11.0 PREDICTION AND ASSESSMENT OF ENVIRONMENTAL EFFECTS

This section of the EASR corresponds to Task 3 and Task 4 of the methodology described in Section 2.3 and summarizes the results of the assessment of effects of the proposed CRRRC on the environment. The completion of Task 3 is summarized in Sections 11.2 to 11.8 while Task 4 is in Section 11.9. The assessments were conducted following the methodology described in the workplans in the approved TOR (Appendix A to the EASR) for each of the environmental components. The assessment was based on the description of the project in Section 10.0 and further detailed in Volume IV D&O Report. The assessment for each of the components is provided in TSDs #2 to #9 that accompany the EASR, for the Geology, Hydrogeology and Geotechnical component in Volume III and for the Surface Water component in Appendix A to the Volume IV D&O Report. In general, the predicted effects of the project are compared to the relevant provincial regulations, standards and guidelines; for those components where these do not exist, the predicted effects are assessed qualitatively.

11.1 In-Design Mitigation Measures and Best Management Practices

In order to ensure that the CRRRC operates in accordance with MOECC and other regulatory requirements and standards, a number of in-design mitigation measures were incorporated. In-design mitigation measures are those that are considered integral to the design and include best management practices for various project components and phases of project activities. These in-design mitigation measures have been assumed in completing the effects assessment and, as such, all the predicted effects described represent the net effects.

Table 11.1-1 lists the mitigation measures and best management practices that were assumed to be incorporated into the design of the CRRRC and considered in the impact assessment. These measures are also intended to be adaptive in the event that alternative mitigation approaches, which achieve the same objective more efficiently, are identified.

Table 11.1-1: In-Design Mitigation Measures and Best Practices

Environmental Component	In-Design Mitigation Measures	Best Management Practices
Atmosphere	▪ Maximize drive-through road patterns on-Site to minimize need for use of back-up alarms ▪ Paved roads in the northern part of the Site ▪ Berms to attenuate noise as required, i.e., from the active face of the landfill, as required ▪ Use equipment that complies with appropriate emission standards ▪ Truck waiting area inside the Site ▪ Maintain existing vegetation in buffer around Site perimeter or, where required construct perimeter screening berms with plantings on top ▪ Receiving of organics and materials at the MRF and C&D processing, inside buildings ▪ Biofilters on the exhaust of air from within the organics processing and PHC contaminated soil treatment facilities ▪ Dust collection system consisting of a bag house and cyclone on exhaust air from the	<u>Air Quality</u> ▪ Place compacted granular materials and, if required, surface sealing on regularly used Site construction roads ▪ Use of typical best management practices for dust suppression, (e.g., covering vehicle loads, use of water or other suppressants, etc.) ▪ Minimize idling of vehicles on-Site <u>Noise</u> ▪ Restrict the use of heavy equipment to daytime hours as best possible ▪ Maintain vehicles and equipment, and ensure they have noise suppression equipment ▪ Control speed limit for traffic on-Site <u>Odour</u>

Environmental Component	In-Design Mitigation Measures	Best Management Practices
	MRF and C&D processing buildings ▪ Low permeability cover of organics primary reactor cells and PHC contaminated soil treatment cells ▪ Flare for combustion of biogas captured from the organics processing and from the landfill ▪ LFG collection system approach using horizontal collection from within the waste, installed during the filling period ▪ Truck tire wash for vehicles leaving the landfill area	▪ Time the frequency of turning of compost piles to avoid development of anaerobic conditions ▪ Introduction of oxygen into the anaerobically digested organics reactors to establish aerobic conditions prior to uncovering them ▪ Manage the working face of the landfill effectively to minimize potential for odorous emissions ▪ Apply appropriate daily cover on landfill ▪ Minimize the area of uncovered waste ▪ Placement of final cover progressively on completed portions of the landfill component ▪ Implement odour control measures for leachate holding and treated effluent ponds, if required, i.e., aeration system, cover, misting system, chemical addition
Geology and Hydrogeology (Groundwater)	▪ Engineered leachate/liquid containment for the landfill, leachate ponds, and organics processing and PHC treatment cells ▪ Perimeter liner system cut-off for the landfill, together with leachate collection system ▪ Adequate buffer width between landfill component and property boundary	▪ Provide construction quality control on all liner and collection system installations ▪ Provide monitoring and maintenance of leachate collection system components ▪ Inspect construction and operating equipment regularly and repair promptly if found to be leaking ▪ Geotechnical monitoring of landfill settlement
Surface Water	▪ Design surface water management systems to separate leachate and liquids from processing from clean surface water runoff ▪ Divert clean runoff to swales, ditches and ponds ▪ Design ditch systems to convey design storm flows ▪ Control post-development discharge flows to match pre-development conditions as close as possible ▪ Enhanced sediment removal in SWM system design ▪ Sedimentation and erosion control measures ▪ Design and construct the component liners and leachate/liquid collection systems to safeguard surface water resources	<u>Surface Water Quality</u> ▪ Implementation of a sediment and erosion control plan during construction and operations ▪ Re-vegetate final landfill cover ▪ Provide monitoring and maintenance of stormwater ponds; provide valve(s) on ponds, where necessary depending on ongoing water quality monitoring, to be able to batch-discharge water from the ponds ▪ Provide monitoring and maintenance of leachate /liquid collection systems ▪ Use standard best management practices for erosion control until vegetation cover is established <u>Surface Water Quantity</u> ▪ Manage surface water on-Site; control off-Site stormwater discharge <u>Accidental Spills</u> ▪ Operate, store and maintain (e.g., re-fuel, lubricate) all equipment and associated

Environmental Component	In-Design Mitigation Measures	Best Management Practices
		materials in an area away from surface water features in a manner that minimizes the potential for the entry of any deleterious substance into water bodies ▪ Inspect construction and operating equipment regularly and repair promptly if found to be leaking ▪ Develop a spill response plan
Biology	▪ Maintain existing perimeter vegetative buffers where possible	▪ Remove vegetative cover progressively in sequence with Site development ▪ Stabilize and re-vegetate (or use other materials appropriate to Site conditions) areas of soil disturbed/exposed during construction ▪ Ongoing review of condition of revegetation and maintenance ▪ Apply best management practices in applying chemical dust suppressants, fertilizers, pesticides and herbicides and minimize their use to the extent possible ▪ Conduct all vegetation clearing activities outside the breeding bird season where possible ▪ To the extent practical, limit the extent of disturbed areas and soil stockpiles, control their orientation (with respect to prevailing wind directions), and for piles to be left in place for a prolonged period of time seed to establish vegetation ▪ Schedule construction activities to minimize area and duration of soil exposure, to the extent practical ▪ Worker awareness program to avoid harm to milksnake (a species of concern), if they are in the Site-vicinity ▪ Manage waste effectively to avoid attracting nuisance wildlife and pests, control the nuisance wildlife populations as permitted and required, and conduct periodic inspections to monitor effectiveness of the pest control
Land Use & Socio-economic **and** **Agriculture**	▪ Maintain appropriate buffer between proposed on-Site activities and off-Site land uses ▪ Maintain perimeter vegetative buffers where possible; construct screening features where there is not already a significant stand of trees ▪ Provide Property Value Protection Plan and possibly other community benefits	▪ Control off-Site nuisance emissions, i.e., air, odour, dust in accordance with MOECC standards ▪ Purchase goods and services locally as best possible ▪ Prevent the on-Site generation and accumulation of litter ▪ Use litter fencing to control windborne trash

Environmental Component	In-Design Mitigation Measures	Best Management Practices
		from leaving Site ▪ Regularly clean up litter both on-Site and in the Site-vicinity ▪ Establish procedure to register and address complaints ▪ Use best efforts to establish a community liaison committee
Culture and Heritage Resources	▪ N/A since low potential for on-Site archaeological resources	▪ Should any archaeological resources be discovered, cease all alteration of the Site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork ▪ Should any human remains be discovered, the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services must be notified ▪ If during the process of development any archaeological resources or human remains of potential Aboriginal interest are encountered, the Algonquins of Ontario Consultation Office will be contacted
Traffic	▪ Provide required intersection improvements at the Site access location off Boundary Road ▪ Provide on-Site queuing area of sufficient capacity to avoid truck queuing on Boundary Road	

11.2 Atmosphere

The atmosphere environment component consists of two sub-components: noise/air quality and odour. The assessment of potential effects of the proposed CRRRC on each is described below.

11.2.1 Noise

The details of the noise assessment are provided in TSD #2.

The noise assessment was carried out at the most sensitive off-Site receptors (PORs) and potential vacant land receptors (VLs) in the Site-vicinity and near the haul route (refer to Figures 8.4.1-1 and 8.4.1-2, respectively). All POR and VL locations identified in this study are best described as being located in a Class 1 area as defined by the MOECC, which is an area with an acoustical environment typical of a major population centre, where the background noise is dominated by the road traffic, often referred to as urban hum (MOE, 2013b). Daytime, evening and nighttime hours for a Class 1 area are defined as follows:

- Daytime – 0700 to 1900 hours;
- Evening – 1900 to 2300 hours; and
- Nighttime – 2300 to 0700 hours.

The proposed operating hours of the landfill, compost facility, hydrocarbon contaminated soil treatment facility, and organics pre-processing are 0600 to 1900 hours. Outdoor activities for the organics processing at the primary reactor cells are limited to 0700 to 1900 hours. The proposed operating times for indoor operations for the MRF and C&D facility are from 0600 to 2300 hours. As such, under normal operations, the assessment for nighttime operations focused on the one hour period from 0600 to 0700 hours. Essential equipment associated with bio-gas, leachate and power generation is required to operate 24 hours per day 365 days of the year. As such, essential equipment has been assessed separately and focused on the period from 2300 to 0600 hours.

Landfill: The methodology was based on the MOECC publication "Noise Guidelines for Landfill Sites" (MOE, 1998c). This guideline outlines the sound level limit criteria for evaluating landfilling operations and ancillary facilities (i.e., stationary noise sources). The sound level limits for landfilling operations are 55 decibels (dBA) and 45 dBA during daytime and nighttime hours, respectively. Should the environment be dominated by noise sources such as industry, commerce or road transportation, which produce sound in excess of the above limits, the higher sound levels may be used as the limit. This guideline also outlines the protocol for evaluating off-Site haul road truck traffic. The assessment first considered the noise emissions associated with the landfilling operations of the CRRRC landfill component. Table 11.2.1-1 provides a summary of the overall sound power data for each noise source considered in the assessment of landfilling operations.

Table 11.2.1-1: Sound Power Data for Landfilling Operations Noise Sources

Source	Quantity	Overall Sound Power Level (dBA)
Loader	1	109
Excavator	1	103
Backhoe	1	92
Grader	1	116
Dozer D6	1	110
Dozer D8	1	114
Compactor	1	108
Water Truck	1	107
Haul Trucks	35 (total peak in and out)	103

Table 11.2.1-2 provides a summary of the maximum landfilling operations noise modelling results for the identified PORs and VLs in the Site-vicinity.

Noise predictions were carried out for each of the eight phases within the landfill (as shown on Figure 10.8-3). Specifically, source locations and elevations were selected to ensure that the predicted Site-vicinity noise levels would result in the worst-case noise predictions at all receptor locations. The corresponding phase within the landfill is presented with the maximum predicted noise level.

Table 11.2.1-2: Landfilling Operations Noise Predictions (dBA)

Receptor	Existing Minimum Noise Levels (0600 to 0700 hours)	Existing Minimum Noise Levels (0700 to 1900 hours)	Maximum Predicted Landfilling Operations Noise Levels (Phase)	Compliant with MOECC Noise Guidelines
POR01	63	65	54 (6)	Yes
POR02	56	58	53 (6)	Yes
POR03	56	58	55 (7)	Yes
POR04	63	65	53 (6)	Yes
POR05	63	65	50 (6)	Yes
POR06	63	65	48 (6)	Yes
POR07	63	65	48 (6)	Yes
POR08	63	65	47 (6)	Yes
POR09	63	65	46 (6)	Yes
POR10	58	58	43 (6)	Yes
VL01	63	65	51 (3)	Yes
VL02	56	58	56 (3)	Yes
VL03	45	55	45 (1)	Yes

As noted above, in order to meet MOECC noise standards, in-design mitigation in the form of berms to attenuate noise are required. As a result of an existing POR, these landfill berms are required during filling of Phases 6, 7 and 8 of the landfill. For VL02 and VL03, berms could be required during filling of Phases 1 and/or 3 if a noise sensitive building is developed in these areas in the interim.

Diversion and Other Facilities: The noise assessment for the other proposed Site components included the MRF, C&D processing facility, organics processing facility, PHC soil treatment, surplus soil management, leaf/yard materials composting, flare, power generation area, maintenance facility, leachate pre-treatment facility, exhaust fans and heating, ventilation and air conditioning (HVAC) equipment. For these facilities, the noise level limits are defined in “NPC-300 Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning” (MOE, 2013b).

Table 11.2.1-3 provides a summary of the overall sound power data for each noise source considered in the assessment of the above ancillary facilities.

Table 11.2.1-3: Sound Power Data for Ancillary Facilities Noise Sources

Source	Quantity	Overall Sound Power Level (dBA)
HVAC	17	83
Large Exhaust	19	87
Ventilation Openings	24	83
Dust Collector	2	102
Welding Fume Hood	1	91
Biofilter	2	90
Pump	1	106
Diesel Generator	1	117
Loader[3]	5	109
Chipper	1	118
Conveyor	2	94
Compost Turner	1	111
Screen	1	104
Air Classifier	1	111
Compost Aerator Fan[1]	4	95
Waste Truck Movements	47 (total peak hour in and out)	103
Truck Idling	5	98
Flare[1]	1	104
Dump Truck	1	108
Grader	1	116
Dozer	1	110
Leachate Truck Movements[1]	2	104
Leachate Truck Pumping[1]	1	111
Excavator[4]	2	103
Skid-steer	1	92
Electrical Generator[1, 2]	7	105

Notes:
[1] Equipment operates 24 hours per day, 365 days per year.
[2] Generators will be equipped with silencers and they will be housed in containers. Generator containers designed not to exceed 55 dBA at 10 m.
[3] The number of loaders modelled is 5, though a total of 4 loaders are shared by ancillary facilities and may operate at one time.
[4] The number of excavators modelled is 2, though 1 excavator is shared by ancillary facilities and may operate at one time.

As the facility operations would begin daily at 0600 hours, Tables 11.2.1-4, 11.2.1-5 and 11.2.1-6 provide, respectively, a summary of the maximum ancillary facilities noise modelling results for daytime (0700 – 1900), evening (1900 – 2300) and nighttime (0600 – 0700) compared to the minimum 1-hour L_{eq} monitored. For the existing PORs and vacant lots VL01 and VL02, the existing minimum 1-hour L_{eq} has been determined by noise monitoring. For the vacant lot VL03, the existing minimum 1-hour L_{eq} due to road traffic has been calculated. Table 11.2.1-7 provides a summary of the maximum noise modelling results for essential equipment for nighttime (2300 to 0600 hours).

Table 11.2.1-4: Daytime (0700 to 1900) Ancillary Facilities Noise Predictions (dBA)

Receptor	Existing Minimum Noise Levels	Maximum Predicted Ancillary Facilities Noise Levels	Compliant with MOECC Noise Guidelines
POR01	65	52	Yes
POR02	58	44	Yes
POR03	58	43	Yes
POR04	65	51	Yes
POR05	65	51	Yes
POR06	65	49	Yes
POR07	65	49	Yes
POR08	65	49	Yes
POR09	65	49	Yes
POR10	58	45	Yes
VL01	65	59	Yes
VL02	58	56	Yes
VL03	57	51	Yes

Table 11.2.1-5: Evening (1900 to 2300) Ancillary Facilities Noise Predictions (dBA)

Receptor	Existing Minimum Noise Levels	Maximum Predicted Ancillary Facilities Noise Levels	Compliant with MOECC Noise Guidelines
POR01	61	39	Yes
POR02	54	32	Yes
POR03	54	29	Yes
POR04	61	38	Yes
POR05	61	36	Yes
POR06	61	35	Yes
POR07	61	35	Yes
POR08	61	35	Yes
POR09	61	35	Yes
POR10	56	31	Yes
VL01	61	46	Yes
VL02	54	46	Yes
VL03	55	47	Yes

Table 11.2.1-6: Nighttime (0600 to 0700) Ancillary Facilities Noise Predictions (dBA)

Receptor	Existing Minimum Noise Levels	Maximum Predicted Ancillary Facilities Noise Levels	Compliant with MOECC Noise Guidelines
POR01	63	52	Yes
POR02	56	44	Yes
POR03	56	43	Yes
POR04	63	50	Yes
POR05	63	50	Yes
POR06	63	49	Yes
POR07	63	49	Yes
POR08	63	49	Yes
POR09	63	49	Yes
POR10	58	44	Yes
VL01	63	58	Yes
VL02	56	56	Yes
VL03	54	50	Yes

Table 11.2.1-7: Nighttime (2300 to 0600) Essential Equipment Noise Predictions (dBA)

Receptor	Existing Minimum Noise Levels	Maximum Predicted Ancillary Facilities Noise Levels	Compliant with MOECC Noise Guidelines
POR01	50	38	Yes
POR02	47	31	Yes
POR03	47	27	Yes
POR04	50	36	Yes
POR05	50	34	Yes
POR06	50	31	Yes
POR07	50	31	Yes
POR08	50	30	Yes
POR09	50	29	Yes
POR10	47	25	Yes
VL01	50	45	Yes
VL02	47	45	Yes
VL03	45	45	Yes

Off-Site Haul Route Traffic Noise: The primary off-Site haul route is along Boundary Road from Highway 417. A maximum of 271 trucks were assumed to come and go from the Site per day. Assuming 10 hours per day and applying a 1.45 peaking factor to all trips to account for random arrivals, the total number of peak hour trips are:

- 271 trips per day/10 hours per day x 1.45 peaking factor = 40 trips per hour entering and exiting

In addition, three leachate trucks per hour were assumed making 43 total trips entering or exiting the Site. Sound energy exposures were determined using STAMSON v5.04 – ORNAMENT, the computerized road traffic noise prediction model of the MOECC. The STAMSON model was calibrated to provide results consistent with the monitored levels. The model was used to predict future traffic noise levels by adding the peak hour number of trucks associated with the Site.

Table 11.2.1-8 provides a summary of the maximum predicted change in noise levels along the haul route (Highway 417 to Boundary Road to Site entrance) based on 86 trucks (43 trips) in a one hour period. As the traffic volume data presented in Table 11.2.1-8 is based on information obtained in 2011, the traffic volume in the analysis was adjusted to account for a growth factor of 2% per year to 2013, to coincide with the year in which the noise measurements were obtained.

Table 11.2.1-8: Change in Noise Levels Due to Off-Site Haul Route

Receptor	Maximum Predicted Change in Noise Level (dB)
POR01, POR04 – POR09, VL01 and VL02	4.9
POR02	1.7
POR03	0.7
POR10	2.8
VL03	N/A*

Note: *VL03 is not located near to the off-Site haul route, therefore no change in noise level is expected.

Table 11.2.1-9 below is provided by the MOECC to assess the effect of off-Site vehicles on the existing noise environment.

Table 11.2.1-9: Effect of Off-Site Vehicles

Sound Level Increase (dB)	Qualitative Rating
1 to 3 inclusive	Insignificant
3 to 5 inclusive	Noticeable
5 to 10 inclusive	Significant
10 and over	Very significant

In accordance with MOECC noise guidelines, the maximum predicted sound level increase of 4.9 dB results in a qualitative rating of 'noticeable' for sensitive receptors along Boundary Road and 'insignificant' elsewhere in the Site-vicinity.

Summary: While predicted noise increases along the approximate 800 metres of Boundary Road from Highway 417 to the Site would be noticeable, the assessment of noise effects has not identified the need for additional mitigation measures.

11.2.2 Air Quality and Odour

The details of the air quality and odour assessment are provided in TSD #3. The methodology for assessing potential effects to air quality and odour resulting from the proposed CRRRC involved three steps:

1) Calculating representative emission rates;

2) Dispersion modelling to predict resulting concentrations of indicator compounds in the environment; and

3) Comparison of predicted concentrations to MOECC standards and guidelines.

The emission estimation methods used followed accepted MOECC practices including where applicable, guidance in the Ontario MOECC document "Procedure for Preparing an Emission Summary and Dispersion Modelling Report" Version 3.0 (MOE, 2009c) (MOECC ESDM Procedure Document).

Models were used to predict ground-level concentrations of indicator compounds. The results were then compared to the relevant regulatory standards. The AERMOD-PRIME (AERMOD) dispersion model (Version 13350) was used for the air dispersion modelling. AERMOD was developed by the United States Environmental Protection Agency (U.S. EPA). This model has also been adopted in Ontario as the regulatory model recommended by the MOECC (MOE, 2009b).

To determine potential effects of the proposed CRRRC on air quality and odour, the predicted concentrations of indicator compounds were compared to MOECC standards and guidelines. The MOECC has point-of-impingement (POI) and ambient air quality criteria (AAQC) for various compounds. The AAQC are commonly used in assessments of general air quality in a community, whereas the POI criteria under O.Reg 419/05 are used to assess specific impacts of an individual facility.

In addition, a working group of provincial, territorial and federal environment ministers has established the Canada-Wide Standards (CWS) for ambient air quality for a number of air contaminants. The CWS are intended to be adopted by the provinces, which have primary regulatory authority over air quality.

The key assumptions used in the assessment are as follows:

- The flare destruction efficiency ranges from 98-99% depending on the contaminant. This assumption is based on typical values provided in Chapter 2.4 of the US EPA AP-42. (US EPA, 2008);
- The electrical generation plant and flare, when in operation, will be operated for 24 hours a day and the LFG and biogas will be directed to either the engines or the flare, with potential excess gas being flared during the ramp up period of the CRRRC operations;
- A collection efficiency of 75% of the LFG and biogas was applied. This is based on typical values provided in Chapter 2.4 of the US EPA AP-42;
- All non-road vehicles will meet Tier 3 standards for non-road compression-ignition engines;
- The proposed CRRRC will employ best management practices to mitigate fugitive road dust; a mitigation factor of 85% is applied on fugitive road dust emissions from paved and unpaved roads;
- Truck traffic at the Site will be limited to 7:00 a.m. to 7:00 p.m.;
- The weight of empty collection trucks is 3 or 10 tonnes depending on the type, while the weight of full collection trucks is 6 or 20 tonnes;
- The maximum flow rate of the biofilter for the petroleum hydrocarbon (PHC) impacted soil treatment area is 15,000 actual cubic meters per hour (Am^3/hr) and for the organics processing building is 72,000 Am^3/hr; and
- The flow rate of the dust collector for the MRF and C&D processing facilities is 15,000 actual cubic feet per minute (acfm).

In addition to assessing air quality and odour effects of the proposed CRRRC, the potential greenhouse gas (GHG) effects were also assessed using the methodology described in the section above, with the exception of the dispersion modelling step. For predicting the potential GHG effects, no dispersion modelling was required.

The emission estimation methods used follow accepted practices for conducting environmental assessments and, where appropriate, guidance in the Ontario MOECC document "*Guideline for Greenhouse Gas Emissions Reporting*" (MOE, 2012c).

The GHG compounds are associated with biogas and LFG combustion from the flare, the power generation area as well as from diesel combustion from tailpipe emissions, vehicle exhausts, and the proposed buildings stationary combustion equipment such as boilers and heaters. Emissions of these compounds are also the result of breakdown of waste material within the landfill and the composting area.

In addition to assessing the potential air quality effects of the proposed CRRRC, and hence the ability of the proposed waste management facility to comply with the requirements of O. Reg. 419/05 (MOE, 2013a), air quality predictions were also used for assessing the potential effect of changes in air quality on other disciplines (i.e., biology and land use & socio-economic). In calculating these emissions, all potential sources of the proposed CRRRC were considered.

11.2.2.1 Potential Air Quality and Odour Effects

<u>Identification of emission sources</u>

Table 11.2.2-1 outlines the activities (i.e., sources of emissions) that have been assessed as part of the air quality assessment.

<u>Air and Odour Emissions</u>

Table 11.2.2-2 summarizes the emission rates in grams per second (g/s) for each activity at the facility.

<u>Mitigation Measures</u>

In determining the air emissions associated with the CRRRC works and activities, consideration was given to those mitigation measures that were considered to be integral to the design and implementation of the works and activities. These mitigation measures, which are considered to be typical and consistent with best practices, were assumed for the purposes of the emission estimates presented above and therefore were incorporated in the effects predictions presented. The in-design mitigation measures that were included in the air quality and odour assessment have been summarized in Table 11.2.2-3.

Table 11.2.2-1: Summary of Sources Assessed for the Air Quality & Odour Assessment

Source Information		Significant (Yes or No)?	Modelled (Yes or No)?	Rationale
General Location	**Source**			
Flare and/or Electrical Generation Plant	Enclosed LFG and biogas flare and/or engines	Yes	Yes	—
Construction and Demolition Processing Facility	Dust collector	Yes	Yes	—
Materials Recovery Facility	Dust collector	Yes	Yes	—
Organics Processing Facility	Biofilter	Yes	Yes	—
	Organics processing operations (material handling)	Yes	Yes	—
	Organics processing operations (tailpipe emissions)	Yes	Yes	—
Composting	Composting, curing and post processing (material handling)	Yes	Yes	—
	Composting, curing and post processing (tailpipe emissions)	Yes	Yes	—
PHC contaminated Soil Treatment Area	Biofilter	Yes	Yes	—
	PHC soil treatment operations (material handling)	Yes	Yes	—
	PHC soil treatment operations (tailpipe emissions)	Yes	Yes	—
Landfill	Landfill Cap	Yes	Yes	—
	Landfill operations (material handling)	Yes	Yes	—
	Landfill operations (tailpipe emissions)	Yes	Yes	—
Leachate Pre-Treatment Facility	Leachate pre-treatment	Yes	Yes	—
	Leachate holding ponds	Yes	Yes	—
Paved Roads	Vehicle exhaust and fugitive road dust	Yes	Yes	—
Unpaved Roads	Vehicle exhaust and fugitive road dust	Yes	Yes	—
Emergency Generator	Diesel emergency power generator used to provide electricity during power outages	Yes	No	The emergency power equipment only operates periodically (rather than continuously) and therefore produces emissions that are negligible relative to the overall emissions from the CRRRC. Additionally, the emergency power generator will not be operating at the same time as any other equipment and therefore is not a part of the worst-case scenario.
Support Activities	Operational support activities, such as maintenance activities (including welding, compressor, diesel fire pump, lights)	No	No	These activities are considered to be negligible in comparison to the other activities occurring on-Site.
	Stationary fuel combustion for comfort heating	Yes	Yes	Emissions from these sources occur seasonally (i.e., do not occur at all times during a year) and are very small compared to mobile combustion sources. For this assessment, only nitrogen oxide emissions were modelled.

Table 11.2.2-2: Summary of Emissions during Operation of the CRRRC

Facility	Activity	Contaminant (g/s)								
		SPM	PM_{10}	$PM_{2.5}$	NO_x/NO_2 [(1)]	SO_2	CO	H_2S	C_2H_3Cl	Odour (OU/s)
Flare and/or Electrical Generation Plant	Enclosed LFG flare and/or LFG and biogas to energy engines	0.1309	0.1309	0.1309	0.4404	0.1018	4.6546	0.0031	0.0002	—
Construction and Demolition Processing Facility	Dust collector	0.0708	0.0708	0.0708	—	—	—	—	—	—
Materials Recovery Facility	Dust collector	0.0708	0.0708	0.0708	—	—	—	—	—	—
Organics Processing Facility	Biofilter	—	—	—	—	—	—	—	—	10,000
	Organics processing operations (material handling)	0.0043	0.0021	0.0003	—	—	—	—	—	—
	Organics processing operations (tailpipe emissions)	0.0278	0.0278	0.0278	0.4472	0.00001	0.4777	—	—	—
Composting	Composting, curing and post processing (material handling)	0.0046	0.0022	0.0003	—	—	—	—	—	309
	Composting, curing and post processing (tailpipe emissions)	0.0559	0.0584	0.0584	1.1572	0.00002	0.9882	—	—	—
PHC contaminated Soil Treatment	Biofilter	—	—	—	—	—	—	—	—	2,083
	PHC contaminated soil treatment operations (material handling)	0.0104	0.0049	0.0007	—	—	—	—	—	—
	PHC contaminated soil treatment operations (tailpipe emissions)	0.0025	0.0025	0.0025	0.0433	0.000001	0.0429	—	—	—
Landfill	Landfill cap	—	—	—	—	—	—	0.0047	0.0004	1,046
	Landfill operations (material handling)	0.0166	0.0078	0.0012	—	—	—	—	—	1,347
	Landfill operations (tailpipe emissions)	0.0618	0.0618	0.0618	1.0799	0.00002	1.0717	—	—	—
Leachate Pre-treatment Facility	Leachate pre-treatment	—	—	—	—	—	—	—	—	6,944
	Leachate equalization ponds	—	—	—	—	—	—	—	—	0.9250

Facility	Activity	Contaminant (g/s)								
		SPM	PM_{10}	$PM_{2.5}$	NO_x/NO_2 (1)	SO_2	CO	H_2S	C_2H_3Cl	Odour (OU/s)
	Leachate effluent pond	—	—	—	—	—	—	—	—	0.9250
Paved Roads	Fugitive road dust	0.6332	0.1215	0.0294	—	—	—	—	—	—
	Vehicle exhaust	0.0013	0.0013	0.0011	0.0315	0.0001	0.0073	—	—	—
Unpaved Roads	Fugitive road dust	0.2880	0.0778	0.0078	—	—	—	—	—	—
	Vehicle exhaust	0.0001	0.0001	0.0001	0.0025	0.0000	0.0006	—	—	—
Emergency Generator (2)	Diesel emergency power generator	0.0004	0.0004	0.0004	0.1446	0.0708	0.0152	—	—	—
Support Activities	Operational support activities, such as maintenance activities (including welding, compressor, diesel fire pump, lights)	These activities are considered to be negligible in comparison to the other activities occurring on-Site.								
	Stationary Fuel Combustion	— (3)	— (3)	— (3)	0.0387	— (3)	— (3)	—	—	—

Notes:
(1) NOx emissions were assumed to be all NO_2
(2) The emergency power generator was evaluated separately as it is used to provide electricity during power outages when other equipment is not in operation.
(3) Other than NOx, compounds from this activity are considered to be negligible in comparison to the other activities occurring on-Site.
— Compound not emitted from that source
SPM = Suspended particulate matter
PM_{10} = Particles nominally smaller than 10 micrometres (μm) in diameter
$PM_{2.5}$ = Particles nominally smaller than 2.5 μm in diameter
SO_2 = Sulphur dioxide
CO = Carbon monoxide
H_2S = Hydrogen sulphide
C_2H_3Cl = Vinyl chloride

Table 11.2.2-3: Summary of In-Design and Best Practice Mitigation Incorporated in the Air Quality and Odour Assessment

Mitigation Measure	Mitigation Specifics	Works and Activities Affected	Compound Affected by Mitigation Measure	Project Phase where Mitigation is being Considered
Dust suppressant on paved and unpaved roadways	Application of dust suppressant on unpaved roads on a routine basis	■ Vehicle movements related to Base, Construction, Waste Excavation, Waste Placement	■ SPM ■ PM_{10} ■ $PM_{2.5}$	■ Construction ■ Operation
Paved road entrance	Sweep the roads to avoid track out and use of a truck tire wash station	■ Vehicle movements	■ SPM ■ PM_{10} ■ $PM_{2.5}$	■ Construction ■ Operation
Maintenance of on-Site vehicles and equipment	On-Site vehicles and equipment engines will meet Tier 3 emission standards and be maintained in good working order	■ On-Site Vehicles	■ NO_2 ■ CO ■ SO_2 ■ SPM ■ PM_{10} ■ $PM_{2.5}$	■ Construction ■ Operation
Minimize idling of vehicles on-Site	Minimize idling of vehicles on-Site	■ On-Site vehicles	■ NO_2 ■ CO ■ SO_2 ■ SPM ■ PM_{10} ■ $PM_{2.5}$	■ Construction ■ Operation
Minimize working face/daily cover	Site is restricted to 1500 m^2 working face, daily cover is required	■ Landfill	■ H_2S ■ C_2H_3Cl ■ Odour	■ Operation
Use of dust collectors, where applicable	—	■ C&D processing facility ■ MRF	■ SPM ■ PM_{10} ■ $PM_{2.5}$	■ Operation
Use of biofilters or other odour control (misting system, aeration, scrubber), where applicable	—	■ Organics Processing ■ PHC contaminated Soil Treatment ■ Leachate Treatment Building ■ Leachate holding pond and treated effluent pond	■ H_2S ■ C_2H_3Cl ■ Odour	■ Operation ■ Post-closure (leachate treatment only)
Capping of Landfill	Landfill will be capped	■ Landfill	■ H_2S ■ C_2H_3Cl ■ Odour	■ Post-closure

Ontario Regulation 419/05

Compliance with O. Reg. 419/05 (MOE, 2013a) is based on achieving the appropriate standards in the natural environment at a POI located at or beyond the property boundary. Table 11.2.2-4 lists the maximum predicted POI concentrations against the relevant O. Reg. 419/05 standards. As noted therein, all of the maximum POI concentrations meet the relevant standards. The CRRRC regulated sources would include LFG, combustion processes and materials handling emissions. The mobile equipment does not need to be considered for permitting under O. Reg. 419/05 when a best management practice is in place. However, for the purpose of this assessment, all outdoor mobile equipment was included in the assessment of compliance with O. Reg. 419/05.

Table 11.2.2-4 presents the maximum concentrations of the indicators along the proposed CRRRC property boundary. The assessment indicates that the proposed facility will be in compliance with O. Reg. 419/05 (MOE, 2013a).

Table 11.2.2-4: Predicted Compliance Air Quality Concentrations at POI

Indicator	Averaging Period	Air Quality Criteria (µg/m³)	Maximum Concentration at POI (µg/m³) (1)	Percentage of Limit (%)
SPM (24-hr)	24-hour	120	98.23	82%
PM_{10} (24-hr)	24-hour	50	23.30	47%
$PM_{2.5}$ (24-hr)	24-hour	25	20.16	81%
NO_X (1-hr)	1-hour	400	68.90	17%
NO_X (24-hr)	24-hour	200	37.15	19%
NO_2 (1-hr)(2)	1-hour	400	68.90	17%
NO_2 (24-hr)(2)	24-hour	200	37.15	19%
SO_2 (1-hr)	1-hour	690	15.91	2%
SO_2 (24-hr)	24-hour	275	8.54	3%
CO (1/2-hr)	½-hour	6000	860.01	14%
H_2S (24-hr)	24-hour	7	0.26	4%
H_2S (10-min)	10-min	13	0.79	6%
C_2H_3Cl (24-hr)	24-hour	1	0.021	2%
Odour (10-min)	10-min	1(3)	0.58	58%

Notes:
µg/m³ – micrograms per cubic metre
(1) Represents the maximum predicted concentrations at POI locations within the lands within the Site-vicinity.
(2) A conservative concentration conversion value of 100% of NO_x was applied to NO_2.
(3) The 99.5th percentile predicted concentration at discrete receptors.

11.2.2.2 Potential Greenhouse Gas Effects

In its comments on the TOR, the City of Ottawa requested an inventory of potential GHG emissions from the CRRRC to assist its efforts in creating an up to date City inventory.

Table 11.2.2-5 summarizes the predicted GHG emission rates in tonnes per year for each activity at the proposed CRRRC for the maximum operating scenario.

Table 11.2.2-5: Summary of Estimated GHG Annual Emission Rates during Operation of the CRRRC

Facility	Contaminant (tonnes)		
	CO_2	CH_4	N_2O
Electrical Generation Plant and/or Flare	34,002	0.62	0.06
C&D Processing Facility	*GHG already accounted for in the stationary fuel combustion*		
Materials Recovery Facility	*GHG already accounted for in the stationary fuel combustion*		
Organics Processing Facility	*GHG already accounted for in the stationary fuel combustion*		
Composting/Curing Pad Activities	18,480	200	15.0
PHC contaminated Soil Treatment Building	*GHG already accounted for in the stationary fuel combustion*		
Leachate Pre-Treatment Facility	*GHG already accounted for in the stationary fuel combustion*		
Landfill	2,983	1,082	—
Stationary Fuel Combustion(1)	1,627	0.08	0.24
Mobile Equipment	12,414	0.70	5.13
Tailpipe (Hauling Trucks)(2)	227	—	—

Notes:
(1) Stationary fuel combustion includes heating of the CRRRC buildings.
(2) Tailpipe emissions include the hauling and leachate trucks.
CO_2 = Carbon dioxide
CH_4 = Methane
N_2O = Nitrous oxide

A comparative life cycle assessment of the proposed CRRRC project was carried out. It compares the diversion from landfill of a portion of the incoming waste to landfilling all of the waste. The model used for the assessment was the GHG Calculator created by Environment Canada (Government of Canada, 2013), and its supporting technical document prepared by ICF Consulting (ICF, 2005). The calculation uses as its reference point, or Functional Unit, 100,000 tonnes of waste received; the output, or Environmental Intervention, is CO2eq. The result is a comparison of net GHG emissions of the proposed CRRRC (using the target diversion ranges in Table 9.1-1) compared to simply landfilling all the waste.

For the present analysis, landfilling of all the IC&I waste received was compared to two levels of diversion: the low and high ends of the target range in Table 9.1-1. The diversion rates used for the following materials: newsprint, mixed paper, cardboard, aluminium, ferrous metals, glass, HDPE, PET and mixed plastics, were 11% (lower end) and 26% (higher end). The diversion rates used for organic waste, to be composted or digested, were 60% (lower end) and 80% (higher end). Excluded were most of the C&D waste and all of the soils (the model does not make provision for their inclusion, presumably because they have little GHG impact).

The estimates of the composition of IC&I and C&D waste were obtained from a report written by Genivar/Kelleher Environmental for the City of Ottawa in 2007 (City of Ottawa, 2007b). The model was set up on the assumption that the landfill component of the CRRRC has a gas recovery rate of 75% and the recovered gas is flared. The system boundaries were chosen to include only on-Site activities; the impact of transportation, for example, was assumed to be the same for all diversion rates.

The results were as follows; at the lower diversion rates for all materials the aggregate GHG reduction (compared to landfill alone) was found to be 29,000 tonnes CO2eq. per 100,000 tonnes of waste received and, at the higher diversion rates, 66,000 tonnes CO2eq. per 100,000 tonnes of waste received. Based on the assumed receipt of a maximum of 450,000 tonnes of all waste/soils at the CRRRC in a given year, once operating at capacity, this equates to an annual GHG emission reduction of between 113,000 tonnes and 257,000 tonnes CO2eq, compared to straight landfilling of these same wastes. If the composition of the incoming waste differs from that shown in Table 9.1-1 of this EA, the reduction in GHG emissions could be higher or lower. Because of various assumptions built into the model, these figures are inherently conservative.

It is quite clear from the analysis that the diversion of IC&I waste as proposed in in relation to the CRRRC has a significant and positive impact on GHG reduction.

11.3 Geology, Hydrogeology & Geotechnical

The sub-components assessed were potential geological impacts, potential hydrogeological impacts (i.e., effects on groundwater quantity and quality) and geotechnical requirements for Site design. The technical details (modelling software, analytical methods, input parameters and detailed results) are provided in the Volume III Geology, Hydrogeology and Geotechnical Report.

The geological and seismic impact assessments were completed by experts in these fields, from both consulting and academia. Acknowledgement of the individuals involved in these assessments, as well as the hydrogeological and geotechnical sub-components, is provided in the Volume III Geology, Hydrogeology and Geotechnical Report.

11.3.1 Potential Geological Impacts

The assessment of potential geological impacts considered the evidence of and potential for movement along bedrock faults in the regional area within which the CRRRC Site is located, the potential for fault rupture at the CRRRC Site and the potential for subsurface settlement from earthquake ground shaking (liquefaction).

Evidence of Movement along Faults in the Regional Area: Published studies at a number of Southern Ontario locations present evidence for vertical offsets in glacial deposits and the underlying basement bedrock. Authors of these studies have concluded that the observed faults are either associated with co-seismic fault movement in the period from about 130,000 years ago to present or they are associated with response to localized pre-Holocene (last 11,700 years) glacial ice movement. Based on detailed analysis and re-interpretation of Rouge River sediments, Godin et al. (2002) concluded that because the deformation features in the glacial sediments and the underlying bedrock are relatively shallow, they were generated by regional and local glacial ice flow, and not deep seated tectonic stress and co-seismic faulting (Godin et al., 2002).

Review of published geologic and seismic information for the region surrounding Ottawa-Gatineau carried out as part of the CRRRC studies found no evidence that mapped bedrock faults have ruptured to the ground surface since the retreat of glacial ice and the Champlain Sea from the Ottawa valley. While there are expected to be high surface stresses at some locations (e.g., Adams and Fenton, 1994), there is no clear association between surficial stress relief and the generation of large local earthquakes. Studies to date, i.e., Aylsworth et al., (2000) indicate that even when larger earthquakes have occurred in the recent past, they may not be of sufficient magnitude (energy) to generate movement or displacement within the bedrock fault to propagate rupture to the ground surface. Furthermore, where evidence of surface faults has been found in local bedrock outcrops, it can usually be explained as resulting from local ice deformation or landslides rather than by the rupture of a major through-going surface or near surface tectonic fault. This conclusion does not preclude the possibility that vertical and/or horizontal fault movements have occurred in the region but are as yet undetected. Based on available information, however, there is no indication of surface ruptures from historical earthquakes at the proposed CRRRC Site or its immediate vicinity.

Joints and faults within the Ottawa-Bonnechere Graben often contain calcite, indicating that they have been cemented after the formation and lithification of the basement rocks (Rimando and Benn, 2005; Adams and Fenton, 1994). Unpublished dates from near-surface (2 mbgs) calcite within multiphase, joint-controlled veins in the Ordovician limestone (Pat Smith, University of Toronto, personal communication) indicate ages of about 100 million years ago and about 50 million years ago for the time of calcite cementation. These ages for episodes of calcite vein filling coincide approximately with the relative age of the youngest of the three deformation phases with the Paleozoic rocks identified by Rimando and Benn (2005). The presence of calcite within most of the fault planes and their early Paleogene (40 to 65 million years ago) and older crystallization ages suggests that there has been no Quaternary movement (including the Holocene Epoch of the past 11,700 years) along calcite-bearing faults and joints in the bedrock in the vicinity of the CRRRC Site.

Potential for Fault Rupture at the CRRRC Site: Fault rupture at the ground surface is a potential geological hazard because the surface fault rupture causes localized differential displacements that can adversely affect engineered structures and facilities. A fault is a planar fracture in the earth along which displacement occurs in response to stresses that accumulate in crustal rocks. Faults can have both vertical and horizontal displacements, although one type of movement is usually dominant. Faults with larger total displacements (100s of metres) have moved repeatedly along the same plane.

To identify the potential for fault rupture at the ground surface of a site, the important faults are those that are accumulating strain in the present-day tectonic strain field. Empirical studies indicate that only the larger faults generate displacements at the ground surface and it is these larger faults that can present a significant hazard to engineered structures. For example, most surface fault ruptures occur in geologically active areas, have single-event horizontal and/or vertical surface displacements that range from about 100 millimetres to 10 metres and are associated with moderate to large earthquakes (moment magnitude $M \geq 6$). Further, these surface rupturing faults usually show repeated displacements in the same location over thousands to millions of years.

The identification of “active” faults and/or lineaments that could intersect the footprint of the CRRRC is based in tectonic geomorphology – the interactions between tectonic and surface processes that shape the landscape. Tectonic geomorphic processes operate in regions of ongoing deformation and at time scales ranging from days to millions of years. An understanding of the geomorphic characteristics and landforms generated by movement at active faults is critical for the evaluation of the fault rupture potential at the CRRRC Site. Fault rupture produces distinctive tectonic geomorphology and landforms such as linear valleys, aligned offset stream channels, linear scarps, aligned linear ridges, faceted ridge spurs and linear vegetation patterns. If these distinctive tectonic geomorphologic landforms can be recognized at the CRRRC Site, then the presence, location, nature, type and activity of the fault or lineament may be evaluated.

Similarly, abrupt offsets or a change in orientation of subsurface geologic layers often indicates that near-surface faults are present at a site. Thus, if tectonic geomorphic features and/or the subsurface layers at the CRRRC Site show abrupt elevation changes, then a fault may be indicated.

Golder Associates Ltd.'s analysis of topography and interpretation of aerial imagery of the CRRRC Site indicate that the Site is essentially horizontal at an elevation of about 76 to 77.5 masl. Neither topographic interpretation nor imagery analysis revealed the existence of tectonic geomorphic features crossing the Site. While that lack of tectonic geomorphology indicates no recently active fault features, it remains possible that anthropogenic modification or localized erosion may have removed diagnostic surface fault features.

Figure 8.5.1-6 provides a generalized west-east cross section through the CRRRC Site, and Figures 8.5.1-7 and 8.5.1-8 are more detailed west-east and north-south cross sections, respectively. A key layer for the evaluation of the potential for past surface fault rupture at this Site is the 0.1-metre to 0.6-metre thick silty layer about 4 to 6 mbgs. This relatively thin silty layer represents a short duration change in the sedimentary depositional environment in the Champlain Sea about 10,000 years ago, perhaps because of a minor change in water depth/sea level or sediment source. This marker bed within the upper part of the silty clay deposit is sub-horizontal; the bottom elevation of the silty layer varies between about elevation 70.5 and 71.5 masl, while the top surface elevation varies between about elevation 71 and 72 masl. Because the silty layer was encountered and identified in all 25 borehole locations advanced in a grid pattern beneath the Site, it is reasonable to interpret that the silty layer is continuous across the CRRRC Site (as illustrated on Figures 8.5.1-7 and 8.5.1-8, as well as on Figure 3-17 in Volume III). The largely consistent elevation and lateral continuity indicates that this layer has not been offset in any significant way by vertical fault displacements at the CRRRC Site. It is reasonable to conclude, therefore, that there has been no surface fault rupture at the CRRRC Site since at least the deposition of the silty layer (i.e., in the past 8,000 to 10,000 years). Further, the evidence from the surrounding geological structure indicates that recent fault movements are unlikely to have occurred within the bedrock underlying the Site and surrounding area.

Considering the regional, local and Site geological conditions within the CRRRC Site and surrounding area, and the nature of "active" faults as described above, it is reasonable to conclude that the probability of future fault movement resulting in large differential displacements at the surface or shallow subsurface at or in the vicinity of the CRRRC Site is negligible. For the reasons discussed in Section 11.3.3 below, even if smaller scale differential displacements were to occur, they are of no engineering significance for the development of the CRRRC Site.

Potential Subsurface Settlement from Ground Shaking: The GSC has studied the effects of possible prehistoric (Holocene) earthquakes on the marine clay deposits in eastern Ontario. Published information on this topic was reviewed and integrated with Site-specific investigation of the clay deposit that underlies the CRRRC Site. The purpose of the review was to assess if the clay deposit beneath or in the area of the Site is likely to have been disturbed by earthquake shaking in eastern Ontario.

Based largely on Aylsworth and Lawrence (2003), following the deposition of the marine clay soils in eastern Ontario about 10,000 years ago, a number of channels (called Paleo-channels) were cut into the clay deposit between about 10,000 and 8,000 years ago by flowing water prior to the development of the present-day alignment of the Ottawa River channel. Four wide channels formed across eastern Ontario. Three channels were oriented northwest to southeast and one connecting these three oriented west to east. By about

8,000 years ago, the Ottawa River established itself in its current course, abandoning these deep, former channels. The western end of one the channels is presently occupied in part by the Mer Bleue to the northwest of Carlsbad Springs. The location of the CRRRC Site is beyond (south of) the area of Paleo-channels.

Analysis of aerial photos and field observations indicate past landslide activity along the margins of the Paleo-channels. Radiocarbon dating of organic materials buried by a number of landslides indicates a common date of about 4,550 years BP. Aylsworth et al. (2000) and Aylsworth and Lawrence (2003) interpreted the age concordance of the large landslide to indicate that they were triggered by a large earthquake event about 4,550 years BP. They estimated the earthquake to have a M greater than 6.2 and probably at least M 6.5.

There are also three large areas of flat-lying low-relief terrain underlain by marine clay soils, located beyond the Paleo-channels that have been found to be highly disturbed. These are located at Treadwell, Wendover and Lefaivre, about 30 to 50 kilometres northeast of the Site. Based on field studies, Aylsworth et al. (2000) interpreted this disturbance as further evidence of a large earthquake of at least M 6.5 about 7,060 years BP. Evidence of disturbance by earthquake shaking is indicated by an irregular, hummocky ground surface in an area that is otherwise flat and underlain by sub-horizontal sediment layers. Layering of the sand and clay soils that underlie the hummocky ground is deformed and in some cases faulted. There is also evidence of sand liquefaction and its upward flow through overlying clay layers. Subsurface investigations of these disturbed areas have included geophysical imaging, test trenching and borehole drilling and sampling programs, and description of the continuous soil cores where the presence of deformation of the subsurface materials was evident.

Key evidence cited by Aylsworth et al. (2000) and Aylsworth and Lawrence (2003) to explain why these three areas experienced disturbance and other areas did not are: 1) the clay deposit is very thick, greater than 100 metres; 2) uncommonly thick layers of liquefiable sand (greater than 10 metres to 20 metres thick) are present within the clay deposit; and 3) the areas are located within deep, locally steep-sided bedrock basins that could amplify earthquake ground shaking. The investigation work in the zone immediately adjacent to the disturbed area showed that where the clay deposit is only 38 metres thick and no thick sand layers were present (i.e., conditions similar to that underlying the CRRRC Site) there was no evidence of sedimentary deformation or disturbance.

The CRRRC Site is located in an area of flat-lying terrain without topographic irregularities and the Site is not in an area inferred to have been disturbed by past earthquakes or landslides. The silty clay underlying the Site is about 30 to 35 metres thick, anomalously thick sand layers are not present within or underlying the clay deposit; and the Site is not located within a deep bedrock depression. That is, none of the factors identified by Aylsworth et. al. (2000) are present at the CRRRC Site.

Although these Site-specific subsurface conditions strongly suggest the absence of amplified earthquake shaking and soft sediment deformation, the soils underlying the Site were also evaluated for any evidence of disturbance. The evaluation was completed using continuous soil cores recovered from the boreholes drilled across the Site. The soil cores were examined for evidence of deformed, tilted or sheared bedding patterns indicative of sand liquefaction and flow. Evidence of sediment disturbance was not observed.

As described above, subsurface investigation of the CRRRC Site identified a continuous silty layer within the upper part of the silty clay deposit. This silty layer is a marker bed throughout the subsurface deposited about 10,000 years ago. The presence of a flat-lying surface topography and the lower horizontal subsurface silty layer supports the conclusion that any strong earthquake shaking during the past 10,000 to 8,000 years has not resulted in liquefaction or other disturbance of the Holocene stratigraphy beneath the Site.

In summary, based on the available regional and Site-specific information, the large pre-historic earthquakes (4,550 and 7,060 years BP) inferred by Aylsworth et al. (2000) and Aylsworth and Lawrence (2003) have not resulted in large scale deformation of the silty clay deposit that underlies the Site. There is no evidence of deformation or displacement in the continuous samples recovered from the Site boreholes completed as part of the EA/EPA investigation. While it is possible that there has been smaller-scale deformation that is not apparent from the Site investigation program, differential settlement associated with strong earthquake shaking (liquefaction),is not considered to be a hazard at the CRRRC Site, nor for the reasons discussed in Section 11.3.3 below to be of engineering significance in any event.

11.3.2 Potential Hydrogeological Impacts

Quantitative assessments of the potential impacts of the CRRRC development on off-Site groundwater quantity and quality were carried out using standard groundwater flow and groundwater contaminant modelling.

Groundwater Quantity: This assessment modelled the potential for the Site development to lower off-Site groundwater levels and thereby affect water supply to off-Site shallow dug wells or to off-Site surface water features. A regional groundwater flow model was constructed using the regional and Site subsurface information. The work considered previous groundwater modelling completed for the Raisin Region – South Nation Source Water Protection study program (Logan et al., 2009; Raisin Region-South Nation Source Protection Region, 2012; WESA, 2010; WESA and EarthFX, 2006; Golder, 2004). The modelling also included the time-dependent effects of consolidation of the clay deposit that underlies the CRRRC Site, which will generate upward hydraulic gradients from the subsurface towards the landfill component for between 25 to 50 years after the waste is placed; the formation of a ‘settlement bowl’ in the clay beneath the landfill; and the reduction in vertical hydraulic conductivity of the clay as a result of consolidation.

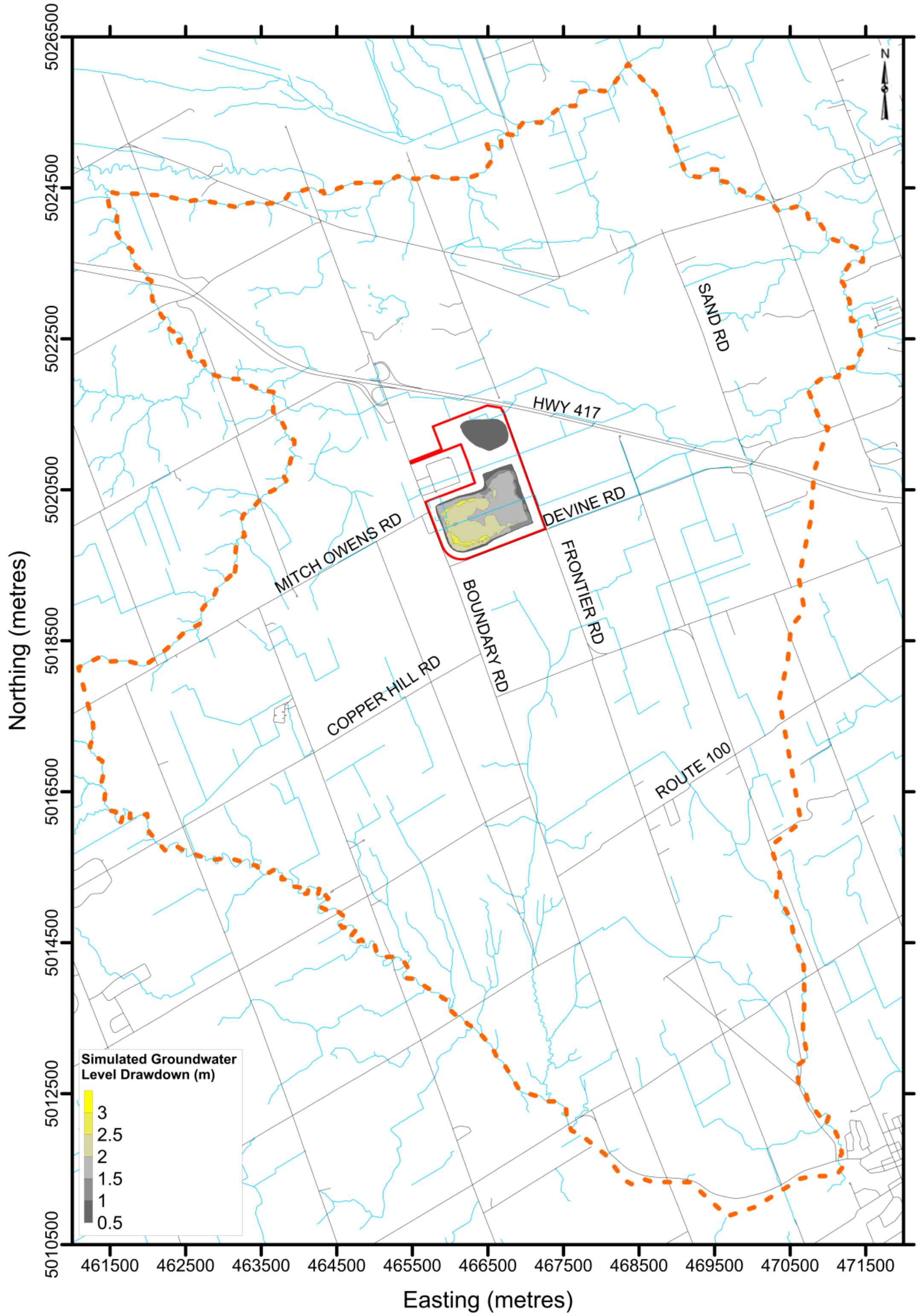
The regional groundwater flow model was bounded by the Bear River Municipal Drain in the west, Bear Brook Creek to the north, the Castor River to the south and the bedrock ridge to the east. The model was calibrated by comparing simulated steady-state groundwater elevations to measured groundwater elevations. Predictive simulations were completed to represent steady-state conditions both with an operating leachate collection system and following failure of the leachate collection system that was assumed to occur after 100 years of operation (as per the MOECC Landfill Standards (MOE, 1998b)).

The predictive model was used to estimate pseudo-steady state seepage rates and groundwater levels for the following scenarios:

- **Predictive Scenario (PS1):** Operating leachate collection system, pre-settlement, operational conditions;
- **Predictive Scenario (PS2):** Operating leachate collection system, post-settlement, closure conditions; and
- **Predictive Scenario (PS3):** Failed leachate collection system, post-settlement, closure conditions.

Groundwater drawdown provides an indication of the extent to which the landfill could potentially affect off-Site groundwater quantity. Groundwater drawdown was calculated for each pre-failure scenario relative to the calibrated pre-development conditions. Groundwater drawdown will be most significant while the leachate collection system is in operation; as such, scenarios PS1 and PS2 represent the greatest potential for groundwater lowering. Figure 11.3.2-1 and Figure 11.3.2-2 show the drawdown iso-contours at steady state for PS1 and PS2, respectively. As shown on the figures, the simulated drawdown does not extend beyond the property boundary for any of the scenarios. Therefore the proposed Site development is not predicted to have any measurable impact on groundwater quantity (and off-Site dug well supply) outside of the property boundary.

Failure of the leachate collection system would result in mounding of leachate within the landfill component. The effect of this mounding on groundwater elevations is shown on Figure 11.3.2-3 for PS3. The predicted effect of the Site on groundwater levels post-failure does not extend beyond the property boundary.



LEGEND

WATERBODIES

ROADS

PROPERTY BOUNDARY

MODEL DOMAIN

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENSE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2011. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

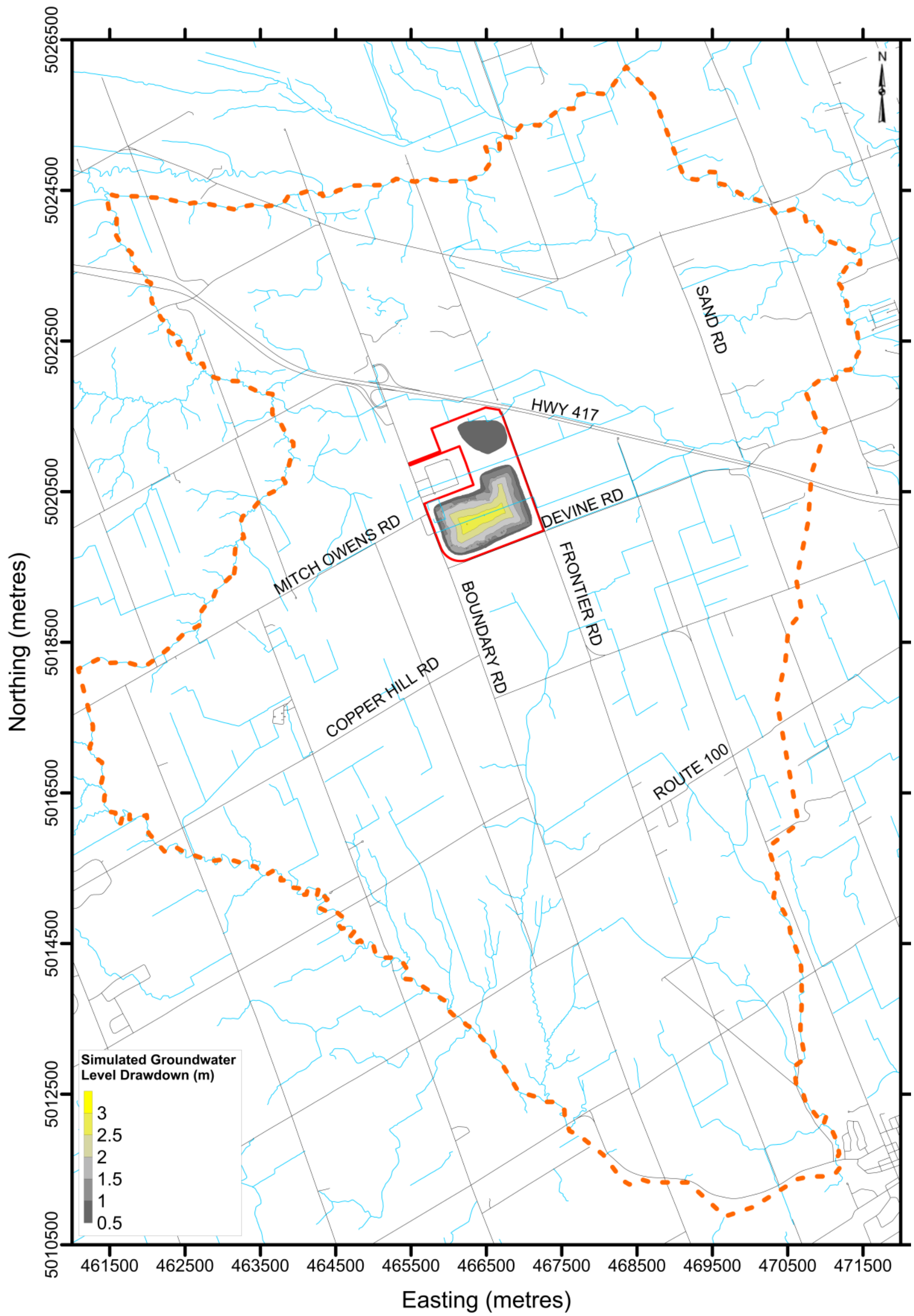
ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SIMULATED PRE-FAILURE GROUNDWATER DRAWDOWN (PS1: PRE-SETTLEMENT)

Golder Associates

PROJECT No. 12-1125-0045			PHASE No. 4500	
DESIGN	MIB	Nov. 2013	SCALE AS SHOWN	REV.0
GIS	--	--	FIGURE 11.3.2-1	
CHECK	PLE	Aug. 2014		
REVIEW	PAS	Aug. 2014		



LEGEND

- WATERBODIES
- ROADS
- PROPERTY BOUNDARY
- MODEL DOMAIN

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENSE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2011. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

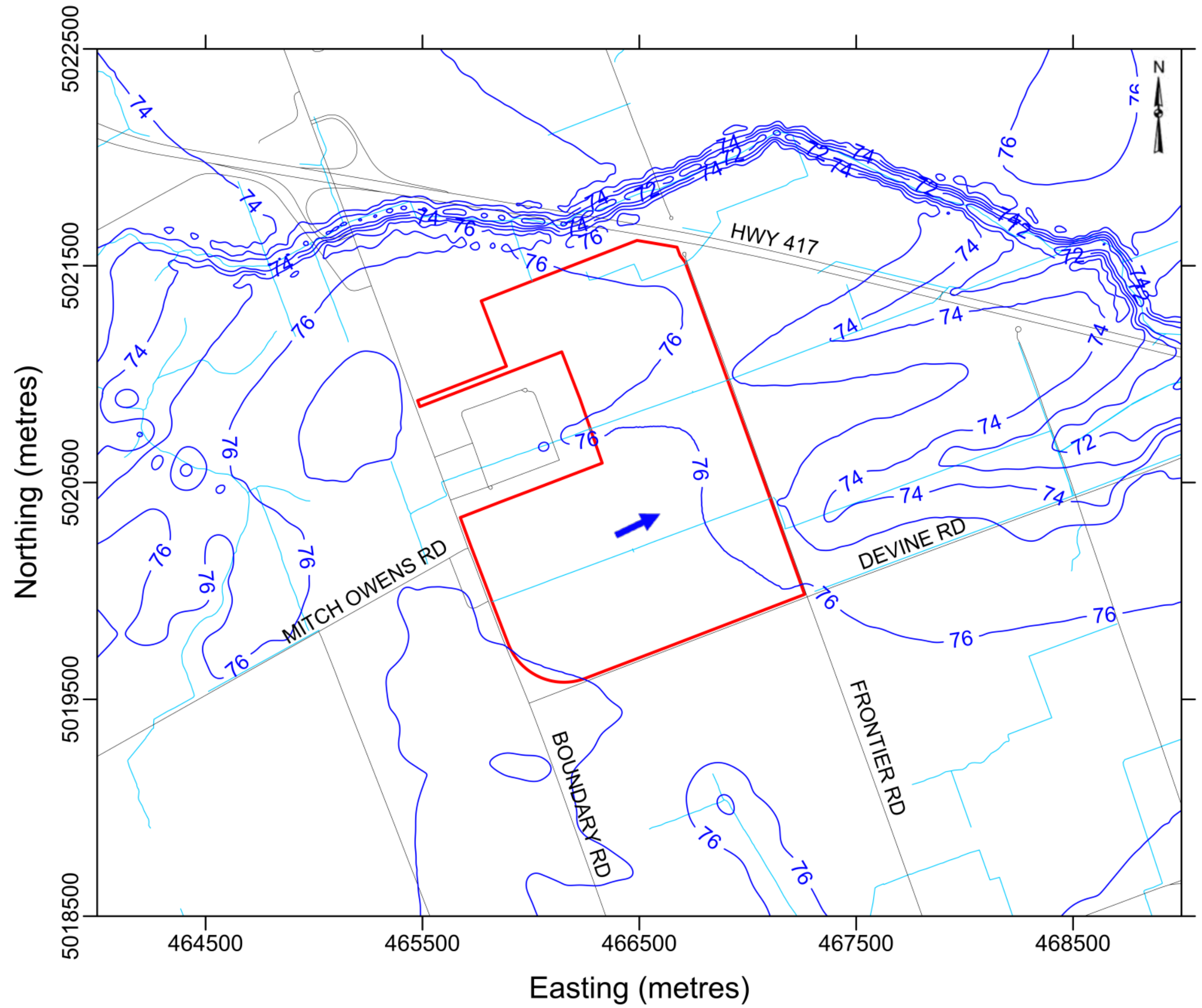
ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SIMULATED PRE-FAILURE GROUNDWATER DRAWDOWN (PS2: POST-SETTLEMENT)

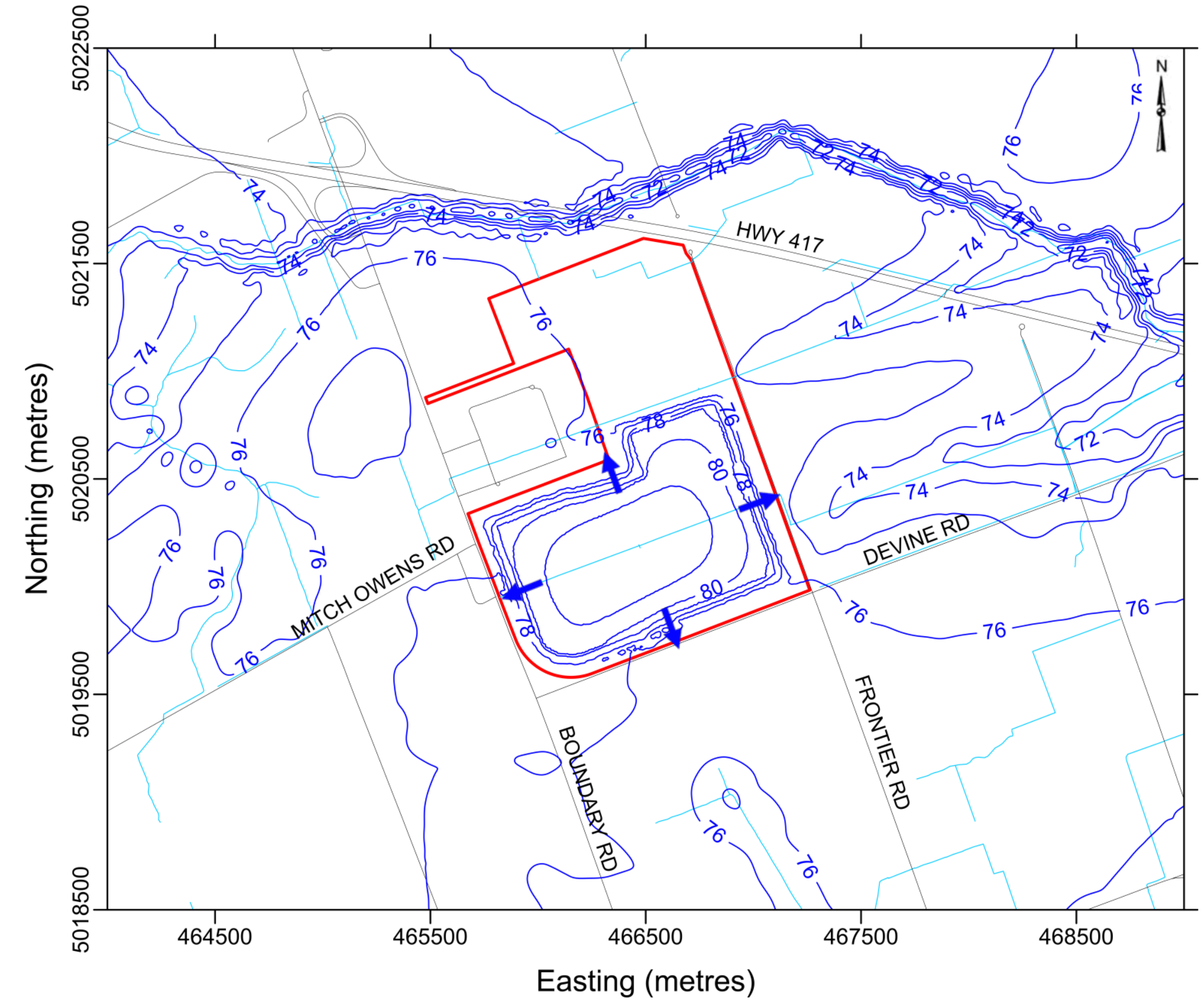
Golder Associates

PROJECT No. 12-1125-0045			PHASE No. 4500	
DESIGN	MIB	Nov. 2013	SCALE AS SHOWN	REV.0
GIS	--	--	FIGURE 11.3.2-2	
CHECK	PLE	Aug. 2014		
REVIEW	PAS	Aug. 2014		



CALIBRATED PRE-DEVELOPMENT CONDITIONS

SLICE 3: SURFICIAL SILTY SAND AND CLAY



STEADY-STATE POST-FAILURE CONDITIONS

SLICE 3: SURFICIAL SILTY SAND AND CLAY

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENSE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2011. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

LEGEND

- WATERBODIES
- ROADS
- PROPERTY BOUNDARY
- 75 GROUNDWATER ELEVATION (metres ABOVE SEA LEVEL) (1 metre contour interval)
- INTERPRETED GROUNDWATER FLOW DIRECTION

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SIMULATED POST-FAILURE GROUNDWATER ELEVATION (PS3: POST-SETTLEMENT)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV.0
DESIGN	MIB	Nov. 2013	FIGURE 11.3.2-3	
GIS	----	----		
CHECK	PLE	Aug. 2014		
REVIEW	PAS	Aug. 2014		

Hydraulic head contours for the silty layer and the glacial till/bedrock contact zone are shown on Figure 11.3.2-4 for the PS3 scenario. These results show that groundwater seepage in the silty layer will flow radially away from the Site until it enters the local flow regime. Groundwater seepage in the glacial till/bedrock contact will be as under existing pre-development conditions and generally flow towards the northeast.

The travel time for particles released under steady-state conditions following failure of the leachate collection system and representative of the first arrival of a conservative tracer at the glacial till/bedrock contact is on the order of 500 years.

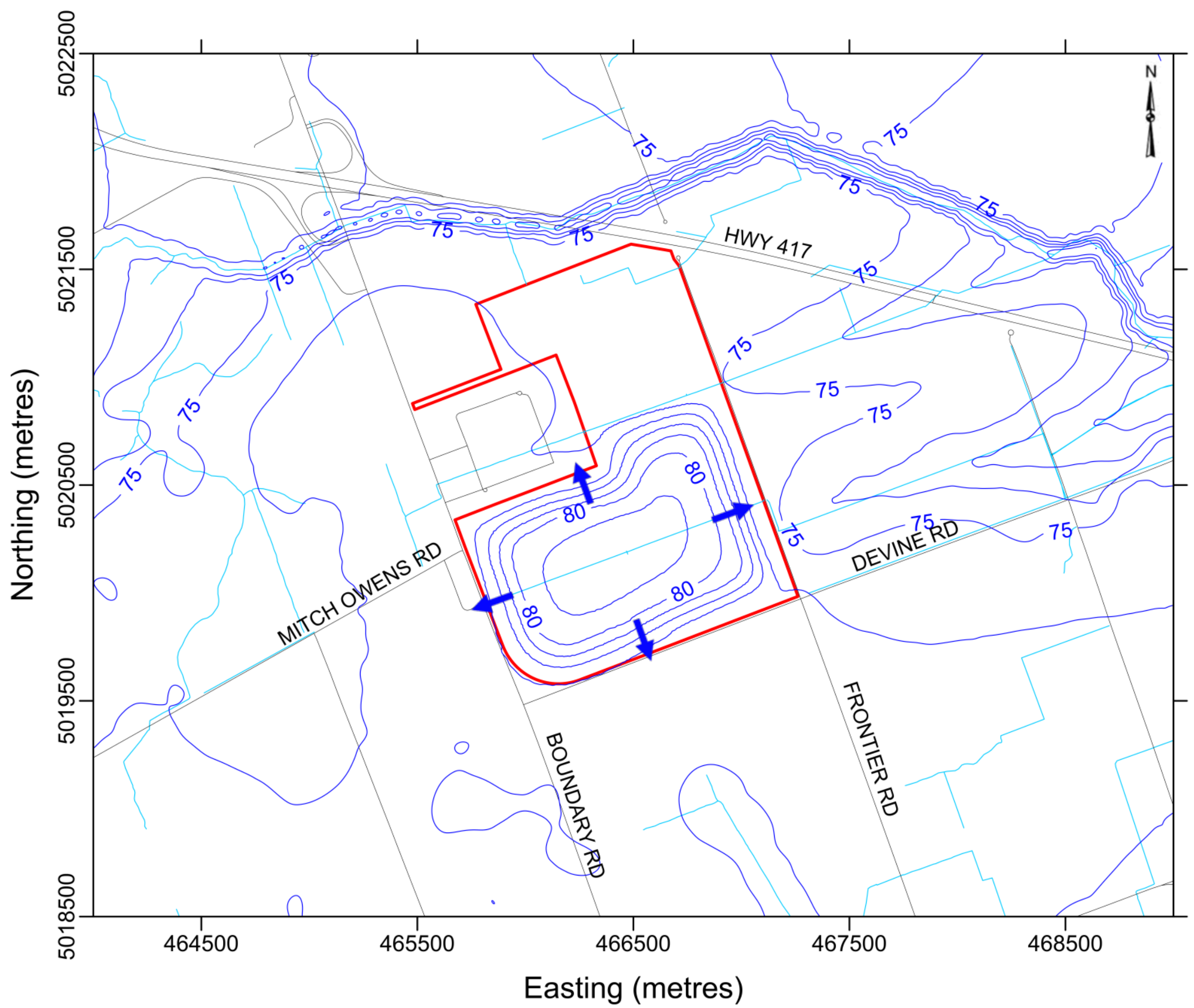
In addition to the predictive modelling, a dug well monitoring and pumping test program was carried out to better understand how dug wells in the vicinity of the Site function. The following summarizes the findings relating to dug well water supply in the vicinity of the Site:

- The dug wells obtain water primarily from the surficial silty sand layer;
- The sustainable pumping rate is approximately 4 Litres per minute; and
- Under typical use, the radius of influence of a dug well (i.e., area of drawdown associated with the water taking) is interpreted to be less than 10 metres. That is, the dug wells are recharged locally (i.e., from the silty sand close to the well).

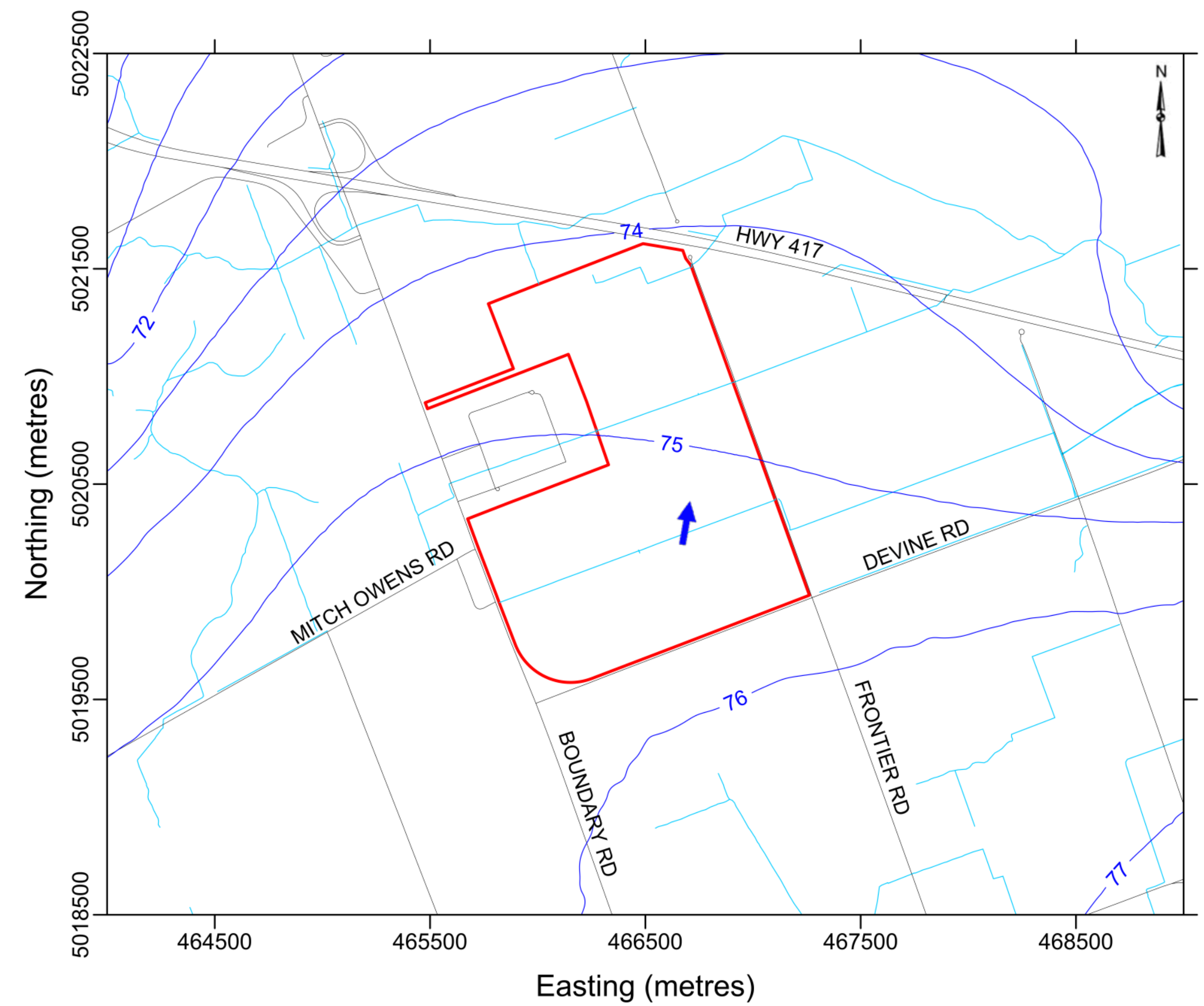
Groundwater Quality: Modelling of long-term groundwater quality impacts for new or expanding landfill sites is required under O. Reg. 232/98 (MOE, 1998a) to demonstrate that the proposed design will meet the requirements of MOECC Guideline B-7 (MOE, 1994b). The Reasonable Use Guideline B-7 establishes a quantitative benchmark for protecting off-Site groundwater quality for drinking water purposes.

In terms of any engineered facilities the Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites (Landfill Standards) (MOE, 1998b) makes the following statement regarding the basis for evaluation of the acceptability of proposed engineered facilities at landfills:

> *"An engineered facility which is to be constructed at a landfilling site for purposes of controlling leachate, groundwater, surface water or landfill gas should be designed such that: the service life of the engineered facility exceeds the period of time during which contaminants may be generated by the site and need to be controlled by the engineered facility to prevent an unacceptable impact; or the engineered facility can be replaced, or an alternative engineered facility can be constructed, as necessary to enable the combined service lives of the engineered facilities to exceed the period of time during which contaminants may be generated by the site and need to be controlled by the engineered facility to prevent an unacceptable impact."*



SLICE 11: SILTY LAYER



SLICE 16: GLACIAL TILL / BEDROCK CONTACT

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENSE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2011. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

LEGEND

- WATERBODIES
- ROADS
- PROPERTY BOUNDARY
- 75 SIMULATED HYDRAULIC HEAD (metres) (one metre contour interval)
- INTERPRETED GROUNDWATER FLOW DIRECTION

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SIMULATED POST-FAILURE HYDRAULIC HEAD (PS3: POST-SETTLEMENT)

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV.0
DESIGN	MIB	Nov. 2013	FIGURE 11.3.2-4	
GIS	----	----		
CHECK	PLE	Aug. 2014		
REVIEW	PAS	Aug. 2014		

The contaminant transport modelling for the proposed landfill was carried out using POLLUTE (Rowe, et al., 1994). POLLUTE is a one-dimensional, analytical contaminant transport model, which can account for contaminant migration from a landfill situated on a multi-layered soil deposit. The model predicts concentrations in the aquifer unit at the down-gradient edge of a landfill. For the hydrogeological conditions at the CRRRC landfill, advection/dispersion and bio-chemical decay are the primary transport processes in the sandy silt and till layers, whereas diffusion is the primary transport process in the upper and lower silty clay layers, with the advection, adsorption and bio-chemical decay playing lesser roles. The boundary condition used for contaminant source concentrations in the landfill is that of a depleting contaminant concentration with time from an initial representative peak value that occurs at the closure of the landfill component. The model and approach used to evaluate groundwater quality impacts was extended for 1,000 years beyond the time that waste filling was assumed to commence. As described in Section 10.8, the landfill component of the CRRRC will be surrounded by a constructed GCL hydraulic barrier keyed into the silty clay, which will cut off the horizontal flow to the surficial silty sand layer and perimeter berm fill. While the silty layer does not convey a substantial amount of water, it was conservatively used in the modelling to represent the groundwater resource that is the most susceptible to landfill leachate impacts. For the purpose of the contaminant transport modelling, the subsurface conditions were simplified as shown on Figure 11.3.2-5 with two distinct silty clay layers of uniform thickness separated by a 0.3 metre silty layer. During operation of the landfill the average thickness of the silty clay deposits below the landfill are 3.3 metres and 23.3 metres for the silty clay above the silty layer and below the silty layer, respectively.

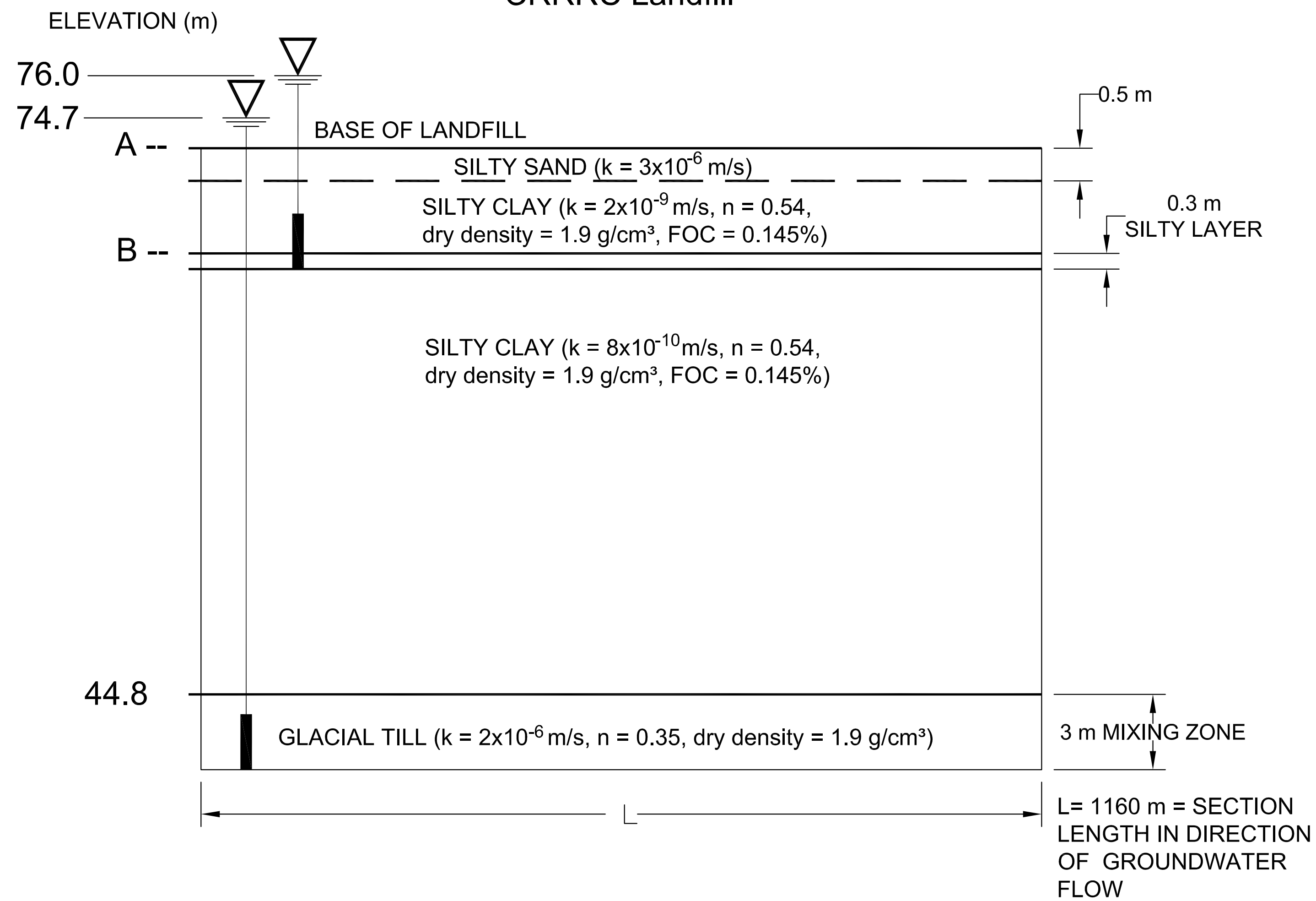
In accordance with O. Reg. 232/98 (MOE, 1998a), the key leachate contaminants modelled for municipal solid waste to address long-term compliance with MOECC Guideline B-7 (MOE, 1994b) are: benzene, cadmium, chloride, lead, 1,4-dichlorobenzene, dichloromethane, toluene and vinyl chloride. Although it is not proposed that the CRRRC receive residential waste[1], and much of the organic component of the waste/residual stream should be able to be diverted from landfill (thus reducing some parameter concentrations in the leachate), utilizing these leachate contaminants and their proposed source concentrations is a conservative approach to impact assessment. In addition to the key leachate contaminants associated with municipal solid waste, boron was also used in consultation with the MOECC based on boron being a typical leachate indicator for IC&I waste.

As described in Section 10.8, a granular drainage blanket will be constructed below the waste and, together with a piping system, will convey the leachate to sumps where it will be removed from the landfill for treatment. It is proposed that the design for the granular drainage layer meet the requirements of Schedule 1 provided in O. Reg. 232/98 (MOE, 1998a). Based on this regulation, the service life of a leachate collection system that meets the requirements in Schedule 1 can be taken as 100 years starting from either year 10 or the mid-point of the landfilling period, whichever is less. For the GCL hydraulic barrier, which derives its hydraulic resistance through natural mineral soils, a service life of greater than one thousand years (as per O. Reg. 232/98) is reasonable.

The results of the hydrogeologic/contaminant transport modelling are presented on Figure 11.3.2-6 that shows the predicted key leachate contaminant parameter concentration variations with time at the downgradient edge of the landfill (100 to 125 metres from the property boundary).

[1] Recyclables from multi-residential developments will be received at the CRRRC if available.

CRRRC Landfill



Years Past Closure	A (m ASL)	B (m ASL)
0 YEARS (CLOSURE)	74.4	71.1
10 YEARS	71.5	69.4
50 YEARS	70.4	68.3
80 YEARS * (FAILURE OF LEACHATE COLLECTION SYSTEM)	70.2	68.1

* Used 100 year settlement numbers at this time to be conservative

NOTES:

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE
CAPITAL REGION RESOURCE RECOVERY CENTRE

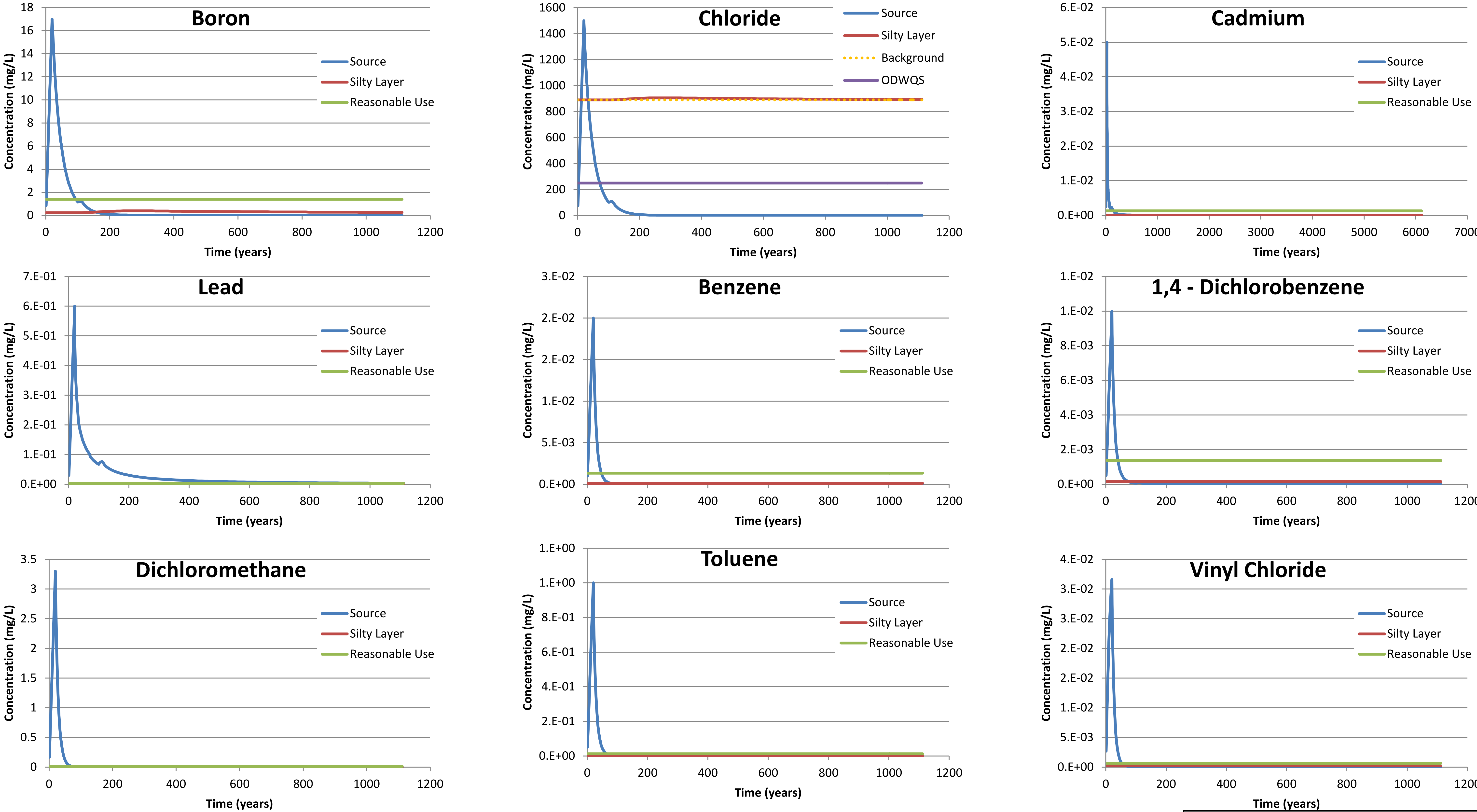
TITLE

SIMPLIFIED CROSS-SECTIONS FOR CONTAMINANT TRANSPORT MODEL

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045	FILE No. 1211250045-V1-EAr-11.3.2-5.DWG
DESIGN	M.K.F.	27 Nov. 2013	SCALE N.T.S. REV. 0
CAD	M.L.F.	27 Nov. 2013	DRAWING No.
CHECK	P.L.E.	Aug. 2014	**Fig. 11.3.2-5**
REVIEW	P.A.S.	Aug. 2014	

PLOT DATE: June 26, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 1 (Report Figures)\Chapter 11\1211250045-V1-EAr-11.3.2-5.DWG



NOTE
THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
RESULTS OF CONTAMINANT TRANSPORT MODEL

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV.0
DESIGN	MKF	Nov. 23/2013		
GIS	---	---		
CHECK	PLE	Aug. 2014		
REVIEW	PAS	Aug. 2014		

FIGURE 11.3.2-6

The results of the modelling for all key landfill leachate contaminant parameters are summarized in Table 11.3.2-1 and indicate essentially no predicted impact on the silty layer at the downgradient edge of the landfill. For all parameters, the Reasonable Use Criteria for the silty layer (indicated in Table 11.3.2-1) are satisfied, noting however that chloride naturally exceeds the ODWQS (MOE, 2003a).

The contaminating lifespan for the proposed landfill component of the CRRRC corresponds to the time at which contaminant concentrations in the landfill have decreased to the extent that the landfill would no longer require the engineered system components to protect off-Site groundwater quality, but can rely on the natural containment provided by the silty clay deposit to do so.

To ensure protection of off-Site groundwater and compliance with MOECC requirements, the design of the proposed CRRRC landfill component relies primarily on: 1) the perimeter GCL hydraulic barrier and operation of the leachate collection system for protection of groundwater quality within the on-Site surficial silty sand layer, and 2) the natural silty clay deposit augmented by the leachate collection system for protection of the groundwater within the on-Site silty layer located several metres below the base of the landfill.

In addition to the above modelling, sensitivity analyses were carried out to assess a number of scenarios related to the potential impact to the subsurface silty layer: all contaminants going to the silty layer; settlement of the underlying clay deposit; and early failure of the leachate collection system beneath the landfill. The sensitivity analyses are reported in Volume III. Under these scenarios, the Site is still predicted to remain in compliance with the Reasonable Use Criteria (MOE, 1994b). All of these analyses show that should the leachate collection system fail after 20 years beyond the mid-point of landfilling or 20 years beyond year 10 after filling commenced, the thickness and low hydraulic conductivity of the natural silty clay deposit would provide the required off-Site groundwater protection. Nevertheless, the leachate collection system while functioning still helps ensure the protection of groundwater within the surficial silty sand layer by reducing leachate mounding on the GCL hydraulic barrier. Monitoring of leachate levels within the landfill will be ongoing during operations and post-closure and determine the need for contingency measures to prevent seeps and breakouts that could potentially impact surface water.

As described in Section 10.8, the design of the leachate collection system is such that leachate movement is towards sumps in the centre portion of the landfill, away from the perimeter of the landfill. The consolidation of the clay under the weight of the landfill will enhance this flow even more over time. As such, a significant mound of leachate will have to build up within the landfill before there is a leachate head against the perimeter of the landfill and the GCL barrier, which would be the condition required for leachate to potentially diffuse through the GCL hydraulic barrier and into the surficial silty sand layer. Should leachate diffusion through the GCL barrier occur it would be detected by the monitoring program and there are a number of contingency measures available to ensure protection of off-Site groundwater in the surficial silty sand layer in such circumstances as described in Section 14.0.

<u>Summary</u>: The following conclusions can be derived from the groundwater modelling analyses described above:

- Groundwater levels (in the surficial silty sand and other strata) will not be affected beyond the property; and
- Off-Site groundwater quality will not be adversely affected by the CRRRC.

Table 11.3.2-1: Predicted Concentrations of Key Leachate Contaminants in the Silty Layer from the CRRRC Landfill

Contaminant	Background Median Concentration in Silty Layer (mg/L)[1]	Ontario Drinking Water Quality Standards [2] (mg/L)	Reasonable Use Criteria [3] (mg/L)	Predicted Peak Concentration* (mg/L)	Predicted Peak Plus Background Concentration* (mg/L)	Time of Peak Concentration** (years)
Boron	0.225	5 (H)	1.42	0.166	0.39	272
Chloride	890	250 (A)	N/A	16	906	272
Cadmium	0.00005	0.005 (H)	0.001	0.00004	0.00009	>1000
Lead	0.00025	0.01 (H)	0.003	0	0.00025	>1000
Benzene	0.0001	0.005 (H)	0.001	0	0.0001	162
1,4-Dichlorobenzene	0.00015	0.005 (H)	0.001	0	0.00015	272
Dichloromethane	0.0005	0.05 (H)	0.01	0	0.0005	122
Toluene	0.0003	0.024 (A)	0.01	0	0.0003	172
Vinyl Chloride	0.0002	0.002 (H)	0.0007	0	0.0002	142

Notes:
(H) Health-related objective.
(A) Aesthetic objective.
N/A – Reasonable Use Criteria concentration cannot be calculated since the background concentration exceeds the ODWQS.
mg/L – milligrams per Litre
1 Based on the median results of groundwater samples taken from groundwater monitoring wells BH12-1-5B, BH12-2-5B, BH12-3-5B, BH12-4-5B, BH13-5-5, BH13-6-5B and BH13-7-4-2 between January and July 2013.
2 Ref. Ontario Drinking Water Quality Standards (MOE, 2003a).
3 Reasonable Use Criteria = Background Concentration + X (ODWQS Criteria - Background Concentration):

where X = 0.25 for health related drinking water parameters
= 0.50 for aesthetic related drinking water parameters

* Based on a 1,000 year contaminant transport modelling time frame, has been added to the background concentration.
** Relative to year 10 of the landfilling period.

11.3.3 Geotechnical Assessment

As described in Section 10.8, the results of stability analyses (under both static and seismic loading conditions) and settlement analyses were used as the basis for the design of the landfill component of the CRRRC.

Static Stability: The static stability analyses indicate that in order to have an adequate factor of safety against instability of the landfill, the following are required: a 3.5 metre high perimeter berm around the landfill with a 36 metre top width; flat sideslopes at 14 horizontal to 1 vertical to a height of 13.5 metres above existing ground and then 20 horizontal to 1 vertical up to a central ridge or peak; and specific setbacks and sideslope inclinations for various facilities adjacent to the landfill (and for excavated features such as ponds elsewhere on the Site). The minimum target factors of safety used for this design were 1.4 for overall and interim waste/landfill slopes and 1.3 for internal perimeter berm and excavation slopes.

Seismic Stability: Dynamic analyses were also carried out to assess the seismic stability of the proposed landfill configuration when subjected to strong earthquake shaking, as well as estimate the associated movements of the waste and underlying clay soils. The analysis considered the Site-specific subsurface conditions, i.e., thick clay soil deposit, and design earthquakes having a return period of 1:2,475 years, consistent with the design shaking set out in the National Building Code of Canada (NRC, 2010). This is also consistent with design guidelines established for solid waste landfills in the United States.

The corresponding seismic ground motion parameters for the Site were evaluated using the seismic hazard models and seismogenic zones developed on a regional basis by Natural Resources Canada for use in the National Building Code of Canada (NRC, 2010).

The de-aggregated hazard for the Site indicates that the earthquake characteristics correspond to "mean" earthquake magnitudes ranging between M6 and M7 with associated distances between 25 kilometres and 72 kilometres from the Site. Bedrock acceleration time-histories that correspond to those earthquake magnitudes were then selected from available synthetic earthquake records for eastern Canada.

Non-linear dynamic time-history analyses were then carried out to assess the seismic stability and deformations of the CRRRC landfill at the closure condition. The seismic ground motions were propagated from the bedrock upwards towards the ground surface using ground response analysis models.

The analyses were carried out using the computer code FLAC^{2D} *V6* (Itasca*,* 2008) and considered conditions after 30 years of operation. Over that time, the self-weight loads imposed by the landfill materials will induce consolidation settlements in the underlying clayey soils, which will increase the strength and stiffness of the clay foundation soils.

The computed seismic loading-induced lateral movements of the landfill for all six of the analyzed time histories are less than 340 millimetres. The calculated earthquake-induced deformations of the landfill are the result of deformations occurring in the upper clay layers directly below the landfill. These results are indicative of a stable landfill under the design seismic loading conditions.

Settlement: The development of the landfill (i.e., the placement of up to 25 metres of waste) will induce time-dependant consolidation of the underlying clay soil deposit. Due to the low hydraulic conductivity of the silty clay, the settlements will be time-dependant in nature and will occur over many years/decades.

A range of values/profiles for both the preconsolidation pressure and the coefficient of consolidation parameters was considered, and several combinations of the two used in the analyses. This methodology results in a range of the calculated possible settlements over time.

The results of the analyses indicate that, under the highest portions of the landfill, the settlements resulting from primary consolidation of the deposit are expected to be in the order of 6 to 8 metres, by about 100 years from the start of consolidation. In the longer term, the settlements would increase beyond this estimate due to secondary compression of the deposit. The calculated range of settlements over time, based on the combination of primary consolidation and secondary compression, are shown on Figure 11.3.3-1.

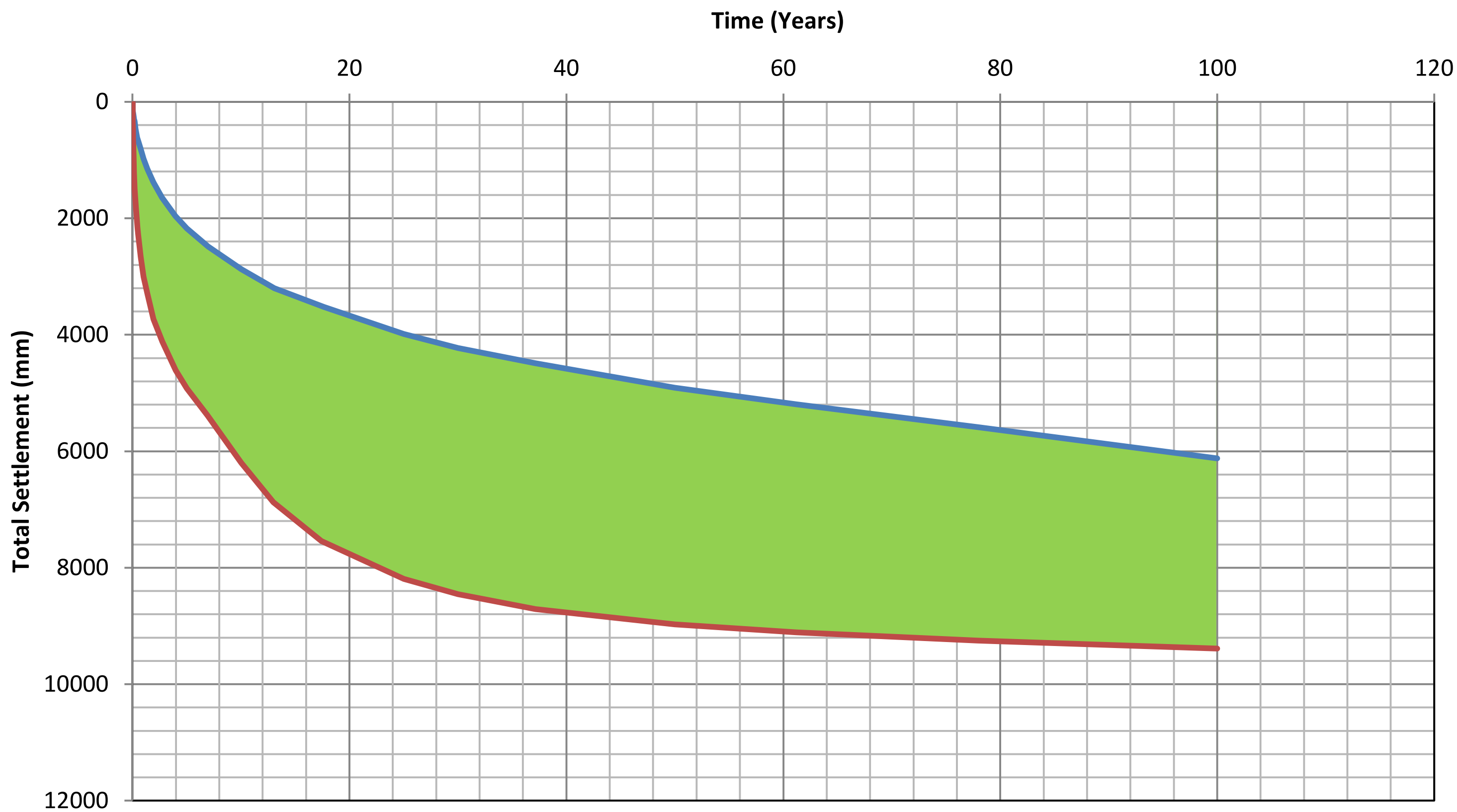
The landfill subgrade settlements will also vary across the footprint, due to the variation in the landfill waste thickness. The calculated range of settlements under waste heights varying up to the maximum proposed waste height, at a time of 100 years following the start of consolidation, are shown on Figure 11.3.3-2. These results were used to evaluate the potential differential settlements of the subgrade (and leachate collection system) beneath different points in the landfill footprint and to design the leachate collection system and assess its expected performance.

As discussed in Section 10.8, the completed landfill geometry (i.e., the elevation of the 'finished' landfill surface and sideslopes) will need to account for subgrade settlements. Because the subgrade surface will be settling while waste is placed, it will not, therefore, likely be technically feasible to actually fill to the theoretical slope/cover geometry. Based on monitoring and the associated gain in strength of the clay as it consolidates, the appropriate final waste thickness (not to exceed the final elevation contours assumed for purposes of this EA) will be determined in consultation with the MOECC prior to placement of the waste in the uppermost phases of the landfill.

The geological assessment described in Section 11.3.1 concluded, based on available information, that there is no evidence of surface fault ruptures from historical earthquakes at the proposed CRRRC Site or its immediate vicinity. The assessment further concluded that there is negligible hazard at the CRRRC Site of future fault movement resulting in large scale differential displacements at the surface or shallow subsurface and that there is also little potential for differential settlement associated with strong earthquake shaking (liquefaction) at the CRRRC Site.

In any event, in terms of the engineering significance or potential effects of surface or subsurface displacements from potential future fault movement on the design and performance of the proposed CRRRC landfill, both the landfill mass itself and the proposed leachate containment and collection system (and its components), are very capable of withstanding significant differential displacements. There is no constructed or manufactured liner system at the base of the landfill as designed; rather, the containment of landfill leachate relies on the natural containment properties of the 30 metres of low permeability silty clay underlying the Site. The proposed leachate containment and collection system has been designed to withstand relatively large differential movements and continue to perform its intended function. For example, this containment and collection system has been designed to function when experiencing the predicted movements associated with long term consolidation of the clay deposit beneath the landfill, i.e., total settlements of 6 to 8 metres under the central portion of the landfill. The containment and collection system has also been designed to accommodate lateral displacements of up to 350 mm under seismic loading conditions. In addition, as discussed in Section 11.3.2, the groundwater analyses show that even if there was an early failure of the leachate collection system, then the thickness and low hydraulic conductivity of the natural silty clay deposit would provide the required off-Site groundwater protection. For these reasons, the effects of surface or subsurface displacements from local fault movement, in the very unlikely event that it occurs during the contaminating lifespan of the landfill, are inconsequential for engineering design or performance of the landfill. It is also noted in this regard, as discussed in Section 11.3.2, that the contaminating lifespan of the landfill (the period of time during which the landfill leachate, if released to the natural environment, would have an adverse effect on off-Site groundwater resources) is very short in geological terms, i.e., only of the order of several decades.

In summary, the geotechnical and geologic assessments considered static stability, seismic (dynamic) stability and longer term settlement. To ensure that the landfill will be stable under normal (static) conditions, the height of the landfill has been restricted, the side slopes flattened compared to that recommended in the Landfill Standards (MOE, 1998b), the landfill was set back from adjacent facilities including ponds; and the landfill was surrounded by a perimeter berm. The stability of the landfill under earthquake shaking conditions was also analyzed. The landfill stability models, which considered the movement of the waste, movement of the underlying clay soils and used Site-specific subsurface conditions, estimated the potential lateral displacement of the landfill to be less than 340 millimetres during the design earthquake. These models indicate that the landfill is stable under the design seismic loading conditions. Finally, based on the characteristics of the silty clay at the Site and the maximum weight of the landfill, it is expected that there will be settlement of the subsurface over many years/decades. After approximately 100 years, the subsurface below the central portions of the landfill (where the landfill is thickest) is expected to settle in the order of 6 to 8 metres. Because the thickness of the waste reduces as the landfill slopes downward to meet the perimeter berm, less settlement is expected towards the outer edges of the landfill as the weight of the landfill is not as great in these areas,. The leachate containment and collection system was designed to account for these longer term settlements so that it would continue to perform as expected during and after the settlement. The effects of small-scale surface or subsurface displacements from fault displacement are, therefore, inconsequential for the engineering design and performance of the landfill component of the CRRRC.



NOTE: THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

Golder Associates

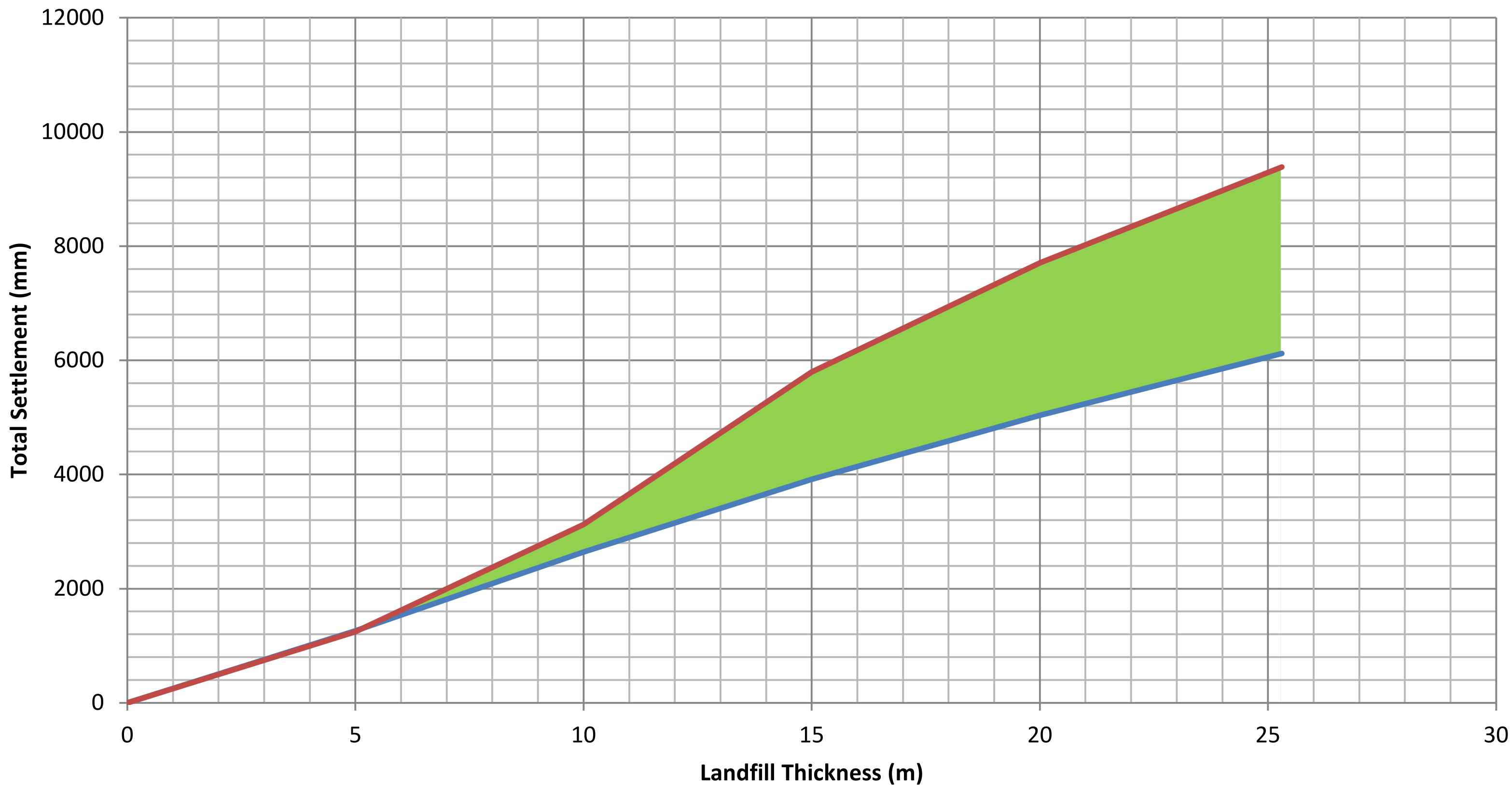
CALCULATED RANGE OF TOTAL SETTLEMENT

SETTLEMENT VERSUS TIME - 25-METRE HIGH LANDFILL

ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

Project No.	12-1125-0045
Drawn:	CK
Date:	Nov. 2013
Checked:	PLE
Review:	PAS

FIGURE 11.3.3-1



NOTE: THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT

Golder Associates

CALCULATED RANGE OF TOTAL SETTLEMENT

TOTAL SETTLEMENT VERSUS LANDFILL THICKNESS - 100 YEARS
ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

Project No.	12-1125-0045
Drawn:	CK
Date:	Nov. 2013
Checked:	PLE
Review:	PAS

FIGURE 11.3.3-2

11.4 Surface Water

The surface water assessment is provided in Appendix A to the Volume IV D&O Report. Surface water quantity and quality were examined in the assessment. The post-development model results were compared to the pre-development results, with consideration of proposed mitigation systems.

Table 11.4-1 below summarizes the criteria used in designing the stormwater management (SWM) system for the CRRRC Site. The general layout of the SWM system is shown on Figure 10-1.

Table 11.4-1: Site SWM Design Criteria

Criterion	Description	Target
Quantity		
Peak Runoff Control	1 in 2 year to 1 in 100 year runoff events	Post-development peak flows at/below pre-development
Conveyance Capacity	Internal drainage ditches, storm sewers and conveyance structures Continuous overland flow route	Design Capacity to accommodate 1 in 25 year design storm Convey the peak flow from the 1 in 100 year design storm
Stormwater Water Quality	TSS	Enhanced Level Treatment (80% TSS removal) (MOE, 2003b)

Predicted Effects on Drainage Areas: The post-development conditions scenario considers the Site Development Plan layout for the ultimate build-out of the CRRRC facilities, the landfill final cover and the SWM controls shown on Figure 11.4-1. The three Site sub-catchment drainage areas and corresponding land uses for the proposed ultimate build-out state of the Site are presented below.

Regimbald Municipal Drain: The proposed northern Regimbald Municipal Drain, sub-catchment area will increase by 3.3 hectares, to a total sub-catchment area of 24.3 hectares. The proposed grading and servicing plans route the drainage from this part of the CRRRC facility area to the two cell SWM/Fire Ponds. This post-development Site sub-catchment area includes buildings, parking areas, roadways, stockpile areas, preserved existing and/or landscaped green space and the two SWM/Fire Pond cells (Ponds 5a and 5b) located in the central area of this sub-catchment.

Simpson Municipal Drain: The proposed Simpson Municipal Drain post-development total sub-catchment area of approximately 83.8 hectares increases from existing conditions by approximately 8.2 hectares. This post-development drainage area is proposed to control runoff via a pond northwest and northeast of the Simpson Drain (Ponds 3, 4a and 4b) and one pond southwest of the drain (Pond 1). The area north of the Drain will include pads for the composting operations and soil treatment facilities, buildings, roadways and leachate storage ponds. The area south of the Simpson Drain will include the northwest segment of the landfill component of the CRRRC.