



8.0 BACKGROUND GROUNDWATER AND SURFACE WATER QUALITY

8.1 Monitoring Well Program

The background groundwater quality program involved collecting samples from selected on-Site monitoring wells installed at locations 12-1 through 12-4 and 13-5 through 13-7 (standpipe locations 12-1-4B, 12-1-5A, 12-2-4, 12-2-5A, 12-3-4B, 12-3-5A, 12-4-4B, 12-4-5A, 13-5-4B, 13-6-4B, 13-6-5A and 13-7-4-1 completed in the mid- and deep silty clay were not included in the groundwater monitoring program). Four rounds of groundwater quality sampling were completed for this assessment at locations 12-1, 12-2 and 12-3 (winter, spring, summer and fall 2013) and three rounds at locations 12-4, 13-5, 13-6 and 13-7 (spring, summer and fall 2013), with the exception of monitoring well 13-7-2, which was installed in June 2013 (summer and fall 2013 only).

The groundwater samples were analyzed for the parameters specified in O.Reg. 232/98 (except for total suspended solids), which lists generic parameters that should be monitored at landfill sites. Total suspended solids were not measured in the samples collected from the monitoring wells because the analysis would be measuring material in the well that has accumulated, and was then re-suspended during the sampling process. All groundwater samples collected were odourless, very light brown to dark brown in colour and had little to high sediment loading. The high sediment loading was primarily found in the groundwater samples from monitors installed in the surficial silty sand and the silty layer.

The groundwater quality results for the on-Site monitoring wells are presented in Table O-1 in Appendix O-I. Based on the results of the groundwater quality sampling program, groundwater quality was variable across the CRRRC Site. Table 8-1 provides a list of the parameters at monitoring wells that were consistently elevated (two or more occasions) compared to the Ontario Drinking Water Quality Standards (ODWQS; MOE, 2006).

Table 8-1: Parameters Consistently Exceeding ODWQS in On-Site Monitoring Wells

| Formation Monitored | Locations | Parameters Consistently Exceeding ODWQS |
|---------------------------------|---|--|
| Surficial Silty Sand | 12-1-6 | DOC, manganese, sodium, TDS |
| | 12-2-6 | manganese |
| | 12-3-6, 13-7-5 | manganese, sodium, TDS |
| | 12-4-6 | DOC, manganese, TDS |
| | 13-5-6 | [none] |
| | 13-6-6 | manganese, TDS |
| Silty layer within Shallow Clay | 12-1-5B, 12-2-5B, 12-3-5B, 12-4-5B, 13-6-5B, 13-7-4-2 | chloride, DOC, manganese, sodium, TDS |
| | 13-5-5 | manganese, TDS |
| Glacial Till | 12-1-4A, 12-3-4A, 13-5-4A, 13-7-3 | barium, chloride, DOC, manganese, sodium, TDS |
| | 12-4-4A | chloride, DOC, sodium, TDS |
| | 13-6-4A | chloride, DOC, manganese, sodium, TDS |
| Upper Bedrock Zone | 12-1-3-1 | barium, chloride, DOC, manganese, methane, sodium, TDS |
| | 12-2-3 | chloride, DOC, sodium, TDS |
| | 12-3-3, 12-4-3, 12-5-3 | barium, chloride, DOC, methane, sodium, TDS |
| | 13-6-3 | barium, chloride, manganese, sodium, TDS |
| | 13-7-2 | Barium, chloride, manganese, methane, sodium, TDS |

Notes: BOD – biochemical oxygen demand; COD – chemical oxygen demand; TDS – total dissolved solids; and TKN – total kjeldahl nitrogen



Elevated concentrations of total phosphorus observed at all seven monitoring wells screened within the silty layer (12-1-5B, 12-2-5B, 12-3-5B, 12-4-5B, 13-5-5, 13-6-5B and 13-7-4-2) and monitoring wells 12-2-6, 13-5-6, 13-6-6 and 13-7-5 screened within the surficial silty sand are likely attributed to the samples having high sediment loadings. A minimum of 5 purge volumes were removed as part of the monitoring well development program prior to groundwater sampling; however, the sediment loading remained high in these samples.

The elevated concentrations measured at monitoring wells presented in Table 8-1 are interpreted to be naturally occurring. Volatile organic compounds (VOCs) including 1,4-dichlorobenzene, benzene, toluene and/or vinyl chloride were detected in trace amounts in groundwater samples collected from monitoring wells screened within the surficial silty sand (13-7-5), the silty layer (12-2-5B, 12-3-5B, 12-4-5B, 13-5-5, 13-6-5B and 13-7-4-2), glacial till (12-4-4) and upper bedrock zone (12-2-3, 12-3-3, 12-4-3 and 13-6-3). VOCs were detected in the first monitoring session only for these locations, with the exception of groundwater samples collected from the silty layer monitoring well 12-3-5B where benzene, toluene and vinyl chloride were consistently detected during consecutive sampling events (winter, summer and fall 2013), and upper bedrock monitoring well 12-2-3 where benzene was detected in the fall 2013 session only. All detections of VOCs were below the applicable ODWQS.

Based on the available information, groundwater quality at the CRRRC Site varies from fresh to brackish and deteriorates with depth. The groundwater within the surficial silty sand and the silty layer typically exceed the ODWQS for TDS and manganese, and occasionally for DOC. Within the glacial till and upper bedrock, elevated concentrations of barium, chloride, sodium and TDS and occasionally manganese are observed compared to the applicable ODWQS. Groundwater quality samples collected in the upper bedrock were also analyzed for dissolved methane, which consistently exceeded the ODWQS at monitoring wells 12-1-3-1, 12-3-3, 12-4-3, 13-5-3 and 13-7-2.

QA/QC results for all duplicate groundwater samples and analytical laboratory equipment blanks were within acceptable tolerance limits.

8.2 Residential Well Program

The residential well sampling program involved collecting groundwater samples from accessible supply wells in the immediate vicinity of the CRRRC Site to characterize background groundwater quality for typical organic and inorganic parameters. Prior to sampling, Golder staff completed a survey with the homeowners to gather information about their water supply. Copies of the completed surveys are provided in Appendix O-II.

Two residential water supply wells and one commercial water supply well were sampled between January 17 and 18, 2013. Residential water supply wells are situated along Frontier Road (two: Frontier-1 and Frontier-2) within the northeast limits of the CRRRC Site, and one commercial supply well (Boundary-1) is situated west of the CRRRC Site. The wells located along Frontier Road are as shown in Figure 8-1. The water supply well survey completed at location Boundary-1 identified the supply well operates at a commercial property and is primarily used for washing equipment. All water supply wells sampled during this program are completed to an approximate depth of 3.7 to 6.1 metres (unknown well depth at Frontier-2) in the overburden and consist of dug wells.

The groundwater quality results for the residential and commercial water supply wells are provided in Table O-2 in Appendix O-II. The results of the water supply sampling program indicate that most parameters analyzed were below the respective ODWQS. Parameters exceeding the ODWQS include DOC and manganese at all three water supply locations, along with TDS and iron at the commercial water supply well only (Boundary-1).



The results of the residential water supply wells sampling program indicate that groundwater quality at the private well locations is comparable to the groundwater quality observed at monitoring wells screened within the surficial silty sand at the Site, with the exception of chloride, COD, total phosphorus, sodium, TDS and TKN that are generally observed at higher concentrations in the CRRRC Site monitoring wells.

8.3 Surface Water Program

The surface water sampling program involved monitoring water quality from a total of nine surface water locations BSW1 through BSW9 (see Figure 2-2). Surface water stations BSW1 through BSW7 were established in December 2012, and surface water stations BSW8 and BSW9 were added to the monitoring program in spring and fall 2013, respectively.

A total of six surface water stations (BSW1, BSW2, BSW3, BSW4, BSW5 and BSW9) are situated within the CRRRC Site, and three surface water stations (BSW6, BSW7 and BSW8) are located east and downgradient of the CRRRC Site.

The surface water stations are as follows:

- BSW1 – discharge of DD2;
- BSW2 – discharge of Simpson Municipal Drain at CRRRC Site boundary;
- BSW3 – discharge at DD1;
- BSW4 – upstream, beginning of Simpson Municipal Drain as it enters CRRRC Site;
- BSW5 – upstream, beginning of DD2;
- BSW-6 – Shaw Creek at Sand Road (downgradient of CRRRC Site);
- BSW-7 – Shaw Creek at Frank Kenny Road (downgradient of CRRRC Site);
- BSW-8 – drainage ditch at Frank Johnson Municipal Drain (downgradient of CRRRC Site prior to discharge to Wilson Johnson Municipal Drain); and,
- BSW-9 – ditch near western property boundary in central portion of Site (DD3).

Surface water sampling was conducted to establish background surface water quality at the CRRRC Site and downgradient of the Site. The surface water monitoring program for this assessment includes up to five sampling events completed on a seasonal basis (December 2012 (winter), May 2013 (spring), July 2013 (summer), October or early-November 2013 (fall) and late-November or December 2013 (winter) between December 2012 and December 2013. Surface water sampling was completed at locations BSW1 through BSW7 on all five occasions, four sessions at BSW8 (spring, summer, fall and winter 2013) and two at BSW9 (fall and winter 2013). The results of the baseline surface water quality program are presented in Appendix P.

Table 8-2 provides a list of the parameters at surface water stations that did not meet Provincial Water Quality Objectives on three or more occasions at BSW1 through BSW7 (five sessions) and two or more occasions at BSW8 and BSW9 (four and two sessions, respectively) (PWQO; MOE, 1994a).



Table 8-2: Parameters Consistently Not Meeting PWQO

| Surface Water Location | Surface Water Feature | Parameters Consistently Not Meeting PWQO |
|------------------------|-----------------------|--|
| BSW1 | DD2 | dissolved oxygen, total phosphorus, iron |
| BSW2 | Simpson Drain | dissolved oxygen, total phosphorus, iron |
| BSW3 | DD1 | dissolved oxygen, total phosphorus, iron |
| BSW4 | Simpson Drain | dissolved oxygen, total phosphorus, iron |
| BSW5 | DD2 | dissolved oxygen, total phosphorus, iron |
| BSW6 | Shaw's Creek | total phosphorus, iron |
| BSW7 | Shaw's Creek | total phosphorus, iron |
| BSW8 | Frank Johnston Drain | dissolved oxygen, total phosphorus |
| BSW9 | DD3 | phenols* |

Note: * based on two sampling events only.

BSW5 was dry during the winter 2012 sampling session and was not sampled. Concentrations of copper exceeded the PWQO at surface water location BSW3 during the winter 2012 sampling session only. An exceedance of the chromium PWQO occurred one time at location BSW4 during the November 2013 sampling session. Concentrations of phenols (total recoverable phenolics) were consistently below or at the detection limit at all surface water monitoring locations throughout the sampling program with the exception of the fall and winter 2013 monitoring events. During the fall 2013 sampling event, concentrations of phenols exceeded the PWQO at all locations with the exception of BSW8. An additional winter 2013 sampling session was added to the monitoring program to confirm these results. Concentrations of phenols exceeded the PWQO at locations BSW1, BSW2, BSW3, BSW5 and BSW8 only during the winter 2013 session. The observed elevated concentrations of phenols in the surface water during the fall and winter 2013 sampling events may be attributed to decomposing plant material as concentrations of phenols at all surface water locations declined during the winter 2013 confirmation sampling session with the exception of BSW8. An exceedance of the phosphorus PWQO occurred one time at location BSW9 during the December 11, 2013 sampling session.

QA/QC results for analytical laboratory equipment blanks and the duplicate surface water samples were within acceptable tolerance limits, with the exception of duplicate concentrations of TSS (1 and 27 mg/L) at BSW1 during the winter 2012 monitoring session. The reason for this deviation is unknown as the surface water samples collected from DD2 were generally clear and sediment-free. Based on the available surface water quality data at BSW1, the analytical results discussed above are interpreted to be representative of the surface water quality.