms.

Groundwater and surface water samples were collected and analyzed as scheduled, with a few exceptions. Departures from the planned 1999 water sampling program are presented below:

- As a result of monitoring well BH96-2 (II) being dry, groundwater samples could not be collected from this well for either monitoring event.

Water samples submitted for laboratory analysis were analyzed for one or more of the following suites of chemical parameters: general chemistry, metals, or surface water specific as listed in Table 1.

4.0 Methods

This section presents the methods used to collect the groundwater and surface water monitoring data, and implement quality assurance and quality control (QA/QC).

4.1 GROUNDWATER MONITORING

4.1.1 Water Level Measurement

Water levels were measured to the nearest 0.01 m using either a Heron (May 1999) or a Waterra (October 1999) water level meter. The electrode was slowly lowered into the well until the meter emitted an audible sound indicating that the electrode had contacted water. The electrode was repeatedly raised and lowered slightly to confirm the exact depth to water. The depth to water from the reference point of the well was read from the graduated tape of the water level meter and recorded. The electrode and approximately 1 m of the graduated tape were cleaned before initial use and after use at each well by rinsing with distilled water. Groundwater elevations were calculated by subtracting the depth-to-water measurement from the surveyed reference elevation (top of casing) for each monitoring well.

The locations of groundwater monitoring wells are shown on Figure 2.

4.1.2 Well Purging

Prior to sampling, each monitoring well was purged to permit the collection of representative groundwater samples. Typically, three times the standing volume of water in the well was purged, unless the well exhibited insufficient yield. For wells with low yields, the well was pumped "dry", allowed to recover, and the process repeated until a minimum of one well volume was removed. Purging was conducted by manual oscillation of the inertial-lift Waterra pump dedicated to each well. Each Waterra pump consists of 16 mm inside diameter, high density polyethylene tubing connected to a Delrin footvalve. Purging was conducted at a rate of approximately 2 L/min with the footvalve located between 0.5 m and 1 m above the bottom of the well. The purge rate and total volume of water purged were measured by collecting purge water in a calibrated bucket.

4.1.3 Field Parameters Measurement

Stantec

Field measurements of temperature, pH, specific conductance, dissolved oxygen and, in May only, turbidity were completed on a sample of groundwater prior to sample collection. During the May 1999 monitoring event, the temperature, pH,

specific conductance, dissolved oxygen and turbidity were all measured using a Horiba U-10 multimeter. During the October 1999 monitoring event temperature and pH were measured using a Hanna pH meter (Model pHep®3), specific conductance was measured using a Myron L conductivity meter (Model EP) and dissolved oxygen was measured using a Yellow Springs Instruments oxygen meter (Model 51 B). The meters were cleaned, calibrated, used and stored in accordance with the manufacturers' instructions. Visual observations of colour and turbidity were also recorded along with the field parameter measurements on the field forms presented in Appendix C.

4.1.4 Sample Collection, Handling and Custody

Following purging, groundwater samples were collected by pouring water directly from the high-density polyethylene (HDPE) tubing into the appropriate pre-labeled sample containers. The sample containers were provided by the analytical laboratory and, where appropriate, were shipped with acid preservative already in the containers. Samples requiring filtration were collected after attaching a high capacity, disposable 0.45 µm (micron) in-line filter to the HDPE tubing. Table 2 summarizes the sample volume collected, type of sample container, sample preservative, filtering requirements and holding times for the required analyses.

After collection, the groundwater samples were carefully packed in insulated sample coolers containing ice packs and stored at approximately 4°C. A chain-of-custody form was completed and included in each cooler. The samples were delivered directly by Stantec personnel, or shipped to the laboratory by overnight courier.

4.1.5 Laboratory Analyses

Seprotech Laboratories, located in Ottawa, Ontario, performed the laboratory analyses. The analyses are summarized in Table 2. The laboratory reports of analyses and corresponding chain-of-custody forms are presented in Appendix D.

4.2 SURFACE WATER MONITORING

Surface water samples were collected from sampling locations shown on Figure 2 and summarized below:

- Surface water sample SW-1 was collected from the stream at the base of the gully into which the waste was placed. This sampling point corresponds to Golder sampling point CSW-1 and is thought to be representative of the surface water discharging from the Site prior to its mixing with surface water from the adjacent Nation Landfill through which the gully passes;

- Surface water sample SW-2, collected on one occasion by BFA from a small ravine that is incised into the riverbank at the north end of the Site, was not included in the 1999 environmental monitoring program;
- Surface water sample SW-5 was collected from the gully at a point halfway between SW-1 and the South Nation River, downstream of the neighbouring Nation Municipal Landfill; and,
- Surface water sample SW-3 was collected from the perimeter cutoff ditch located in the far northwest corner of the property at the top of the embankment to the South Nation River. SW-3 was added to the sampling program in October 1999 because the newly excavated ditch, not monitored previously, cuts off most of the groundwater flowing from the landfill towards the west and discharges it to the South Nation River.

Surface water flow in the gully and perimeter cutoff ditch was estimated by measuring the cross-sectional area of the ditch or gully at the point of sampling and using a floating object to estimate flow velocity.

Surface water samples were collected by removing the cap from the sample container and slightly immersing the container in the water. A depth-integrated sample (surface to 0.15 m deep) was collected by allowing the water to slowly enter the container. Care was taken to prevent any acid preservative in the sample container from escaping. Prior to collecting surface water samples, Stantec staff cleared the water surface of any floating particulates using a clean disposable latex or nitrile glove. Surface water samples were stored, handled and analyzed following the same procedures described for groundwater samples in Sections 4.1.4 and 4.1.5.

4.3 QUALITY ASSURANCE AND QUALITY CONTROL

The data quality objectives (DQOs) and quality assurance and quality control (QA/QC) procedures incorporated into the environmental monitoring program are described in this section. DQOs were established to ensure that the quality of the monitoring data was appropriate for its intended use.

4.3.1 Groundwater Elevation Data

Data quality was assured by performing successive measurements in the field, checking all data transcription and calculations, and comparing any anomalous measurements with historical values.

4.3.2 Groundwater and Surface Water Quality Data

For groundwater and surface water samples, the DQO for the chemical concentration data required that the data be precise, accurate, representative, comparable and complete. Data quality was assured by:

- submitting field QC samples for analysis;
- laboratory QA/QC procedures;
- checking all data transcription;
- performing a detailed data validation on the analytical results; and,
- undertaking response actions, as necessary.

The 1999 monitoring program incorporated the submission and analysis of one field blank sample. The field blank was prepared during the October monitoring event by filling one set of sample containers designated for surface water sample analysis with commercially purchased distilled water. The field blank sample bottles were labelled with a fictitious sample ID (SW-7) and submitted for the same analyses as the surface water samples.

5.0 Results

This section presents the results of groundwater level monitoring and water quality sampling for the 1999 environmental monitoring program. Data collected in 1999 by Golder (Golder, 2000) and SNRCA (MOE, 2000) supplemented the monitoring data collected by Stantec at the Site. The data collected by BFA (BFA, 1997) in 1996 were used to complete a preliminary assessment of temporal trends in the monitoring data.

The results are presented in two sections as they pertain to groundwater and surface water.

5.1 GROUNDWATER

Water level data collected during the 1999 monitoring program are used to describe the hydrogeology of the Site. Analytical results for groundwater samples are presented to assess the impact of Site activities on the water quality on neighbouring properties and the South Nation River.

5.1.1 Groundwater Elevation Data

The depth to water measurements and calculated groundwater elevations for the 1999 monitoring program are presented in Table 3. The groundwater elevations are illustrated on Figure 3 for the monitoring events in May and October. Due to the well spacing and limited number of monitoring locations, water level elevation contours have not been generated.

As shown on Figure 3, the groundwater flow in the silty sand unit (shallow aquifer) is approximately to the north and northwest. Most of the groundwater from the shallow aquifer is interpreted to discharge into the gully that intersects the property immediately to the north of the fill area. The lateral hydraulic gradient in the shallow aquifer was calculated to be 0.004 m/m for both monitoring events based on the distance and the difference in elevations between wells BH96-4 and BH96-1. Groundwater flow on the north side of the gully is likely affected by both the South Nation River and the gully. As illustrated on Figure 3, it is expected that groundwater flow is influenced by the topography at the Site.

The groundwater elevations were between 0.06 m and 0.2 m higher in the spring than in the fall monitoring event with the exception of the groundwater elevation at well BH96-3, which was 0.72 m lower in the May 1999 monitoring event. As noted in Section 2.2, BH96-3 is screened in silty clay unit, while the other monitoring wells are screened in the silty sand unit.

The 1999 groundwater elevations were not consistent with the groundwater elevations measured in 1996 by BFA. In general the water levels measured in 1999 were 1 m lower than in 1996 with the exception of the water levels measured at BH96-1, which were fairly similar. Continued monitoring is required before any trends can be established.

5.1.2 Hydraulic Conductivity and Flow Velocity

The groundwater velocity in the silty sand unit was estimated using the geometric mean hydraulic conductivity of 2×10^{-6} m/s, a hydraulic gradient of 0.004 m/m (Section 5.1.1) and an assumed porosity of 0.30 (Freeze and Cherry, 1979). Using the procedure described in Section 2.3, an average linear groundwater velocity of approximately 1 metre/year was calculated for groundwater flowing through the silty sand aquifer.

5.1.3 Groundwater Quality

Summaries of all available (current and historical) groundwater quality data are presented in Tables 4 and 5. To evaluate the potential impact of the landfill on groundwater quality of neighbouring properties, the groundwater quality in wells downgradient of the waste disposal area was compared with groundwater quality in the well located upgradient of the waste disposal area. Concentrations in groundwater at both upgradient and downgradient wells were compared with ODWOs (MOE, 1994a), where established. The Reasonable Use Concept (MOE, 1994b and 1994c) was used to assess the potential for the Site to have unacceptable impacts on downgradient groundwater quality. Groundwater quality at downgradient wells was compared with the Reasonable Use concentrations (presented in Table 6) derived from the background groundwater quality.

5.1.3.1 Background Well

Monitoring well BH96-4 is located at the approximate midpoint of the southern property boundary, upgradient from the limit of refuse disposal in the landfill. Water quality in this well is believed to be representative of background conditions in the shallow silty sand aquifer.

The background concentrations were fairly consistent with the measurements reported in 1996 by BFA. The groundwater sample collected in 1996 had concentrations of aluminum, iron and manganese that exceeded the ODWO criteria; however, these parameters were not detected at concentrations that exceeded ODWOs in 1999. Total hardness, turbidity and, in one instance, colour were the only

parameters exceeding ODWOs in the 1999 samples, and they are summarized as follows:

- Total hardness (measured as $CaCO_3$) concentrations ranged from 124 mg/L to 140 mg/L, which slightly exceeded the ODWO Operational Guideline (OG) of 80 mg/L to 100 mg/L. The hardness of the groundwater is primarily caused by the presence of calcium and magnesium and is believed to be naturally occurring and not attributable to the Site. Groundwater quality with hardness concentrations of up to 500 mg/L is considered poor but tolerable;
- Turbidity in the background well ranged from 18.7 nephelometric turbidity units (NTU) to 187 NTU. The ODWO Aesthetic Objective (AO) for turbidity is 5 NTU. Turbidity is caused by suspended particles and gives an indication of well development or well construction. Well development removes fine-grained materials from around the filter pack and well screen that may otherwise interfere with groundwater quality. If the screened interval in a monitoring well has a slot size that is too large for the material into which it is installed or if an inappropriate filter pack sand has been selected, fine-grained materials may enter the well. There were no specific well construction details addressing slot size or filter pack size in the BFA report (BFA, 1997), nor was there any indication that the monitoring wells were developed after they were installed; and,
- The colour of the samples collected from well BH96-4 ranged from 3 true colour units (TCU) to 13 TCU. The ODWO AO for turbidity is 5 TCU. Colour in water may be due to the presence of dissolved organic matter, suspended matter associated with turbidity, or certain metals such as iron, manganese and copper.

The groundwater quality data for samples collected at BH96-4 indicates that the groundwater flowing through the shallow aquifer does not appear to be adversely impacted prior to migration through the landfill area. The summary of historical groundwater quality data for background well BH96-4 is presented in Table 4.

5.1.3.2 Downgradient Wells

Evaluation of groundwater quality for the wells located downgradient (north of the waste disposal area) indicated that several parameters exceeded ODWO criteria and that the concentrations of most of these parameters are greater than in the samples collected from background well BH96-4. This would suggest that the landfill is impacting groundwater quality at downgradient wells. The parameters identified as exceeding the ODWOs were total hardness, alkalinity (in one well), turbidity, colour, total dissolved solids, iron and manganese. The groundwater samples collected in 1996 also had concentrations of aluminum that exceeded the ODWO criteria; however, this parameter was not detected at concentrations that exceeded ODWOs in 1999. As with the background data, the results of laboratory analysis of

groundwater samples collected in 1999 were fairly consistent with the measurements reported for 1996 (BFA, 1997).

It was noted that all of the parameters identified as exceeding the ODWOs were considered non-health related parameters. There were no exceedances of the ODWOs for health related parameters.

The summary of historical groundwater quality data for downgradient wells is presented in Table 5. The parameters exceeding the ODWOs are summarized as follows:

- Total hardness (measured as $CaCO_3$) ranged from 199 mg/L to 1,100 mg/L and exceeded ODWOs in all downgradient wells. The total hardness measured in the downgradient wells were on average between 2 and 5 times greater than detected in the background well;
- Alkalinity (also measured as $CaCO_3$) ranged from 15 mg/L to 1,300 mg/L. Only alkalinity concentrations in well BH96-1 exceeded the ODWO OG of 30 mg/L to 500 mg/L. However, the average alkalinity in the downgradient wells was between 1.5 and 7 times greater than that detected in the background well;
- Turbidity in the downgradient wells ranged from 4.1 NTU to >200 NTU and exceeded ODWOs in all downgradient wells. The turbidity levels were about 2 times greater in the downgradient wells, with the exception of BH96-3, which was 2 times lower than the background well. As suggested in Section 4.2.1, lack of proper well development or inappropriate well construction may be the cause of the turbid groundwater samples;
- The colour of the samples collected from the downgradient wells ranged from 1 TCU to 65 TCU and exceeded ODWOs in downgradient wells BH96-1 and BH96-2(I). The measurements of colour in the downgradient wells were relatively similar to the background well;
- Total dissolved solids (TDS) represents the sum of dissolved minerals in the water. TDS concentrations ranged from 314 mg/L to 1,503 mg/L in the groundwater samples collected from the downgradient wells. The ODWO AO for TDS is 500 mg/L. The ODWO was exceeded in samples collected from monitoring wells BH96-1 and BH96-3. TDS in the downgradient wells was detected at concentrations between 2 and 6 times greater than concentrations in the background well;
- Iron was detected in the samples collected from the downgradient wells at concentrations ranging from 0.12 mg/L to 111 mg/L. The ODWO AO for iron (0.30 mg/L) was exceeded in one or more of the groundwater samples collected from each well in 1999, with the exception of the samples collected from BH96-3. Similarly, the average concentrations of iron, by well, were 100 times to 200 times

greater than background with the exception of BH96-3, which had an average concentration that was less than background. Iron is a very common constituent of landfill leachate-impacted water and is a reactive species in groundwater. Elevated iron concentrations are associated with the reducing conditions typical of landfills and precipitates out of solution in an oxidizing environment; and,

- Manganese was detected at concentrations in exceedance of the ODWO AO (0.05 mg/L) in the samples collected from the downgradient wells, with the exception of the samples collected from BH96-3 in 1999. Manganese concentrations ranged from <0.01 mg/L to 7.3 mg/L. The average concentrations of manganese ranged from 2 times (BH96-3) to 177 times (BH96-1) greater than background. Manganese is a very common landfill leachate constituent and is a reactive species in groundwater. As with iron, elevated manganese concentrations are associated with the reducing conditions typical of landfills and precipitates out of solution in an oxidizing environment.

As mentioned in Section 5.1.3.1 and in the discussion on iron and manganese above, reducing conditions typically exist within landfill refuse. The lowered average concentrations of dissolved oxygen (3.0 mg/L and 2.6 mg/L) and sulphate (3.5 mg/L and 9.5 mg/L) in wells BH96-1 and BH96-2(I), respectively support this statement. Average concentrations of dissolved oxygen (8.2 mg/L) and sulphate (315 mg/L) in well BH96-3 are higher than those in the background well. Two conclusions can be drawn from this observation; the first is that reducing conditions likely do not exist in well BH96-3 and the second is that well BH96-3 does not seem to be hydraulically connected to wells BH96-1 and BH96-2(I).

Considering that there are at most three (3) data points for each parameter analyzed, there is insufficient data to draw conclusions with respect to temporal trends. However, based on the available groundwater data, there does appear to be a spatial trend between well BH96-3 (north of the deep gully) and wells BH96-1, BH96-2(I) and BH96-2(II) south of the deep gully. In general, the groundwater samples collected from BH96-3 have lower concentrations and fewer exceedences of ODWOs than those collected from BH96-1, BH96-2(I) and BH96-2(II). A possible explanation for this spatial trend may be that the deep gully hydraulically separates the well BH96-3 from the other wells. The gully likely acts as a discharge zone for groundwater flowing northward through the silty sand unit and the buried waste. Leachate-impacted groundwater was observed to exfiltrate into the deep gully and it is unlikely to be reaching BH96-3. Furthermore, the silty sand unit was not present at well BH96-3, which is screened in the silty clay unit.

Stantec

5.1.3.3 Reasonable Use Concept

The Reasonable Use Concept (MOE, 1994b and 1994c) is intended to be applied to groundwater to determine what constitutes a reasonable use of groundwater on land

associated with or adjacent to potential sources of subsurface contamination. Reasonable Use is used to determine maximum acceptable groundwater concentrations for groundwater migrating from a waste disposal site. The concept is applied to groundwater at each monitoring well at the downgradient Site boundary. Although the north boundary of the Site is the South Nation River, for the purposes of applying the Reasonable Use Concept, wells BH96-1, BH96-2(I) and BH96-2(II) effectively serve as downgradient Site boundary wells as explained in Section 5.1.3.2. In assessing the amount of impact that is acceptable, consideration is given to background groundwater quality, the present quality of the groundwater and the potential impact of groundwater from all sources.

The maximum acceptable concentration (Cm) of a particular parameter that can occur in groundwater at the downgradient Site boundary is calculated using the following equation:

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

Where Cb is the average background concentration, Cr is the ODWO for the parameter, and x is a constant that reduces the constituent to a level considered by the MOE to have a negligible effect on the use of the water (0.5 for non-health related parameters or 0.25 for health-related parameters). Levels of a parameter greater than Cm may have an effect on the use of groundwater on the adjacent property.

It should be noted that groundwater use downgradient of the Site is very unlikely due to the proximity of the South Nation River, which likely acts as a flow divide in the silty sand aquifer. In addition, the silty clay aquitard underlying the silty sand shallow aquifer may act as a confining unit that would likely protect the deeper aquifer into which most local domestic wells have been installed.

Table 6 presents a comparison of the 1999 groundwater quality data to Reasonable Use concentrations. It was noted that the concentrations of several parameters exceeded the ODWOs (refer to Section 5.1.3.2). Further impairment of the groundwater quality above the ODWO criteria for these parameters in the wells mentioned in Section 5.1.3.2 is unacceptable.

The parameters that exceeded the calculated Reasonable Use concentrations were as follows:

- Alkalinity in BH96-1 and BH96-3;
- Arsenic in BH96-1;
- Total dissolved solids in BH96-2(I); and,
- Sulphate and aluminum in BH96-3.

Therefore, further impairment of the groundwater quality above the Reasonable Use concentrations for these parameters in the wells mentioned is also unacceptable.

All of the above parameters, with the exception of arsenic are non-health related parameters. Although arsenic, a health-related parameter, exceeded the Reasonable Use concentration at BH96-1, it is unlikely that groundwater originating from this location would be used as a potable water supply. The conceptual hydrogeologic model presented in Section 2.3 interprets that groundwater in the vicinity of BH-96-1 likely discharges to surface water in the gully. The assessment of surface water quality is presented in Section 5.2.2.

5.2 SURFACE WATER

Observations and surface water flow data collected during the 1999 monitoring program are used to describe Site drainage. Analytical results for surface water samples are presented to assess the impact of Site activities on the water quality on neighbouring properties and the South Nation River.

5.2.1 Site Drainage

The surface water flow during the May 1999 monitoring event was measured at 36 L/min at sampling point SW-5 and was not measured at sampling point SW-1 due to insufficient flow of water. The surface water flow during the October 1999 monitoring event was measured at 66 L/min at sampling points SW-1 and SW-3, and 24.3 L/min at sampling point SW-5, respectively.

5.2.2 Surface Water Quality

Surface water samples were collected from the perimeter cutoff ditch and from the deep gully as described in Section 4.2 (refer to Figure 2). The surface water quality data are presented in Table 7. As mentioned in Section 1.1, additional surface water quality data were provided by Golder for two of the same sampling points used by Stantec (SW-1 and SW-5 along the deep gully) and for four locations on the South Nation River. The MOE also provided surface water quality data collected by the SNRCA for a point approximately 2.5 km upstream of the Site. The Golder and SNRCA water quality data are also presented in Table 7.

Comparison of the groundwater quality results to the surface water quality data suggests that the majority of the leachate-impacted water generated at the Site migrates to the surface water environment rather than impacting the groundwater. A detailed evaluation of the surface water quality data has been divided into a section on the perimeter cutoff ditch and deep gully, and a section on the South Nation River (Sections 5.2.2.1 and 5.2.2.2, respectively).

5.2.2.1 Perimeter Cutoff Ditch and Deep Gully

Evaluation of the surface water quality data for the one sample collected from the ditch along the west side of the Site (SW-3) indicated that aluminum, cobalt and silver exceeded the PWQO criteria. The cobalt (0.0007 mg/L) and silver (0.0002 mg/L) exceedences were slightly above the PWQO and the method detection limit (MDL). Decreased instrument resolution at low concentrations may account for the cobalt and silver detection. The aluminum exceedance (0.12 mg/L) was 1.5 times the PWQO and is considered minor. Because flow rates for the ditch and the South Nation River are not available, the contribution of leachate-impacted surface water from the ditch to the South Nation River can not be determined. However, the flow rate in the ditch is expected to be very low compared to the South Nation River, and, given the low concentrations reported at well BH96-3, it is expected that the mass flux from the ditch to the river would be negligible.

Samples were collected at sampling point SW-1 on four separate sampling events in 1999. Evaluation of the surface water quality data for samples collected from the deep gully at SW-1 (Golder sample CSW-1) indicated that the following parameters exceeded PWQO criteria (the number of exceedances per samples analyzed and concentration ranges are also listed per parameter):

General Chemistry

- Dissolved oxygen (DO) – ranged from 1 to 9.3 mg/L. Two of three samples were below the PWQO, which was set at 6 mg/L as a conservative measure using the average of the measured surface water temperatures (13.3°C) and the corresponding cold water biota objective;
- Alkalinity (3 of 4 samples) – ranged from 419 mg/L to 1,120 mg/L. The Interim PWQO (IPWQO) is 30 mg/L to 500 mg/L;
- Un-ionized ammonia (NH_3-N) (4 of 4 samples) – ranged from 0.033 mg/L to 0.37 mg/L. The PWQO for NH_3-N is 0.02 mg/L;
- Hydrogen sulphide (2 of 2 samples) – ranged from <0.01 mg/L to 0.1 mg/L. The PWQO for hydrogen sulphide is 0.002 mg/L;
- Phenols (3 of 4 samples) – ranged from <0.001 mg/L to 0.015 mg/L. The PWQO for phenols is 0.001 mg/L; and,
- Total phosphorus (4 of 4 samples) – ranged from 0.10 mg/L to 0.33 mg/L. The IPWQO for total phosphorus was set at 0.03 mg/L because sampling was performed on rivers and streams.

Metals

- Aluminum (1 of 4 samples) – ranged from <0.03 mg/L to 0.17 mg/L. The IPWQO for aluminum is 0.075 mg/L based on total aluminum in clay-free samples;
- Boron (2 of 2 samples) – ranged from 0.64 mg/L to 1.85 mg/L. The IPWQO for boron is 0.2 mg/L;
- Cobalt (4 of 4 samples) – ranged from 0.0015 mg/L to 0.016 mg/L. The IPWQO for cobalt is 0.0006 mg/L;
- Iron (4 of 4 samples) – ranged from 11.2 mg/L to 47.6 mg/L. The PWQO for iron is 0.3 mg/L; and,
- Silver (2 of 4 samples) – ranged from <0.0001 mg/L to 0.0008 mg/L. The PWQO for silver is 0.0001 mg/L.

The monitoring results for SW-1 suggest that leachate-impacted groundwater is discharging to the gully. Based on the available data at sampling location SW-1, no significant temporal variations were noted between the various sampling events in 1999 or between the 1999 and 19996 data. The possibility exists that there may be seasonal temporal trends but there is insufficient data to draw conclusions at this time.

Samples were collected at sampling point SW-5 on 11 sampling events in 1999. Evaluation of the surface water quality data for samples collected from the gully at SW-5 indicated that the following parameters exceeded PWQO criteria (the number of exceedances and concentration ranges are also listed per parameter):

General Chemistry

- Alkalinity (5 of 6 samples) – ranged from 462 mg/L to 827 mg/L;
- Un-ionized ammonia (NH_3-N) (15 of 15 samples) – ranged from 0.08 mg/L to 0.7 mg/L;
- Hydrogen sulphide (7 of 11 samples) – ranged from <0.01 mg/L to 0.02 mg/L;
- Phenols (2 of 7 samples) – ranged from <0.001 mg/L to 0.02 mg/L; and,
- Total phosphorus (6 of 7 samples) – ranged from 0.03 mg/L to 0.43 mg/L.

Metals

- Aluminum (3 of 7 samples) – ranged from <0.03 mg/L to 1.46 mg/L;
- Boron (5 of 5 samples) – ranged from 0.81 mg/L to 1.57 mg/L;
- Cobalt (5 of 7 samples) – ranged from <0.0005 mg/L to 0.0077 mg/L;
- Iron (6 of 7 samples) – ranged from 0.04 mg/L to 12.6 mg/L;

- Nickel (1 of 7 samples) – ranged from <0.01 mg/L to 0.03 mg/L. The PWQO for nickel is 0.025 mg/L;
- Silver (2 of 7 samples) – ranged from <0.0001 mg/L to 0.0005 mg/L;
- Vanadium (1 of 7 samples) – ranged from <0.005 mg/L to 0.01 mg/L. The IPWQO for vanadium is 0.007 mg/L; and,
- Zinc (5 of 7 samples) – ranged from 0.03 mg/L to 0.19 mg/L. The PWQO for zinc is 0.03 mg/L.

The monitoring results for SW-5 suggest that leachate-impacted groundwater is discharging to the gully. Based on the available data at sampling location SW-5, no temporal variations were noted. There is no historical data for SW-5 prior to 1999 since BFA did not sample at this particular location. The possibility exists that there may be seasonal temporal trends but there is not yet sufficient data to make any conclusions.

5.2.2.2 South Nation River

Golder collected surface water samples from four sampling points on the South Nation River. Sampling point SW-7 was collected from a point approximately 250 m upstream of the shared boundary between both landfills, SW-8 from a point approximately 100 m downstream of the shared boundary between both landfills, and SW-9 and SW-10 from the mixing zone at the mouth of the gully. Staff from SNRCA collected surface water samples from a point on the South Nation River approximately 2.5 km upstream of both landfills.

Upstream

Upstream water quality data establishes background conditions for the South Nation River that can be used to evaluate if surface water discharge to the river is degrading the river water quality.

Samples were collected at sampling point SW-7 on four separate sampling events in 1999. Evaluation of the surface water quality data for the samples collected from SW-7 indicated that the following parameters exceeded PWQO criteria (the number of exceedances and concentration ranges are also listed per parameter):

General Chemistry

- Hydrogen sulphide (1 of 2 samples) – ranged from <0.001 mg/L to 0.02 mg/L; and,
- Total phosphorus (4 of 4 samples) – ranged from 0.04 mg/L to 0.20 mg/L.

Metals

- Aluminum (3 of 4 samples) – ranged from <0.03 mg/L to 0.68 mg/L; and,

- Iron (2 of 4 samples) – ranged from <0.01 mg/L to 0.45 mg/L.

With the exception of one exceedance of aluminum (0.68 mg/L) in May 1999, the metals exceedences in the samples collected from SW-7 were slightly above PWQO criteria.

Samples were collected at the upstream SNRCA location on five separate sampling events, one in September 1998 and four in 1999. Evaluation of the surface water quality data for samples collected from approximately 2.5 km upstream of the landfills indicated that the following parameters exceeded PWQO criteria (the number of exceedances and concentration ranges are also listed per parameter):

General Chemistry

- Dissolved oxygen (DO) (1 of 4 samples) – ranged from 0.08 to 8.54 mg/L. The PWQO which was set at 4 mg/L as a conservative measure using the average of the measured surface water temperatures (20.9°C) and the corresponding cold water biota objective; and,
- Total phosphorus (5 of 5 samples) – ranged from 0.038 mg/L to 0.10 mg/L.

Metals

- Aluminum (5 of 5 samples) – ranged from 0.10 mg/L to 0.15 mg/L;
- Cadmium (2 of 5 samples) – ranged from 0.0001 mg/L to 0.0004 mg/L. The PWQO for cadmium is 0.0002 mg/L; and,
- Cobalt (1 of 5 samples) – ranged from 0.0001 mg/L to 0.0010 mg/L. The IPWQO for cobalt is 0.0006 mg/L.

Microbiological

- Escherichia Coli (2 of 5 samples) – ranged from 8 counts/100 mL to 200 counts/100 mL. The PWQO for E. Coli is 100 counts/100 mL.

Analytical results were not available for hydrogen sulphide, phenols, boron and silver in the SNRCA data set. Microbiological data was only available for the SNRCA data set.

Generally, no historical data was available for the upstream monitoring locations, and therefore it was not possible to evaluate annual changes in water quality at these locations.

Mixing Zone

Surface water samples were collected from mixing zone monitoring locations SW-9 and SW-10 on two separate sampling events in 1999. Evaluation of the surface water quality data for the samples collected from SW-9 and SW-10 indicated that the

following parameters exceeded PWQO criteria (the number of detects and concentration ranges are also listed per parameter):

General Chemistry

- Hydrogen sulphide (2 of 4 samples) – ranged from <0.01 mg/L to 0.02 mg/L;
- Phenols (2 of 4 samples) – ranged from <0.001 mg/L to 0.011 mg/L; and,
- Total phosphorus (4 of 4 samples) – ranged from 0.04 mg/L to 0.07 mg/L.

Metals

- Aluminum (1 of 4 samples) – ranged from <0.03 mg/L to 0.12 mg/L.

The concentrations of the general chemistry parameters detected above the PWQO criteria were similar to the upstream data. Similarly, the metals exceedences were slightly above the PWQO criteria. The only potential indicator of leachate impact is the exceedances of the PWQO for phenols. Phenols did not exceed the PWQO in the upstream samples. However, it should be recognized the only two sampling events have bee completed in the mixing zone. Longer term monitoring would be required to confirm these exceedances.

It was not possible to evaluate annual variations in water quality in the mixing zone because no historical data is available.

Downstream

Samples were collected at sampling point SW-8 on four separate sampling events in 1999. Evaluation of the surface water quality data for the samples collected from SW-8 indicated that the following parameters exceeded PWQO criteria (the number of detects and concentration ranges are also listed per parameter):

General Chemistry

- Hydrogen sulphide (1 of 2 samples) – ranged from <0.01 mg/L to 0.01 mg/L;
- Phenols (1 of 4 samples) – ranged from <0.001 mg/L to 0.003 mg/L; and,
- Total phosphorus (4 of 4 samples) – ranged from 0.04 mg/L to 0.12 mg/L.

Metals

- Aluminum (3 of 4 samples) – ranged from 0.07 mg/L to 0.23 mg/L; and,
- Iron (1 of 4 samples) – ranged from <0.01 mg/L to 0.59 mg/L.

As with the mixing zone data, the general chemistry parameters detected above the PWQO criteria were similar to the upstream data and the metals exceedences were slightly above the PWQO criteria.

The only potential indicator of leachate impact is the exceedance of the PWQO for phenols. Phenols did not exceed the PWQO in the upstream samples. It should be recognized that only two sampling events have been carried out at the downstream monitoring locations. Longer term monitoring data would be required to confirm this exceedance. Iron exceeded the PWQO in one of the samples collected at SW-8; however, the iron concentration was similar in magnitude to that measured at upstream monitoring location SW-7.

Since historical water quality data is not available, comments regarding temporal variations can not be made.

As mentioned in Section 5.2.2.1, because flow rates for the South Nation River are not available, the contribution of leachate-impacted surface water from the gully to the South Nation River can not be determined and, as a result, loading rates to the river can not be calculated. Surface water quality, in the mixing zone and downstream of the landfills appears to be slightly impacted beyond the level of that reported for the upstream water quality; however, on-going surface water monitoring in the South Nation River would be required to confirm the preliminary interpretation. Specifically, although elevated concentrations of alkalinity, un-ionized ammonia, phenols, total phosphorus, boron, cobalt, iron, silver and zinc were reported in the samples collected from the gully, these impacts have not been identified in the samples collected from the South Nation River, with the exception of phenols and iron.

5.3 QUALITY ASSURANCE AND QUALITY CONTROL

This section summarizes the assessment of data quality and whether each data set met its respective DQO such that it was acceptable for use in the preceding Sections 5.1 to 5.2.

5.3.1 Groundwater Elevation Data

The groundwater elevation data met the DQO established for these data sets, as presented in Section 4.3.1.

5.3.2 Groundwater and Surface Water Quality Data

The DQO for the water sample analyses required the data to be precise, accurate, representative, comparable and complete. In general, the DQO was met for these data with only minor exceptions as discussed below.

The results of the field blank have also been presented in Table 7. The results indicate that the level of pH (5.18 pH units) and concentrations of copper

(0.235 mg/L) and zinc (0.20 mg/L) exceeds the PWQO criteria. The dissolution of carbon dioxide into distilled water to form carbonic acid may account for the lowered pH reported. However, the possibility exists that the distilled water used to generate the field blank was contaminated. Given that none of the results of analyses for the surface water samples collected in October had pH levels or copper and zinc concentrations that exceeded the PWQOs, with the exception of the zinc concentration detected in SW-5 (0.19 mg/L), the surface water samples have likely not been positively biased by sample handling procedures.

Representative data were obtained by following sample collection, handling, and analysis procedures appropriate for the monitoring program, and by incorporating data validation procedures. Comparable data were obtained by following the same sample collection and laboratory analysis procedures between monitoring events to the extent possible.

6.0 Conclusions

The 1999 environmental monitoring program at the Village of Casselman Landfill Site consisted of groundwater and surface water monitoring. The conclusions based on this first year of monitoring are:

- The water table is encountered in the silty sand unit and is interpreted to be controlled by seasonal recharge. Groundwater flow is interpreted to be directed to the north and northwest across the Site. In 1999 the lateral hydraulic gradient was 0.004 m/m and the groundwater velocity in the shallow subsurface (silty sand unit) was 1 m/yr;
- The Site is likely a local groundwater discharge zone based on the local relief and surficial drainage patterns. On-site drainage ditches and the deep gully intercept groundwater flow and collect surface water runoff, and discharge it to the South Nation River. Shallow groundwater flow not intercepted by the surface features mentioned, discharges into the South Nation River;
- Water quality data from monitoring well BH96-4, which represents background conditions, suggests that the groundwater flowing through the shallow aquifer is not adversely impacted prior to migration through the landfill area;
- Based on the conceptual model of groundwater flow first presented by BFA and groundwater elevation monitoring, it appears that well BH96-3 is not hydraulically connected to wells BH96-1 and BH96-2(I).
- The parameters exceeding the ODWOs in groundwater samples collected from the downgradient wells were total hardness, alkalinity (in BH96-1), turbidity, colour, total dissolved solids, iron and manganese. There were no exceedences of the health-related parameters in samples collected from the downgradient wells;
- In addition to the ODWO exceedences, parameters that exceeded the Reasonable Use concentrations were alkalinity in BH96-1 and BH96-3, total dissolved solids in BH96-2(I), arsenic in BH96-1, and aluminum and sulphate in BH96-1. The only health-related parameter in this group is arsenic. Since it is unlikely that the groundwater between the downgradient wells and the South Nation River will be used as a potable water supply, and given that arsenic was not detected in any of the surface water samples above the PWQO, the reported arsenic concentration is expected to have a negligible effect on downgradient water use;
- Comparison of groundwater quality data to surface water quality data suggests that the majority of the leachate-impacted water generated at the Site seems to migrate to the surface water environment rather than impacting the groundwater;

- Evaluation of the surface water quality data alone for the one sample collected from the ditch along the west side of the Site (SW-3) suggests that the contribution of leachate-impacted surface water from the ditch to the South Nation River is likely not significant. Furthermore, the flow rate in the ditch is expected to be very low compared to the South Nation River, and, given the low concentrations reported at well BH96-3, it is expected that the mass flux from the ditch to the river would be negligible.
- Surface water quality data collected from the deep gully (SW-1 and SW-5) suggests that leachate-impacted groundwater is discharging to the gully.
- Evaluation of the upstream data established that concentrations of hydrogen sulphide, total phosphorus, aluminum, and iron above PWQO criteria.
- The only potential indicators of leachate impact in the South Nations River are phenols concentrations above the PWQO that were identified at the mixing zone and the downstream sampling locations.

7.0 Recommendations

The following modifications to the environmental monitoring program for the Village of Casselman Landfill Site are recommended:

- Groundwater monitoring should continue semiannually with water levels and groundwater samples collected from each well. Due to the turbidity reported in samples collected from the monitoring wells, an effort should be made to properly develop the wells prior to sampling;
- Surface water monitoring frequency should be increased to quarterly monitoring to permit monitoring of seasonal fluctuations in surface water quality. Surface water samples should be collected from SW-1, SW-3 and SW-5;
- It is recommended that surface water samples be collected from two locations on the South Nation River, one upstream of the Site and one downstream of the Site, in order to assess whether water quality of the South Nation River is being impacted by the Village of Casselman Landfill;
- The effects of the discharge of leachate-impacted groundwater to surface water and potential mitigation measures should be investigated as part of the 2000 work program.
- The parameter list for laboratory analyses should be modified as follows to include only those parameters specific to ODWO and PWQO criteria:

  Groundwater Parameters

  General Chemistry – pH, specific conductance, temperature, colour, turbidity, alkalinity, un-ionized ammonia, chloride, fluoride, nitrate-N, nitrite-N, total phosphorus, sulphate, total dissolved solids, and total hardness.

  Metals – aluminum, arsenic, barium, boron, cadmium, chromium, copper, iron, lead, manganese, selenium, sodium and zinc.

  Surface Water Parameters

  General Chemistry – pH, specific conductance, temperature, colour, dissolved oxygen, turbidity, alkalinity, un-ionized ammonia, chloride, fluoride, nitrate-N, nitrite-N, phenols, total phosphorus, sulphate, total dissolved solids, and total hardness.

  Metals – aluminum, antimony, arsenic, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, nickel, selenium, silver, thallium, tungsten, vanadium, zinc and zirconium.

Although the parameter lists for groundwater and surface water monitoring differ somewhat, it is suggested that the groundwater and surface water samples be analyzed for the same parameters for comparison purposes; and,

- Begin time trend analyses for selected parameters, such as dissolved oxygen, turbidity, hydrogen sulphide, total phosphorus, aluminum, and iron, to establish if seasonal trends in water quality exist in either the surface water in the gully or the South Nation River.

All of which is respectfully submitted

STANTEC CONSULTING LTD.

Marc Oudejans B.Sc.
Hydrogeologist

David Flynn M.A.Sc., P.Eng
Environmental Engineer

8.0 References

Beatty Franz & Associates Limited. (BFA), 1997. Hydrogeological Assessment of the Village of Casselman Landfill Site. Prepared for McNeely Engineering Consultants Limited. March 1997.

Chapman, L.J. and Putnam, D.F., 1984. The Physiography of Southern Ontario. Ministry of Natural Resources, Ontario Geological Survey. Special Volume 2.

Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice – Hall Inc., New Jersey, 604pp.

Golder Associates Ltd. (Golder), 2000. Status Report on Surface Water Monitoring Program, Central and Casselman Landfill Sites. February 14, 2000.

Hvorslev, M.J., 1951. Time log and soil permeability in groundwater observations. US Army Corps of Engineers. Waterways Experimental Station. Bulletin 36, Vicksburg, Mississipi

McNeely Engineering Consultants Ltd. (McNeely), 1997. Landfill Development, Operation and Closure Report for Waste Disposal Site. Prepared for Village of Casselman. May 1997.

Ministry of Environment (MOE), 2000. Personal communication of tabulated results of water quality analysis for South Nation River Conservation Authority (SNRCA) sampling location no. 18207010002.

Ministry of Environment and Energy (MOE), 1994a. Ontario Drinking Water Objectives. Revised 1994.

Ministry of Environment and Energy (MOE), 1994b. The Incorporation of the Reasonable Use Concept into the MOE Groundwater Management Activities. Guideline B-7.

Ministry of Environment and Energy (MOE), 1994c. Determination of Contaminant Limits and Attenuation Zones. Procedure B-7-1.

Ministry of Environment and Energy (MOE), 1994d. Water Management Policies, Guidelines and Provincial Water Quality Objectives of the Ministry of Environment and Energy. Publication No. PIBS 3303E.

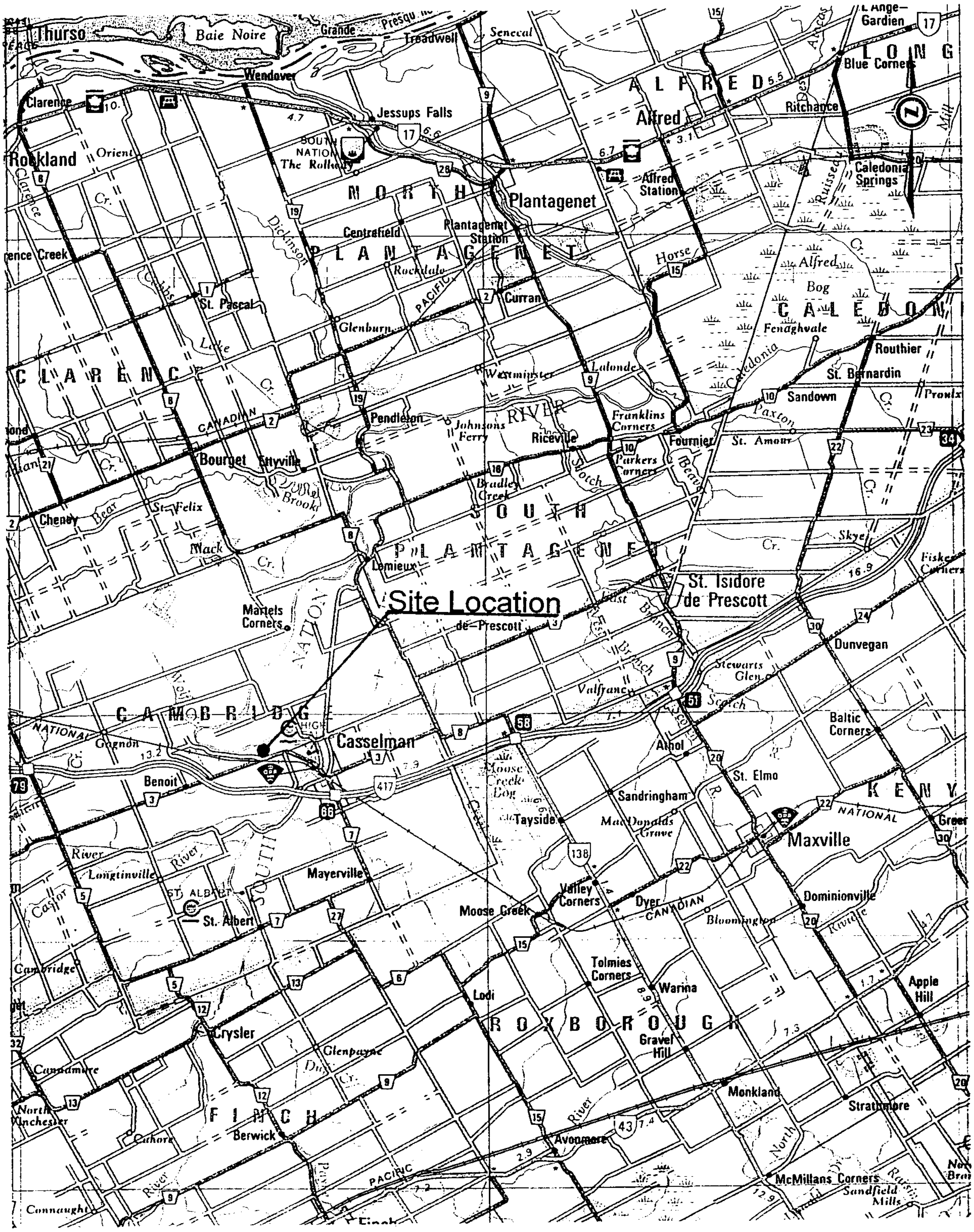
Ontario Geological Survey (OGS), 1979. Geological Highway Map, Southern Ontario, Map 2441.

Stantec Consulting Limited (Stantec), 2000. Nation Municipality & Casselman Village Landfills Leachate Treatment Options Report. Prepared for Nation Municipality and Casselman Village, January 2000.

APPENDIX A

FIGURES

Stantec



Legend

Stantec

0:\611-Hydrogeology\634-46550\Feb-00\63446550sl.dwg

February 25, 2000 09:03 AM

Client/Project

Village of Casselman Landf
1999 Monitoring Program
Report

Figure No.

1.0

Title

Site Location

00.02.11

Stantec

APPENDIX B

TABLES

Table 1
Summary of 1999 Monitoring Program

Location ID	Water Level Monitoring		Water Sampling					
			General Chemistry		Metals		Surface Water Specific	
	May	October	May	October	May	October	May	October
Monitoring Wells								
BH96-1	X	X	X	X	X	X		
BH96-2(I)	X	X	X	X	X	X		
BH96-2(II)	X	X						
BH96-3	X	X	X	X	X	X		
BH96-4	X	X	X	X	X	X		
Surface Water								
SW-1			X	X	X	X	X	X
SW-3				X		X		X
SW-5			X	X	X	X	X	X

Notes:

<u>General Chemistry</u>

pH
specific conductance
colour
turbidity
alkalinity (as $CaCO_3$)
total ammonia-N
un-ionized ammonia-N
bromide
chloride
fluoride
nitrate-N
nitrite-N
phosphate-P
total phosphorus
sulphate
total organic carbon
total dissolved solids
carbonate (CO_3)
bicarbonate (HCO_3)
hardness (as $CaCO_3$)
Langelier index

<u>Metals</u>

aluminum
antimony
arsenic
barium
beryllium
bismuth
boron
calcium
cadmium
chromium
cobalt
copper
gallium
iron
lead
lithium
magnesium
manganese
molybdenum
nickel
niobium
potassium
selenium
silicon
silver
sodium
strontium
thallium
tin
titanium
tungsten
vanadium
yttrium
zinc
zirconium

<u>Surface Water Specific</u>

phenols
dissolved oxygen
basic oxygen demand (BOD)
total nitrogen
saturation pH

Table 2
Summary of Sample Analyses, Preservation and Holding Times

Parameter	Analytical Method	Sample Volume	Sample Container	Field Filtering	Preservative	Holding Time
pH	APHA 4500	125 mL	plastic	none	cool	4 days
Specific Conductance	APHA 2510					28 days
Colour	APHA 2120					2 days
Turbidity	APHA 2130					2 days
Alkalinity (as $CaCO_3$)	APHA 2320					4 days
Total Ammonia-N	APHA 4500NH_3-H					4 day
Bromide	APHA 4500					28 days
Chloride	APHA 4500					28 days
Fluoride	APHA 4500					28 days
Nitrate-N	APHA 4500-N-C					5 days
Nitrite-N	APHA 4500-N-C					5 days
Total Nitrogen (Kjeldahl)	APHA 4500 B N ORG					10 days
Phosphate-P	APHA 4500-P-F					5 days
Total Phosphorus	APHA 4500-P-F					28 days
Sulphate	APHA 4500					28 days
Total Organic Carbon	APHA 5310C					10 days
Total Dissolved Solids	APHA 2540					7 days
Total Hardness	APHA 2340C					6 months
Metals[1]	APHA 3120B	125 mL	plastic	0.45 µm in-line	cool, HNO_3 to pH<2	6 months
Metals[2]	APHA 3113A					
Antimony, Arsenic	APHA 3114C					
Selenium	APHA 3114B					
Phenols	NAQUADAT 06537L	250 mL	amber glass	none	cool, $CuSO_4$ to pH<2	5 days
Dissolved Oxygen	APHA 4500 OC					
Biochemical Oxygen Demand	APHA 5210	250 mL	clear glass	none	cool	4 days

Notes:

APHA - American Public Health Association, from the Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 17th Edition, 1989 and 1991 Supplement.

[1] - ICP Metals method APHA 3120 B by inductively-coupled plasma - atomic emission spectrometry

[2] - Metals method APHA 3113 A for lower detection limits by graphite furnace - atomic absorption spectrometry

Table 3
Groundwater Elevation Data - 1999

Well ID	Reference Elevation (m amsl)	Riser Stick-up (m)	Ground Surface Elevation (m amsl)	19-Nov-96		15-May-99		21-Oct-99	
				Water Level (m btoc)	Water Elevation (m amsl)	Water Level (m btoc)	Water Elevation (m amsl)	Water Level (m btoc)	Water Elevation (m amsl)
Monitoring Wells									
BH96-1	64.73	0.71	64.02	1.93	62.80	1.69	63.04	1.89	62.84
BH96-2(I)	64.57	0.86	63.71	1.41	63.16	2.59	61.98	2.65	61.92
BH96-2(II)	65.01	1.30	63.71	1.66	63.35	dry	< 62.13	dry	< 62.13
BH96-3	62.59	0.98	61.61	1.23	61.36	2.24	60.35	1.52	61.07
BH96-4	65.62	0.95	64.67	1.10	64.52	1.86	63.76	2.05	63.57

Notes:

m amsl - metres above mean sea level

m btoc - metres below top of casing

dry - total depth of well (2.88 m btoc) measured in May 1999

Table 4
Summary of Historical Groundwater Quality Data for Background Well BH96-4

Sample Location Sampled By Date Collected	OWDO[1]			Method Detection Limit		BH96-4 BF&A 19-Nov-96	BH96-4 Stantec 16-May-99	BH96-4 Stantec 22-Oct-99
Analyzed by	Type	Value	Units	(Zenon)	(Seprotech)	(Zenon)	(Seprotech)	(Seprotech)
Field Parameters								
Dissolved Oxygen		n/v	mg/L	-	-	-	5.6	2.0
pH	OG	6.5-8.5	pH units	-	-	-	7.85	7.90
Specific Conductance	n/v	n/v	µS/cm	-	-	-	278	250
Temperature	AO	15	°C	-	-	-	8.7	11.0
Turbidity	AO	5	NTU	-	-	-	**519**	-
General Chemistry								
pH	OG	6.5-8.5	pH units			7.80	8.05	7.53
Specific Conductance		n/v	µS/cm	4.2	1	270	252	302
Colour	AO	5	TCU	1	1	***13***	3	***6.2***
Turbidity	AO	5	NTU	0.01	0.1	***48***	***187***	***18.6***
Alkalinity (as $CaCO_3$)	OG	30-500	mg/L	1	1	130	114	116
Total Ammonia-N		n/v	mg/L	0.03	0.01	0.13	0.03	<0.01
Un-ionized Ammonia-N		n/v	mg/L	-	0.01	-	<0.01	<0.01
Bromide		n/v	mg/L	0.1	0.4	<0.10	<0.4	<0.4
Chloride	AO	250	mg/L	0.5	0.1	1.9	1.8	1.6
Fluoride	MAC	1.5	mg/L	0.03	0.1	0.12	0.2	0.2
Nitrate-N	MAC	10.0	mg/L	0.05	0.1	0.06	0.1	0.1
Nitrite-N	MAC	1.0	mg/L	0.05	0.1	<0.05	0.1	<0.1
Phosphate-P		n/v	mg/L	0.1	0.01	<0.10	0.06	20
Total Phosphorus		n/v	mg/L	0.02	0.01	-	0.77	0.54
Sulphate	AO	500	mg/L	0.1	1	26	20	0.09
Total Organic Carbon		n/v	mg/L	0.16	0.3	4.5	0.7	1.2
Total Dissolved Solids	AO	500	mg/L		1	159	168	208
Carbonate (CO_3)		n/v	mg/L	1	1	<1	<1	<1
Bicarbonate (HCO_3)		n/v	mg/L	1	1	130	139	142
Total Hardness (as $CaCO_3$)	OG	80-100	mg/L	1	1	***140***	***124***	***136***
Langelier Saturation Index		n/v				0.01	0.19	-0.27
Metals								
Aluminum	OG	0.10	mg/L	0.03	0.01	***1.7***	<0.01	0.01
Antimony		n/v	mg/L	-	0.001	-	<0.001	<0.001
Arsenic	IMAC	0.025	mg/L	-	0.001	-	<0.001	<0.001
Barium	MAC	1.0	mg/L	0.001	0.005	0.030	0.020	0.024
Beryllium		n/v	mg/L	0.001	0.005	<0.001	<0.005	<0.005
Bismuth		n/v	mg/L	-	0.05	-	<0.05	<0.05
Boron	IMAC	5.0	mg/L	0.01	0.01	0.013	0.01	0.02
Cadmium	IMAC	0.005	mg/L	0.002	0.0001	<0.002	<0.0001	<0.0001
Calcium		n/v	mg/L	0.2	0.03	36	32.1	37.4
Chromium	MAC	0.05	mg/L	0.004	0.01	<0.004	<0.01	<0.01
Cobalt		n/v	mg/L	0.01	0.01	<0.01	<0.01	<0.01
Copper	AO	1.0	mg/L	0.006	0.01	0.007	<0.01	<0.01
Gallium		n/v	mg/L	-	0.05	-	<0.05	<0.05
Iron	AO	0.30	mg/L	0.01	0.02	***1.4***	<0.02	<0.02
Lead	MAC	0.01	mg/L	0.02	0.0002	<0.02	<0.0002	<0.0002
Lithium		n/v	mg/L	-	0.005	-	0.011	<0.005
Magnesium		n/v	mg/L	0.05	0.01	11	10.4	10.3

Table 4
Summary of Historical Groundwater Quality Data for Background Well BH96-4

Sample Location Sampled By Date Collected	ODWO[1]			Method Detection Limit		BH96-4 BF&A 19-Nov-96	BH96-4 Stantec 16-May-99	BH96-4 Stantec 22-Oct-99
Metals (cont'd)								
Manganese	AO	0.05	mg/L	0.005	0.01	***0.055***	<0.01	<0.01
Molybdenum		n/v	mg/L	0.01	0.02	<0.01	<0.02	<0.02
Nickel		n/v	mg/L	0.01	0.02	<0.01	<0.02	-
Niobium		n/v	mg/L	-	0.02	-	<0.02	<0.02
Phosphorus		n/v	mg/L	0.06	0.1	<0.06	-	<0.1
Potassium		n/v	mg/L	1.0	0.4	2.4	1.3	1.5
Selenium	MAC	0.01	mg/L	0.001	0.001	-	<0.001	<0.001
Silicon		n/v	mg/L	0.05	0.05	12	7.45	7.93
Silver		n/v	mg/L	0.01	0.01	<0.01	<0.01	<0.01
Sodium	AO	200	mg/L	0.1	0.2	4.5	4.2	3.9
Strontium		n/v	mg/L	0.001	0.005	0.078	0.060	0.069
Sulphur		n/v	mg/L	0.06	-	6.8	-	-
Thallium		n/v	mg/L	0.06	0.0002	<0.06	<0.0002	<0.0002
Tin		n/v	mg/L	0.05	0.2	<0.05	<0.2	<0.2
Titanium		n/v	mg/L	0.01	0.01	0.087	<0.01	<0.01
Tungsten		n/v	mg/L	-	0.05	-	<0.05	<0.05
Vanadium		n/v	mg/L	0.005	0.005	0.007	<0.005	<0.005
Yttrium		n/v	mg/L	-	0.005	-	<0.005	<0.005
Zinc	AO	5.0	mg/L	0.005	0.01	0.015	<0.01	<0.01
Zirconium		n/v	mg/L	0.01	0.01	<0.01	<0.01	<0.01

Notes:

[1] Reference: Ontario Ministry of the Environment, revised 1994. Ontario Drinking Water Objectives

µS/cm	microSiemens per centimetre
°C	degrees Celsius
µg/L	micrograms per litre
mg/L	milligrams per litre
MAC	Maximum Acceptable Concentration
IMAC	Interim Maximum Acceptable Concentration
AO	Aesthetic Objective
OG	Operational Guideline
n/v	No ODWO has been established.
201	The value exceeds the respective objective.
-	Analysis not performed.
<	The parameter was not detected at the quantitation limit shown.

Analytical results for 1996 presented herein are as reported by Beatty Franz & Associates Ltd. in the March 1997 Report entitled: *Hydrogeological Assessment of the Village of Casselman Landfill*.

Table 5
Summary of Historical Groundwater Quality Data for Downgradient Wells

Sample Location		OWDO[1]		Method Detection Limit		BH96-1	BH96-1	BH96-1	BH96-2(I)	BH96-2(I)	BH96-2(I)	BH96-2(II)	BH96-3	BH96-3	BH96-3
Sampled By						BF&A	Stantec	Stantec	BF&A	Stantec	Stantec	BF&A	BF&A	Stantec	Stantec
Date Collected						19-Nov-96	16-May-99	22-Oct-99	19-Nov-96	16-May-99	22-Oct-99	19-Nov-96	19-Nov-96	16-May-99	22-Oct-99
Analyzed By	Type	Value	Units	(Zenon)	(Seprotech)	(Zenon)	(Seprotech)	(Seprotech)	(Zenon)	(Seprotech)	(Seprotech)	(Zenon)	(Zenon)	(Seprotech)	(Seprotech)
Field Parameters															
Dissolved Oxygen		n/v	mg/L	-	-	-	1.99	4.0	-	1.72	3.5	-	-	8.25	8.2
pH	OG	6.5-8.5	pH units	-	-	-	6.34	6.80	-	6.80	7.30	-	-	7.48	7.70
Specific Conductance	n/v	n/v	µS/cm	-	-	-	1220	1,700	-	496	700	-	-	827	1,100
Temperature	AO	15	°C	-	-	-	8.2	10.0	-	8.3	11.0	-	-	10.7	9.0
Turbidity	AO	5	NTU	-	-	-	*533*	-	-	*472*	-	-	-	*155*	-
General Chemistry															
pH	OG	6.5-8.5	pH units			6.82	6.76	6.26	6.94	7.72	6.54	6.91	7.68	8.04	7.42
Specific Conductance		n/v	µS/cm	4.2	1	2,200	935	1,825	560	425	663	610	680	852	1,234
Colour	AO	5	TCU	1	1	*45*	*65*	*44.5*	*24*	*22*	*19.9*	*26*	*36*	1	2.9
Turbidity	AO	5	NTU	0.01	0.1	*77*	*>200*	*>200*	*14*	*>200*	*>200*	*33*	*6.1*	*115*	4.1
Alkalinity (as $CaCO_3$)	OG	30-500	mg/L	1	1	*1,300*	480	*726*	310	230	15	300	230	350	308
Total Ammonia-N		n/v	mg/L	0.03	0.01	46	13.8	24.4	12	4.73	10.3	8.6	0.37	0.19	<0.01
Un-ionized Ammonia-N		n/v	mg/L	-	0.01	-	0.01	0.01	-	0.04	<0.01	-	-	<0.01	<0.01
Bromide		n/v	mg/L	0.1	0.4	0.30	<0.4	1.2	0.12	<0.4	<0.4	<0.10	<0.10	<0.4	<0.4
Chloride	AO	250	mg/L	0.5	0.1	150	32.1	76.8	3.8	1.9	1.9	3.7	0.99	1.3	1.6
Fluoride	MAC	1.5	mg/L	0.03	0.1	0.09	0.2	0.2	0.10	0.2	0.2	0.10	0.11	0.2	0.2
Nitrate-N	MAC	10.0	mg/L	0.05	0.1	<0.05	0.1	0.6	0.085	<0.1	0.1	0.21	0.061	0.2	0.2
Nitrite-N	MAC	1.0	mg/L	0.05	0.1	<0.05	<0.1	<0.1	<0.05	<0.1	<0.1	<0.05	<0.05	0.1	<0.1
Phosphate-P		n/v	mg/L	0.1	0.01	<0.10	0.14	0.03	<0.10	0.05	0.03	<0.10	<0.10	0.03	0.02
Total Phosphorus		n/v	mg/L	0.02	0.01	-	1.18	1.91	-	0.86	0.56	-	-	0.23	0.09
Sulphate	AO	500	mg/L	0.1	1	46	2	5	26	1	18	74	120	180	450
Total Organic Carbon		n/v	mg/L	0.16	0.3	67	21.2	46.8	32	7.9	12.1	74	7.8	7.9	2.7
Total Dissolved Solids	AO	500	mg/L		1	*1,530*	*608*	*1,190*	315	314	398	385	392	*596*	*944*
Carbonate (CO_3)		n/v	mg/L	1	1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Bicarbonate (HCO_3)		n/v	mg/L	1	1	1,300	586	886	310	281	18	300	230	427	376
Total Hardness (as $CaCO_3$)	OG	80-100	mg/L	1	1	*1,100*	*402*	*663*	*230*	*199*	*299*	*220*	*330*	*468*	*694*
Langelier Saturation Index		n/v				1.0	0.12	-0.04	-0.21	0.40	-1.8	-0.28	0.44	1.12	0.62
Metals															
Aluminum	OG	0.10	mg/L	0.03	0.01	*0.28*	<0.01	0.06	*0.28*	<0.01	0.02	*0.25*	*0.78*	<0.01	0.14
Antimony		n/v	mg/L	-	0.001	-	<0.001	0.128	-	0.002	0.174	-	-	<0.001	0.064
Arsenic	IMAC	0.025	mg/L	-	0.001	-	0.008	<0.001	-	0.002	<0.001	-	-	<0.001	<0.001
Barium	MAC	1.0	mg/L	0.001	0.005	0.56	0.070	0.024	0.11	0.055	0.024	0.10	0.037	0.040	0.024
Beryllium		n/v	mg/L	0.001	0.005	<0.001	<0.005	<0.005	<0.001	<0.005	<0.005	<0.001	<0.001	<0.005	<0.005
Bismuth		n/v	mg/L	-	0.05	-	<0.05	<0.05	-	<0.05	<0.05	-	-	<0.05	<0.05
Boron	IMAC	5.0	mg/L	0.01	0.01	0.48	0.16	0.43	0.074	0.01	0.10	0.099	0.021	0.02	0.03
Cadmium	IMAC	0.005	mg/L	0.002	0.0001	<0.002	<0.0001	<0.0001	<0.002	<0.0001	<0.0001	<0.002	<0.002	<0.0001	<0.0001
Calcium		n/v	mg/L	0.2	0.03	380	148	225	68	59	91.1	66	78	104	164
Chromium	MAC	0.05	mg/L	0.004	0.01	<0.004	<0.01	<0.01	<0.004	<0.01	<0.01	<0.004	<0.004	<0.01	<0.01
Cobalt		n/v	mg/L	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	AO	1.0	mg/L	0.006	0.01	<0.006	<0.01	<0.01	<0.006	<0.01	<0.01	<0.006	<0.006	<0.01	<0.01

Table 5
Summary of Historical Groundwater Quality Data for Downgradient Wells

Sample Location		OWDO[1]		Method Detection Limit		BH96-1	BH96-1	BH96-1	BH96-2(I)	BH96-2(I)	BH96-2(I)	BH96-2(II)	BH96-3	BH96-3	BH96-3
Sampled By						BF&A	Stantec	Stantec	BF&A	Stantec	Stantec	BF&A	BF&A	Stantec	Stantec
Date Collected						19-Nov-96	16-May-99	22-Oct-99	19-Nov-96	16-May-99	22-Oct-99	19-Nov-96	19-Nov-96	16-May-99	22-Oct-99
Analyzed By	Type	Value	Units	(Zenon)	(Seprotech)	(Zenon)	(Seprotech)	(Seprotech)	(Zenon)	(Seprotech)	(Seprotech)	(Zenon)	(Zenon)	(Seprotech)	(Seprotech)
Metals (cont'd)															
Gallium		n/v	mg/L	-	0.05	-	<0.05	<0.05	-	<0.05	<0.05	-	-	<0.05	<0.05
Iron	AO	0.30	mg/L	0.01	0.02	*100*	*83.4*	*111*	*35*	*42.9*	*62.2*	*40*	*0.58*	0.16	0.12
Lead	MAC	0.01	mg/L	0.02	0.0002	<0.02	<0.0002	<0.0002	<0.02	<0.0002	<0.0002	<0.02	<0.02	<0.0002	<0.0002
Lithium		n/v	mg/L	-	0.005	-	0.017	<0.005	-	0.011	<0.005	-	-	0.022	<0.005
Magnesium		n/v	mg/L	0.05	0.01	32	7.65	24.2	15	12.4	17.1	15	32	50.0	68.2
Manganese	AO	0.05	mg/L	0.005	0.01	*7.3*	*2.70*	*3.24*	*2.3*	*2.61*	*2.77*	*2.7*	*0.11*	0.05	<0.01
Molybdenum		n/v	mg/L	0.01	0.02	<0.01	<0.02	<0.02	<0.01	<0.02	<0.02	<0.01	<0.01	<0.02	<0.02
Nickel		n/v	mg/L	0.01	0.02	0.012	<0.02	-	<0.01	<0.02	-	<0.01	<0.01	<0.02	-
Niobium		n/v	mg/L	-	0.02	-	<0.02	<0.02	-	<0.02	<0.02	-	-	<0.02	<0.02
Phosphorus		n/v	mg/L	0.06	0.4	<0.06	-	0.4	<0.06	-	0.3	<0.06	<0.06	-	0.1
Potassium		n/v	mg/L	1.0	0.4	60	17.9	29.5	8.0	2.0	8.4	9.6	4.9	5.0	5.8
Selenium	MAC	0.01	mg/L	-	0.001	-	<0.001	<0.001	-	<0.001	<0.001	-	-	<0.001	<0.001
Silicon		n/v	mg/L	0.05	0.05	11	5.57	9.00	6.9	7	7.34	6.2	6.7	4.67	3.48
Silver		n/v	mg/L	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	AO	200	mg/L	0.1	0.2	61	25.3	50.2	7.8	5.6	10.8	35	19	22.5	12.8
Strontium		n/v	mg/L	0.001	0.005	1.9	0.570	0.952	0.27	0.195	0.341	0.31	0.34	0.415	0.535
Sulphur		n/v	mg/L	0.06	-	20	-	-	8.1	-	-	24	47	-	-
Thallium		n/v	mg/L	0.06	0.0002	<0.06	0.0003	<0.0002	<0.06	<0.0002	<0.0002	<0.06	<0.06	<0.0002	<0.0002
Tin		n/v	mg/L	0.05	0.2	<0.05	0.2	0.4	<0.05	<0.2	0.3	<0.05	<0.05	<0.2	<0.2
Titanium		n/v	mg/L	0.01	0.01	0.016	<0.01	<0.01	0.016	<0.1	<0.01	0.013	0.038	<0.01	<0.01
Tungsten		n/v	mg/L	-	0.05	-	<0.05	<0.05	-	<0.05	<0.05	-	-	<0.05	<0.05
Vanadium		n/v	mg/L	0.005	0.005	0.007	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Yttrium		n/v	mg/L	-	0.005	-	<0.005	<0.005	-	<0.005	<0.005	-	-	<0.005	<0.005
Zinc	AO	5.0	mg/L	0.005	0.01	0.18	<0.01	<0.01	0.013	<0.01	<0.01	0.013	<0.005	<0.01	<0.01
Zirconium		n/v	mg/L	0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	-

Notes:

[1] Reference: Ontario Ministry of the Environment, revised 1994. Ontario Drinking Water Objectives

µS/cm	microSiemens per centimetre
°C	degrees Celsius
NTU	nephelometric turbidity units
mg/L	milligrams per litre
MAC	Maximum Acceptable Concentration
IMAC	Interim Maximum Acceptable Concentration
AO	Aesthetic Objective
OG	Operational Guideline
n/v	No ODWO has been established.
201	The value exceeds the respective objective.
-	Analysis not performed.
<	The parameter was not detected at the quantitation limit shown.

Analytical results for 1996 presented herein are as reported by Beatty Franz & Associates Ltd. in the March 1997 Report entitled: Hydrogeological Assessment of the Village of Casselman Landfill.

Table 6

Comparison of 1999 Groundwater Quality Data to Reasonable Use Concentrations

Sample Location Sampled By Date Collected	OWDO[1]			BH96-4 Stantec 16-May-99	BH96-4 Stantec 22-Oct-99	Reasonable Use Concentration[2]	BH96-1 Stantec 16-May-99	BH96-1 Stantec 22-Oct-99	BH96-2(I) Stantec 16-May-99	BH96-2(I) Stantec 22-Oct-99	BH96-3 Stantec 16-May-99	BH96-3 Stantec 22-Oct-99
	Type	Value	Units									
Field Parameters												
Dissolved Oxygen		n/v	mg/L	5.6	2.0		1.99	4.0	1.72	3.5	8.25	8.2
pH	OG	6.5-8.5	pH units	7.85	7.90	8.2	6.34	6.80	6.80	7.30	7.48	7.70
Specific Conductance	n/v	n/v	µS/cm	278	250		1220	1,700	496	700	827	1,100
Temperature	AO	15	°C	8.7	11.0	12	8.2	10.0	8.3	11.0	10.7	9.0
Turbidity	AO	5	NTU	***519***	-		***533***	-	***472***	-	***155***	-
General Chemistry												
pH	OG	6.5-8.5	pH units	8.05	7.53	8.1	6.76	6.26	7.72	6.54	8.04	7.42
Specific Conductance		n/v	µS/cm	252	302		935	1,825	425	663	852	1,234
Colour	AO	5	TCU	3	***6.2***		***65***	***44.5***	***22***	***19.9***	1	2.9
Turbidity	AO	5	NTU	***187***	***18.6***		***>200***	***>200***	***>200***	***>200***	***115***	4.1
Alkalinity (as $CaCO_3$)	OG	30-500	mg/L	114	116	308	***480***	***726***	230	15	***350***	308
Total Ammonia-N		n/v	mg/L	0.03	<0.01		13.8	24.4	4.73	10.3	0.19	<0.01
Un-ionized Ammonia-N		n/v	mg/L	<0.01	<0.01		0.01	0.01	0.04	<0.01	<0.01	<0.01
Bromide		n/v	mg/L	<0.4	<0.4		<0.4	1.2	<0.4	<0.4	<0.4	<0.4
Chloride	AO	250	mg/L	1.8	1.6	126	32.1	76.8	1.9	1.9	1.3	1.6
Fluoride	MAC	1.5	mg/L	0.2	0.2	0.5	0.2	0.2	0.2	0.2	0.2	0.2
Nitrate-N	MAC	10.0	mg/L	0.1	0.1	2.6	0.1	0.6	<0.1	0.1	0.2	0.2
Nitrite-N	MAC	1.0	mg/L	0.1	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Phosphate-P		n/v	mg/L	0.06	20		0.14	0.03	0.05	0.03	0.03	0.02
Total Phosphorus		n/v	mg/L	0.77	0.54		1.18	1.91	0.86	0.56	0.23	0.09
Sulphate	AO	500	mg/L	20	0.09	255	2	5	1	18	180	***450***
Total Organic Carbon		n/v	mg/L	0.7	1.2		21.2	46.8	7.9	12.1	7.9	2.7
Total Dissolved Solids	AO	500	mg/L	168	208	344	***608***	***1,190***	314	***398***	***596***	***944***
Carbonate (CO_3)		n/v	mg/L	<1	<1		<1	<1	<1	<1	<1	<1
Bicarbonate (HCO_3)		n/v	mg/L	139	142		586	886	281	18	427	376
Total Hardness (as $CaCO_3$)	OG	80-100	mg/L	***124***	***136***	115	***402***	***663***	***199***	***299***	***468***	***694***
Langelier Saturation Index		n/v		0.19	-0.27		0.12	-0.04	0.40	-1.8	1.12	0.62
Metals												
Aluminum	OG	0.10	mg/L	<0.01	0.01	0.1	<0.01	0.06	<0.01	0.02	<0.01	***0.14***
Antimony		n/v	mg/L	<0.001	<0.001		<0.001	0.128	0.002	0.174	<0.001	0.064
Arsenic	IMAC	0.025	mg/L	<0.001	<0.001	0.007	***0.008***	<0.001	0.002	<0.001	<0.001	<0.001
Barium	MAC	1.0	mg/L	0.020	0.024	0.267	0.070	0.024	0.055	0.024	0.040	0.024
Beryllium		n/v	mg/L	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth		n/v	mg/L	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Boron	IMAC	5.0	mg/L	0.01	0.02	1.3	0.16	0.43	0.01	0.10	0.02	0.03

Table 6
Comparison of 1999 Groundwater Quality Data to Reasonable Use Concentrations

Sample Location Sampled By Date Collected	OWDO[1]			BH96-4 Stantec 16-May-99	BH96-4 Stantec 22-Oct-99	Reasonable Use Concentration[2]	BH96-1 Stantec 16-May-99	BH96-1 Stantec 22-Oct-99	BH96-2(I) Stantec 16-May-99	BH96-2(I) Stantec 22-Oct-99	BH96-3 Stantec 16-May-99	BH96-3 Stantec 22-Oct-99
	Type	Value	Units									
Metals (cont'd)												
Cadmium	IMAC	0.005	mg/L	<0.0001	<0.0001	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Calcium		n/v	mg/L	32.1	37.4		148	225	59	91.1	104	164
Chromium	MAC	0.05	mg/L	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt		n/v	mg/L	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	AO	1.0	mg/L	<0.01	<0.01	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Gallium		n/v	mg/L	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	AO	0.30	mg/L	<0.02	<0.02	0.16	***83.4***	***111***	***42.9***	***62.2***	0.16	0.12
Lead	MAC	0.01	mg/L	<0.0002	<0.0002	0.0027	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Lithium		n/v	mg/L	0.011	<0.005		0.017	<0.005	0.011	<0.005	0.022	<0.005
Magnesium		n/v	mg/L	10.4	10.3		7.65	24.2	12.4	17.1	50.0	68.2
Manganese	AO	0.05	mg/L	<0.01	<0.01	0.03	***2.70***	***3.24***	***2.61***	***2.77***	0.05	<0.01
Molybdenum		n/v	mg/L	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel		n/v	mg/L	<0.02	-		<0.02	-	<0.02	-	<0.02	-
Niobium		n/v	mg/L	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus		n/v	mg/L	-	<0.1		-	0.4	-	0.3	-	0.1
Potassium		n/v	mg/L	1.3	1.5		17.9	29.5	2.0	8.4	5.0	5.8
Selenium	MAC	0.01	mg/L	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silicon		n/v	mg/L	7.45	7.93		5.57	9.00	7	7.34	4.67	3.48
Silver		n/v	mg/L	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	AO	200	mg/L	4.2	3.9	102	25.3	50.2	5.6	10.8	22.5	12.8
Strontium		n/v	mg/L	0.060	0.069		0.570	0.952	0.195	0.341	0.415	0.535
Sulphur		n/v	mg/L	-	-		-	-	-	-	-	-
Thallium		n/v	mg/L	<0.0002	<0.0002		0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Tin		n/v	mg/L	<0.2	<0.2		0.2	0.4	<0.2	0.3	<0.2	<0.2
Titanium		n/v	mg/L	<0.01	<0.01		<0.01	<0.01	<0.1	<0.01	<0.01	<0.01
Tungsten		n/v	mg/L	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Vanadium		n/v	mg/L	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Yttrium		n/v	mg/L	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc	AO	5.0	mg/L	<0.01	<0.01	2.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zirconium		n/v	mg/L	<0.01	<0.01		<0.01	0.02	<0.01	0.02	<0.01	-

Notes:

[1] Reference: Ontario Ministry of the Environment and Energy (MOE), revised 1994. Ontario Drinking Water Objectives

[2] Reference: Ontario Ministry of the Environment and Energy (MOE), revised 1993. The Incorporation of the Reasonable Use Concept into the Groundwater Management Activities of the MOEE. Guideline B-7.
The maximum background concentration was calculated using the equation: Cm = Cb + x(Cr-Cb) as described in the text. When a value has been listed as less than (<) the method detection limit (MDL), the MDL has been used to generate a number for calculation purposes. To obtain values for Cb, background data from monitoring well BH96-4 were averaged

µS/cm	microSiemens per centimetre
°C	degrees Celsius
NTU	nephelometric turbidity units
mg/L	milligrams per litre
MAC	Maximum Acceptable Concentration
IMAC	Interim Maximum Acceptable Concentration

AO	Aesthetic Objective
OG	Operational Guideline
n/v	No ODWO has been established.
201	The value exceeds the respective objective.
480	The value exceeds the Reasonable Use concentration.
-	Analysis not performed.
<	The parameter was not detected at the quantitation limit shown

Table 7
Summary of Historical Surface Water Quality Data

Sample Location						Toe of Buried Waste in Deep Gully					Ravine	Ditch	Midpoint of Deep Gully		
Sampe ID	PWQO[1]			Method Detection Limit		SW1	SW1	SW1	CSW1	CSW1	SW2	SW3	SW5	SW5	SW5
Sampled By						BF&A	Stantec	Stantec	Golder	Golder	BF&A	Stantec	Golder	Stantec	Golder
Date Collected						19-Nov-96	16-May-99	22-Oct-99	06-Dec-99	30-Dec-99	19-Nov-96	22-Oct-99	13-May-99	16-May-99	18-Oct-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Zenon	Seprotech	Seprotech	Accutest	Accutest	Zenon	Seprotech	Accutest	Seprotech	Accutest
Field Parameters															
Dissolved Oxygen		n/v	mg/L	-	-	-	4.84	5.6	-	-	-	11.2	-	3.62	-
pH	PWQO	6.5-8.5	pH units	-	-	-	7.01	7.60	-	-	-	*8.60*	-	7.68	-
Specific Conductance		n/v	µS/cm	-	-	-	2,990	2,400	-	-	-	370	-	2,060	-
Temperature	PWQO	15[3]	°C	-	-	-	*16.5*	12.0	-	-	-	7.0	-	*19.2*	-
Turbidity	PWQO	n/v	NTU	-	-	-	160	-	-	-	-	-	-	18	-
General Chemistry															
pH	PWQO	6.5-8.5	pH units	-	-	7.48	7.55	7.19	7.10	7.10	7.89	7.95	7.8	7.86	8
Saturation pH		n/v	mg/L	-	-	6.24	6.14	6.19	-	-	7.38	7.4	-	6.39	-
Specific Conductance		n/v	µS/cm	4.2	1	2,200	2,470	2,650	1,000	2,510	410	397	1,050	1,810	1,150
Biochemical Oxygen Demand (BOD)		n/v	mg/L	-	1	-	12	12	25	14	-	<1	-	56	-
Chemical Oxygen Demand (COD)		n/v	mg/L	-	-	-	-	-	73	115	-	-	90	-	88
Colour		n/v	TCU	1	1	25	42	37	18	29	19	9	-	42	-
Dissolved Oxygen	PWQO	5,6[4]	mg/L	-	1	-	*1*	*1*	9.3	-	-	-	8.1	7	7.9
Turbidity		n/v	NTU	0.01	0.1	6.1	>200	>200	>100	>100	10	1.4	-	4.6	-
Alkalinity (as $CaCO_3$)	IPWQO	30-500	mg/L	1	1	*890*	*1,110*	*1,020*	419	*1,090*	180	182	*710*	*682*	*735*
Total Ammonia-N		n/v	mg/L	0.03	0.01	47	56.2	61.7	22.5	75.1	0.04	0.08	44.5	27.1	27.3
Un-ionized Ammonia-N	PWQO	0.02[5]	mg/L	-	0.01	*0.26***	*0.37*	*0.26*	*0.033*	*0.11*	*0.03***	<0.01	*0.70*	*0.36*	*0.33*
Bromide		n/v	mg/L	0.1	0.4	0.46	0.6	3.3	-	-	<0.10	<0.4	-	0.3	-
Chloride		n/v	mg/L	0.5	0.1	180	220	252	85	250	9.3	3.0	145	143	166
Fluoride		n/v	mg/L	0.03	0.1	0.09	0.2	0.2	-	-	0.08	0.2	-	0.2	-
Hydrogen Sulphide	PWQO	0.002	mg/L	-	-	-	-	-	*0.1*	<0.01	-	-	-	-	-
Nitrate-N		n/v	mg/L	0.05	0.1	0.32	0.5	1.1	1.2	<0.1	<0.05	<0.1	4.63	3.5	2.15
Nitrite-N		n/v	mg/L	0.05	0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.05	<0.1	0.2	0.6	<0.1
Total Nitrogen		n/v	mg/L	-	0.05	-	79.8	65.2	24.3	75.1	-	0.20	-	42.0	-
Phenols	PWQO	0.001	mg/L	0.001	0.001	*0.0048*	*0.015*	<0.001	*0.006*	*0.007*	*0.0010*	<0.001	<0.001	*0.028*	<0.001
Phosphate-P		n/v	mg/L	0.1	0.01	<0.10	0.07	0.07	-	-	<0.10	0.03	<0.03	0.05	0.06
Total Phosphorus	IPWQO	0.03^	mg/L	0.02	0.01	*0.15*	*0.13*	*0.10*	*0.33*	*0.11*	*0.084*	*0.05*	*0.07*	*0.08*	*0.43*
Sulphate		n/v	mg/L	0.1	1	100	55	75	105	74	28	24	128	121	89
Dissolved Organic Carbon (DOC)		n/v	mg/L	-	-	-	-	-	27.0	50.0	-	-	41.2	-	33
Total Organic Carbon		n/v	mg/L	0.16	0.3	30	47.0	41.2	-	-	7.7	5.0	1156	32.8	1,110
Total Dissolved Solids (TDS)		n/v	mg/L	-	1	1,270	1,600	1,590	736	1,420	245	264	-	1,140	-
Total Suspended Solids (TSS)		n/v	mg/L	-	-	-	-	-	182	113	-	-	-	-	-
Carbonate (CO_3)		n/v	mg/L	1	1	2.5	<1	<1	-	-	1.3	<1	-	<1	-
Bicarbonate (HCO_3)		n/v	mg/L	1	1	880	1,360	1,240	-	-	180	222	695	832	653
Total Hardness (as $CaCO_3$)		n/v	mg/L	1	1	730	800	774	435	770	240	215	-	681	-
Langelier Saturation Index		n/v	n/a	-	-	1.2	1.41	1.00	-	-	0.51	0.55	-	1.47	-
Metals															
Aluminum	IPWQO	0.075 *	mg/L	0.03	0.01	0.033	0.04	0.05	*0.17*	<0.03	*1.6*	*0.12*	0.05	*0.11*	<0.03
Arsenic	PWQO	0.1	mg/L	-	0.001	-	<0.001	<0.001	-	-	-	<0.001	-	<0.001	-
Barium		n/v	mg/L	0.001	0.005	0.45	0.758	0.663	0.230	0.700	0.03	0.019	0.190	0.220	0.280
Beryllium	PWQO	1.1	mg/L	0.001	0.005	<0.001	<0.005	<0.005	<0.002	<0.002	<0.001	<0.005	<0.01	<0.005	<0.01
Bismuth		n/v	mg/L	-	0.05	-	<0.05	<0.05	-	-	-	<0.05	-	<0.05	-
Boron	IPWQO	0.2	mg/L	0.01	-	*1.2*	-	-	*0.64*	*1.85*	0.022	-	*1.17*	-	*1.32*

Table 7
Summary of Historical Surface Water Quality Data

Sample Location		PWQO[1]			Method Detection Limit		Toe of Buried Waste in Deep Gully					Ravine	Ditch	Midpoint of Deep Gully		
Sampe ID							SW1	SW1	SW1	CSW1	CSW1	SW2	SW3	SW5	SW5	SW5
Sampled By							BF&A	Stantec	Stantec	Golder	Golder	BF&A	Stantec	Golder	Stantec	Golder
Date Collected							19-Nov-96	16-May-99	22-Oct-99	06-Dec-99	30-Dec-99	19-Nov-96	22-Oct-99	13-May-99	16-May-99	18-Oct-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Zenon	Seprotech	Seprotech	Accutest	Accutest	Zenon	Seprotech	Accutest	Seprotech	Accutest
Metals (cont'd)																
Cadmium	PWQO	0.0002	mg/L	0.002	0.0001	<0.002	<0.0001	<0.0001	<0.00015	<0.00015	<0.002	<0.0001	<0.00015	<0.0001	<0.00015
Calcium		n/v	mg/L	0.2	0.03	210	220	57.4	118	216	67	15.0	206	196	184.0
Chromium	PWQO	0.1	mg/L	0.004	0.01	<0.004	<0.01	<0.01	<0.01	<0.01	0.005	<0.01	<0.01	<0.01	<0.01
Cobalt	IPWQO	0.0006	mg/L	0.01	0.0005	<0.01	*0.011*	*0.016*	*0.0015*	*0.0017*	<0.01	*0.0007*	<0.0004	<0.0005	*0.0049*
Copper	PWQO	0.01	mg/L	0.006	0.0005	0.0012	0.0022	0.0023	<0.005	<0.005	0.0038	0.0011	<0.005	0.0098	<0.005
Gallium		n/v	mg/L	-	0.05	-	<0.05	<0.05	-	-	-	<0.05	-	<0.05	-
Iron	PWQO	0.30	mg/L	0.01	0.02	*29*	*43.1*	*40.1*	*11.2*	*47.6*	*1.6*	0.16	0.04	*1.99*	*5.25*
Lead	PWQO	0.025	mg/L	0.02	0.0002	0.0010	<0.0002	<0.0002	<0.002	<0.002	0.0015	<0.0002	<0.002	<0.0002	0.002
Lithium		n/v	mg/L	-	0.005	-	0.010	<0.005	-	-	-	<0.005	-	<0.005	-
Magnesium		n/v	mg/L	0.05	0.01	48	60.1	57.4	34	56	16	15.0	44.0	45.9	47.0
Manganese		n/v	mg/L	0.005	0.01	1.0	0.51	0.36	0.18	0.45	0.023	<0.01	0.7	0.79	0.83
Mercury	PWQO	0.0002	mg/L	-	-	-	-	-	<0.0002	<0.0002	-	-	-	-	-
Molybdenum		n/v	mg/L	0.01	0.002	<0.01	0.006	0.006	<0.01	<0.01	<0.01	<0.002	<0.01	0.003	<0.01
Nickel	PWQO	0.025	mg/L	0.01	0.02	0.018	<0.02	0.02	<0.01	<0.01	0.014	<0.002	<0.01	<0.02	<0.01
Niobium		n/v	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus		n/v	mg/L	0.06	0.1	0.086	-	0.3	-	-	<0.06	0.2	-	-	-
Potassium		n/v	mg/L	1.0	0.4	84	140	105	43	100	4.2	0.7	72.0	88.0	66.0
Selenium	PWQO	0.1	mg/L	0.001	0.001	-	<0.001	<0.001	-	-	-	<0.001	-	<0.001	-
Silicon		n/v	mg/L	0.05	-	9.2	-	-	5.9	10.1	7.8	-	5.6	-	8
Silver	PWQO	0.0001	mg/L	0.01	0.0001	<0.01	<0.0001	*0.0008*	*0.002*	<0.0001	<0.01	*0.0002*	*0.0002*	<0.0001	<0.0001
Sodium		n/v	mg/L	0.1	0.2	110	171	164	57	166	9.1	4.9	108	111	111
Strontium		n/v	mg/L	0.001	0.005	1.100	1.30	1.08	0.479	1.12	0.22	0.15	0.928	0.942	0.947
Sulphur		n/v	mg/L	0.06	-	32	-	-	36	25	9.9	-	43	-	28
Thallium	IPWQO	0.0003	mg/L	0.06	0.0002	<0.06	0.0002	<0.0002	<0.005	<0.005	<0.06	<0.0002	<0.005	<0.0002	<0.005
Tin		n/v	mg/L	0.05	-	<0.05	-	-	<0.05	<0.05	<0.05	-	<0.05	-	-
Titanium		n/v	mg/L	0.01	0.01	<0.010	0.03	<0.01	0.04	<0.01	0.091	<0.01	<0.01	0.02	<0.01
Vanadium	IPWQO	0.007	mg/L	0.005	0.005	<0.005	<0.005	<0.005	<0.007	<0.007	<0.005	<0.005	<0.007	<0.005	<0.007
Yttrium		n/v	mg/L	-	0.005	-	<0.005	<0.005	-	-	-	<0.005	-	<0.005	-
Zinc	PWQO	0.03	mg/L	0.005	0.01	0.026	0.03	<0.01	0.03	<0.01	*0.063*	<0.01	0.03	*0.06*	*0.17*
Zirconium	IPWQO	0.004	mg/L	0.01	-	<0.01	-	-	-	-	<0.01	-	-	-	-
Microbiological																
Escherichia Coli (*E. coli*)	[6]	100	Counts/100ml	na	na	-	-	-	-	-	-	-	-	-	-
Fecal Streptococcus		n/v	Counts	na	na	-	-	-	-	-	-	-	-	-	-
Psuedomonas Aeruginosa		n/v	Counts	na	na	-	-	-	-	-	-	-	-	-	-

Table 7
Summary of Historical Surface Water Quality Data

Sample Location	PWQO[1]			Method Detection Limit		Midpoint of Deep Gully								Field Blank[2]
Sampe ID						SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW7
Sampled By						Stantec	Golder	Golder	Golder	Golder	Golder	Golder	Golder	Stantec
Date Collected						22-Oct-99	27-Nov-99	04-Dec-99	06-Dec-99	11-Dec-99	19-Dec-99	30-Dec-99	30-Dec-99	22-Oct-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Seprotech	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Seprotech
Field Parameters														
Dissolved Oxygen		n/v	mg/L	-	-	5.0	-	-	-	-	-	-	-	-
pH	*PWQO*	6.5-8.5	pH units	-	-	8.10	-	-	-	-	-	-	-	-
Specific Conductance		n/v	µS/cm	-	-	1,700	-	-	-	-	-	-	-	-
Temperature	*PWQO*	15[3]	°C	-	-	12.0	-	-	-	-	-	-	-	-
Turbidity	*PWQO*	n/v	NTU	-	-	-	-	-	-	-	-	-	-	-
General Chemistry														
pH	*PWQO*	6.5-8.5	pH units	-	-	7.54	7.6	-	7.5	-	-	*11*	7.9	*5.18*
Saturation pH		n/v	mg/L	-	-	6.36	-	-	-	-	-	-	-	11.62
Specific Conductance		n/v	µS/cm	4.2	1	1,970	810	-	1,000	-	-	-	1,800	59
Biochemical Oxygen Demand (BOD)		n/v	mg/L	-	1	16	15	20	19	17	54	78	27	<1
Chemical Oxygen Demand (COD)		n/v	mg/L	-	-	-	58	50	46	-	71	89	77	-
Colour		n/v	TCU	1	1	32	-	-	19	-	-	-	28	<1
Dissolved Oxygen	*PWQO*	5,6[4]	mg/L	-	1	7	8.1	-	8.8	-	-	-	7.2	-
Turbidity		n/v	NTU	0.01	0.1	120	29	15	30	10	>100	>100	44	0.1
Alkalinity (as $CaCO_3$)	*IPWQO*	30-500	mg/L	1	1	*741*	-	-	462	-	-	-	*755*	10
Total Ammonia-N		n/v	mg/L	0.03	0.01	22.7	14.5	17	17	22.5	30.4	36	34.6	2.39
Un-ionized Ammonia-N	*PWQO*	0.02[5]	mg/L	-	0.01	*0.21*	*0.11*	*0.11***	*0.08*	*0.21***	*0.28***	*0.52***	*0.27*	<0.01
Bromide		n/v	mg/L	0.1	0.4	2.1	-	-	-	-	-	-	-	0.4
Chloride		n/v	mg/L	0.5	0.1	167	-	-	80	-	-	-	168	4.8
Fluoride		n/v	mg/L	0.03	0.1	0.2	-	-	-	-	-	-	-	<0.1
Hydrogen Sulphide	*PWQO*	0.002	mg/L	-	-	-	*0.01*	*0.01*	*0.02*	<0.01	*0.01*	*0.2*	<0.01	-
Nitrate-N		n/v	mg/L	0.05	0.1	3.3	-	-	20.6	-	-	-	3.06	<0.1
Nitrite-N		n/v	mg/L	0.05	0.1	<0.1	-	-	<0.1	-	-	-	<0.1	<0.1
Total Nitrogen		n/v	mg/L	-	0.05	25.9	-	-	17.8	-	-	-	34.6	2.08
Phenols	*PWQO*	0.001	mg/L	0.001	0.001	<0.001	-	-	<0.001	-	-	-	*0.012*	<0.001
Phosphate-P		n/v	mg/L	0.1	0.01	0.06	-	-	-	-	-	-	-	<0.01
Total Phosphorus	*IPWQO*	0.03^	mg/L	0.02	0.01	*0.33*	-	-	*0.06*	-	-	-	*0.24*	<0.01
Sulphate		n/v	mg/L	0.1	1	86	-	-	123	-	-	-	121	<1
Dissolved Organic Carbon (DOC)		n/v	mg/L	-	-	-	-	-	19.9	-	-	-	31.2	-
Total Organic Carbon		n/v	mg/L	0.16	0.3	29.2	-	-	-	-	-	-	-	0.2
Total Dissolved Solids (TDS)		n/v	mg/L	-	1	1,080	-	-	764	-	-	-	1,116	35
Total Suspended Solids (TSS)		n/v	mg/L	-	-	-	-	-	70	-	-	-	143	-
Carbonate (CO_3)		n/v	mg/L	1	1	<1	-	-	-	-	-	-	-	<1
Bicarbonate (HCO_3)		n/v	mg/L	1	1	904	-	-	-	-	-	-	-	12
Total Hardness (as $CaCO_3$)		n/v	mg/L	1	1	688	-	-	487	-	-	-	602	<1
Langelier Saturation Index		n/v	n/a	-	-	1.18	-	-	-	-	-	-	-	-6.44
Metals														
Aluminum	*IPWQO*	0.075 *	mg/L	0.03	0.01	*1.46*	-	-	*0.08*	-	-	-	<0.03	0.04
Arsenic	*PWQO*	0.1	mg/L	-	0.001	<0.001	-	-	-	-	-	-	-	<0.001
Barium		n/v	mg/L	0.001	0.005	0.272	-	-	0.140	-	-	-	0.210	<0.005
Beryllium	*PWQO*	1.1	mg/L	0.001	0.005	<0.005	-	-	<0.002	-	-	-	<0.002	<0.005
Bismuth		n/v	mg/L	-	0.05	<0.05	-	-	-	-	-	-	-	<0.05
Boron	*IPWQO*	0.2	mg/L	0.01	-	-	-	-	*0.81*	-	-	-	*1.57*	-

Table 7
Summary of Historical Surface Water Quality Data

Sample Location	PWQO[1]			Method Detection Limit		Midpoint of Deep Gully								Field Blank[2]
Sampe ID						SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW7
Sampled By						Stantec	Golder	Golder	Golder	Golder	Golder	Golder	Golder	Stantec
Date Collected						22-Oct-99	27-Nov-99	04-Dec-99	06-Dec-99	11-Dec-99	19-Dec-99	30-Dec-99	30-Dec-99	22-Oct-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Seprotech	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Seprotech
Metals (cont'd)														
Cadmium	*PWQO*	0.0002	mg/L	0.002	0.0001	<0.0001	-	-	<0.00015	-	-	-	<0.00015	<0.0001
Calcium		n/v	mg/L	0.2	0.03	48.0	-	-	137.0	-	-	-	165	0.04
Chromium	*PWQO*	0.1	mg/L	0.004	0.01	<0.01	-	-	<0.01	-	-	-	<0.01	<0.01
Cobalt	*IPWQO*	0.0006	mg/L	0.01	0.0005	*0.0077*	-	-	*0.0012*	-	-	-	*0.0012*	<0.0005
Copper	*PWQO*	0.01	mg/L	0.006	0.0005	0.004	-	-	<0.005	-	-	-	<0.005	*0.24*
Gallium		n/v	mg/L	-	0.05	<0.05	-	-	-	-	-	-	-	<0.05
Iron	*PWQO*	0.30	mg/L	0.01	0.02	*12.6*	-	-	*1.6*	-	-	-	*2.47*	0.04
Lead	*PWQO*	0.025	mg/L	0.02	0.0002	0.0018	-	-	<0.002	-	-	-	<0.002	0.0079
Lithium		n/v	mg/L	-	0.005	<0.005	-	-	-	-	-	-	-	<0.005
Magnesium		n/v	mg/L	0.05	0.01	48.0	-	-	35.0	-	-	-	46.0	0.04
Manganese		n/v	mg/L	0.005	0.01	0.73	-	-	0.3	-	-	-	0.77	<0.01
Mercury	*PWQO*	0.0002	mg/L	-	-	-	-	-	<0.0002	-	-	-	<0.0002	-
Molybdenum		n/v	mg/L	0.01	0.002	0.003	-	-	<0.01	-	-	-	<0.01	<0.002
Nickel	*PWQO*	0.025	mg/L	0.01	0.02	*0.03*	-	-	<0.01	-	-	-	<0.01	<0.02
Niobium		n/v	mg/L	-	-	-	-	-	-	-	-	-	-	-
Phosphorus		n/v	mg/L	0.06	0.1	0.6	-	-	-	-	-	-	-	<0.1
Potassium		n/v	mg/L	1.0	0.4	70.4	-	-	42.00	-	-	-	52.0	<0.4
Selenium	*PWQO*	0.1	mg/L	0.001	0.001	<0.001	-	-	-	-	-	-	-	<0.001
Silicon		n/v	mg/L	0.05	-	-	-	-	5.3	-	-	-	7.8	-
Silver	*PWQO*	0.0001	mg/L	0.01	0.0001	*0.0005*	-	-	0.0001	-	-	-	<0.0001	<0.0001
Sodium		n/v	mg/L	0.1	0.2	116	-	-	60	-	-	-	86	4.9
Strontium		n/v	mg/L	0.001	0.005	0.933	-	-	0.615	-	-	-	0.96	<0.005
Sulphur		n/v	mg/L	0.06	-	-	-	-	43	-	-	-	44	-
Thallium	*IPWQO*	0.0003	mg/L	0.06	0.0002	<0.0002	-	-	<0.005	-	-	-	<0.005	<0.0002
Tin		n/v	mg/L	0.05	-	-	-	-	<0.05	-	-	-	<0.05	-
Titanium		n/v	mg/L	0.01	0.01	0.11	-	-	<0.01	-	-	-	<0.01	<0.01
Vanadium	*IPWQO*	0.007	mg/L	0.005	0.005	*0.010*	-	-	<0.007	-	-	-	<0.007	<0.005
Yttrium		n/v	mg/L	-	0.005	<0.005	-	-	-	-	-	-	-	<0.005
Zinc	*PWQO*	0.03	mg/L	0.005	0.01	*0.19*	-	-	*0.05*	-	-	-	*0.05*	*0.20*
Zirconium	*IPWQO*	0.004	mg/L	0.01	-	-	-	-	-	-	-	-	-	-
Microbiological														
Escherichia Coli (*E. coli*)	[6]	100	Counts/100ml	na	na	-	-	-	-	-	-	-	-	-
Fecal Streptococcus		n/v	Counts	na	na	-	-	-	-	-	-	-	-	-
Psuedomonas Aeruginosa		n/v	Counts	na	na	-	-	-	-	-	-	-	-	-

Table 7
Summary of Historical Surface Water Quality Data

Sample Location		PWQO[1]			Method Detection Limit		250 m Upstream of Site (East Boundary)				2500 m Upstream of Site (East Boundary)				
Sampe ID							SW7	SW7	SW7	SW7	18207010002	18207010002	18207010002	18207010002	18207010002
Sampled By							Golder	Golder	Golder	Golder	SNRCA	SNRCA	SNRCA	SNRCA	SNRCA
Date Collected							13-May-99	18-Oct-99	06-Dec-99	30-Dec-99	22-Sep-98	11-May-99	16-Jun-99	12-Jul-99	15-Sep-99
Analyzed By	Type	Value	Units	Zenon	Seprotech		Accutest	Accutest	Accutest	Accutest	na	na	na	na	na
Field Parameters															
Dissolved Oxygen		n/v	mg/L	-	-		-	-	-	-	-	-	-	-	-
pH	*PWQO*	6.5-8.5	pH units	-	-		-	-	-	-	-	-	-	-	-
Specific Conductance		n/v	µS/cm	-	-		-	-	-	-	-	-	-	-	-
Temperature	*PWQO*	15[3]	°C	-	-		-	-	-	-	17.0	17.4	22.9	25.3	21.8
Turbidity	*PWQO*	n/v	NTU	-	-		-	-	-	-	-	-	-	-	-
General Chemistry															
pH	*PWQO*	6.5-8.5	pH units	-	-		8.4	8.2	7.0	7.9	8.28	8.40	8.42	8.46	8.23
Saturation pH		n/v	mg/L	-	-		-	-	-	-	-	-	-	-	-
Specific Conductance		n/v	µS/cm	4.2	1		370	460	465	651	527	572	628	601	577
Biochemical Oxygen Demand (BOD)		n/v	mg/L	-	1		-	-	4.0	1	1.2	2.6	2.2	1.4	3.0
Chemical Oxygen Demand (COD)		n/v	mg/L	-	-		24	23	21	17	-	-	-	-	-
Colour		n/v	TCU	1	1		-	-	31	26	-	-	-	-	-
Dissolved Oxygen	*PWQO*	5,6[4]	mg/L	-	1		9.8	12.0	14.5	7.1	n/a	8.02	8.54	7.72	*0.08*
Turbidity		n/v	NTU	0.01	0.1		-	-	19.0	9.2	7.08	10.20	5.27	6.38	8.75
Alkalinity (as $CaCO_3$)	*IPWQO*	30-500	mg/L	1	1		220	208	217	231	198	217	223	214	181
Total Ammonia-N		n/v	mg/L	0.03	0.01		0.23	0.04	0.15	0.19	0.092	0.056	0.038	0.048	0.002
Un-ionized Ammonia-N	*PWQO*	0.02[5]	mg/L	-	0.01		<0.02	<0.02	<0.02	<0.02	0.0052	0.0042	0.0043	0.0069	0.0001
Bromide		n/v	mg/L	0.1	0.4		-	-	-	-	-	-	-	-	-
Chloride		n/v	mg/L	0.5	0.1		35	57	41	49	33.4	36.4	33.8	41.2	59.6
Fluoride		n/v	mg/L	0.03	0.1		-	-	-	-	-	-	-	-	-
Hydrogen Sulphide	*PWQO*	0.002	mg/L	-	-		-	-	*0.02*	<0.001	-	-	-	-	-
Nitrate-N		n/v	mg/L	0.05	0.1		0.20	1.93	3.44	4.18	0.075	0.180	5.700	2.190	0.024
Nitrite-N		n/v	mg/L	0.05	0.1		<0.1	<0.100	<0.100	<0.100	0.011	0.017	0.110	0.086	0.008
Total Nitrogen		n/v	mg/L	-	0.05		-	-	1.010	1.07	0.94	0.88	0.98	0.96	0.64
Phenols	*PWQO*	0.001	mg/L	0.001	0.001		<0.0010	<0.0010	<0.0010	0.001	-	-	-	-	-
Phosphate-P		n/v	mg/L	0.1	0.01		<0.03	<0.03	-	-	0.016	0.008	0.002	0.004	0.040
Total Phosphorus	*IPWQO*	0.03^	mg/L	0.02	0.01		*0.20*	*0.07*	*0.06*	*0.04*	*0.048*	*0.056*	*0.044*	*0.038*	*0.100*
Sulphate		n/v	mg/L	0.1	1		45	70	68	75	-	-	-	-	-
Dissolved Organic Carbon (DOC)		n/v	mg/L	-	-		12	8	10	10	-	-	-	-	-
Total Organic Carbon		n/v	mg/L	0.16	0.3		-	-	-	-	-	-	-	-	-
Total Dissolved Solids (TDS)		n/v	mg/L	-	1		356	384	412	408	-	-	-	-	-
Total Suspended Solids (TSS)		n/v	mg/L	-	-		-	-	10	6	-	-	-	-	-
Carbonate (CO_3)		n/v	mg/L	1	1		-	-	-	-	-	-	-	-	-
Bicarbonate (HCO_3)		n/v	mg/L	1	1		-	-	-	-	-	-	-	-	-
Total Hardness (as $CaCO_3$)		n/v	mg/L	1	1		273	293	318	312	222	258	283	267	252
Langelier Saturation Index		n/v	n/a	-	-		-	-	-	-	-	-	-	-	-
Metals															
Aluminum	*IPWQO*	0.075 *	mg/L	0.03	0.01		*0.68*	*0.09*	*0.09*	<0.030	*0.14*	*0.12*	*0.10*	*0.15*	*0.10*
Arsenic	*PWQO*	0.1	mg/L	-	0.001		-	-	-	-	-	-	-	-	-
Barium		n/v	mg/L	0.001	0.005		0.050	0.070	0.060	0.07	0.048	0.050	0.057	0.060	0.057
Beryllium	*PWQO*	1.1	mg/L	0.001	0.005		<0.01	<0.01	<0.01	<0.002	0.00003	0.00001	0.00001	0.00001	-0.00002
Bismuth		n/v	mg/L	-	0.05		-	-	-	-	-	-	-	-	-
Boron	*IPWQO*	0.2	mg/L	0.01	-		0.020	0.030	0.020	0.06	-	-	-	-	-

Table 7
Summary of Historical Surface Water Quality Data

Sample Location	PWQO[1]			Method Detection Limit		250 m Upstream of Site (East Boundary)				2500 m Upstream of Site (East Boundary)				
Sampe ID						SW7	SW7	SW7	SW7	18207010002	18207010002	18207010002	18207010002	18207010002
Sampled By						Golder	Golder	Golder	Golder	SNRCA	SNRCA	SNRCA	SNRCA	SNRCA
Date Collected						13-May-99	18-Oct-99	06-Dec-99	30-Dec-99	22-Sep-98	11-May-99	16-Jun-99	12-Jul-99	15-Sep-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Accutest	Accutest	Accutest	Accutest	na	na	na	na	na
Metals (cont'd)														
Cadmium	PWQO	0.0002	mg/L	0.002	0.0001	<0.00015	<0.00015	<0.00015	<0.00015	0.0001	*0.0003*	0.0002	*0.0004*	-0.0002
Calcium		n/v	mg/L	0.2	0.03	73	78	86	82	56.7	67.3	74.0	64.9	57.6
Chromium	PWQO	0.1	mg/L	0.004	0.01	<0.010	<0.010	<0.010	<0.01	0.0006	-0.0002	0.0008	0.0002	0.0003
Cobalt	IPWQO	0.0006	mg/L	0.01	0.0005	<0.0004	<0.0004	<0.0004	0.0004	0.0003	*0.0010*	-0.0001	0.0006	0.0004
Copper	PWQO	0.01	mg/L	0.006	0.0005	<0.0050	<0.0050	<0.0050	<0.0005	0.001	0.001	0.002	0.002	0.001
Gallium		n/v	mg/L	-	0.05	-	-	-	-	-	-	-	-	-
Iron	PWQO	0.30	mg/L	0.01	0.02	<0.010	*0.45*	*0.31*	0.29	0.177	0.148	0.115	0.127	0.106
Lead	PWQO	0.025	mg/L	0.02	0.0002	<0.002	<0.002	<0.002	<0.002	-0.0023	0.0027	0.0001	-0.0005	-0.0023
Lithium		n/v	mg/L	-	0.005	-	-	-	-	-	-	-	-	-
Magnesium		n/v	mg/L	0.05	0.01	22	24	25	26	19.6	21.8	23.8	25.4	26.2
Manganese		n/v	mg/L	0.005	0.01	<0.0100	<0.0200	<0.0100	<0.01	0.034	0.041	0.019	0.022	0.082
Mercury	PWQO	0.0002	mg/L	-	-	-	-	<0.0002	<0.0002	-	-	-	-	-
Molybdenum		n/v	mg/L	0.01	0.002	<0.010	<0.010	<0.010	<0.01	0.002	0.002	0.001	0.002	0.004
Nickel	PWQO	0.025	mg/L	0.01	0.02	<0.010	<0.010	<0.010	<0.010	0.0010	0.0002	0.0008	0.0003	0.0014
Niobium		n/v	mg/L	-	-	-	-	-	-	-	-	-	-	-
Phosphorus		n/v	mg/L	0.06	0.1	-	-	-	-	-	-	-	-	-
Potassium		n/v	mg/L	1.0	0.4	3.0	4.0	4.0	2.0	3.98	3.84	2.96	3.13	4.41
Selenium	PWQO	0.1	mg/L	0.001	0.001	-	-	-	-	-	-	-	-	-
Silicon		n/v	mg/L	0.05	-	0.4	2.1	4.0	4.3	-	-	-	-	-
Silver	PWQO	0.0001	mg/L	0.01	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	-	-
Sodium		n/v	mg/L	0.1	0.2	23	34	25	21	20.2	31.5	23.1	28.2	36.7
Strontium		n/v	mg/L	0.001	0.005	0.503	0.702	0.512	0.65	0.43	0.50	0.69	0.70	0.72
Sulphur		n/v	mg/L	0.06	-	14	22	23	25	-	-	-	-	-
Thallium	IPWQO	0.0003	mg/L	0.06	0.0002	<0.050	<0.050	<0.050	<0.005	-	-	-	-	-
Tin		n/v	mg/L	0.05	-	<0.050	-	<0.050	<0.05	-	-	-	-	-
Titanium		n/v	mg/L	0.01	0.01	<0.010	<0.010	<0.010	<0.010	0.006	0.004	0.004	0.005	0.003
Vanadium	IPWQO	0.007	mg/L	0.005	0.005	<0.007	<0.007	<0.007	<0.007	0.002	0.001	0.003	0.003	0.002
Yttrium		n/v	mg/L	-	0.005	-	-	-	-	-	-	-	-	-
Zinc	PWQO	0.03	mg/L	0.005	0.01	<0.0100	<0.0100	<0.0100	<0.01	0.002	0.002	0.002	0.002	0.002
Zirconium	IPWQO	0.004	mg/L	0.01	-	-	-	-	-	-	-	-	-	-
Microbiological														
Escherichia Coli (*E. coli*)	[6]	100	Counts/100ml	na	na	-	-	-	-	52	64	*200*	*112*	8
Fecal Streptococcus		n/v	Counts	na	na	-	-	-	-	52	4	100	92	16
Psuedomonas Aeruginosa		n/v	Counts	na	na	-	-	-	-	<2	<2	<2	<2	<2

Table 7
Summary of Historical Surface Water Quality Data

Sample Location						Mixing Zone				100 m Downstream of Site (East Boundary)			
Sampe ID	PWQO[1]			Method Detection Limit		SW9	SW9	SW10	SW10	SW8	SW8	SW8	SW8
Sampled By						Golder	Golder	Golder	Golder	Golder	Golder	Golder	Golder
Date Collected						06-Dec-99	30-Dec-99	06-Dec-99	30-Dec-99	13-May-99	18-Oct-99	06-Dec-99	30-Dec-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest
Field Parameters													
Dissolved Oxygen		n/v	mg/L	-	-	-	-	-	-	-	-	-	-
pH	PWQO	6.5-8.5	pH units	-	-	-	-	-	-	-	-	-	-
Specific Conductance		n/v	µS/cm	-	-	-	-	-	-	-	-	-	-
Temperature	PWQO	15[3]	°C	-	-	-	-	-	-	-	-	-	-
Turbidity	PWQO	n/v	NTU	-	-	-	-	-	-	-	-	-	-
General Chemistry													
pH	PWQO	6.5-8.5	pH units	-	-	7.5	7.6	7.2	7.9	7.9	8.1	6.8	7.9
Saturation pH		n/v	mg/L	-	-	-	-	-	-	-	-	-	-
Specific Conductance		n/v	µS/cm	4.2	1	470	639	465	685	380	480	460	658
Biochemical Oxygen Demand (BOD)		n/v	mg/L	-	1	1	1	1	<1	-	-	1	2
Chemical Oxygen Demand (COD)		n/v	mg/L	-	-	23	13	21	15	21	23	23	26
Colour		n/v	TCU	1	1	26	25	26	24	-	-	26	27
Dissolved Oxygen	PWQO	5,6[4]	mg/L	-	1	14.1	8.6	13.0	7.8	9.4	12.0	7.5	7.4
Turbidity		n/v	NTU	0.01	0.1	19.0	9.2	17.0	9.4	-	-	16.0	9.2
Alkalinity (as $CaCO_3$)	IPWQO	30-500	mg/L	1	1	221	223	222	245	222	209	220	230
Total Ammonia-N		n/v	mg/L	0.03	0.01	0.10	0.19	0.12	0.11	0.29	0.06	0.13	0.13
Un-ionized Ammonia-N	PWQO	0.02[5]	mg/L	-	0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Bromide		n/v	mg/L	0.1	0.4	-	-	-	-	-	-	-	-
Chloride		n/v	mg/L	0.5	0.1	45	49	46	48	36	58	46	49
Fluoride		n/v	mg/L	0.03	0.1	-	-	-	-	-	-	-	-
Hydrogen Sulphide	PWQO	0.002	mg/L	-	-	*0.020*	<0.01	*0.020*	<0.01	-	-	*0.01*	<0.01
Nitrate-N		n/v	mg/L	0.05	0.1	3.59	4.17	3.55	4.17	0.25	2.00	3.74	4.22
Nitrite-N		n/v	mg/L	0.05	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Nitrogen		n/v	mg/L	-	0.05	1.06	1.01	1.01	1.03	-	-	0.98	1.01
Phenols	PWQO	0.001	mg/L	0.001	0.001	<0.001	*0.011*	<0.001	*0.008*	<0.001	<0.001	<0.001	*0.003*
Phosphate-P		n/v	mg/L	0.1	0.01	-	-	-	-	0.36	0.30	-	-
Total Phosphorus	IPWQO	0.03^	mg/L	0.02	0.01	*0.07*	*0.04*	*0.05*	*0.04*	*0.12*	*0.06*	*0.06*	*0.04*
Sulphate		n/v	mg/L	0.1	1	66	75	65	76	45	70	69	75
Dissolved Organic Carbon (DOC)		n/v	mg/L	-	-	10	9	10	10	11	8	10	10
Total Organic Carbon		n/v	mg/L	0.16	0.3	-	-	-	-	-	-	-	-
Total Dissolved Solids (TDS)		n/v	mg/L	-	1	408	408	404	420	438	436	404	434
Total Suspended Solids (TSS)		n/v	mg/L	-	-	12	2	13	5	-	-	7	4
Carbonate (CO_3)		n/v	mg/L	1	1	-	-	-	-	-	-	-	-
Bicarbonate (HCO_3)		n/v	mg/L	1	1	-	-	-	-	-	-	-	-
Total Hardness (as $CaCO_3$)		n/v	mg/L	1	1	324	347	311	355	282	289	311	312
Langelier Saturation Index		n/v	n/a	-	-	-	-	-	-	-	-	-	-
Metals													
Aluminum	IPWQO	0.075 *	mg/L	0.03	0.01	<0.03	<0.03	*0.120*	<0.03	*0.23*	*0.10*	*0.10*	0.070
Arsenic	PWQO	0.1	mg/L	-	0.001	-	-	-	-	-	-	-	-
Barium		n/v	mg/L	0.001	0.005	0.060	0.060	0.060	0.070	0.050	0.070	0.06	0.060
Beryllium	PWQO	1.1	mg/L	0.001	0.005	<0.003	<0.002	<0.002	<0.002	<0.01	<0.01	<0.002	<0.002
Bismuth		n/v	mg/L	-	0.05	-	-	-	-	-	-	-	-
Boron	IPWQO	0.2	mg/L	0.01	-	0.020	0.050	0.020	0.050	0.020	0.030	0.02	0.060

Table 7
Summary of Historical Surface Water Quality Data

Sample Location	PWQO[1]			Method Detection Limit		Mixing Zone				100 m Downstream of Site (East Boundary)			
Sampe ID						SW9	SW9	SW10	SW10	SW8	SW8	SW8	SW8
Sampled By						Golder	Golder	Golder	Golder	Golder	Golder	Golder	Golder
Date Collected						06-Dec-99	30-Dec-99	06-Dec-99	30-Dec-99	13-May-99	18-Oct-99	06-Dec-99	30-Dec-99
Analyzed By	Type	Value	Units	Zenon	Seprotech	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest	Accutest
Metals (cont'd)													
Cadmium	*PWQO*	0.0002	mg/L	0.002	0.0001	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Calcium		n/v	mg/L	0.2	0.03	85	96	85	99	75	78	85	82
Chromium	*PWQO*	0.1	mg/L	0.004	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	*IPWQO*	0.0006	mg/L	0.01	0.0005	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Copper	*PWQO*	0.01	mg/L	0.006	0.0005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Gallium		n/v	mg/L	-	0.05	-	-	-	-	-	-	-	-
Iron	*PWQO*	0.30	mg/L	0.01	0.02	0.19	0.21	0.25	0.27	<0.01	*0.59*	0.30	0.21
Lead	*PWQO*	0.025	mg/L	0.02	0.0002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lithium		n/v	mg/L	-	0.005	-	-	-	-	-	-	-	-
Magnesium		n/v	mg/L	0.05	0.01	24	25	24	26	23	23	24	26
Manganese		n/v	mg/L	0.005	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
Mercury	*PWQO*	0.0002	mg/L	-	-	<0.0002	<0.0002	<0.0002	<0.0002	-	-	<0.0002	<0.0002
Molybdenum		n/v	mg/L	0.01	0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	*PWQO*	0.025	mg/L	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Niobium		n/v	mg/L	-	-	-	-	-	-	-	-	-	-
Phosphorus		n/v	mg/L	0.06	0.1	-	-	-	-	-	-	-	-
Potassium		n/v	mg/L	1.0	0.4	3.0	3.0	3.0	3.0	3.0	4.0	4.0	3.0
Selenium	*PWQO*	0.1	mg/L	0.001	0.001	-	-	-	-	-	-	-	-
Silicon		n/v	mg/L	0.05	-	3.7	4.2	3.5	4.3	0.5	2.1	4.1	4.2
Silver	*PWQO*	0.0001	mg/L	0.01	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Sodium		n/v	mg/L	0.1	0.2	25	26	25	26	24	35	25	21
Strontium		n/v	mg/L	0.001	0.005	0.51	0.64	0.51	0.66	0.51	0.69	0.52	0.64
Sulphur		n/v	mg/L	0.06	-	23	25	22	25	15	22	23	25
Thallium	*IPWQO*	0.0003	mg/L	0.06	0.0002	<0.005	<0.005	<0.005	<0.005	<0.0050	<0.0050	<0.0050	<0.0050
Tin		n/v	mg/L	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05
Titanium		n/v	mg/L	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	*IPWQO*	0.007	mg/L	0.005	0.005	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Yttrium		n/v	mg/L	-	0.005	-	-	-	-	-	-	-	-
Zinc	*PWQO*	0.03	mg/L	0.005	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zirconium	*IPWQO*	0.004	mg/L	0.01	-	-	-	-	-	-	-	-	-
Microbiological													
Escherichia Coli (*E. coli*)	[6]	100	Counts/100ml	na	na	-	-	-	-	-	-	-	-
Fecal Streptococcus		n/v	Counts	na	na	-	-	-	-	-	-	-	-
Psuedomonas Aeruginosa		n/v	Counts	na	na	-	-	-	-	-	-	-	-

Notes:

[1] Reference: Ontario Ministry of the Environmentand Energy (MOE), revised 1994. Policies, Guidelines, Provincial Water Quality Objectives (PWQO).

[2] Field Blank labelled as SW-7 for blind submission to laboratory

[3] The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

[4] PWQO for Dissolved Oxygen set at 5 mg/L or 6 mg/L as a conservative measure using the average of the known surface water temperatures (20.9 °C for SNRCA data and 13.3 °C for all other data, respectively) and the objective for cold water biota.

[5] To account for pH and temperature effects in aqueous ammonia solutions, un-ionized ammonia concentrations were calculated using the method described in the PWQO.

[6] Based on a recreational water quality guideline published by the Ontario Ministry of Health in 1992.

°C degrees Celsius

PWQO Provincial Water Quality Objectives

IPWQO Interim Provincial Water Quality Objectives

na not available

NTU Nephelometric Turbidity Units (SNRCA data reported in FTU - Formazin Turbidity Units

µS/cm microSiemens per centimetre

mg/L milligrams per litre

n/v No PWQO has been established.

- Analysis not performed.

201 The value exceeds the respective objective.

< The parameter was not detected at the quantitation limit shown.

Unless otherwise noted the samples have not been filtered and represent total ion concentrations in water

* At pH >6.5 to 9.0, the interim PWQO is 75 µg/L based on total aluminum measured in clay-free samples.

** A conservative assumption of 10°C was used for temperature, where the sample pH was not available or acceptable, an average of the previous and later pH was used.

^ Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.03 mg/L.

Analytical results for 1996 presented herein are as reported by Beatty Franz & Associates Ltd. in the March 1997 Report entitled Hydrogeological Assessment of the Village of Casselman Landfill.

Stantec

APPENDIX C

FIELD FORMS

Stantec Consulting Limited
871 Victoria Street North Kitchener,
Ontario,Canada N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

Stantec

Project Name: Casselman Village Landfill
Project Number: 634 46550

Date: October 21/99
Field Personnel: JF Dubé, G. Laland

Record the condition and type of each item.

	well ID	Well ID Marked	Flush-mount or above ground protective casing	Surface seal type and condition	Lock key number and condtion	Riser Stick-up	J-plug or cap	Reference Point marked	Dedicated Sampling Equipment	Necessary Repairs	Comments
1	96-4	yes	Above ground	Exist ground	N/A	1.89	Plastic	No	yes	NO	
2											
3	96-2(I)	yes	Aboveground	Exist ground	N/A	0.85	Plastic	No	yes	NO	Near 4 m. ditch
4											
5	96-2I	yes	Aboveground	Exist ground	N/A	1.28	None	No	yes	NO	Near 4m. ditch
6											
7	96-3	yes	Above grand	Exist ground	N/A	1.00	Plastic	No	yes	NO	
8											
9	96-1	yes	Aboveground	Exist ground	N/A	0.71	Plastic	NO	yes	NO	Waste placednearby
10											
11											
12											
13											
14											
15	N/A	Not applicable									
16											

Quality Control: This form is complete (✓) & legible (✓).
check (√)

Gerry Lalonde
(inspected by)

October 25/99
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax (519) 579-6733

WATER LEVEL FORM

Project Name: Casselman Village Landfill
Project Number: 634 46550
Date: October 21/99
Field Personnel: JF Dubé, G. Lalonde

Measuring Equipment: Water level meter - Waterra
Serial Number:
Units of Measurement: Cms.
Weather: Sunny +5°C

well ID	Measurement #1 Time	Measurement #1 Water Level (m btoc)	Measurement #2 Time	Measurement #2 Water Level (m btoc)	Measurement #3 Time	Measurement #3 Water Level (m btoc)	Comments (colour, odour, sediment load, &/or presence of product, films, etc.)
1 96-4	9:47	1.89	10:11	1.89	Oct 21 measurements		grey color, silty deposi-
2 Oct 22					9:05	1.52	immediate recovery (minutes)
3 96-2(1)	10:21	2.65	10:41	2.70	Oct 21 measurements		grey color, silty, gas odor.
4 Oct 22/99					9:38	2.63	
5 96-2 II	10:22	dry	—	—			Deep ditch ± 4m deep
6							next to piezometer
7 96-3	10:51	1.52	11:11	5.17			Slightly grey - few
8 Oct 22					10:15	1.60	sediments - slow recovery
9 96-1	11:34	2.05	11:45	4.22			Slow recovery, strong 1/2
10 Oct 22		~~2.06~~			11:00	2.06	and gas, dense grey water
11							TD 4.58
12 SW1	location in gully along fenceline dividing Central & Casselman landfills						
13							
14 SW3	Ditch at N.W. corner 1ft wide x 2' deep x 1m/15 seconds						
15							
16 SW5	Gully between Central & Casselman landfills - approximately 1/2						
17	distance between South Nation River and north toe of waste						
18	placed in gully						
19							
20 SW7	Dup/QC sample - distilled water						
21							
22							
23							
24							
25							

Quality Control:
check (_√_)

This form is complete (✓) & legible (✓). Water level measurements are within historical values (✓) & stable (✓).
Water level meter is functioning normally (✓) and units of measurement are shown (✓).
Well IDs marked and confirmed (✓), reference points clearly marked (X), and well conditions documented (✓).
Wells with water-tight caps, in low K units, or which "popped" when opened were allowed time to stabilize (✓).

Gerry Lalonde — (inspected by)
Oct 25/99 — (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-1

General Information:

Project Name: Casselman V.
Project Number: 63446550
Sampling Date: Oct 21/99.
Field Personnel: DF Dubé
Weather: Sunny +10°C

Activity: Purge + Sample
Purging Equipment: Waterra
Sampling Equipment: Waterra
Sampling Depth: 4.5-4.6
Well Yield: low

Well Diameter: 50mm
Well Stickup: 0.706
Initial Water Level: 2.05 Time 11:37
Well Total Depth: 4.60
1 Casing Volume:

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
Oct 21											
11:37	—		4.0	10.0	6.7	1500	5.4				Dark black silty sediment gas odor strong.
Oct 22	4.0		0.5	10	6.8	1700	4.0				Same as above

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-1	Oct 22 11:10	Phenol	250 ml. brown glass	P
96-1	Oct 22 11:10	BOD5	250 ml clear glass	P
96-1	Oct 22 11:10	General	125 ml plastic	None
96-1	Oct 22 11:10	Metals	125 ml plastic	P & FF

Comments:

- Purge using 300 mm deep strokes on tubing — 25 strokes per litre of water (measured 3 X)
- Filter changed when filling metal analysis bottle - slow pumping

Quality Control:

check (√)

This form is complete (√) & legible (√). Field measurements are within historical values (√) & stable (√).
Meters are calibrated (√) and units shown (√). Well ID has been confirmed (√) and well condition documented (√).
Sample and QC sample IDs recorded (√), and containers, analyses, field filtering, and preservation indicated (√).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (√).

Gerry Labbé
(inspected by)

Oct 25/99
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96 - 2(1)

General Information:

Project Name: Casselman V.
Project Number: 634H6550
Sampling Date: Oct. 21/99
Field Personnel: JF Dubé
Weather: Sunny +5°C

Activity: Purge + Sample
Purging Equipment: Waterra
Sampling Equipment: Waterra
Sampling Depth: 4.3 - 4.4 mbtoc
Well Yield: Medium

Well Diameter: 50mm
Well Stickup: 0.85 m
Initial Water Level: 2.65 mbtoc Time 10:21
Well Total Depth: 4.480 mbtoc
1 Casing Volume:

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
Oct 21											
10:21	N/A		8.0	10.0	7.1	750	2.4			2.65	Silty sediment, grey, odor
Oct 22											
9:41	± 4.		1.0	11	7.3	700	3.5			2.63	Med. grey colour

Sample Collection Information: Oct 22/99.

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-2	9:45	General	125 ml plastic	NONE/NG
96-2	9:47	Metals	125 ml plastic	HNO3 Hard, preserved
96-2	9:52	Phenols	250 ml - glass - brown	Preserved

Comments:

- Purged using 300 mm deep strokes — total 430 strokes to obtain 4 L.
- Filter did not plug for metal analysis

Quality Control:

check (√)

This form is complete (✓) & legible (✓). Field measurements are within historical values (✓) & stable (✓).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓).
Sample and QC sample IDs recorded (✓), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓).

Gary Lalonde (inspected by)

Oct 25/99 (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-3

General Information:

Project Name: Casselman V.
Project Number: 63446550
Sampling Date: Oct. 21/99
Field Personnel: J.F. Bird
Weather: Sunny, clear +5°C

Activity: Purge & Sample
Purging Equipment: Waterra
Sampling Equipment: Waterra
Sampling Depth: 6.2 - 6.3 mbtoc
Well Yield: Low (high, medium, low)

Well Diameter: 50mm
Well Stickup: 1.00m
Initial Water Level: 1.52 Time 10:51
Well Total Depth: 6.310 mbtoc
1 Casing Volume:

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
10:51			12	10.0	7.5	110	6.0			1.52	135 pumps water level drops at approx. 0.3m from bottom of well. very light grey, no odour
10:20	Oct 22		0-5	9	7.7	1100	8.2				

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-3	Oct 22	Phenol	250 ml brown glass	P
96-3	Oct 22	Metal	125 ml plastic	P + FF
96-3	Oct 22	General	125 ml plastic	Nothing.

Comments:

- Clear water being drawn at end of purging - recovery not quick enough to maintain water in standpipe - at end of purging, pumping is from the bottom 300 mm. only.

Quality Control:

check (√)

This form is complete (√) & legible (√). Field measurements are within historical values (√) & stable (√). Meters are calibrated (√) and units shown (√). Well ID has been confirmed (√) and well condition documented (√). Sample and QC sample IDs recorded (√), and containers, analyses, field filtering, and preservation indicated (√). Any discontinuity in time from the start of purging to date and time of sample collection is documented (√).

Gerry Kolonko
(inspected by)

Oct 25/99
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-4

General Information:

Project Name: Casselman landfill
Project Number: 63446550
Sampling Date: October 21/22
Field Personnel: JF Dubé
Weather: Sunny + 5°C

Activity: Purge + Sample
Purging Equipment: Waterra
Sampling Equipment: Waterra
Sampling Depth: 4.2 - 4.3
Well Yield: High

Well Diameter: 50mm
Well Stickup: 0.840
Initial Water Level: 1.89 Time 10:00
Well Total Depth: 4.350
1 Casing Volume:

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
10:00			12.0	10.0	7.6	240	3.2			1.89	SILTY Sediment, NO ODOUR
Oct 22											
9:07	1.82			11	7.9	250	2.0			1.82	Medium grey silt, no odour

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-4	9:24		1 litre	NO preservative
96-4	9:25	Metal	0.5 litre.	Preserved + filtered
96-4	9:26	Phenol	500 ml brown	Preserved - no filter

Comments:

- 96-4 well is used for background water quality - silt and sand loading is constant during purging
- well is redeveloped as quickly as it is purged
- filter did not plug when filling metal analysis bottle.

Quality Control:

check (√)

This form is complete (√) & legible (√). Field measurements are within historical values (√) & stable (√). Meters are calibrated (√) and units shown (√). Well ID has been confirmed (√) and well condition documented (√). Sample and QC sample IDs recorded (√), and containers, analyses, field filtering, and preservation indicated (√). Any discontinuity in time from the start of purging to date and time of sample collection is documented (√).

Glen Labrie (inspected by)

Oct 25/99 (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: SW1

General Information:

Project Name: Carlsmith Landfill
Project Number: 1634-0550
Sampling Date: Oct 22/99
Field Personnel: CER, JD / G Lalonde
Weather: Cloudy + 10°C

Activity: Sampling
Purging Equipment: —
Sampling Equipment:
Sampling Depth:
Well Yield:

Well Diameter: N/A
Well Stickup: N/A
Initial Water Level: N/A Time
Well Total Depth: N/A
1 Casing Volume: N/A

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
Oct 22	—	—	—	12	7.6	2400	5.6				

Sample Collection Information: Oct 22/99

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
SW1	11:30	Phenol	250 ml brown glass	P
SW1	11:30	BOD5	250 ml clear glass	P
SW1	11:30	Metal	125 ml plastic	P + FF
SW1	11:30	General	125 ml plastic	Nothing

Comments:

- Flow in gully = 300 m wide x 25 m deep 7 sec / metre (velocity)
- Oily substance flowing on surface
- Pictures were taken

Quality Control:

check (√)

This form is complete (√) & legible (√). Field measurements are within historical values (√) & stable (√). Meters are calibrated (√) and units shown (√). Well ID has been confirmed (√) and well condition documented (√). Sample and QC sample IDs recorded (√) and containers, analyses, field filtering, and preservation indicated (√). Any discontinuity in time from the start of purging to date and time of sample collection is documented (√).

Gerry Lalonde (inspected by)

Oct 25/99 (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: SW-3

General Information:

Project Name: Casselman Landfill — Activity: Sampling — Well Diameter: —

Project Number: 1,34 46550 — Purging Equipment: — — Well Stickup: —

Sampling Date: Oct 22/99. — Sampling Equipment: — — Initial Water Level: — Time 10:10

Field Personnel: CE Bull/G. Lalonde — Sampling Depth: — — Well Total Depth: —

Weather: Cloudy ~ 10 °C — Well Yield: — — 1 Casing Volume:

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
					8.6		~~16~~				
10:10	—	—	—	7°C		370	11.2				Clear

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
SW-3	Oct 22 10:10	Phenols	250 ml brown glass	P
SW-3	Oct 22 10:10	Metal	125 ml plastic	P + FF
SW-3	Oct 22 10:10	General	125 ml plastic	Nothing.

Comments:

SW 3 is located at N.W. corner of property - discharges to South Nation River.

- Flow → 0.3 m wide x 25 mm deep
  V = 1m. in 47 seconds
- Most of the flow from ditch is due to groundwater flow into ditch from South and west sides of property.

Quality Control:

check (√)

This form is complete (✓) & legible (✓). Field measurements are within historical values (✓) & stable (✓).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓).
Sample and QC sample IDs recorded (✓), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (—).

Gerry Lalonde — (inspected by) — Oct 25/99 — (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: SW5

General Information:

Project Name: Cambridge V. Landfill
Project Number: 6344550
Sampling Date: Oct 22/99
Field Personnel: G. Budd/G. Lalonde
Weather: Mainly +10°C

Activity: Sampling
Purging Equipment: —
Sampling Equipment: —
Sampling Depth: —
Well Yield: —

Well Diameter: —
Well Stickup: —
Initial Water Level: — Time 11:45
Well Total Depth: —
1 Casing Volume: —

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
11:45				12°C	8.1	1700	5				

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
SW5	Oct 22 11:45	Phenols	250ml brown glass	P
SW5	" "	BOD5	250 ml clear glass	P
SW5	" "	Metal	125 ml plastic	P+FF
SW5	" "	General	125 ml plastic	Nothing.

Comments:

- SW5 location corresponds to the same location that was sampled by Golder Associates labelled also SW5 one week ago.

Quality Control:

check (√)

This form is complete (√) & legible (√) Field measurements are within historical values (√) & stable (√).
Meters are calibrated (√) and units shown (√). Well ID has been confirmed (√) and well condition documented (√).
Sample and QC sample IDs recorded (√) and containers, analyses, field filtering, and preservation indicated (√).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (√).

Gerry Lalonde (inspected by)

Oct 25/99 (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: QA/QC

General Information:

Project Name: Cambridge V. | Activity: Sampling | Well Diameter: —
Project Number: 6344650 | Purging Equipment: — | Well Stickup: —
Sampling Date: Oct 22/99 | Sampling Equipment: — | Initial Water Level: — Time 1:30 p.m.
Field Personnel: [illegible] G Lalock | Sampling Depth: — | Well Total Depth: —
Weather: Cloudy +10°C | Well Yield: — | 1 Casing Volume: —

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
SW 7	1:30 pm	Metals.	125 ml plastic	P ~~HNO3~~
SW 7	1:30 p.m.	General.	125 ml plastic	Nothing.

Comments:

Distilled water - bottles labelled as SW-7.

Quality Control:

check (_√_)

This form is complete (✓) & legible (✓). Field measurements are within historical values (✓) & stable (✓).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓).
Sample and QC sample IDs recorded (✓), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓).

Gerry Lalock (inspected by) — Oct 25/99 (date)

SAMPLE SUBMISSION SHEET

Seprotech LABORATORIES
2378 Holly Lane
Ottawa, Ontario
Canada K1V 7P1
Tel: (613) 523-1641
Fax: (613) 731-0851

DATE (D / M / Y) 22/10/99.
CLIENT REF / QUOTATION
P.O. NO.

RESULTS AND INVOICE INFORMATION

RESULTS TO: Stantec Consulting. INVOICE TO: Stantec Consulting
400 1505 Laperrière
OTTAWA ON

NUMBER OF SAMPLES:

SPECIAL INSTRUCTIONS: Same sampling routine as for
sheets for spring monitoring program.

SAMPLE TYPE

☐ Waste Water ☑ Leachate ☐ Rock ☐ Sediment ☐ Oil
☐ Surface Water ☐ Soil ☐ Other
☐ Drinking Water ☐ Sludge

INORGANIC PARAMETERS

R-BOTTLE

☐ ACIDITY ☐ SiO_2
☐ ALKALINITY ☐ TURBIDITY
☐ pH ☐ COLOUR
☐ OH ☐ CONDUCTIVITY
☐ HCO_3 ☐ Cr Hex
☐ CO_3 ☐ F
☐ Cl ☐ NO_3N
☐ SO_4 ☐ NO_2N
☐ HARDNESS ☐ BOD_5
☐ Ca ☐ TAN + LIG
☐ Mg ☐ TSS
☐ K ☐ TDS
☐ Na ☐ SO_3
☐ Br ☐ ODOUR

M-BOTTLE

☐ Ag ☐ Al ☐ As ☐ Ba
☐ Be ☐ Bi ☐ B ☐ Ca
☐ Cu ☐ Co ☐ Cr ☐ Cu
☐ Fe ☐ Ga ☐ K ☐ Li
☐ Mg ☐ Mn ☐ Mo ☐ Na
☐ Nb ☐ Ni ☐ Pb ☐ Sb
☐ Se ☐ Si ☐ Sn ☐ Sr
☐ Ti ☐ U ☐ V ☐ W
☐ Y ☐ Zn ☐ Zr
☐ ICP-dissolved ☐ ICP-Total

H_2S-BOTTLE

☐ H_2S

Hg-BOTTLE

☐ MERCURY

OTHER INORGANIC

☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____

N/P-BOTTLE

☐ TKN ☐ PTOT
☐ COD ☐ NH_3N

CN-BOTTLE

☐ CN TOT ☐ CNO
☐ CNS ☐ CN WAD

ORGANIC PARAMETERS

EXTRACTABLES

☐ EPA 625
☐ ACIDS ONLY
☐ BASE / NEUTRALS ONLY
☐ GLYCOLS
☐ CHLORINATED HYDROCARBON
☐ DIOXINS / FURANS
☐ TOTAL PETROLEUM HYDROCARBON
☐ FATTY ACIDS / RESINS
☐ PAH ☐ PCBs

PESTICIDES-HERBICIDES

☐ ORGANOCHLORINE
☐ PHENOXY ACID HERBICIDE
☐ ORGANOPHOSPHORUS
☐ CARBONATES
☐ ONTARIO DRINKING WATER

VOLATILES

☐ EPA 624 ☐ BETX
☐ THM ☐ METHANE

PHE-BOTTLE

☐ PHENOL

TOC/DOC-BOTTLE

☐ TOC ☐ DOC

BACT-BOTTLE

☐ TOT COL ☐ STAND PC
☐ FEC COL ☐ FEC STREP
☐ E. COLI ☐ BACKGROUND

O + G -BOTTLE

☐ OG (TOTAL) ☐ OG (MINERAL)

OTHER ORGANIC

☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____
☐ _____

PACKAGES

(SEE PRICE LIST FOR SPECIFIC PARAMETERS OF PACKAGES LISTED BELOW)

☐ ONTARIO DRINKING WATER OBJECTIVES - COMPLETE LIST
☐ ONTARIO DRINKING WATER OBJECTIVES - REDUCED LIST
☐ ONTARIO DRINKING WATER SUPPLY PACKAGE FOR SUBDIVISIONS
☐ POTABLE WATER PARAMETERS (HOME OWNER)

SEWER USE BY-LAW

☐ STORM SEWER
☐ SANITARY SEWER
☐ CRITERIA FOR PROPOSED LAND USE

REGULATION 347 PARAMETERS

☐ INORGANIC ORGANIC ☐ PCB ☐ THM ☐ PESTICIDES

☐ DECOMMISSIONING AND CLEAN UP GUIDELINES FOR SOILS
☐ OPEN WATER DISPOSAL ANALYSES
☐ SEWER SLUDGE ANALYSES
☐ ICP SCAN - SOILS
☐ WHOLE ROCK

REPORT FORMAT

☑ HARD COPY ☐ DISK
PREFERRED SOFTWARE _____

DO YOU WISH SAMPLES RETURNED? ☐ YES ☑ NO

WHITE - LAB PINK - CLIENT

Stantec Consulting Limited
871 Victoria Street North Kitchener,
Ontario,Canada N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

Stantec

Project Name: Cassalman V. Landfill

Project Number: 634/46550

Date: May 16, 1999

Field Personnel: Gerry Lalonde

Record the condition and type of each item.

	well ID	Well ID Marked	Flush-mount or above ground protective casing	Surface seal type and condition	Lock key number and condtion	Riser Stick-up metres.	J-plug or cap	Reference Point marked	Dedicated Sampling Equipment	Necessary Repairs	Comments metres.
1											
2	96-1	NO	No casing		None	0.706	Plastic bag	NO	Waterra		T.D. = 4.60
3											
4	96-2 I	No	No casing		None	0.90	Plastic bag	No	Waterra.		T.D. 4.480
5											
6	96-2(II)	NO	No casing		None.	1.290	Cap	No	Waterra		T.D. 2.88 m
7											
8	96-3	NO	NO		None	1.00 m	Plastic bag	NO	Waterra.		T.D. = 6.310 m
9											
10	96-4	NO	NO		None.	0.840	Plastic bag	NO	Waterra		T.D. = 4.350 m
11											
12											
13											
14											
15											
16											

Quality Control: *check (_ √_)*

This form is complete (√) & legible (√).

Gerry Lalonde
(inspected by)

May 17/99
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

WATER LEVEL FORM

Project Name: Casselman V. Landfill
Project Number: 63446550
Date: May 15 & 16
Field Personnel: Gerry Lalonde

Measuring Equipment: Heron 60m water level
Serial Number:
Units of Measurement: cms
Weather: Sunny + 24°C

	well ID	Measurement #1 Time	Measurement #1 Water Level (m btoc)	Measurement #2 Time	Measurement #2 Water Level (m btoc)	Measurement #3 Time	Measurement #3 Water Level (m btoc)	Comments (colour, odour, sediment load, &/or presence of product, films, etc.)
1	96-1	16:58	1.690	10:47	1.670			Small H_2S, dark grey color
2		May 15	metres.	May 16				
3								
4	96-2 (I)	16:06	2.590	11:23	2.580			Light grey colour
5		May 15		May 16				
6								
7	96-2 II	16:06	dry	11:23	dry			Dry well.
8		May 15		May 16				
9								
10	96-3	16:26	2.240	11:43	5.15			Water clear
11		May 15		May 16				
12								
13	96-4	15:32	1.860	10:16	1.870			Very light green colour
14		May 15		May 16				
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

Quality Control:
check (_ √_)

This form is complete (√) & legible (√). Water level measurements are within historical values (_) & stable (_).
Water level meter is functioning normally (√) and units of measurement are shown (√).
Well IDs marked and confirmed (√), reference points clearly marked (√), and well conditions documented (√).
Wells with water-tight caps, in low K units, or which "popped" when opened were allowed time to stabilize (√).

Gerry Lalonde
(inspected by)

May 17/99
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-1

General Information:

Project Name: Cassselman Landfill
Project Number: 634 4655
Sampling Date: May 16/99
Field Personnel: G. Lalonde
Weather: + 18°C

Activity: Purge & Sample
Purging Equipment: Waterra
Sampling Equipment:
Sampling Depth: 4.5-4.6
Well Yield: Low

Well Diameter: 50 mm
Well Stickup: 0.706
Initial Water Level: 1.670 Time 16:58
Well Total Depth: 4.60
1 Casing Volume: 6 litres

Development and/or Purging Information: May 15/99.

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
May 15/99											
16:58	3.0-4.5	1.25	10	8.2	6.34	1.22	1.99		533	1.690	Dark grey, smell H_2S, heavy sediment
				After pumping, 10 litres in 8 minutes, the w/l						4.26	Settling 0.05

Sample Collection Information: May 16/99.

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-1	10:47	Metals.	125 ml plastic	Preserved + filtered
96-1	10:47	Anions.	1000 ml plastic	None.
96-1	10:47	Phenols	250 ml brown glass	Preserved

Comments:

H_2S smell while purging - heavy sediment load - difficult to filter due to sediment load - dark grey in color - slow recovery - pumping water from bottom only. - could only pump 10 litres and dry out well on May 15/99 Driest April on record - last day of rain was 2 weeks ago

Quality Control:

check (✓)

This form is complete (✓) & legible (✓). Field measurements are within historical values (✓) & stable (✓)
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓)
Sample and QC sample IDs recorded (✓), and containers, analyses, field filtering, and preservation indicated (✓)
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓)

Gary Lalonde
(inspected by)

May 17/99.
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-2(I)

General Information:

Project Name: Casselman V. Landfill
Project Number: 63446550
Sampling Date: May 16/99
Field Personnel: Gerry Lalonde
Weather: +16°C

Activity: Purge & Sample
Purging Equipment: Waterra
Sampling Equipment: Waterra
Sampling Depth:
Well Yield: Medium

Well Diameter: 50 mm
Well Stickup: 0.90
Initial Water Level: 2.590 Time 16:05
Well Total Depth: 4.480
1 Casing Volume: 6 litres

Development and/or Purging Information: May 15

Time Minutes	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
14		1.3	18	8.3	6.80	0.496	1.72		472	2.590	Solvents = 0.01
			Started 14 minutes of pumping,						the WL	2.76	

Sample Collection Information: May 16/99

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-2	11:23	Metals	125 ml plastic	Preserved + filtered
96-2	11:23	Anions	1000 ml plastic	None
96-2	11:23	Phenols	250 ml. amber glass	Preserved

Comments:

- Water slightly grey
- All samples stored in coolers with ice.

Quality Control:

check (_ √)

This form is complete (✓) & legible (✓). Field measurements are within historical values (✓) & stable (✓).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓).
Sample and QC sample IDs recorded (_), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓).

Gerry Lalonde
(inspected by)

May 17/99
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-2 TI

General Information:

Project Name: Cavendish Landfill
Project Number: 1,3446550
Sampling Date: 11 Jan 16/99
Field Personnel: G. Lalonde
Weather: + 18°C.

Activity: Purge & sample
Purging Equipment: —
Sampling Equipment: —
Sampling Depth:
Well Yield: DRY

Well Diameter: 50 mm
Well Stickup: 1.290
Initial Water Level: 2.840 Time 16:07
Well Total Depth: 2.880
1 Casing Volume: ——

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
										Dry.	

Sample Collection Information: 11 Jan 16/99

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
No samples collected.				

Comments:

Standpipe was dry — deep drill ± 3 metres within 3 metres of borehole — water table below well screen.

Quality Control:

check (_ √_)

This form is complete (✓) & legible (✓). Field measurements are within historical values (__) & stable (__).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓).
Sample and QC sample IDs recorded (__), and containers, analyses, field filtering, and preservation indicated (__).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (__).

G. Lalonde
(inspected by)

11 Jan 17/99.
(date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-3

General Information:

Project Name: Casselman V. Landfill | Activity: Purge + sample | Well Diameter: 50 mm
Project Number: 63L46550 | Purging Equipment: Waterra | Well Stickup: 1.0 m
Sampling Date: May 11/99 | Sampling Equipment: Waterra | Initial Water Level: 2.24 Time
Field Personnel: G. Landale | Sampling Depth: | Well Total Depth: 6.310
Weather: +18°C | Well Yield: Low | 1 Casing Volume: 8 litres

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
May 15/99.											
19 minutes		1.3	24	10.7	7.48	0.827	8.25		155	2.24	Salinity 0.03
			After pumping 24 litres, the water level							5.930	
May 11 @ 11:43										5.15	

Sample Collection Information: May 16/99.

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-3	11:43	Metals	125 ml plastic	Preserved + filtered
96-3	11:43	Anions	1000 ml plastic	None
96-3	11:43	Phenols	250 ml brown glass	Preserved

Comments:

- Water was clear with little sediment.
- Difficult in getting sufficient water for sampling due to low water level in pipe.
- All samples stored in coolers with ice.

Quality Control:

check (✓)

This form is complete (✓) & legible (✓). Field measurements are within historical values (✓) & stable (✓).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (✓).
Sample and QC sample IDs recorded (✓), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓).

Glen Landale. (inspected by)

May 17/99. (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: 96-4

General Information:

Project Name: Cavalman V. Landfill
Project Number: 1,24 46,550
Sampling Date: May 16/99
Field Personnel: G. Valmás
Weather: + 18°C
Activity: Purge and sample
Purging Equipment: Waterra
Sampling Equipment: Waterra
Sampling Depth:
Well Yield: Medium.
Well Diameter: 50mm
Well Stickup: 0.240
Initial Water Level: 1,260 Time 15:22
Well Total Depth: 4.350
1 Casing Volume: 8 litres.

Development and/or Purging Information: May 15/99

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
						mS/cm					
23 min.		1.0	24	8.7	7.85	0.278	5.60		519	1.26	Silt ~ 0.01
			After pumping for 23 minutes, the water level							1.90	
May 16 @ 10:16										1.87	

Sample Collection Information: May 16, 1999

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
96-4	10:16	Metals	125 ml plastic	Preservative
96-4	10:16	Anions	1000 ml. plastic	None
96-4	10:16	Phenols	250 ml brown glass	Preserved

Comments:

- Pump 24 litres - water remains cloudy - contains suspended sediment
- Difficult to filter because of sediment clogging filter.
- BH 96-4 represents background conditions in south end of site.

Quality Control:

check (_ √)

This form is complete (√) & legible (√). Field measurements are within historical values (_) & stable (√).
Meters are calibrated (√) and units shown (√). Well ID has been confirmed (√) and well condition documented (√).
Sample and QC sample IDs recorded (√), and containers, analyses, field filtering, and preservation indicated (√).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (√).

Gerry Valmás (inspected by)

May 17/99 (date)

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: SW 1

General Information:

Project Name: Cassleman V. Landfill
Project Number: 63446550
Sampling Date: May 16, 1999
Field Personnel: G. Lalonde
Weather: ~18°C

Activity: Sample
Purging Equipment: —
Sampling Equipment: —
Sampling Depth:
Well Yield:

Well Diameter: —
Well Stickup: —
Initial Water Level: Time
Well Total Depth:
1 Casing Volume:

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (µmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
13:00	N/A	N/A	N/A	16.5	7.01	2.99	4.84		160		Salin 0.14

Sample Collection Information:

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
SW1	13:00	Metals	125 ml plastic	Preserved w/ HNO3
SW1	13:00	Anions	1000 ml plastic	None
SW1	13:00	Phenols	250 ml brown glass	Preserved
SW1	13:00	DO/BOD	250 ml clear glass	Preserved (2 vials)

Comments:

- SW1 station at fenceline in Route 1 - Notable to measure flow because channel is only 150 mm wide, 75 mm deep and flowing about ± 10 cm/s.
- Small channel flows into stagnant water downstream (5-10 metres from here).

Quality Control:

check (_ √_)

This form is complete (✓) & legible (✓). Field measurements are within historical values (_) & stable (✓).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (✓) and well condition documented (_).
Sample and QC sample IDs recorded (_), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓).

Glen Lalonde.
(inspected by)

May 17/99
(date)

Stantec

Stantec Consulting Limited
871 Victoria Street North
Kitchener, Ontario, Canada
N2B 3S4
Tel:(519) 579-4410
Fax: (519) 579-6733

MONITORING WELL SAMPLING FORM

Well ID: SW5

General Information:

Project Name:	Casselman V. Landfill	Activity:	Sample	Well Diameter:	—
Project Number:	634 4140	Purging Equipment:	—	Well Stickup:	—
Sampling Date:	May 16, 1999	Sampling Equipment:	—	Initial Water Level:	— Time
Field Personnel:	G. Lalonde	Sampling Depth:	—	Well Total Depth:	—
Weather:	+18°C - Sunny	Well Yield:	—	1 Casing Volume:	—

Development and/or Purging Information:

Time	Intake Depth (m btoc)	Purge Rate (Lpm)	Total Vol. Removed (L)	Temp. (°C)	pH (STD)	Specific Conductance (μmhos/cm)	Dissolved Oxygen (mg/L)	ORP (mV)	Turbidity (NTU)	Water Level (m btoc)	Comments (colour, odour, sediment load, product/films)
13:15	N/A	N/A	N/A	19.2	7.68	2.06	3.62		18		Salinity 0.09

Sample Collection Information: May 16/99

Sample ID	Time Collected	Analysis	Container (no., size & type)	Preservative and/or Field Filtered
SW5	13:15	Metals	125 ml plastic	Preserved
SW5	13:15	Anions	1000 ml plastic	None
SW5	13:15	Phenols	250 ml brown glass	Preserved
SW5	13:15	DO / BOD	250 ml clear glass	Preserved (2 vials)

Comments:

- SW5 numbering corresponds to Golder Associates monitoring for Central site @ Nation. Flow measured at 6 litres per 10 seconds or 36 lpm. (measured with pail). SW5 located about 25 metres from discharge point to South Nation River within Ravine 1 - sampling point is downstream of garbage.
-

Quality Control:

check (✓)

This form is complete (✓) & legible (✓). Field measurements are within historical values (_) & stable (_).
Meters are calibrated (✓) and units shown (✓). Well ID has been confirmed (_) and well condition documented (_).
Sample and QC sample IDs recorded (_), and containers, analyses, field filtering, and preservation indicated (✓).
Any discontinuity in time from the start of purging to date and time of sample collection is documented (✓).

G. Lalonde
(inspected by)

May 17/99
(date)

Stantec

APPENDIX D

LABORATORY CERTIFICATES OF ANALYSIS

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Gerry Lalonde
page 1 of 2

Report: 992989869
Project: Casselman Village Landfill
Submitted by: G.L.
Date submitted: October 22, 1999
Date printed: December 02, 1999

Matrix: ground water

Parameter	Units	Det. Limit	96-1	96-2	96-3	96-4
total phosphorus	mg/L	0.01	1.91	0.56	0.09	0.54
total organic carbon	mg/L	0.3	46.8	12.1	2.7	1.2
total hardness as $CaCO_3$	mg/L	1	663	299	694	136
alkalinity as $CaCO_3$	mg/L	1	726	15	308	116
bicarbonate (HCO_3)	mg/L	1	886	18	376	142
carbonate (CO_3)	mg/L	1	<1	<1	<1	<1
bromide	mg/L	0.4	1.2	<0.4	<0.4	<0.4
chloride	mg/L	0.1	76.8	1.9	1.1	1.6
fluoride	mg/L	0.1	0.2	0.2	0.2	0.2
nitrate - N	mg/L	0.1	0.6	0.1	0.2	0.1
nitrite - N	mg/L	0.1	<0.1	<0.1	<0.1	<0.1
phosphate-P	mg/L	0.01	0.03	0.03	0.02	0.09
sulphate	mg/L	1	5	18	450	20
conductivity	µmhos/cm	1	1825	663	1234	302
pH	units		6.26	6.54	7.42	7.53
total dissolved solids	mg/L	1	1190	398	944	208
total ammonia-N	mg/L	0.01	24.4	10.3	<0.01	<0.01
un-ionized ammonia-N	mg/L	0.01	0.01	<0.01	<0.01	<0.01
colour	TCU	1	44.5	19.9	2.9	6.2
turbidity	NTU	0.1	>200	>200	4.1	18.6
antimony	mg/L	0.001	0.002	0.001	<0.001	<0.001
arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
selenium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
lead	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
thallium	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Langelier Index			-0.04	-1.8	0.62	-0.27

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Gerry Lalonde
page 2 of 2

Report: 992989869
Project: Casselman Village Landfill
Submitted by: G.L.
Date submitted: October 22, 1999
Date printed: December 02, 1999

Matrix: ground water

Parameter	Units	Det. Limit	96-1	96-2	96-3	96-4
aluminum	mg/L	0.01	0.06	0.02	0.14	0.01
barium	mg/L	0.005	0.128	0.174	0.064	0.024
beryllium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
bismuth	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
boron	mg/L	0.01	0.43	0.10	0.03	0.02
calcium	mg/L	0.03	225	91.1	164	37.4
chromium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
cobalt	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
copper	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
gallium	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
iron	mg/L	0.02	111	62.2	0.12	<0.02
lithium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
magnesium	mg/L	0.01	24.2	17.1	68.2	10.3
manganese	mg/L	0.01	3.24	2.77	<0.01	<0.01
molybdenum	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
niobium	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
phosphorus	mg/L	0.4	0.4	0.3	0.1	0.1
potassium	mg/L	0.4	29.5	8.4	5.8	1.5
silicon	mg/L	0.05	9.00	7.34	3.48	7.93
silver	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
sodium	mg/L	0.2	50.2	10.8	12.8	3.9
strontium	mg/L	0.005	0.952	0.341	0.535	0.069
tin	mg/L	0.2	0.4	0.3	<0.2	<0.2
titanium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
tungsten	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
vanadium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
yttrium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
zinc	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
zirconium	mg/L	0.01	0.02	0.02		<0.01

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Gerry Lalonde
page 1 of 2

Report: 992989868
Project: Casselman Village Landfill
Submitted by: G.L.
Date submitted: October 22, 1999
Date printed: December 07, 1999

Matrix: surface water

Parameter	Units	Det. Limit	SW1	SW3	SW5	SW7
total phosphorus	mg/L	0.01	0.10	0.05	0.33	<0.01
total organic carbon	mg/L	0.3	41.2	5.0	29.2	0.2
total hardness as $CaCO_3$	mg/L	1	774	215	688	<1
alkalinity as $CaCO_3$	mg/L	1	1020	182	741	10
bicarbonate (HCO_3)	mg/L	1	1240	222	904	12
carbonate (CO_3)	mg/L	1	<1	<1	<1	<1
bromide	mg/L	0.4	3.3	<0.4	2.1	0.4
chloride	mg/L	0.1	252	3.0	167	4.8
fluoride	mg/L	0.1	0.2	0.2	0.2	<0.1
nitrate - N	mg/L	0.1	1.1	<0.1	3.3	<0.1
nitrite - N	mg/L	0.1	<0.1	<0.1	<0.1	<0.1
phosphate-P	mg/L	0.01	0.07	0.03	0.06	<0.01
sulphate	mg/L	1	75	24	86	<1
conductivity	µmhos/cm	1	2650	397	1970	59
pH	units		7.19	7.95	7.54	5.18
total dissolved solids	mg/L	1	1590	264	1080	35
total ammonia-N	mg/L	0.01	61.7	0.08	22.7	2.39
un-ionized ammonia-N	mg/L	0.01	0.26	<0.01	0.21	<0.01
colour	TCU	1	37	9	32	<1
turbidity	NTU	0.1	>200	1.4	120	0.1
phenols	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
dissolved oxygen	mg/L	1	1		7	
total nitrogen	mg/L	0.05	65.2	0.20	25.9	2.08
arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
selenium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
$B.O.D._5$	mg/L	1	12	<1	16	<1
Langelier Index			1.00	0.55	1.18	-6.44
saturation pH			6.19	7.40	6.36	11.62

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Jerry Lalonde
page 2 of 2

Report: 992989868
Project: Casselman Village Landfill
Submitted by: G.L.
Date submitted: October 22, 1999
Date printed: December 07, 1999

Matrix: surface water

Parameter	Units	Det. Limit	SW1	SW3	SW5	SW7
aluminum	mg/L	0.01	0.05	0.12	1.46	0.04
barium	mg/L	0.005	0.663	0.019	0.272	<0.005
beryllium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
bismuth	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
chromium	mg/L	0.01	<0.01	0.01	0.01	<0.01
gallium	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
iron	mg/L	0.02	40.1	0.16	12.6	0.04
lithium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
manganese	mg/L	0.01	0.36	<0.01	0.73	<0.01
nickel	mg/L	0.02	0.02	<0.02	0.03	<0.02
phosphorus	mg/L	0.1	0.3	0.2	0.6	<0.1
strontium	mg/L	0.005	1.08	0.147	0.933	<0.005
titanium	mg/L	0.01	<0.01	<0.01	0.11	<0.01
vanadium	mg/L	0.005	<0.005	<0.005	0.010	<0.005
yttrium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
zinc	mg/L	0.01	<0.01	<0.01	0.19	0.20
cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
cobalt	mg/L	0.0005	0.0156	0.0007	0.0077	<0.0005
copper	mg/L	0.0005	0.0023	0.0011	0.0040	0.235
lead	mg/L	0.0002	<0.0002	<0.0002	0.0018	0.0079
molybdenum	mg/L	0.002	0.006	<0.002	0.003	<0.002
silver	mg/L	0.0001	0.0008	0.0002	0.0005	<0.0001
thallium	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
calcium	mg/L	0.03	214	60.8	195	0.05
magnesium	mg/L	0.01	57.4	15.0	48.0	0.04
potassium	mg/L	0.4	105	0.7	70.4	<0.4
sodium	mg/L	0.2	164	4.9	116	4.9

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Jerry Lalonde
page 1 of 2

Report: 991375539
Project: Casselman Village Landfill
Submitted by: J.L.
Date submitted: May 17, 1999
Date printed: June 04, 1999

Matrix: ground water

Parameter	Units	Det. Limit	96-1	96-2	96-3	96-4
total phosphorus	mg/L	0.01	1.18	0.86	0.23	0.77
total organic carbon	mg/L	0.3	21.2	7.9	7.9	0.7
total hardness as $CaCO_3$	mg/L	1	402	199	468	124
alkalinity as $CaCO_3$	mg/L	1	480	230	350	114
bicarbonate (HCO_3)	mg/L	1	586	281	427	139
carbonate (CO_3)	mg/L	1	<1	<1	<1	<1
bromide	mg/L	0.4	<0.4	<0.4	<0.4	<0.4
chloride	mg/L	0.1	32.1	1.9	1.3	1.8
fluoride	mg/L	0.1	0.2	0.2	0.2	0.2
nitrate - N	mg/L	0.1	0.1	<0.1	0.2	0.1
nitrite - N	mg/L	0.1	<0.1	<0.1	0.1	0.1
phosphate-P	mg/L	0.01	0.14	0.05	0.03	0.06
sulphate	mg/L	1	2	1	180	20
conductivity	µmhos/cm	1	935	425	852	252
pH	units		6.76	7.72	8.04	8.05
total dissolved solids	mg/L	1	608	314	596	168
total ammonia-N	mg/L	0.01	13.8	4.73	0.19	0.03
un-ionized ammonia-N	mg/L	0.01	0.01	0.04	<0.01	<0.01
colour	TCU	1	65	22	1	3
turbidity	NTU	0.1	>200	>200	115	187
antimony	mg/L	0.001	<0.001	0.002	<0.001	<0.001
arsenic	mg/L	0.001	0.008	0.002	<0.001	<0.001
selenium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
lead	mg/L	0.0002	<0.0002	<0.0002	<0.0002	<0.0002
thallium	mg/L	0.0002	0.0003	<0.0002	<0.0002	<0.0002
Langelier Index			0.12	0.40	1.12	0.19

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Jerry Lalonde

Report: 991375539
Project: Casselman Village Landfill
Submitted by: J.L.
Date submitted: May 17, 1999
Date printed: June 04, 1999

Matrix: ground water

Parameter	Units	Det. Limit	96-1	96-2	96-3	96-4
aluminum	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
barium	mg/L	0.005	0.070	0.055	0.040	0.020
beryllium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
bismuth	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
boron	mg/L	0.01	0.16	0.01	0.02	0.01
calcium	mg/L	0.03	148	59.0	104	32.1
chromium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
cobalt	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
copper	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
gallium	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
iron	mg/L	0.02	83.4	42.9	0.16	<0.02
lithium	mg/L	0.005	0.017	0.011	0.022	0.011
magnesium	mg/L	0.01	7.65	12.4	50.0	10.4
manganese	mg/L	0.01	2.70	2.61	0.05	<0.01
molybdenum	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
nickel	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
niobium	mg/L	0.02	<0.02	<0.02	<0.02	<0.02
potassium	mg/L	0.4	17.9	2.0	5.0	1.3
silicon	mg/L	0.05	5.57	7.00	4.67	7.45
silver	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
sodium	mg/L	0.2	25.3	5.6	22.5	4.2
strontium	mg/L	0.005	0.570	0.195	0.415	0.060
tin	mg/L	0.2	0.2	<0.2	<0.2	<0.2
titanium	mg/L	0.01	<0.01	<0.1	<0.01	<0.01
tungsten	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
vanadium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
yttrium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
zinc	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
zirconium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Jerry Lalonde
page 1 of 2

Report: 991375538
Project: Casselman Village Landfill
Submitted by: J.L.
Date submitted: May 17, 1999
Date printed: June 04, 1999

Matrix: surface water

Parameter	Units	Det. Limit	SW1	SW5		
total phosphorus	mg/L	0.01	0.13	0.08		
total organic carbon	mg/L	0.3	47.0	32.8		
total hardness as $CaCO_3$	mg/L	1	800	681		
alkalinity as $CaCO_3$	mg/L	1	1110	682		
bicarbonate (HCO_3)	mg/L	1	1360	832		
carbonate (CO_3)	mg/L	1	<1	<1		
bromide	mg/L	0.4	0.6	0.3		
chloride	mg/L	0.1	220	143		
fluoride	mg/L	0.1	0.2	0.2		
nitrate - N	mg/L	0.1	0.5	3.5		
nitrite - N	mg/L	0.1	<0.1	0.6		
phosphate-P	mg/L	0.01	0.07	0.05		
sulphate	mg/L	1	55	121		
conductivity	µmhos/cm	1	2470	1810		
pH	units		7.55	7.86		
total dissolved solids	mg/L	1	1600	1140		
total ammonia-N	mg/L	0.01	56.2	27.1		
un-ionized ammonia-N	mg/L	0.01	0.37	0.36		
colour	TCU	1	42	42		
turbidity	NTU	0.1	>200	4.6		
phenols	mg/L	0.001	0.015	0.028		
dissolved oxygen	mg/L	1	1	7		
total nitrogen	mg/L	0.05	79.8	42.0		
arsenic	mg/L	0.001	<0.001	<0.001		
selenium	mg/L	0.001	<0.001	<0.001		
$B.O.D._5$	mg/L	1	12	56		
Langelier Index			1.41	1.47		
saturation pH			6.14	6.39		

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor

Seprotech Laboratories

Certificate of Analysis

Client:
Stantec Consulting Ltd.
400-1505 Laperriere Ave.
Ottawa, Ontario
K1Z 7T1
Attention: Jerry Lalonde
page 2 of 2

Report: 991375538
Project: Casselman Village Landfill
Submitted by: J.L.
Date submitted: May 17, 1999
Date printed: June 04, 1999

Matrix: surface water

Parameter	Units	Det. Limit	SW1	SW5		
aluminum	mg/L	0.01	0.04	0.11		
barium	mg/L	0.005	0.758	0.220		
beryllium	mg/L	0.005	<0.005	<0.005		
bismuth	mg/L	0.05	<0.05	<0.05		
chromium	mg/L	0.01	<0.01	<0.01		
gallium	mg/L	0.05	<0.05	<0.05		
iron	mg/L	0.02	43.1	1.99		
lithium	mg/L	0.005	0.010	<0.005		
manganese	mg/L	0.01	0.51	0.79		
nickel	mg/L	0.02	<0.02	<0.02		
strontium	mg/L	0.005	1.30	0.942		
titanium	mg/L	0.01	0.03	0.02		
vanadium	mg/L	0.005	<0.005	<0.005		
yttrium	mg/L	0.005	<0.005	<0.005		
zinc	mg/L	0.01	0.03	0.06		
cadmium	mg/L	0.0001	<0.0001	<0.0001		
cobalt	mg/L	0.0005	0.0110	<0.0005		
copper	mg/L	0.0005	0.0022	0.0098		
lead	mg/L	0.0002	<0.0002	<0.0002		
molybdenum	mg/L	0.002	0.006	0.003		
silver	mg/L	0.0001	<0.0001	<0.0001		
thallium	mg/L	0.0002	0.0002	<0.0002		
calcium	mg/L	0.03	220	196		
magnesium	mg/L	0.01	60.1	45.9		
potassium	mg/L	0.4	140	88.0		
sodium	mg/L	0.2	171	111		

Seprotech Laboratories
2378 Holly Lane, Ottawa, Ontario, K1V 7P1, Canada
Tel: (613)523-1641, Fax: (613)731-0851

Dave Peeler, Lab Supervisor