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# Surface Water Assessment Report for the West Carleton Environmental Centre Landfill

Report

Environment

Waste Management

# Surface Water Assessment Report for the West Carleton Environmental Centre Landfill

**Prepared by:**

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**Project Number:**

60289364

**Date:**

July, 2014

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*AECOM: 2012-01-06*

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July 25, 2014

Mr. Wayne Jenken
Area Landfill Engineer
Waste Management
8039 Zion Line
Watford, ON N0M 2S0

Dear Mr. Jenken:

**Project No:** **60289364**

**Regarding:** **Surface Water Assessment Report for the West Carleton Environmental Centre Landfill**

AECOM is pleased to provide you with the attached Surface Water Assessment Report for the West Carleton Environmental Centre Landfill.

If you should have any comments or questions, please contact me by email or at 905-747-7434.

Sincerely,
**AECOM Canada Ltd.**

Larry Fedec, P. Eng., M.B.A.
Manager, Waste Services
*Larry.Fedec@aecom.com*

LMF:mm
Encl.

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# 1. Introduction

The West Carleton Environmental Centre (WCEC) is located on the west side of Carp Road north of Highway 417 and owned by Waste Management (WM) of Canada Corporation. The property is legally described as part of Lots 2, 3 and 4, Concession II, and part of Lots 3, 4 and 5, Concession III of the former Township of West Carleton (now City of Ottawa). The existing landfill is now closed. An Environmental Assessment (EA) which identified the preferred landfill expansion alternative (AECOM 2012) following the requirements of the provincial Environmental Assessment Act, has already been prepared, submitted and approved by the Ontario Minister of the Environment. It was approved by the Minister in September 2013. This Surface Water Assessment Report is primarily based on the *Environmental Impact Statement for the West Carleton Environmental Centre Landfill Expansion* (EIS) (AECOM 2014), *Supporting Document 5 – Detailed Impact Assessment Reports (Environmental Assessment for a New Landfill Footprint at the West Carleton Environmental Centre, Surface Water Detailed Impact Assessment* (AECOM 2012), and *Development and Operations Report: West Carleton Environmental Centre* (WSP 2014).

## 1.1 Study Area

The southern half of the proposed landfill expansion area is situated on WM-owned lands and the northern half is on lands that WM has options to purchase. The proposed landfill would be situated immediately north of the existing, now closed landfill. The final contours of the proposed landfill reflect a rectangular landform with a maximum elevation (top of final cover) of 155.0 mASL. This elevation is approximately 30 m above the surrounding existing grade. By comparison, the maximum elevation of the existing Ottawa WMF landfill is considerably higher at approximately 172 mASL. The contours reflect maximum side slopes of 4H to 1V, and a minimum slope of 5%. The footprint area of the new landfill is 37.8 ha but including surrounding roads, stormwater ponds and clearing, the landfill operations will cover approximately 68 ha.

The existing landfill site and proposed landfill expansion area are situated adjacent to the south tributary of the Huntley Creek sub-watershed of Carp River. The existing WM Ottawa landfill and proposed expansion lies within the watershed of the Carp River. It drains an area of approximately 306 km² and discharges to the Ottawa River at Fitzroy Harbour. For most of its length, the Carp River flows through poorly drained clay soils in a relict glaciofluvial channel of the Ottawa River. The Carp River has four major tributaries draining into it: Corkery Creek, Huntley Creek, Feedmill Creek and Poole Creek. The sub-watershed area is relatively flat with a significant amount of wetland and scattered agricultural use as well as ongoing estate-lot residential development.

The south tributary of the Huntley Creek has a limited drainage area with a headwater area generally defined to the west and south by Highway 417, to the north by Cavanmore Road, and to the east by Carp Road (**Figure 1**). Local drainage patterns are somewhat undefined and are characterized by large wetland areas that have significant storage potential, especially in the vicinity of the landfill site. Depending on the magnitude of rainfall and the storage-discharge characteristics of the various wetland areas, flow from these locations may or may not be realized on adjacent lands and at the landfill Site.

A portion of the existing landfill site was a former gravel pit and has relatively permeable, silty-sandy soils. Municipal water supply in adjacent built-up areas to the south (Ottawa – Stittsville) and east (Ottawa - Kanata) is from the Ottawa River at the Britannia intake, while water supply for the built up area to the north (Ottawa-Carp) is from local municipal wells. Water supply for the rural areas is from private wells.

# 2. Existing Conditions

There are no permanent or intermittent streams within the proposed landfill footprint, and therefore there is no change to the frequency, magnitude or duration of stream flow, water levels, annual water budgets, etc. expected for surface water bodies on the Site. On the existing site, there are two (2) stormwater management (SWM) ponds that discharge to groundwater. The existing private water and sewage services at the existing landfill are suitable for continued use by WM for the proposed WCEC development and the continued use by WM is not expected to have an impact on the groundwater quality of neighbouring properties (WESA, 2014).

## 2.1 Surface Water Quantity

The Site is situated within the South Huntley Creek watershed, which drains in an easterly direction north of the Site. The South Huntley Creek is a tributary of Huntley Creek, which in turn empties into the Carp River northeast of the Site (**Figure 1**). Catchments have been identified that contribute flow to the south tributary of Huntley Creek at the crossing located south of the intersection of Carp Road and Richardson Sideroad. The remaining drainage area for the south tributary, upstream of Richardson Sideroad, has not been formally identified but is likely constrained to the west by Highway 417 and to the north by Cavanmore Road. Surface runoff from these drainage areas are conveyed by either small natural streams or roadside ditches. Roadway crossing along William Mooney Road, Richardson Sideroad and Carp Road typically comprise of corrugated steel pipes (CSP) or small concrete box structures.

The Site is relatively flat with the exception of the existing landfill mound, which rises approximately 40 – 45 m above the adjacent ground. Generally, the land slopes north-easterly and local drainage patterns are influenced by wetlands and manmade depressions (ponds, pits). These features serve as groundwater recharge areas and contribute to South Huntley Creek base flow. A portion of the groundwater flow is also drawn by the quarry east of the Site.

For additional information regarding surface water quantities, please refer to *Development and Operations Report: West Carleton Environmental Centre* (WSP 2014).

### *2.1.1 Drainage Areas with No Off-Site Drainage*

As shown on **Figure 2**, the existing landfill footprint belongs to three (3) separate, no outlet Drainage Areas B, C and D. The existing waste transfer and processing facility (WTPF) in the southwest part of the Site is located within Drainage Area E. The old aggregate extraction pit (Depression #5) forms another no outlet Drainage Area A. In total, on Site, no outlet areas occupy 127.5 ha out of 188.3 ha under pre-development conditions.

#### *2.1.1.1 Drainage Area A*

Drainage Area A, located in the northeast corner of the Site, occupies approximately 10.08 ha. Surface water drains overland into Depression #5 which is an old, presently unused aggregate extraction pit. The west part of the existing Laurysen manufacturing facility and gravel yard west of the building belong to this catchment. Surface water flow is not channelized. The bottom of Depression #5 is at approximately 117.5 mASL.

#### *2.1.1.2 Drainage Area B*

Drainage Area B is subdivided into two (2) subcatchments, B1 and B2. Catchment B1 collects stormwater from the north slope of the existing landfill. The landfill perimeter ditch directs stormwater to the existing Stormwater Pond #1 which overflows into the elongated natural wetland (Depression #3). Under high flow conditions Depression #3 may overflow into the rehabilitated old Dibbley Pit (Depression #4) which has a bottom elevation at approximately 122.0 mASL. Sub-Area B2 drains directly into Depression #4. Drainage Area B has a very large water storage capacity particularly within Depression #4 where the water level would have to rise more than 3 m before overflowing in a northerly direction. Drainage Area B encompasses 39.47 ha.

#### *2.1.1.3 Drainage Area C*

Drainage Area C is also subdivided into two (2) subcatchments, C1 and C2. Area C1 includes a large portion of the south slope of the existing landfill and lands to the south of the existing landfill. Sub-basin C2 collects runoff from the majority of the Closed South Cell including the poplar plantation and lands surrounding the Gas to Energy Facility. Area C1 drains via manmade ditch into existing Stormwater Pond #2. Under high flow conditions, this pond may overflow into adjacent Depression #1 which services sub-basin C2. Depression #1 also has substantial storage capacity and the water level may rise up to 124.5 mASL (approximately 2 m) without overflowing. Drainage Area C encompasses 45.19 ha. In the future, poplar/willow plantations may occupy part of Subcatchment Areas C1 and C2 and will ultimately drain to Depression #1. Flows would be reduced if poplars/willows were planted compared to present flows.

#### *2.1.1.4 Drainage Area D*

Drainage Area D includes the most easterly part of the existing landfill and the north section of the Closed South Cell. Stormwater drains into Depression #2 which lies south of the lined part of the existing landfill. Ground elevations range from 121.5 (bottom of Depression #2) to 170 mASL at the top of the existing landfill mound. The area occupies 21.34 ha. Poplar/willow may also be developed in the west part of this area.

#### *2.1.1.5 Drainage Area E*

This 11.50 ha catchment in the southeast part of the Site is very flat and mostly tree covered. Stormwater drains into the wetland inside the wooded area north of Highway 417. The existing waste transfer station is located within the slightly elevated west part of this area.

### *2.1.2 Drainage Areas Discharging Off-Site*

The remaining drainage areas (SH1 and SH2) discharge off-Site to the South Huntley Creek and Drainage Area FD to the Highway 417 drainage system and ultimately to Feedmill Creek. A small portion of the Site near the existing landfill entrance (Drainage Area F) drains into the quarry on the east side of Carp Road. Generally, drainage areas discharging off-Site are located along the Site perimeter and do not encroach waste fill or waste processing areas.

#### *2.1.2.1 Drainage Area F*

This relatively small drainage area of 5.8 ha, on the west side of Carp Road near the existing landfill entrance, drains northerly along the roadside ditch which crosses Carp Road south of the existing Laurysen building entrance. Further downstream this channel enters Huntley Quarry. The 1:100 year peak flow at the Carp Road crossing is estimated at 0.99 $m^3/s$. This area has a higher level of imperviousness due to paved road surfaces within the Carp Road allowance and near the existing landfill entrance.

#### 2.1.2.2 Drainage Area SH1

This large catchment of 41.35 ha occupies the northwest part of the Site. Generally, it drains northerly towards South Huntley Creek through several channels. A large part of this area drains overland towards Richardson Sideroad along an undefined flow path. Ditching north of the WTPF directs stormwater westerly across William Mooney Road where it joins the tributary of South Huntley Creek. In summary, stormwater outletting from this basin follows multiple pathways instead of a single concentrated channel.

The area is relatively flat with ground elevations varying from 127 mASL in the south beside the existing landfill to 121.5 mASL in the north near the property boundary. This basin includes a large woodlot and open field which is used for agricultural purposes.

#### 2.1.2.3 Drainage Area SH2

Runoff from this area of 5.77 ha, located in the northeast corner of the Site, drains northerly via roadside ditch along Carp Road into South Huntley Creek. This area includes the commercial/industrial strip on the west side of Carp Road including a large part of the Laurysen manufacturing facility. Generally land in this part of the Site slopes easterly towards Carp Road. The Rational Method 1:100 year peak flow at the outlet of this area was calculated as 0.75 $m^3/s$.

#### 2.1.2.4 Drainage Area FD

This small drainage area of 7.79 ha is situated along the southern property boundary and drains into the Highway 417 ditching system which ultimately discharges into the Carp River through Feedmill Creek east of the Site. There is minimal direct off-Site discharge from this catchment, generally limited to the external slopes of perimeter berms along the south and east boundaries of the landfill property.

## 2.2 Water Quality

### 2.2.1 Background

Surface runoff from the existing landfill and on-Site service roadways generally does not discharge off-Site. Runoff is directed to stormwater management (SWM) facilities where collected surface water either evaporates or recharges to groundwater. An exception is the southwest corner of the existing landfill Site where the Site currently drains west to William Mooney Road.

The water quality monitoring program for surface water for the existing landfill Site included both on-Site and off-Site sampling locations relating to the Annual Reports (WESA 2003 through 2013). Detailed results for this monitoring program can be found in the annual report series: *Annual Report – Waste Management Ottawa Landfill (WESA 2003 through 2013)* and in **Appendix A (Tables A1 and A2),** which contains detailed summaries of surface water monitoring results.

Surface water monitoring at additional off-Site locations was undertaken in 2006 and 2011, for the EA, to identify baseline water quality conditions. The results from these surveys have been summarised for water quality field parameters including pH, temperature, conductivity, and dissolved oxygen and assessment criteria parameters as identified in Table A and Table B in *Technical Guidance Document - Monitoring and Reporting for WDS - Ground and Surface Water (MOE 2010)*.

The on-Site surface water monitoring was undertaken for several years in the vicinity of the SWM ponds, at Sites S6, S8, S17 and "POND" but was discontinued in 2008 given that surface water does not discharge off-Site from the SWM facilities (**Figure 4**). A review of the parameter values summarised in **Appendix A** suggests that on-Site SWM runoff is not impacted by waste or waste management activities: typically the values for surface water parameters do not exceed Provincial Water Quality Objectives (PWQO). Accordingly, the Site Environmental Monitoring Plan (EMP) was revised to reflect the reduced monitoring and focused on potential down-gradient groundwater impacts and monitoring. This included monitoring in the Highway 417 north ditch which is believed to intercept the groundwater table.

Current surface water monitoring sites located along the Highway 417 north ditch east of Carp Road include S1, S3 and S10 drain to Feedmill Creek. Sampling is conducted on a semi-annual basis (Spring and Fall).

Surface water samples were not obtained from S1 and S3 in the Fall of 2013 due to construction on Highway 417, which prevent access to the monitoring locations. The 2013 results for the highway ditch locations are consistent with the previous years. The leachate indicators are generally found at or near the lower limit of their historical range. There was an exceedance of the Assessment Limits for the Site at S1 for Boron. Iron continued to exceed the PWQO at S1, S3 and S10. However, iron is not an Assessment Parameter for the WM Ottawa Landfill. The presence of iron-stained sediment and suspended material sat S1 and S3 may influence the iron concentrations observed in these samples.

There were no VOCs detected in the surface water sample collected in 2013.

The 2013 monitoring results for M4 (downstream culvert) have decreased from 2012, as the shallow groundwater – surface water regime equilibrates following the site re-grading activities. The concentrations of water quality parameters at M5 (upstream ponded area) are generally lower than, or similar to, M4. The only exceedance in the surface water limits in 2013 was for boron at M4.

### *2.2.2 Baseline Water Quality Monitoring*

Baseline surface water quality samples from Huntley Creek, South Huntley Creek and its tributaries were collected by AECOM three times in 2006 and three times in 2011 to provide a baseline for future landfill activities.

In 2006, samples were taken at locations G, C, A and J. Location G was not flowing (hence not sampled) during the July sampling event and Site C was not sampled during the April sampling event (**Figure 4**). Only location G and C were sampled during the October sampling event. The spring sample was taken on April 11, 2006 after more than three days without rain. The second sample was taken on July 26, 2006 immediately after a 32 mm rain event. The third sample was taken on October 24, 2006 during a rain event and after several weeks of wet weather. Results of the water quality sampling are presented in **Table 1** for MOE assessment criteria parameters and in detail in **Appendix A**.

In 2011, samples were again taken at locations G, C, A and J as well as at a new location, K, on the main branch upstream of the confluence with South Huntley Creek. Location K is likely the only surface water monitoring site that reflects runoff from a relatively undisturbed "natural" upstream drainage area. The samples collected in September reflect baseflow conditions while the October samples were the result of runoff from an extended period of rainfall. Again, results for MOE assessment criteria parameters are summarised in **Table 1**.

The results were compared to the PWQO (MOE 1994). PWQOs are a set of guidelines used for the management of the province's water resources. During the sampling periods, and for all sites, MOE assessment criteria parameters were below their PWQO except for one occurrence of Boron and two for Iron.

## Table 1. Surface Water – Water Quality Results, 2006 and 2011

| Sample ID: | Type: | Field | | | | Lab | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PARAMETER | Temp. | pH | Conductivity | Dissolved Oxygen | Arsenic | Barium | Boron | Cadmium | Chloride | Chromium | Copper | Iron | Lead | N-NH3 (Ammonia) | N-NH3 (unionized) | N-NO2 (Nitrite) | N-NO3 (Nitrate) | pH | Phenols | Total Dissolved Solids | Total Suspended Solids | Zinc |
| | UNITS: | °C | - | mS/cm | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | | mg/L | mg/L | mg/L | mg/L |
| | PWQO: | -- | 6.5-8.5 | -- | -- | 0.1 | -- | 0.2 | 0.0002 | 0 | 0 | 0.005 | 0.3 | 0.005 | -- | 0.02 | -- | -- | 6.5-8.5 | 0.001 | -- | 0.00 | 0.03 |
| | Detection Limit: | 0.5 | 0.01 | -- | 0.01 | 0.001 | 0.01 | 0.01 | 0.0001 | 1 | 0.001 | 0.001 | 0.03 | 0.001 | 0.02 | 0.02 | 0.1 | 0.1 | | 0.001 | 1 | 2 | 0.01 |
| | Sample Date | | | | | | | | | | | | | | | | | | | | | | |
| Site A | 2011-10-20 | 11.5 | 6.95 | 482 | 6.5 | <0.001 | 0.05 | -- | <0.0001 | 62 | <0.001 | 0 | -- | -- | 0.04 | <0.02 | <0.10 | 0.16 | -- | -- | 241 | 22 | 0 |
| Site A | 2006-11-04 | 11.7 | 8.08 | 670 | 12.27 | ND | 0.061 | 0.012 | ND | 112 | ND | 0.001 | 0.06 | ND | ND | - | ND | 0.50 | 8.30 | -- | 503 | 1.00 | ND |
| Site A | 2006-07-06 | 21.3 | - | 965 | 8.9 | ND | 0.11 | 0.038 | ND | 138 | ND | 0.001 | 0.10 | ND | 0.05 | 0.00 | ND | ND | 8.30 | -- | 707 | ND | 0.01 |
| Site C | 2011-10-20 | 12.1 | 7.41 | 762 | 3.9 | <0.05 | 0.11 | -- | <0.01 | 86 | <0.05 | 0 | -- | -- | 0.42 | <0.02 | <0.10 | 7.73 | -- | -- | 381 | 54 | <0.05 |
| Site C | 2006-10-24 | -- | -- | -- | -- | ND | 0.075 | 0.04 | ND | 163 | ND | 0.002 | 0.17 | ND | 0.20 | 0.02 | ND | 1.60 | 8.10 | -- | -- | 10.00 | ND |
| Site G | 2006-11-04 | 18.3 | 7.72 | 976 | 10.25 | ND | 0.059 | 0.022 | ND | 127 | ND | 0.001 | ND | ND | ND | -- | ND | 0.70 | 8.30 | -- | 551 | ND | ND |
| Site G | 2006-10-24 | -- | -- | -- | -- | 0.002 | 0.1 | 0.63 | 0.0002 | 193 | ND | 0.017 | **0.91** | 0.0035 | 9.73 | 1.00 | 0.29 | 2.50 | 8.00 | -- | -- | 2.00 | 0.02 |
| Site C | 2006-07-06 | 25.8 | -- | 960 | 10.7 | ND | 0.084 | 0.03 | ND | 170 | ND | 0.002 | 0.27 | ND | 0.11 | 0.01 | 0.04 | 0.20 | 8.30 | -- | 664 | 1.00 | 0.009 |
| Site J | 2011-10-20 | 12.7 | 7.73 | 693 | 6.1 | <0.001 | 0.06 | -- | <0.0001 | 89 | 0.001 | 0.002 | -- | -- | 0 | <0.02 | <0.10 | 0.67 | -- | -- | 346 | 20 | <0.01 |
| Site J | 2011-09-30 | 16 | 7.89 | 1193 | 8.2 | <0.001 | 0.12 | 0.12 | <0.0001 | 166 | 0.004 | 0.001 | <0.03 | <0.001 | <0.02 | <0.02 | <0.10 | 0.31 | 8.04 | <0.001 | 596 | <2 | <0.01 |
| Site J | 2011-09-27 | 19.2 | 7.98 | 1200 | 8.9 | <0.001 | 0.13 | 0.15 | <0.0001 | 174 | 0.003 | <0.001 | <0.03 | <0.001 | 0.02 | <0.02 | <0.10 | 0.66 | 8.19 | <0.001 | 597 | <2 | <0.01 |
| Site J | 2006-11-04 | 11.5 | 8.13 | 739 | 13.21 | 0.001 | 0.077 | 0.084 | ND | 116 | ND | 0.005 | 0.27 | 0.0013 | 0.41 | 0.01 | 0.05 | 0.50 | 8.30 | -- | 672 | ND | 0.006 |
| Site J | 2006-07-06 | 18.7 | - | 1019 | 6.9 | ND | 0.13 | 0.11 | ND | 133 | ND | 0.002 | **0.53** | ND | 0.17 | 0.01 | 0.04 | 1.10 | 8.10 | -- | 754 | ND | ND |
| Site K | 2011-10-20 | 11.1 | 6.96 | 432 | 7.6 | <0.05 | 0.09 | -- | <0.01 | 76 | <0.05 | <0.01 | -- | -- | <0.02 | <0.02 | <0.10 | 0.34 | -- | -- | 217 | 121 | <0.05 |
| Site K | 2011-09-30 | 18.2 | 7.89 | 1061 | 7.4 | <0.001 | 0.12 | 0.02 | <0.0001 | 200 | 0.004 | <0.001 | 0.16 | <0.001 | 0.07 | <0.02 | <0.10 | 0.12 | 8.03 | <0.001 | 530 | 20 | <0.01 |
| Site K (2006 Site) | 2011-09-27 | 19.8 | 7.98 | 1164 | 8.4 | <0.001 | 0.14 | 0.11 | <0.0001 | 181 | 0.003 | <0.001 | 0.06 | <0.001 | 0.03 | <0.02 | <0.10 | 0.24 | 8.19 | <0.001 | 587 | <2 | <0.01 |

*Note:* *Detection limit for 2006 = 0.005*
*-- Not Sampled*
*2011 =Field Reading*
*Exceeds PWQO*

Of note, from the detailed results in 2006 as reported in **Appendix A** and that were not MOE assessment criteria parameters:

- *E. coli* exceeded the guideline in all samples and nutrient levels are high, both of which and can be attributed to upstream agricultural activity. The presence of cattle from local dairy farming operations and local wildlife sources, including waterfowl and beaver/muskrat, could be major sources of any *E.coli* found within surface water in the vicinity of the existing landfill. As well, local residential septic systems could be a contributing factor if they were not performing to specification.
- Site J showed PWQO exceedances. During the April sampling event, Total Phosphorus and Aluminum were above their respective PWQO. In addition, Ammonia, Magnesium, and Zinc were higher than their upstream counterparts. During the July sampling event, Total Phosphorus and Aluminum were again above their respective PWQO. In addition, Ammonia, Magnesium and E. coli were higher than their upstream counterparts. The samples do not reflect signature characteristics of leachate contamination and, therefore, the elevated metal levels are assumed to be a function of the activities of industrial land uses in the area, including truck traffic.

### *2.2.3 Water Quality Summary*

Water quality in South Huntley Creek varied significantly between sites and sampling dates, generally reflecting local upstream land uses. Overall, water quality varied from poor to moderate influenced by nutrient enrichment and the presence of E. coli.

### *2.2.4 Source Protection Planning*

A review of information obtained from the *Proposed Assessment Report – Mississippi Valley Source Protection Area (RVCA-MVC 2010)* confirms that the subject Study Area is located well south of the Village of Carp Wellhead Protection Zone (WHPZ). Further, a review of the Ottawa (Britannia) Intake Protection Zone (IPZ) Vulnerability Scoring map indicates that the Study Area is situated within the lowest scoring zone (3.6) and would therefore not be subject to any special source protection policies.

## 2.3 Stormwater Management Facilities

The existing surface water drainage system directs stormwater runoff to two SWM facilities (recharge ponds) with stormwater eventually being discharged to the overburden water table. The SWM facility volume is sized to handle the 5-year design event rainfall. The SWM facility areas were found to have silty-sand soils that are excellent for recharge ponds. The two recharge pond surface areas were determined by undertaking hydraulic calculations using the Hantush Analytical Model to ensure groundwater mounding was at or below the pond bottom elevations.

The two constructed SWM facilities have emergency overflow spillways to prevent overtopping if the ponds are full or the design flow/volume is exceeded and will flow to lower Site areas and pond or recharge at these lower elevations. Depressions #3/#4 and Depression #1 fulfil these functions for SWMF #1 and SWMF #2, respectively and have capacity to accommodate between 15 to 20 times the runoff from the 1:100 year rainfall event before capacity is exceeded. A third recharge pond was never constructed and existing Depression Area #2 currently fulfils the recharge function with a capacity that is over 20 times the runoff from the 1:100 year event.

This also implies a significant capacity to store the 1:100 Year Spring melt runoff whose volume would likely be in the order of 7 times the 1:100 year rainfall runoff implying the depression areas have storage capacity at 2 to 3 times the volume of a 1:100 Year Spring melt event.

Should these capacities ever be exceeded, which is unlikely, flow would be east overland to the Carp Road and/or north to South Huntley Creek.

# 3. Surface Water Assessment

There are no permanent or intermittent streams within the preferred landfill footprint. The nearest fish habitat to the new landfill footprint location is seasonal habitat associated with an intermittent agricultural channel (Tributary C) located approximately 250 m away from the preferred landfill footprint on the west side of William Mooney Rd. This channel flows through an agricultural landscape before entering South Huntley Creek on the North Side of Richardson Side Road. South Huntley Creek fish habitat within the Site vicinity is seasonal in nature and poor in quality.

There is a limited amount of direct off-Site discharge to surface water. Exceptions to this are the external slopes of the vegetated perimeter berms along the east and south boundaries of the existing landfill property, however, this amount of surface runoff is minor and not in contact with operations at the Site. Runoff flows into the Carp Road and Highway 417 drainage systems. Also, a small area of drainage from the extreme western end of the Site, north of the service entrance flows into the ditch along William Mooney Road, then northward into a tributary of Huntley Creek.

The nearest area that is potentially part of the Provincially Significant Goulbourn Wetland lies at least 400 m from the nearest point of the proposed landfill footprint. It is well beyond the required buffer area. It is also a sufficient distance that no impacts to the functions and features of the wetland are anticipated. No mitigation or special precautions are required.

The assessment of impacts associated with the proposed Landfill Footprint was undertaken as part of the EA.

The preferred leachate collection and management system for the landfill consists of disposal of leachate through discharge to the City of Ottawa sanitary sewer system, in tandem with disposal through irrigation of trees, and will not have an impact on surface water.

Surveys in 2005 and 2006 (Gartner Lee 2006) determined that an ephemeral pool and agricultural drainage ditch lying on the west side of the WM facility currently provide seasonal and wet-weather surface water flow into an unnamed tributary of Huntley Creek, hereafter referred to as South Huntley Creek. The entire Huntley Creek sub-watershed is 4900 ha including the area drained by South Huntley Creek. South Huntley Creek has not been assigned a thermal designation (i.e., warm/cold water) from the Ontario Ministry of Natural Resources but the Carp River Watershed/Subwatershed Study (Robinson, 2004) designates the South Huntley Creek as containing a degraded warm water fish community. South Huntley Creek eventually flows into Huntley Creek, which has been designated by the Carp River Watershed/Subwatershed study as a cold water stream (Robinson, 2004).

A desktop analysis was completed for the project limits using aerial photography and topographic maps. A field assessment of identified surface aquatic features within the study area was conducted on May 26, July 26, September 28 and October 24, 2006.

To confirm and supplement this earlier work, AECOM completed an on-Site review of watercourses to confirm their existence and overall condition. This work was undertaken between May 3rd and 4th, 2011. During this time, an aquatic biologist visited each watercourse within the proposed landfill study area and examined characteristics such as:

- Presence or absence;
- Overall channel condition;
- Riparian (shoreline) features;
- Water depth, flow and visual quality (i.e., clear, muddy);
- Adjacent impacts or factors affecting the watercourse, such as agriculture, forestry development, etc.; and,
- Potential for fish or fish habitat.

# 4. Surface Water Assessment Results

## 4.1 Assessment Approach

During Site operation, surface water impact potential is as follows:

From a water quality perspective, this will mean potential water quality impacts due to accidental leachate seeps to the surface and/or increases in Total Suspended Solids (TSS) concentration due to runoff from the internal gravelled access roadways.

From a water quantity perspective, there are two main impacts. The first is the effect on local drainage patterns since surface water runoff from the landfill would likely have to be diverted away from private lands to the north, and the swale that runs through it conveying surface water, north, to South Huntley Creek. This diversion would:

- Reduce flows to the swale, which would then be maintained only by adjacent surface and groundwater flow. This impact would not be mitigated.
- Reduce flows (by less than 5%) to South Huntley Creek tributary along Richardson Side Road. This impact would not be mitigated.
- Require the re-location of existing Stormwater Management Facility (SWMF) #1 as a new two stage SWMF to the east.

The second is changes in local topography provided by the relatively steep-sloped (from a hydrologic perspective) landfill configuration and a resulting reduction in travel time (as a result of increased flow velocities) that would create increased peak flows with potential to increase downstream water levels and flood damage.

## 4.2 Aquatic Survey Results

The dominant watercourse within the project limits is South Huntley Creek (**Figure 5**). South Huntley Creek is a permanent warm water system that has been significantly impacted historically by surrounding agricultural land use; and linear developments such as roadways which have bisected its length into smaller reaches, separated generally by culverts. The most unaltered and natural portion of South Huntley Creek occurs in the upper watershed southwest of William Mooney Road (Tributaries A and B). A smaller series of intermittent reaches occur east of William Mooney Road and just south Richardson Sideroad.

Small drainages to the creek were historically located within the current landfill property limits, however these historical reaches have been realigned or buried within culverts and no longer occur as open creek channels (Tributary E). No watercourses occur within the area of the proposed landfill footprint. AECOM identified three different tributaries of South Huntley Creek.

Tributary A originates south of Highway 417 and flows northwesterly through the Goulbourn Wetland. This tributary possesses a relatively natural channel form typically 1.0-1.5 m wide with 10 to 15 mm of flowing water on average over much of its length (**Plates 1 and 2**). It is generally situated within woodlands although portions pass through areas of open and active agricultural use. Specifically, cattle grazing and pasture lands. Tributary A provides habitat suitable for supporting a bait and forage fish population, although AECOM did not observe fish during their field reconnaissance. Bottom substrates were largely clay and sand/gravel within the reach. The channel also contained instream structure such as gravel areas, boulders and woody debris; features important to fish for feeding, rearing and cover. Flows at the time of assessment were abnormally elevated, however its hydraulic connection to wetlands likely provides sufficient baseflow to sustain water year round and even in low water years, there are adequate refuge pools to sustain small fish groupings.

**Plate 1.** Natural channel within Tributary A showing pool/glide habitats within wooded area

**Plate 2.** Tributary A passing from wooded area into pasture lands.

Tributary B originates in the Goulbourn Wetland and flows southeasterly. This tributary has been highly altered by historical and current agricultural activities, including recent evidence of cattle access and crossing. There was no discernable channel for about half of its length due to flooding and significant channel degradation. Flows were not measureable due to the absence of a defined channel and flooded condition. Tributary B lacks habitat suitable for supporting a permanent fish community. It is also considered that ongoing disturbance will further impair creek function and deter fish from re-colonizing the reach, even though its hydraulic connection to wetlands may provide some flow on a year round basis.

Tributary C of South Huntley Creek is an agricultural drain that runs parallel to William Mooney Road. It flows northwest and is intercepted by the first and second tributaries discussed approximately 400 m south of Richardson Sideroad. This tributary has been highly altered by historical agricultural land use and is subject to current impacts resulting from adjacent crop farming. It is a linear channel dominated by shoreline grasses and some sedges (**Plates 3 and 4**). Trees occur randomly along the channel but provide very little shading to the watercourse. There are no pool or riffle habitats present in this tributary. South of the inflow of Tributaries A and B, Tributary C had no discernable flow during AECOM's investigations, despite an abnormally wet period preceding the Site visit. The channel north of that point contained flow, largely originating from tributaries A and B.

**Plate 3.** Tributary C displaying agricultural channel, south of property laneway upstream **from** the confluence with Tributary A and B.

**Plate 4.** Tributary C displaying agricultural channel, northwest of property laneway, downstream of the confluence with Tributary A and B.

Based on these preliminary investigations, it appears that the tributary functions solely as an agricultural drain and does not provide fish habitat. Ongoing agriculture, including crop planting up to top of bank will further impair the tributary and its water quality.

Roadside surveys of Tributary D confirmed the existing condition to be typical of an ephemeral or intermittent watercourse, as the channel contained little or no discernable flow. Bifurcation of the creek and distribution through culverts beneath Richardson Sideroad have likely caused the creek to acquire its current condition. It is unlikely Tributary D can support a resident fish population, and its likely function is the provision of indirect fish habitat for warm water baitfish species in downstream reaches.

### *4.2.1 South Huntley Creek Fisheries Resources*

To confirm the watercourse conditions and presence of fisheries resources, temperature, stream flow and electrofishing work was undertaken in 2006 (Gartner Lee 2006).

#### *4.2.1.1 Temperature*

Three continuous Onset Tidbit temperature loggers were installed in South Huntley Creek. Two loggers were installed along William Mooney Road and the third logger was installed at Richardson Sideroad (Site 4). Loggers were installed on April 13, 2006 and removed on September 28, 2006.

Site 1, located adjacent to the existing landfill on William Mooney Road, was dry for the majority of the summer. During the May sampling event, there was a shallow pool of water on the northeast side of William Mooney Road. Mapping of surficial geology indicates the presence of a clay lens in this area. The pool is fed by surface water from a wooded swale running east under the fence of the existing landfill facility. It contained water during the spring and fall, and for brief periods following several very large summer storm events. The stream temperature graph reflects the same water and air temperatures for the end of July through September, 2006 indicating that it was dry. When water was present, the average summer (July and August) water temperature was 20.1 ºC. This system is ephemeral and is considered warm water when flowing.

Water temperatures at Site 2 also reflected the air temperature indicating that it is a warm water system with little to no groundwater influence. The average summer (July and August, 2006) water temperature was 19.7 ºC, similar to the average summer air temperature of 20.9°C. The slightly cooler water temperatures are most likely the result of inputs from wetlands southwest of the monitoring station.

Site 4 is located approximately 3.5 km downstream from Site 1, on the north side of Richardson Sideroad. Summer water temperatures at this Site were, on average, 3°C cooler than air temperatures. The average summer (July and August, 2006) water temperature was 17.9°C. The water temperatures at this Site indicate that the thermal regime for this portion of the stream is cool water. Cool water systems are defined as having average daily maximum water temperatures of approximately 18°C.

### *4.2.2 Stream Flow*

Stream flow was measured using a Marsh McBernie flow meter on several occasions. Flow was recorded only at Sites 1, 5 and 6 during the July Site visit due to technical difficulties. The flow measurements were used in conjunction with stream depths to produce discharge information. Discharge information along with staff gauge readings are presented in **Table 2**.

**Table 2. Discharge and Staff Gauge Readings**

| Date | Precipitation[1] (mm) | Staff Gauge Reading (m) | | | | Discharge (L/s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *CARP1 S. Huntley* | *CARP2 S. Huntley* | *CARP4 S. Huntley* | *CARP5 S. Huntley* | *CARP1 S. Huntley* | *CARP2 S. Huntley* | *CARP3 S. Huntley* | *CARP4 S. Huntley* | *CARP5 S. Huntley* | *CARP6 S. Huntley* |
| **11-Apr-06** | 0.0 | 0.12 | 0.29 | 0.44 | 0.36 | 0 | 56 | 114 | 109 | 159 | 870 |
| **18-May-06** | 28.2 | 0.28 | 0.39 | - | - | - | - | - | - | - | - |
| **26-Jul-06** | 32.0 | 0.00 | 0.08 | 0.44 | 0.01 | dry | - | - | - | 3.2 | 164.0 |
| **19-Sep-06** | 4.6 | 0.00 | - | - | - | dry | - | - | - | - | - |
| **28-Sep-06** | 4.0 | 0.00 | 0.10 | 0.42 | 0.05 | dry | 0.7 | 1.4 | 12.0 | 13.7 | - |
| **24-Oct-06** | 13.0 | 0.15 | 0.31 | - | - | - | - | - | - | - | - |

*Note: 1. Precipitation for 48 hours prior to sampling.*

#### *4.2.2.1 Site 1 – South Huntley Creek*

This Site is located on Tributary C adjacent to the landfill. On the northeast side of William Mooney Road, there is a pool of water, which steadily decreased during the summer. The water temperature in the pool was 21.2º C on April 12, 2006, significantly higher than the other sites on the same date. The May, July and October Site visits were conducted after rain events, during which a small amount of water was flowing in the ditch. During the August Site visit, the ditch was dry indicating that the ditch is ephemeral. Approximately 150 m downstream, water flows in from another tributary from the southwest substantially increasing stream flow.

#### *4.2.2.2 Site 2 – South Huntley Creek*

Site 2 is located on William Mooney Road, near Richardson Sideroad and this is located approximately 40 m from the edge of the re-zoning application. This section of the stream is permanent and ranged from 0.75 to 1.25 m wide and 0.04 to 0.3 m deep during the Site visits. On the north side of the road, the stream flows through agricultural and livestock (cow) fields before flowing under William Mooney Road through a concrete box culvert. For approximately 100 m downstream of the road, the stream is unaltered before becoming straightened along the edge of a farm field. Water then flows in a ditch along Richardson Side Road for approximately 250 m. Water draining from various fields collects in this ditch, increasing stream flow.

#### *4.2.2.3 Site 3 – South Huntley Creek*

This Site is located at Carp Road. This section of the stream is permanent and ranged from 0.12 to 0.27 m deep and 1.2 to 1.9 m wide during the Site visits. On the west side of Carp Road, the stream is channelized for approximately 50 m by concrete (~1 m high) walls. Large patches of vegetation grow in channel causing braiding. East of Carp Road, the stream bottom is hardened with sediment (gravel, sand) on top. The hardened bottom is an impervious surface that limits the burrowing depth of fish and benthic invertebrate habitat. Two small watercress plants were found near the culvert indicating the potential for groundwater seepage in the area. Riparian vegetation consists only of mown grass on either side of Carp Road. After passing Carp Road, South Huntley Creek enters the M-Con Products Inc. quarry property.

*Site 4 – South Huntley Creek*
Site 4 is located on Richardson Sideroad, near Oak Creek Road, downstream of M-Con Products Inc. Riparian vegetation and canopy cover at this Site is fair (~40%). The average stream width was 3 m and the depth ranged from 0.2 to 0.5 m. Bottom sediment was mainly sand with some gravel and rock. Orange staining, possibly indicating groundwater, was noted on the left bank (when facing upstream) on the downstream (north) side of the culvert.

## 4.3 Significant Wetlands

No provincially significant wetlands occur on the Site but one is situated nearby. Portions of the Provincially Significant Goulbourn Wetland have been mapped by OMNR in the core natural area approximately 400 m southwest of the landfill property at its closest point and more than 600 m from the closest point of the new landfill footprint.

There are several non-regulated wetland features within the study area which include a deciduous swamp unit on the north boundary that extends onto the adjacent property, a pond and marsh of non-natural origin located in the old aggregate pit. There are also several units of marsh, thicket swamp and pond also of man-made origin on the north side of the existing landfill, and are apparently fed by surface runoff. These wetlands all form functional amphibian breeding areas.

## 4.4 Impacts on Terrestrial Environment

As noted in AECOM (2011) there are no permanent or intermittent streams in the area of the proposed landfill. As such, there are no predicted changes in water quality, aquatic habitat or aquatic biota. The nearest fish habitat is seasonal habitat associated within an agricultural channel (Tributary C) located approximately 250 m away from the proposed landfill location on the west side of William Mooney Drive.

The nearest area that is potentially part of the Provincially Significant Goulbourn Wetland lies at least 600 m from the nearest point of the proposed landfill footprint. It is also a sufficient distance that no impacts to the functions and features of the wetland are anticipated. No mitigation or special precautions are required.

There is some non-significant wetland proposed to be removed with the landfill expansion. In total 4.0 ha of wetland are proposed for removal. These wetlands were created as a result of past human activities (former gravel pit and storm water collection ponds) and therefore are not provincially significant.

# 5. Post-Development Site Stormwater Conditions

Post-development conditions are characterized by higher runoff coefficients and shorter travel times (time of concentration) due to steep landfill grades and flow channelization. These factors tend to increase peak flows but because the Site design is based on no off-Site discharge, peak flow attenuation is not an issue for the landfill development area. Refer to **Figure 3** for the outline of the post-development drainage areas. Runoff from the proposed landfilling area will be contained on-Site in Infiltration Basin #2. Please refer to *Development & Operations Report: West Carleton Environmental Centre* (WSP 2014) for more detailed information.

The existing Stormwater Pond #1 and small wetland (Depression #3) located within the landfill expansion area will be eliminated and replaced with new clay lined Stormwater Pond #1 and Infiltration Basin #1 within Depression #4. Similarly, Stormwater Pond #2 and Infiltration Basin #2 are proposed in the area designated as Depression #5. Infiltration Basin #2 will service the entire landfill expansion area while Infiltration Basin #1 almost the entire north half of the existing landfill. The landfill expansion will shift drainage boundaries within Drainage Areas A and B, and in catchments located along the Site perimeter (SH1, SH2 and F). Drainage patterns within the remaining part of the property will be hardly affected and generally will remain the same as under pre-development conditions. There will be a significant increase in the size of on-Site no outlet areas to 151.76 ha from 127.48 ha under pre-development conditions. As a result, more stormwater will be contained on-Site and recharged into groundwater and less discharged off-Site as surface flow from lands located along the Site perimeter.

Drainage Areas A and B were subdivided in small subcatchments for the purpose of hydrologic modelling which was used for sizing of the proposed stormwater storage facilities. Cumulative runoff coefficients and times of concentration were established in a similar fashion as those for the pre-development conditions. Runoff coefficient for the entire study area will increase to 0.35 from 0.29 before the development.

### *5.1.1 Drainage Areas with No Off-Site Drainage*

#### *5.1.1.1 Drainage Area A*

This drainage area was subdivided into nine (9) smaller sub-areas to facilitate hydrologic modelling. The overall size of the catchment will expand to 51.66 ha. The cumulative runoff coefficient was calculated as 0.432 in comparison to 0.29 prior to landfill expansion. The Rational Method 1:100 year peak flow at Pond #2 was calculated as 5.31 $m^3/s$. Stormwater Pond #2 will control stormwater flows by providing temporary storage and treatment before releasing water into Infiltration Basin #2. All runoff originating from the landfill expansion area will be handled within this catchment. The proposed landfill will be graded such that all runoff from the mound will drain toward the landfill perimeter and be intercepted by the perimeter ditching. The ditching system will direct stormwater into Stormwater Pond #2. A large part of the on-Site road network, including the main access road and scale house area, will be also routed through Stormwater Pond #2. Stormwater accumulating over the landfill base during base preparation as well as stormwater pools west of the lined area will be pumped to the perimeter ditching system, on an as required basis.

#### *5.1.1.2 Drainage Area B*

This watershed was also subdivided into multiple sub-areas to facilitate hydrologic modelling. Drainage Area B will be smaller, 22.58 ha down from 39.47 ha originally as a result of the proposed development. The northwest part of the catchment will be shifted into Drainage Area A and comprise part of the landfill footprint. The cumulative runoff coefficient increases to 0.398 from 0.32 prior to development. The overall CN number was estimated at 79.1 and the Rational Method 1:100 year flow at Pond #1 was calculated as 2.13 $m^3/s$.

Stormwater Pond #1 and Infiltration Basin #1 will function in the same fashion as stormwater storage facilities within Drainage Area A. New ditching will be provided on the west and south side of the existing landfill to intercept runoff coming from side slopes and direct it towards new Stormwater Pond #1. The south half of the main access road between two (2) mounds and the entire mini-transfer area (MTA) are included within this drainage basin.

#### *5.1.1.3 Remaining Drainage Areas*

The size of Drainage Areas C, D and E will not change as a result of the landfill expansion as there is no major development planned for the south half of the WM property. Construction activities will be limited to the leachate treatment plant, contingency poplar plantation, road improvement (paving), extension of underground utilities and minor building improvements (blower building). These activities will have a negligible effect on the existing drainage patterns, and stormwater flows will remain the same as under pre-development conditions.

### *5.1.2 Drainage Areas Discharging Off-Site*

#### *5.1.2.1 Drainage Area F*

The catchment boundary will be slightly realigned as a result of the landfill expansion with a minor reduction in size to 5.24 ha from 5.8 ha. The imperviousness level will increase with construction of the new access road off Carp Road and the Carp Road widening near the new entrance. This part of the Site will also be subject to landscaping activities such as tree and bush planting, etc. The runoff coefficient for this area will increase by approximately 10% to 0.38. The 1:100 year peak flow will remain at the pre-development level of 0.99 $m^3$/s. This area will continue to discharge into the quarry east of the Site.

#### *5.1.2.2 Drainage Area SH1*

The post-development size of this area will decrease to 18.44 ha down from 41.35 ha. For this reason there will be no increase in flows leaving the Site. A decrease in size of this basin is a result of the proposed development; a portion of this area would become part of the landfill footprint. Generally, this area extends near the limit of the development area and as such will not see major construction activities. Clearing and earthwork will be limited to the south and east catchment boundary. Landscaping and reforestation activities will take place within the westerly and northerly buffer area.

#### *5.1.2.3 Drainage Area SH2*

This area will not be heavily affected by the proposed development and its boundary will be slightly realigned because of interference with Infiltration Basin #2 and Stormwater Pond #2. Other project related activities will be limited to the Carp Road widening and minor landscaping work along the Site boundary. Post-development size of this catchment will shrink to 5.06 ha down from 5.77 ha originally. The runoff coefficient remains unchanged at 0.36 after development. The 1:100 year flow was estimated as 0.66 $m^3$/s at the catchment outlet and is lower than under pre-development conditions.

#### *5.1.2.4 Drainage Area FD*

There will be no change in hydrologic characteristics of this area as there is no new development proposed within this part of the Site.

## 5.2 Post-Development Stormwater System Infrastructure

The following is a description of the infrastructure that will be developed to manage stormwater and surface water flows. This is detailed further in the *Development & Operations Report: West Carleton Environmental Centre* (WSP 2014).

### *5.2.1 Ditching*

Ditching will be trapezoidal in the section with bottom width ranging from zero (triangular section) to 2 m depending on estimated flow. The highest flows will be in the landfill perimeter ditch draining into Stormwater Pond #2. The design 1:25 year flow for the south and north branches of the landfill perimeter ditch near Pond #2 inlet was calculated at approximately 1.8 $m^3$/s. Water depth under such flow in trapezoidal channel having a bottom width of 2 m and a slope of 0.5% would be 0.5 m which is less than the minimum ditch depth of approximately 1.1 m.

The landfill perimeter ditch will have an outer slope of 3H: 1V (minimum) and an inner (landfill side) slope of 4H: 1V (minimum) which is the same as the landfill side slopes. All other ditches will have side slopes not steeper than 3H: 1V. Generally, the proposed ditches are relatively flat at grades around 0.5%. Flow velocity under such conditions for the 1:25 year storm event will be low at less than 1.0 m/s. Such velocities are suitable for grass lining which will assist in sediment filtering and erosion control.

Locally, ditching will be steeper and all ditches sloping at more than 3 to 4% will be rip rap lined with appropriately sized stone over geotextile. This includes ditching along the high access road having a grade of up to 8%. The rip rap lining will also be provided at all culvert ends, ditch inlets and at ditch alignment changes exceeding 45 degrees. Rip rap grouting may be used to further reduce erosion potential and washouts. Rock check dams will be installed along the long, steep ditch sections to reduce flow velocity.

Erosion control mats and sod may be used wherever establishment of vegetation cover is critical.

### *5.2.2 Storm Sewers and Culverts*

Two (2) sections of storm sewers are part of the proposed drainage system. The first is 300 mm diameter overflow line for Infiltration Basin #1 discharging into Infiltration Basin #2. This line is provided in compliance with design guidelines which require overflow protection for infiltration basins. The line will not transmit any stormwater under normal conditions.

The second short section of storm sewer will service the mini-transfer drop-off area. This sewer line will be equipped with an isolation valve and Stormceptor unit to provide continuous treatment of total suspended solids as well as oil separation in case of an accidental spill upstream within the drop-off area. The above noted system components will prevent pollution from reaching Stormwater Pond #1 and ultimately Infiltration Basin #1.

Corrugated steel pipe (circular and arch) will be used for culvert installation. Corrugated steel pipe arch (CSPA) is proposed under roads where increased depth of cover is required to withstand loadings from vehicular traffic. Concrete culverts are proposed at critical locations where heavy truck traffic is anticipated and where lighter pipe integrity could be in question.

All culverts were sized for the 1:25 year flow with sufficient spare capacity to allow for the 1:100 year flow to pass without overtopping ditch embankments.

### 5.2.3 Stormwater Ponds

Two (2) new stormwater ponds are proposed for surface water quality control in accordance with the MOE Landfill Design Standards. The ponds will attenuate peak flows but this function is not important since pre-treated stormwater discharges into the infiltration basin where it is recharged into the shallow groundwater system. The ponds outflow rates are controlled by recharge capacity of the shallow groundwater regime in the vicinity of the downstream infiltration facilities.

The ponds internal side slopes will be 4H:1V (minimum) and external side slopes 3H:1V (minimum). Each pond will consist of the following storage zones:

- Permanent water pool, which includes sediment storage – between pond bottom and invert of the outlet pipe; and,
- Settlement zone – above invert of the outlet pipe.

The outlet pipe will be a relatively small diameter culvert (HDPE pipe) equipped with an isolation valve. All ponds will be lined with a 600 mm clay liner. The pond base and side slopes up to 0.3 m above the normal water level will be covered with at least 150 mm of drainage gravel which will be placed over geotextile separator. The gravel layer will protect the underlying clay liner and serve as an indicator during sediment removal operations. In addition, drainage gravel will protect pond side slopes against wave action. The remaining portion of the internal side slopes will be top soiled and vegetated. Fill placed within containment berms will consist of well compacted fine grained soils. In order to increase the infiltration contact area with native soils, fill material underlying the clay liner below the pond base will be composed of well compacted permeable granular material (sand). All surficial, in-place loose fill will be removed down to native soil before any fill placement. A large quantity of such unsuitable material has been identified through the geotechnical investigation within Dibbley Pit (Depression #4).

The proponent may change the lining of the stormwater ponds and use geomembrane supported geosynthetic clay liner (GCL) instead of a conventional clay liner. This option would be decided based on economics and subject to a geotechnical slope stability assessment.

Each pond will be capable of settling particles larger than 40 microns even during major storm events. It was determined that both ponds will be capable of settling particles as small as 7 microns. A high sediment capture efficiency is caused by relatively low outflow rates.

Both ponds have sufficient capacity to store/treat all runoff generated from the 25 mm storm event. This volume, as determined through hydrologic modelling, is 436 $m^3$ and 1,296 $m^3$ for Ponds #1 and #2 respectively and they are substantially lower than the corresponding permanent water pool volumes of 2,600 $m^3$ and 4,200 $m^3$.

Both ponds were sized with a relatively high length to width ratio exceeding 4:1.

A plunge pool (forebay) will be provided near each pond inlet to capture coarser suspended particles.

The forebay will be 0.5 m deeper then pond bottom design elevation, providing additional sediment storage capacity. The forebay area will also be covered with drainage gravel and geotextile. Each pond inlet will be reinforced with rip rap. Removed sediment will be used as daily cover within the active disposal area.

A rip rap baffle across the pond width downstream of the inlet(s) is proposed to improve flow distribution, minimize short circuiting and to separate forebay from the more quiescent settling zone. Each pond will be equipped with a rip rap lined overflow spillway sized for the 1:100 year flow rate discharging into the downstream infiltration basin. Pond draining time will not exceed 48 hours.

### 5.2.4 Infiltration Basins

Infiltration facilities are designed to capture and retain runoff and allow it to infiltrate rather than discharge to surface water. This system has several benefits such as reducing surface runoff volume and pollutant discharge as well as augmenting low flow stream conditions and thus supporting wildlife habitat during low flow periods.

Subsurface exploration consisting of several borings was carried out to determine in-situ soil and groundwater conditions within the designated groundwater recharge areas. The permeability of soil from numerous samples collected within the footprint of infiltration facilities was estimated with the Hazen formula and ranged from $5x10^{-2}$ cm/s to $1.6\ x10^{-5}$ cm/s.

The constant rate infiltration rate of 12 mm/hr. was selected for design in consultation with the project hydrogeologist based on the observed local subsurface conditions. This rate was used as an input in hydrologic modelling and was used for sizing of both basins.

Groundwater recharge at infiltration facilities will result in the long term localized mounding of the shallow groundwater table. The maximum long term rise of the shallow groundwater was determined by the hydrogeologist using “Modflow” groundwater flow computer model as follows:

- Infiltration Basin #1 – 120.81 mASL
- Infiltration Basin #2 – 120.86 mASL

Infiltration basin base elevations were selected to provide at least 1 m separation from the maximum predicted groundwater level.

Suspended solids loading in stormwater draining into each basin will be largely reduced by sedimentation taking place in both of the new stormwater ponds. This will control/reduce blinding and plugging of the basin base surface.

The following dimensions were established for the base of each infiltration basin:

- Infiltration Basin #1 – 116 x 158 m
- Infiltration Basin #2 – 118 x 217 m

Maximum water storage under the 1:100 year design storm was calculated as 5,669 $m^3$ for Basin #1 and 15,530 $m^3$ for Basin #2. Each basin will have substantial additional capacity above the design water level which was calculated as follows:

- Infiltration Basin #1 – 19,573 $m^3$
- Infiltration Basin #2 – 28,062 $m^3$

This additional storage will provide a safety cushion in case of an extreme storm, heavier than the 1:100 year design event.

Imported, permeable fill will be required for construction of each basin. Permeable fill (sand having permeability ranging from 0.01 – 0.001 cm/s) will be placed loose over the scarified native soil following removal of all unsuitable loose fill material which was identified mainly within Infiltration Basin #1 area. Interior and exterior side slopes of infiltration basins will be 3H: 1V. Fill placed within containment berms will consist of fine grained soil with the uppermost 600 mm consisting of the clay liner. Permeable material placed below the containment berms will be compacted to 98% SPMDD. Impermeable containment berms are required to ensure integrity and stability of fills when exposed to hydraulic gradients resulting from a sudden rise of water level. This requirement applies to the east and northeast berm in Infiltration Basin #2. The remaining banks of the basins constructed as fill or cut will not require the same treatment as exterior containment berms and engineered fill may be used at these locations. All interior and exterior side slopes of infiltration basins will be topsoiled and vegetated, with the base remaining bare so it could be raked and scarified when needed. Permeable sand on the bottom of an infiltration basin will intercept silt, sediment and debris that could otherwise clog the base of the basin. The upper 50 – 100 mm of this sand layer can be readily restored following removal operations. Sand replacement material shall be of the same quality as originally installed material (hydraulic conductivity $1x10^{-4}$ to $1x10^{-5}$ m/s).

Rip rap lining for energy dissipation will be provided at all inlets into the basin for erosion control. All basins will also be equipped with an access ramp for maintenance access. Overflow spillways are provided in accordance with design guidelines to protect infiltration facilities against catastrophic failure from excessive rise in water level but due to the significant additional capacity within the basins are never anticipated to be used.

### *5.2.5 Operational Controls*

Under normal conditions, isolation valves on the outlet piping from stormwater ponds will be open allowing water to drain by gravity into infiltration basins. These valves will be closed if contamination is suspected including the valve controlling drainage from the mini-transfer drop-off area.

Stormwater will flow into the ponds, deposit the coarse fraction of sediment in the forebay and settle smaller particles in the aft-bay section of the stormwater ponds before water is released into the infiltration basin.

In day-to-day operation, staff will visually monitor all stormwater ponds. Should contamination be suspected, testing of the stormwater pond's contents will be carried out by hand-held, on-Site instrumentation to measure conductivity, pH and visual aesthetic conditions. Conditions present on-Site that might indicate the necessity to monitor the pond's contents could include the following:

- Visible leachate seep to surface water flowing to one of the surface water ponds;
- Evidence of dark stained water;
- Oil or any other substance in amounts sufficient to create a visible film, sheen or foam on the receiving waters; or,
- Accumulation of floating or settleable solids.

The isolation valve on the outlet piping would be closed and remain closed when the pond's water quality is in question. A sample taken for further analysis would be placed in a "rush" category for reporting by an independent laboratory. If the stormwater does not satisfy the trigger concentrations then the stormwater contingency plan will be initiated.

The isolation valve controlling the MTA shall be closed immediately after spill detection and remain closed until satisfactory clean-up is completed and the area suitable for normal operations.

Depending on the type and severity of contamination, it may be desirable to remove accumulated sediment from the forebay and/or aft bay of the stormwater pond.

These procedures will allow control of surface water discharging into infiltration basins. Under normal conditions, surface water draining into infiltration facilities shall be deemed suitable for groundwater recharge.

### 5.2.6 Mitigation Measures

During Site operations, surface water impact mitigation is proposed as follows:

Water quality impacts would be mitigated by the two-stage surface water management facility (SWMF) to remove larger particle size TSS loading and provide for emergency leachate/spill containment in the Stage 1 sediment forebay with Stage 2 providing extended control for additional TSS removal. SWMF outflow would be as groundwater discharge (infiltration), with the SWMF incorporating existing local excavation as previously practised at the existing Site.

The water quantity impacts would be mitigated by Stage 1 and Stage 2 of the SWMF providing attenuation of post-development flows to pre-development levels. SWMF outflow would be as groundwater discharge (infiltration), with the SWMF incorporating existing local excavation that would contain the 1:100 year runoff.

In more detail, stormwater management (SWM) for the expanded Site will be achieved through integration of the existing and proposed system of ditches, culverts, storm sewers and SWM ponds that have been designed to mitigate the impacts of stormwater runoff on water quantity and water quality before discharge to South Huntley Creek. The SWM criteria, as identified by the MOE in Ontario Regulation 232/98 and related Landfill Standards Guidelines (1998), include:

- Ditching designed to accommodate runoff from a 1:25 year rainfall event;
- Detention of runoff from a 4-hour 25 mm rainfall event; and
- Attenuation of peak flows to pre-development levels for all rainfall events up to and including the 1:100 year Return Period event.

The existing site and proposed landfill footprint area is founded on relatively permeable soils and there is currently no direct discharge to South Huntley Creek from the landfill proper or its servicing roads and operational areas. Rather, discharge is to three defined recharge areas, two of which have sedimentation forebays, the recharge areas eventually discharging through groundwater, to South Huntley Creek. The proposed SWM system for the expansion is planned in a similar manner and will account for the relocation of one of the existing recharge areas that will be removed to accommodate the new landfill footprint.

The two (2) new SWM ponds will be designed as two-stage facilities with an emergency flow control valve in-between the two stages.

The first stage will function not only as a sedimentation cell but also as an emergency response cell where runoff can be stored in case of surface water contamination by leachate or on-Site spills. Discharge can be shut-off in case of an emergency in which leachate has been found to be contaminating the surface water runoff. There will be regular inflow monitoring of indicator parameters to trigger a shutdown response using either a control valve or gate. This pond will be lined and designed to retain runoff from the 1:100 year rainfall until appropriate treatment can be applied and the runoff either treated and discharged to the second stage or pumped and hauled for treatment elsewhere.

The second stage will be an unlined infiltration pond for recharge purposes and is sized to accommodate the volume from the 1:100 year runoff from respective catchment areas. Other design features will include:

- First stage invert higher than the invert of the second stage and likely higher than the design water level to ensure positive drainage.
- Design water level for the volume of runoff from the 1:100 year rainfall event since the SWMF would likely have no natural positive outlet given the adjacent topography.

- Design water levels not higher than adjacent service roads.
- Emergency overflow routes to be defined once the facility characteristics are more clearly understood. With no positive outflow, the recharge rate governs the rate of water level reduction and available capacity for the next rainfall event.

With respect to the infiltration pond potentially freezing in the winter, thereby preventing infiltration, it is anticipated that these stormwater ponds will be empty at the beginning of the winter season. It may be possible that the saturated soil layer could freeze in the winter and infiltration would be limited until spring thaw. However, the combined design volume and additional 1 m of freeboard provided within the SWM ponds can contain the runoff generated from all design storm events.

Fill or excavation will be carried out, as required, to control drainage and achieve positive grades to appropriate outlets, and culverts/storm sewers will be installed, where needed, to convey flows under travelled sections of the Site.

Any accidents or malfunctions (i.e., spills to surface water) will be limited in their spatial and temporal extent, such that they will not result in the loss of any component of the aquatic system.

The proposal has been reviewed for Natural Hazards, Natural Heritage and Water quality and quantity by the Mississippi Valley Conservation Authority (MVCA), which posed no objection to the proposal. The letter confirming the review of the proposal is provided in **Appendix B**.

# 6. Environmental Effects Monitoring

There will be regular monitoring of SWMP inflows for emergency response purposes. For additional monitoring details, please refer to the *Environmental Monitoring Plan, West Carleton Environmental Centre* Report (WESA, 2014).

From within the boundaries of the landfill property, there is a limited amount of direct off-Site discharge of surface water; the majority of surface water drainage is contained within the landfill property and is directed to on-Site ponds, which are engineered, or natural, or remain following extraction of aggregate. The exceptions to this are the external slopes of the vegetated perimeter berms along the east and south boundaries of the landfill property; however, this amount of surface runoff is very minor and is not in contact with operational activities at the landfill. Runoff from the vegetated berms flows into the Carp Road and Highway 417 drainage systems. There is also a small area of drainage from the extreme western end of the Site, north of the service entrance, which flows into the ditch along William Mooney Road, and then northward into a Tributary of Huntley Creek. On the northern portion of the WCEC property, an agricultural ditch directs surface water drainage northward to a wooded area. The drainage ditch will be covered by the new landfill and will not be used in the future.

The monitoring locations and analytical parameters have been selected to identify the characteristics of the water down gradient from the landfill. Because of the orientations and flow directions of the Highway 417 drainage system and surrounding agricultural drains, there is no suitable location to monitor background surface water quality so that is can be compared to downgradient water quality.

## 6.1 Surface Water Elevation Monitoring

Surface water elevations will be monitored semi-annually at three (3) locations from seven (7) different monitors.

**Table 3. Surface Water Elevation Monitoring Locations**

| Location | Surface Water Monitors (7 Locations) |
|---|---|
| **South of the closed landfill, on WM property** | • S17 (southeast stormwater recharge pond)<br>• Pond (on the former Bradley Pit) |
| **Southeast of closed landfill, along Highway 417 ditch** | • S1<br>• S2<br>• S3 |
| **East of new landfill** | • Infiltration Basin #1<br>• Infiltration Basin #2 |

## 6.2 Surface Water Quality Monitoring

Surface water quality monitoring will be conducted to determine if the closed or new landfill, or operation of the stormwater management ponds, are impacting groundwater quality. **Table 4** shows the proposed surface water quality monitoring program.

**Table 4. Surface Water Quality Monitoring Program**

| Drainage Course | Monitoring Location (10 Locations) | Monitoring Frequency |
|---|---|---|
| **Highway 417 Ditch** | • S1<br>• S3<br>• S10 | • Twice per year (Spring and Fall) |
| **CAZ southeast of closed landfill** | • M4<br>• M5 | • Twice per year (Spring and Fall) |
| **Western boundary of closed landfill** | • Culvert G | • Twice per year (Spring and Fall) |
| **New stormwater management ponds** | • Infiltration Basin #1<br>• Infiltration Basin #2 | • Quarterly (March, June, September, December) |
| | • Lined Pond #1<br>• Lined Pond #2 | • Once every two months |

The parameters monitored at each location, as well as the surface water quality assessment limits, are further discussed in the *Environmental Monitoring Plan, West Carleton Environmental Centre* Report (WESA, 2014).

The following commitments have been proposed for ensuring that the identified mitigation or compensation measures and monitoring requirements are carried out as part of the construction, operation, and maintenance of the undertaking:

a) The two-stage SWM facilities will be built to address surface water runoff from the Site and emergency response to accidental leachate seeps or spills.
b) Inflow to SWM ponds will be regularly monitored to identify emergency response situations including leachate seeps and on-Site spills.
c) Emergency response will occur and leachate/pollutant-impacted runoff will be treated as required.
d) Annual, periodic SWM pond inflow and off-Site surface water monitoring will occur for parameters as identified by the MOE in their surface water assessment criteria as it relates to landfill Sites.

# 7. Conclusions

The closed landfill, and also the new landfill, was developed with no off-Site discharge or surface water. Post-development conditions are characterized by higher runoff coefficients and shorter travel times (time of concentration) due to steep landfill grades and flow channelization. These factors tend to increase peak flows but because the Site design is based on no off-Site discharge, peak flow attenuation is not an issue for the landfill development area. Runoff from the proposed landfilling area will be contained on-Site in Infiltration Basin #2.

The existing Stormwater Pond #1 and small wetland (Depression #3) located within the landfill expansion area will be eliminated and replaced with new clay lined Stormwater Pond #1 and Infiltration Basin #1 within Depression #4. Similarly, Stormwater Pond #2 and Infiltration Basin #2 are proposed in the area designated as Depression #5. Infiltration Basin #2 will service the entire landfill expansion area while Infiltration Basin #1 almost the entire north half of the existing landfill. The landfill expansion will shift drainage boundaries within Drainage Areas A and B, and in catchments located along the Site perimeter (SH1, SH2 and F). Drainage patterns within the remaining part of the property will be hardly affected and generally will remain the same as under pre-development conditions. There will be a significant increase in the size of on-Site no outlet areas to 151.76 ha from 127.48 ha under pre-development conditions. As a result, more stormwater will be contained on-Site and recharged into groundwater and less discharged off-Site as surface flow from lands located along the Site perimeter.

As noted in AECOM (2011) there are no permanent or intermittent streams in the area of the proposed landfill. As such, there are no predicted changes in water quality, aquatic habitat or aquatic biota. The nearest fish habitat is seasonal habitat associated within an agricultural channel (Tributary C) located approximately 250 m away from the proposed landfill location on the west side of William Mooney Drive. Water quality in South Huntley Creek, when tested in 2006 and 2011, varied significantly between sites and sampling dates, generally reflecting local upstream land uses. Overall, water quality varied from poor to moderate.

The nearest area that is potentially part of the Provincially Significant Goulbourn Wetland lies at least 600 m from the nearest point of the proposed landfill footprint. It is also a sufficient distance that no impacts to the functions and features of the wetland are anticipated. No mitigation or special precautions are required.

There is some non-significant wetland proposed to be removed with the landfill expansion. In total 4.0 ha of wetland are proposed for removal. These wetlands were created as a result of past human activities (former gravel pit and storm water collection ponds) and therefore are not provincially significant.

A surface water monitoring program will be conducted to ensure that the quality of water surrounding the new landfill is not impacted by the closed or new landfill, or operation of the stormwater management ponds.

The new landfill is not expected to pose a change to surface water off-Site, as all surface water will be managed on-Site, with the exception of the external slopes of perimeter berms along the south and east boundaries of the landfill property. The proposal has been reviewed for Natural Hazards, Natural Heritage and Water quality and quantity by the Mississippi Valley Conservation Authority (MVCA), which posed no objection to the proposal.

# 8. References


AECOM, 2011:
Environmental Assessment for a New Landfill Footprint at the West Carleton Environmental Centre: Biology Existing Conditions Report. Prepared for Waste Management of Canada Corporation.

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Rideau Valley Conservation Authority (MVCA) 2010:
Proposed Assessment Report – Mississippi Valley Source Protection Area

Robinson Consultants, 2004:
Carp River Watershed / Subwatershed Study Volume 1 – Main Report. Prepared for the City of Ottawa. http://www.mvc.on.ca/water/carpriver.pdf

WESA, 2014:
Environmental Monitoring Plan: Groundwater, Surface Water, Leachate & Subsurface Gas Components. Prepared for Waste Management of Canada Corporation.

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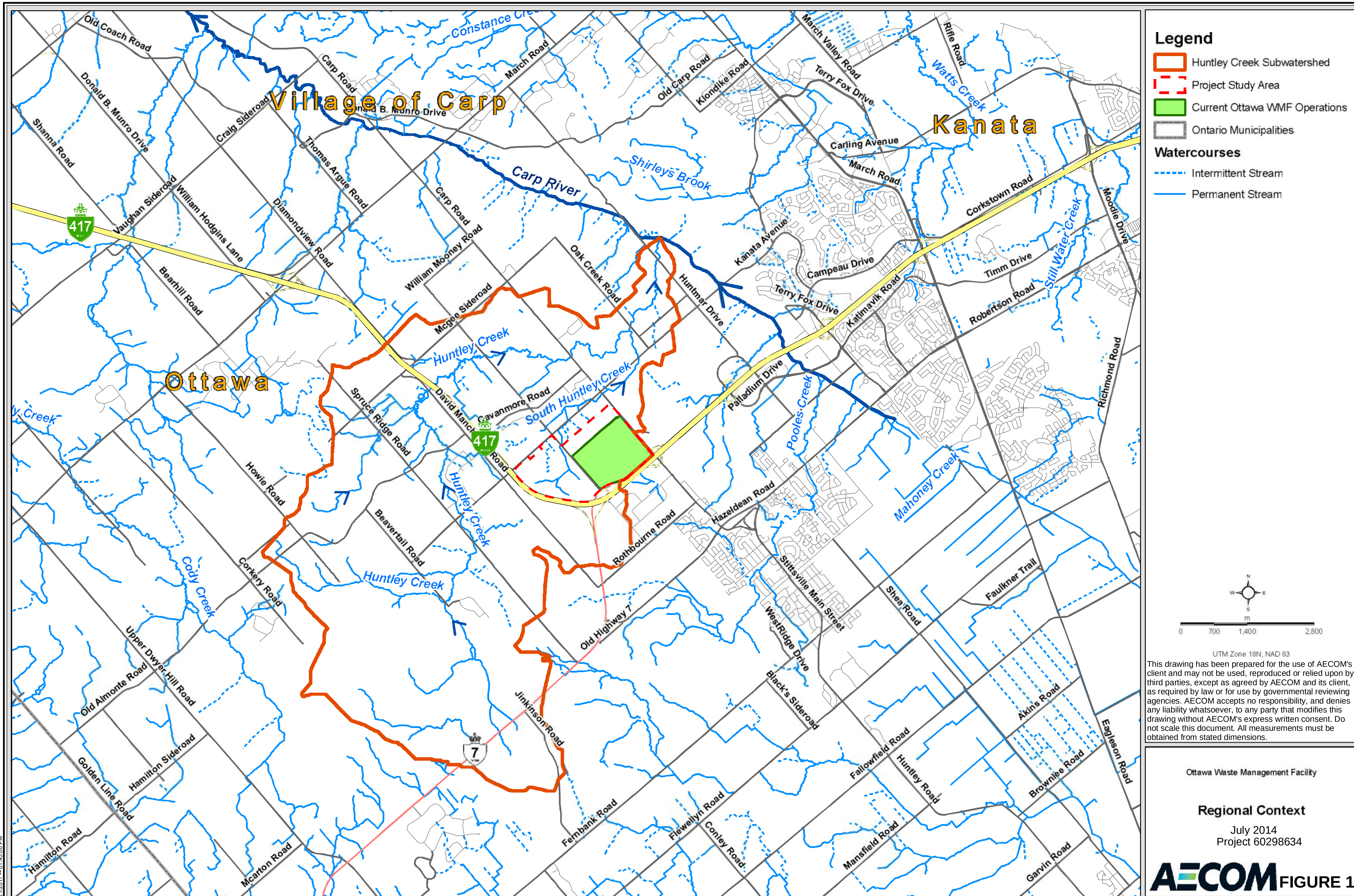
Groundwater Impact Assessment Reports.

WESA, 2014:
2013 Annual Report: Waste Management Ottawa Landfill.

WSP, 2014:
Groundwater Impact Assessment Reports. Development and Operations Report: West Carleton Environmental Centre.

# Figures

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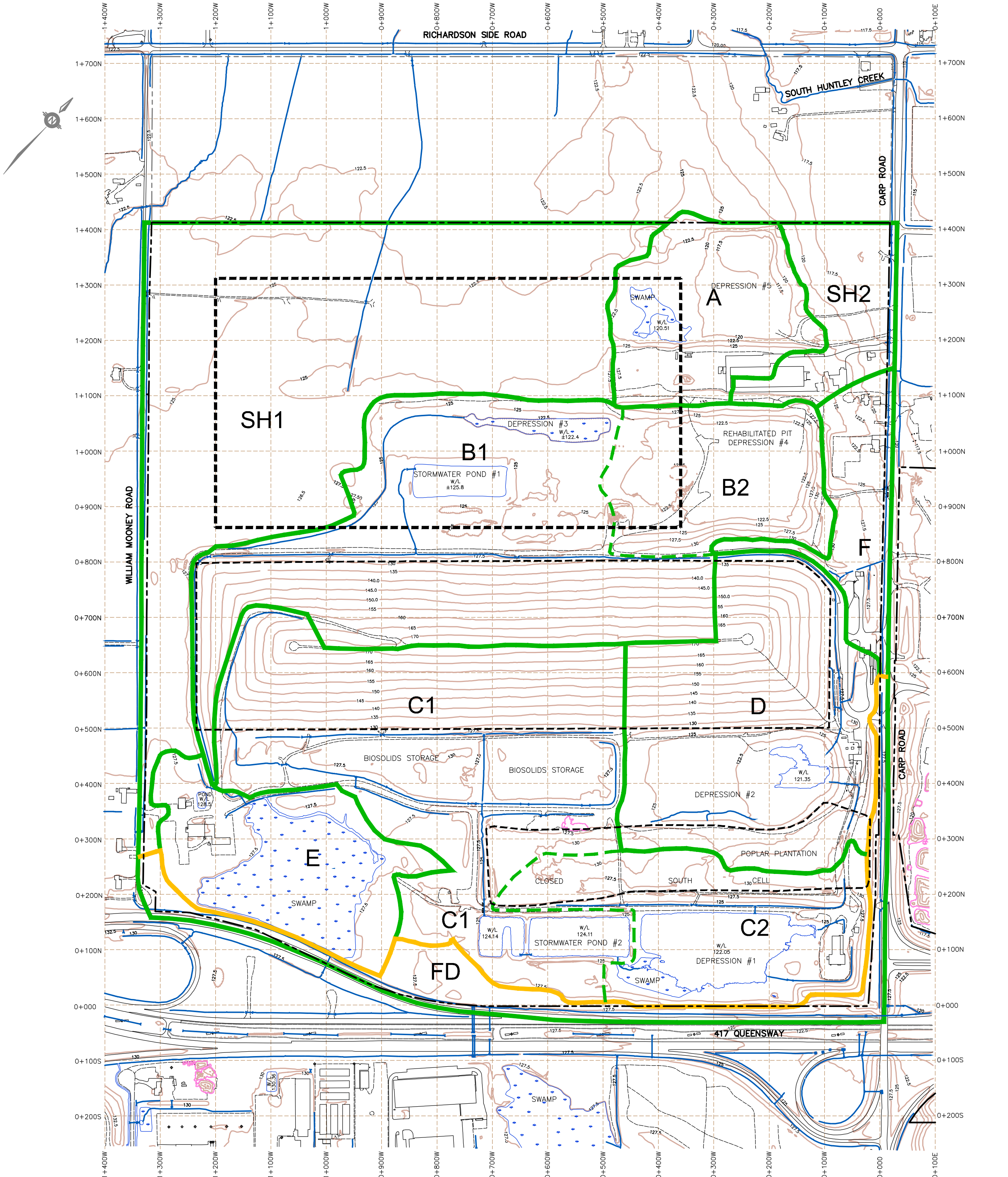



**LEGEND :**

- LIMIT OF DRAINAGE AREA
- LIMIT OF SUBCATCHMENT AREA
- DIVISION BETWEEN FEEDMILL AND SOUTH HUNTLEY CREEK WATERSHEDS
- PROPOSED LANDFILL LIMIT
- WASTE MANAGEMENT OF CANADA PROPERTY LIMIT
- EXISTING LANDFILL LIMIT
- EXISTING GROUND CONTOURS

SCALE :1:10.000:
0 80 160 240 320 400m

July 2014
Project 60298634
**FIGURE 2**
Resource: from WSP Figure 8-1.



FIGURE 8-1

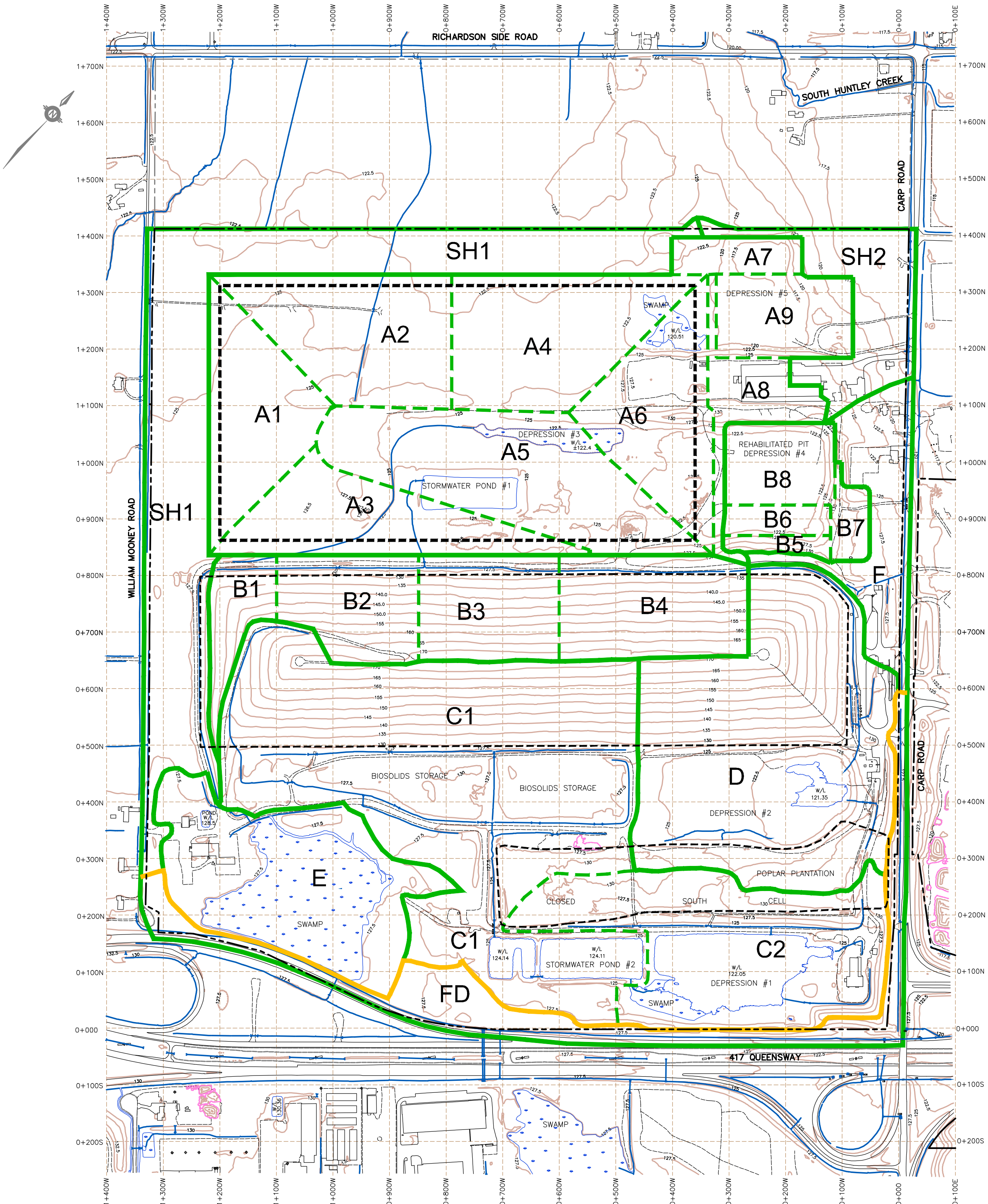
DWN BY: T C G
CHK BY: P S B
DATE: APR 28, 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.
DRAWING NO. 131-19416-00 – 8-1

PRE-DEVELOPMENT DRAINAGE AREAS
WEST CARLETON ENVIRONMENTAL CENTRE

WASTE MANAGEMENT

WSP
101-1450 1st AVENUE W
OWEN SOUND (ONTARIO) CANADA N4K 6W2
TEL.: 519-376-7612 | FAX: 519-376-8008 | WWW.WSPGROUP.COM




**LEGEND :**

- LIMIT OF DRAINAGE AREA
- LIMIT OF SUBCATCHMENT AREA
- DIVISION BETWEEN FEEDMILL AND SOUTH HUNTLEY CREEK WATERSHEDS
- PROPOSED LANDFILL LIMIT
- WASTE MANAGEMENT OF CANADA PROPERTY LIMIT
- EXISTING LANDFILL LIMIT
- EXISTING GROUND CONTOURS

SCALE :1:10.000:
0 80 160 240 320 400m

July 2014
Project 60298634

**FIGURE 3**

Resource: from WSP Figure 8-2.

G:\2013\OS\13-401 - Environmental\131-19416-00 - Ottawa Landfill Expansion\DRAWINGS FOR DaD\131-19416-00-8-2.dwg Apr 28, 2014 - 11:00am



FIGURE 8-2

DWN BY: T C G
CHK BY: P S B
DATE: APR 28, 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

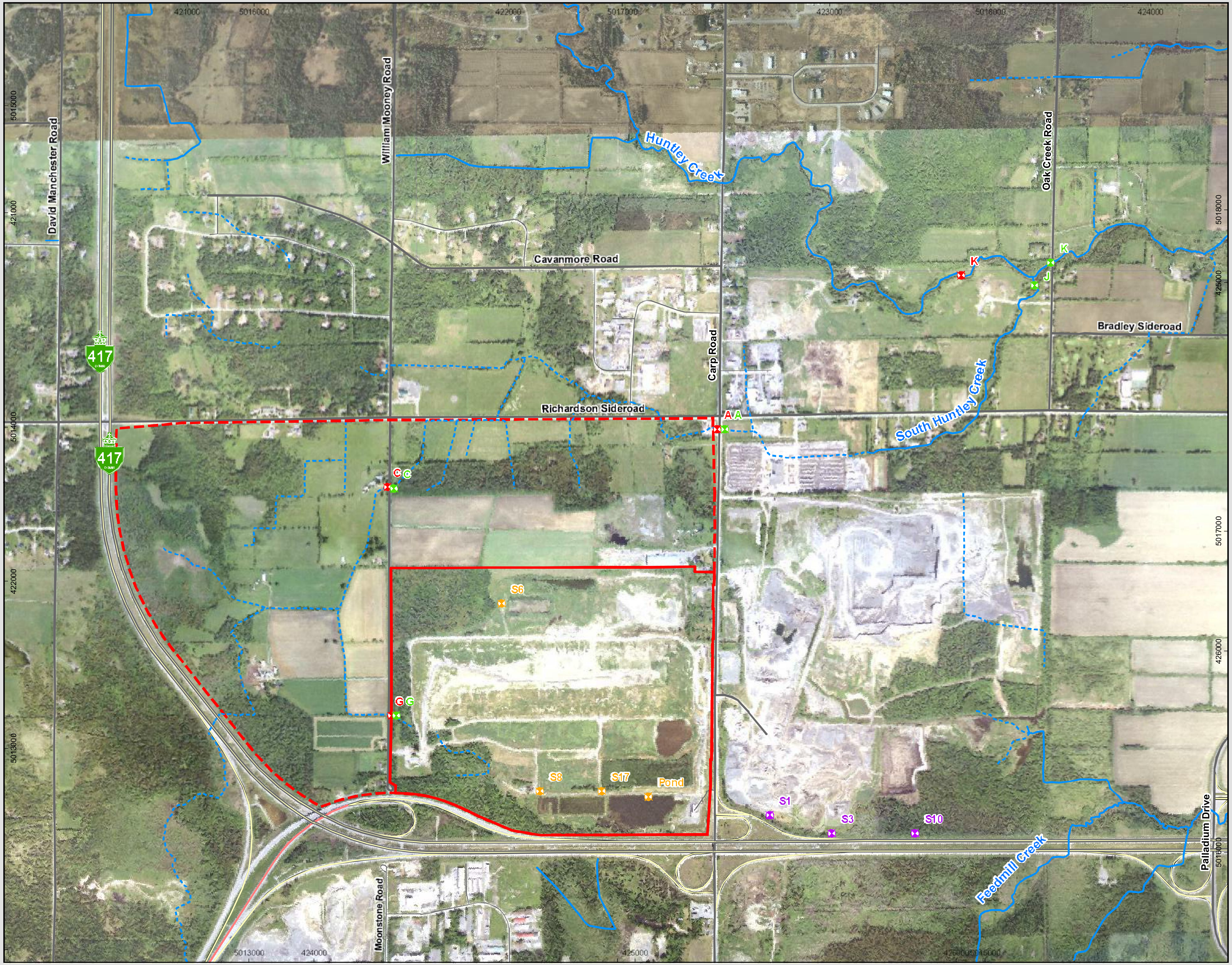
DRAWING NO. 131-19416-00 – 8-2

POST-DEVELOPMENT DRAINAGE AREAS

WEST CARLETON ENVIRONMENTAL CENTRE

WASTE MANAGEMENT

WSP
101-1450 1st AVENUE W
OWEN SOUND (ONTARIO) CANADA N4K 6W2
TEL.: 519-376-7612 | FAX: 519-376-8008 | WWW.WSPGROUP.COM




**Legend**

**Surface Water Monitoring Stations**

- AECOM - 2006
- AECOM - 2011
- S-WESA 2003 - 2007
- S-WESA 2003 - 2010
- On-site Study Area
- Current Ottawa WMF Operations
- Intermittent Stream
- Permanent Stream

Basemapping from Ontario Ministry of Natural Resources
Orthophotography: 2005, 2008 and 2010

m
0 75 150 300 450
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UTM Zone 17N, NAD 83



Waste Management of Canada Corporation
West Carleton Environmental Centre

**Monitoring Stations**

July 2014
Project 60298634

AECOM **FIGURE 4**

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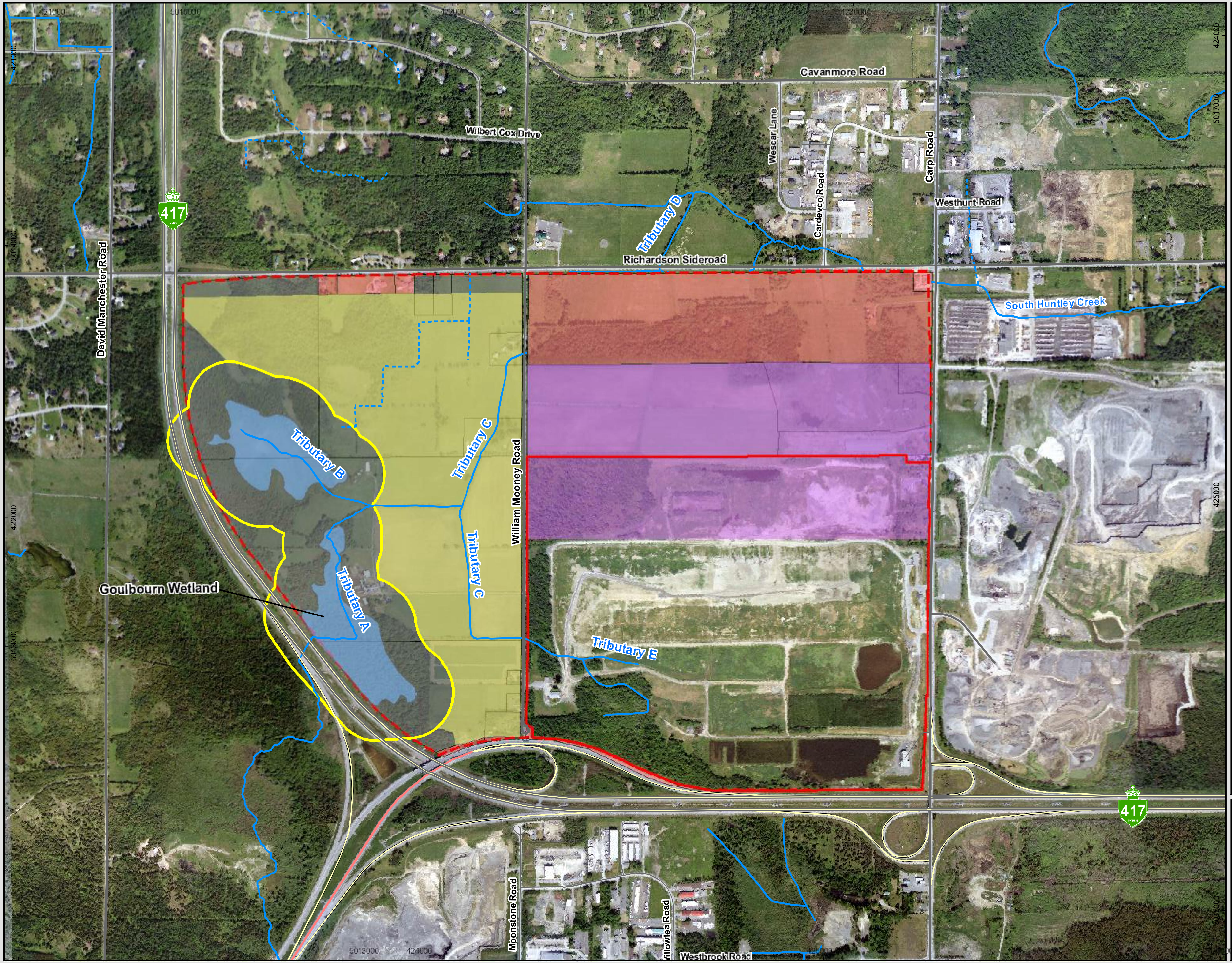


**Legend**

- Intermittent Stream
- Permanent Stream
- PSW Buffer Area (120 m)
- PSW
- Lands Owned/Optioned by WM
- Lands Not Owned/Optioned by WM
- On-site Study Area
- Current Ottawa WMF Operations
- West Footprint Envelope
- North Footprint Envelope

Basemapping from Ontario Ministry of Natural Resources
Orthophotography: 2005, and 2010

m
0 100 200 400
1:12,000
UTM Zone 17N, NAD 83



Waste Management of Canada Corporation
West Carleton Environmental Centre

**Watercourses Within Study Area**

July 2014
Project 60298634

AECOM **FIGURE 5**

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# Appendix A

## Surface Water Quality Monitoring Results

Appendix A1: SURFACE WATER QUALITY (PIL, SIL)
Waste Management Ottawa Landfill

| Location | Sample Date | Alkalinity mg/L | Ammonia mg/L | Un-ionized ammonia (mg/L) | Barium mg/L | Boron mg/L | Cadmium mg/L | Calcium mg/L | Chemical Oxygen Demand mg/L | Chloride mg/L | Chromium (+3) mg/L | Chromium (+6) mg/L | Chromium (total) mg/L | Conductivity uS/cm | Cyanide (free) mg/L | Cyanide mg/L | Dissolved Organic Carbon mg/L | Hardness mg/L | Iron mg/L | Lead mg/L | Magnesium mg/L | Manganese mg/L | Nitrate mg/L | Nitrite mg/L | pH unitless | Potassium mg/L | Sodium mg/L | Sulphate mg/L | Total Dissolved Solids mg/L | Total Kjeldahl Nitrogen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 1-Jun-00 | 417 | 14.4 | 0.037 | 0.62 | 0.36 | < 0.00015 | 182 | 112 | 421 | | | < 0.01 | 2300 | | < 0.02 | | | 74 | < 0.002 | 33 | 0.95 | 0.87 | < 0.1 | | 26 | 264 | 173 | | 14.4 |
| S1 | 22-Nov-00 | 524 | 15.4 | 0.024 | 0.43 | 0.39 | < 0.005 | 205 | 92 | 464 | | | < 0.01 | 2530 | | 0.03 | | | 15.2 | < 0.001 | 41 | 1.22 | < 0.1 | < 0.1 | | 28 | 243 | 150 | | 16.6 |
| S1 | 11-May-01 | 500 | 15.8 | 0.023 | 0.35 | 0.44 | 0.0002 | 177 | 41 | 464 | | | 0.002 | 2320 | | < 0.005 | | | 3.94 | < 0.001 | 35 | 0.61 | 0.83 | < 0.1 | | 29 | 233 | 118 | | 16.5 |
| S1 FD | 11-May-01 | 499 | 15.8 | 0.023 | 0.35 | 0.44 | 0.0002 | 179 | 44 | 462 | | | 0.002 | 2270 | | < 0.005 | | | 3.92 | < 0.001 | 36 | 0.63 | 0.83 | < 0.1 | | 30 | 229 | 118 | | 16 |
| S1 | 13-Nov-01 | 531 | 16.7 | 0.015 | 0.36 | 0.51 | < 0.0001 | 193 | 54 | 509 | | | 0.002 | 2690 | | 0.008 | | | 10.4 | < 0.001 | 48 | 0.95 | < 0.1 | < 0.1 | | 35 | 268 | 206 | | 18.8 |
| S1 | 15-May-02 | 291 | 4.51 | 0.008 | 0.16 | 0.24 | < 0.0001 | 145 | 22 | 399 | | | < 0.001 | 2100 | | < 0.005 | | | 0.88 | < 0.001 | 22 | 0.21 | 3.42 | < 0.1 | | 21 | 252 | 161 | | 5.27 |
| S1 | 12-Nov-02 | 328 | 9.3 | 0.006 | 0.28 | 0.3 | < 0.0001 | 172 | 20 | 552 | | | < 0.005 | 2760 | | < 0.005 | | | 11.1 | < 0.001 | 31 | 0.73 | 0.7 | < 0.1 | | 42 | 333 | 235 | | 12.3 |
| S1 | 22-May-03 | 308 | 1.49 | 0.005 | 0.18 | 0.32 | < 0.0001 | 183 | 21 | 794 | | | < 0.005 | 2440 | | < 0.005 | | | 2.24 | < 0.001 | 34 | 0.21 | 2.88 | < 0.1 | | 21 | 346 | 233 | | 2.5 |
| S1 | 15-Aug-03 | | 5.6 | 0.005 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 5-Nov-03 | 419 | 5.45 | 0.028 | 0.32 | 0.29 | < 0.0001 | 189 | 33 | 583 | | | 0.001 | 2910 | | < 0.005 | | | 15.7 | < 0.001 | 33 | 0.82 | 0.25 | < 0.1 | | 28 | 367 | 177 | | 8.15 |
| S1 | 22-Dec-03 | | 6.01 | 0.012 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 11-Feb-04 | | 4.63 | 0.023 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 30-Apr-04 | 373 | 5.1 | 0.018 | 0.35 | 0.29 | < 0.0001 | 171 | 33 | 336 | | | 0.001 | 2090 | | < 0.005 | | | 15.8 | < 0.001 | 33 | 0.95 | 0.18 | < 0.1 | | 18 | 230 | 205 | | 6.56 |
| S1 | 8-Sep-04 | | 3.75 | 0.007 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 5-Nov-04 | 261 | 2.58 | 0.017 | 0.32 | 0.39 | < 0.0001 | 104 | 19 | 372 | | | 0.015 | 2090 | | < 0.005 | | | 10.7 | 0.005 | 33 | 1.3 | 1.29 | < 0.1 | | 17 | 233 | 201 | | 3.87 |
| S1 | 27-Apr-05 | 297 | 2.16 | 0.002 | 0.2 | 0.24 | < 0.0001 | 134 | 19 | 345 | | | < 0.001 | 1960 | | < 0.005 | | | 4.05 | < 0.001 | 35 | 0.45 | 1.39 | < 0.1 | | 12 | 266 | 147 | | 4.2 |
| S1 | 24-Aug-05 | | 1.91 | 0.028 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 28-Nov-05 | 372 | 3.39 | 0.005 | 0.26 | 0.31 | < 0.0001 | 186 | 29 | 547 | | | 0.004 | 2680 | | < 0.005 | | | 10.9 | < 0.001 | 36 | 1.17 | 1.42 | < 0.1 | | 16 | 296 | 129 | | 4.49 |
| S1 FD | 28-Nov-05 | 373 | 3.27 | 0.005 | 0.25 | 0.26 | < 0.0001 | 188 | 30 | 550 | | | 0.005 | 2710 | | < 0.005 | | | 10.9 | < 0.001 | 37 | 1.16 | 1.5 | < 0.1 | | 16 | 299 | 131 | | 4.75 |
| S1 | 26-Apr-06 | 379 | 2.56 | 0.004 | 0.24 | 0.33 | < 0.0001 | 180 | 25 | 514 | | | < 0.005 | 2610 | | < 0.005 | | | 2.54 | < 0.001 | 34 | 0.45 | 1.26 | < 0.1 | | 13 | 282 | 174 | | 3.95 |
| S1 | 29-Aug-06 | | 1.34 | 0.008 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 7-Nov-06 | 321 | 2.02 | 0.008 | 0.19 | 0.43 | < 0.0001 | 161 | 28 | 536 | | | 0.006 | 2580 | | < 0.005 | | | 3.98 | < 0.001 | 34 | 0.64 | 1 | < 0.1 | | 15 | 386 | 202 | | 2.62 |
| S1 | 24-Apr-07 | 396 | 1.89 | 0.005 | 0.18 | 0.45 | < 0.0001 | 158 | 23 | 389 | | | 0.008 | 2250 | | < 0.005 | | | 2.41 | < 0.001 | 33 | 0.54 | 1 | < 0.1 | | 13 | 262 | 153 | | 2.98 |
| S1 | 16-Aug-07 | | 1.39 | 0.009 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S1 | 27-Nov-07 | 286 | 1.71 | 0.001 | 0.16 | 0.32 | < 0.0001 | 140 | 16 | 363 | | | < 0.001 | 2140 | | < 0.005 | | | 6.04 | < 0.001 | 30 | 0.61 | 0.68 | < 0.1 | | 13 | 247 | 216 | | 2.1 |
| S1 | 23-May-08 | 338 | 1.35 | 0.006 | 0.2 | 0.43 | < 0.0001 | 150 | 33 | 490 | | | < 0.005 | 2520 | < 0.002 | | 7.7 | 520 | 1 | < 0.0005 | 33 | 0.37 | 1.6 | 0.01 | 8 | 12 | 290 | 190 | 1510 | 2.6 |
| S1 FD | 23-May-08 | 339 | 1.34 | 0.006 | 0.2 | 0.42 | < 0.0001 | 160 | 30 | 490 | | | < 0.005 | 2530 | < 0.002 | | 7.9 | 520 | 2.8 | < 0.0005 | 33 | 0.38 | 1.4 | 0.01 | 7.9 | 12 | 290 | 204 | 1520 | 3 |
| S1 | 19-Nov-08 | 331 | 2.91 | 0.003 | 0.25 | 0.52 | < 0.0001 | 230 | 25 | 500 | | | < 0.005 | 2810 | < 0.002 | | 7.1 | 660 | 11 | 0.0007 | 46 | 0.98 | 0.4 | 0.01 | 8 | 17 | 340 | 381 | 1840 | 3 |
| S1 | 29-Apr-09 | 311 | 1.19 | 0.005 | 0.23 | 0.49 | < 0.0001 | 240 | 23 | 520 | | | < 0.005 | 2670 | 0.002 | | 8.1 | 510 | 5.2 | 0.0012 | 44 | 0.52 | 2.6 | 0.14 | 7.8 | 16 | 350 | 230 | 1760 | 2 |
| S1 | 29-Oct-09 | 344 | 2.82 | 0.009 | 0.24 | 0.49 | < 0.0001 | 190 | 22 | 580 | | | < 0.005 | 2970 | < 0.002 | | 8.9 | 590 | 5.8 | < 0.0005 | 39 | 1 | 0.3 | < 0.01 | 7.6 | 15 | 370 | 250 | 2000 | 3.5 |
| S1 FD | 29-Oct-09 | 342 | 2.71 | 0.009 | 0.24 | 0.46 | < 0.0001 | 180 | 25 | 580 | | | < 0.005 | 2970 | < 0.002 | | 8.1 | 570 | 5.6 | < 0.0005 | 39 | 0.96 | 0.3 | < 0.01 | 7.7 | 15 | 370 | 240 | 1900 | 3.2 |
| S1 | 28-Apr-10 | 332 | 1.16 | 0.004 | 0.24 | 0.4 | < 0.0001 | 170 | 26 | 640 | | | < 0.005 | 2900 | < 0.002 | | 8.5 | 520 | 1.4 | < 0.0005 | 35 | 0.36 | 1.8 | 0.01 | 7.9 | 14 | 520 | 120 | 1830 | 2.1 |
| S1 FD | 28-Apr-10 | 333 | 1.2 | 0.004 | 0.24 | 0.41 | < 0.0001 | 180 | 26 | 630 | | | < 0.005 | 2880 | < 0.002 | | 8.2 | 510 | 1.5 | < 0.0005 | 36 | 0.38 | 1.7 | 0.02 | 8 | 14 | 430 | 140 | 1810 | 2.4 |
| S1 | 2-Nov-10 | 375 | 3.09 | 0.047* | 0.3 | 0.46 | < 0.0001 | 200 | 41 | 620 | | | < 0.005 | 3070 | < 0.002 | | 8.6 | 580 | 8.6 | < 0.0005 | 42 | 1.1 | < 0.1 | 0.02 | 7.85 | 16 | 440 | 130 | 1950 | 4 |
| S1 FD | 2-Nov-10 | 382 | 2.75 | 0.042* | 0.29 | 0.42 | 0.0002 | 190 | 36 | 710 | | | < 0.005 | 3200 | < 0.002 | | 9.1 | 550 | 7.4 | < 0.0005 | 42 | 1.1 | 0.1 | < 0.01 | 7.91 | 16 | 470 | 100 | 1980 | 3.9 |
| S1 | 3-May-11 | 232 | 1.15 | 0.005 | 0.17 | 0.28 | < 0.0001 | 160 | < 4 | 390 | | | < 0.005 | 2010 | < 0.002 | | 5.3 | 390 | 1.6 | 0.0009 | 29 | 0.26 | 1.5 | 0.09 | 7.95 | 11 | 270 | 150 | 1220 | 1.9 |
| S1 | 8-Nov-11 | 358 | 2.68 | 0.006 | 0.28 | 0.44 | < 0.0001 | 170 | 41 | 520 | | | < 0.005 | 2650 | < 0.002 | | 8.4 | 510 | 14 | < 0.0005 | 34 | 0.93 | < 0.1 | < 0.01 | 7.54 | 14 | 330 | 150 | 1450 | 3.3 |
| S1 | 7-May-12 | 360 | 1.14 | 0.005 | 0.26 | 0.36 | < 0.0001 | 180 | 24 | 610 | | | < 0.005 | 2900 | < 0.002 | | 9.2 | 580 | 2.1 | < 0.0005 | 37 | 0.45 | 0.64 | < 0.01 | 7.88 | 12 | 400 | 180 | 1720 | 1.8 |
| S1 | 29-Oct-12 | 400 | 1.14 | 0.002 | 1 | 0.51 | < 0.0001 | 810 | 38 | 430 | | | 0.015 | 3000 | < 0.002 | | 10 | 720 | 150 | 0.0095 | 59 | 1.8 | < 0.1 | < 0.01 | 7.83 | 18 | 370 | 390 | 1900 | 2.4 |
| S1 | 24-May-13 | 110 | 1.23 | 0.014 | 0.31 | 0.48 | 0.0001 | 1200 | 89 | 190 | | | 0.031 | 1700 | 0.003 | | 3.8 | 390 | 27 | 0.017 | 51 | 0.83 | 4.4 | 0.31 | 8.05 | 19 | 210 | 400 | 1140 | 4 |
| S1 | 30-Oct-13 | No Sample collected; highway construction | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Appendix A1: SURFACE WATER QUALITY (PIL, SIL)
Waste Management Ottawa Landfill

| Location | Sample Date | Alkalinity mg/L | Ammonia mg/L | Un-ionized ammonia (mg/L) | Barium mg/L | Boron mg/L | Cadmium mg/L | Calcium mg/L | Chemical Oxygen Demand mg/L | Chloride mg/L | Chromium (+3) mg/L | Chromium (+6) mg/L | Chromium (total) mg/L | Conductivity uS/cm | Cyanide (free) mg/L | Cyanide mg/L | Dissolved Organic Carbon mg/L | Hardness mg/L | Iron mg/L | Lead mg/L | Magnesium mg/L | Manganese mg/L | Nitrate mg/L | Nitrite mg/L | pH unitless | Potassium mg/L | Sodium mg/L | Sulphate mg/L | Total Dissolved Solids mg/L | Total Kjeldahl Nitrogen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S3 | 1-Jun-00 | 263 | 0.42 | 0.013 | 0.11 | 0.05 | < 0.00015 | 112 | 44 | 172 | | | < 0.01 | 1090 | | < 0.02 | | | 0.64 | < 0.002 | 13 | 0.11 | 2.39 | 0.14 | | 3 | 116 | 412 | | 1.16 |
| S3 | 22-Nov-00 | 392 | 4.41 | 0.011 | 0.33 | 0.17 | < 0.005 | 177 | 54 | 608 | | | < 0.01 | 2550 | | < 0.005 | | | 1.8 | < 0.001 | 31 | 1.07 | 0.62 | < 0.1 | | 15 | 335 | 79 | | 4.89 |
| S3 | 11-May-01 | 445 | 2.48 | 0.011 | 0.4 | 0.19 | 0.0002 | 211 | 38 | 720 | | | 0.001 | 2760 | | < 0.005 | | | 1.81 | < 0.001 | 38 | 1.1 | 1.59 | < 0.1 | | 15 | 330 | 124 | | 2.31 |
| S3 | 13-Nov-01 | 247 | 5.75 | 0.017 | 0.15 | 0.33 | < 0.0001 | 197 | 31 | 503 | | | < 0.001 | 2420 | | < 0.005 | | | 0.4 | < 0.001 | 42 | 0.25 | 4.5 | < 0.1 | | 26 | 253 | 298 | | 5.89 |
| S3 | 15-May-02 | 225 | 0.89 | 0.004 | 0.1 | 0.07 | < 0.0001 | 107 | 34 | 397 | | | < 0.001 | 1890 | | < 0.005 | | | 0.27 | < 0.001 | 13 | 0.06 | 0.8 | < 0.1 | | 4 | 279 | 94 | | 1.5 |
| S3 | 12-Nov-02 | 404 | 1.84 | 0.001 | 0.29 | 0.13 | < 0.0001 | 225 | 31 | 719 | | | < 0.005 | 3260 | | < 0.005 | | | 2.58 | < 0.001 | 31 | 0.7 | 0.56 | < 0.1 | | 27 | 409 | 176 | | 2.64 |
| S3 | 22-May-03 | 358 | 1.25 | 0.010 | 0.27 | 0.18 | < 0.0001 | 237 | 27 | 830 | | | < 0.005 | 2970 | | < 0.005 | | | 1.56 | < 0.001 | 39 | 0.77 | 2.03 | < 0.1 | | 15 | 410 | 200 | | 1.7 |
| S3 | 15-Aug-03 | | 1.07 | 0.002 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S3 | 5-Nov-03 | 295 | 2.21 | 0.016 | 0.2 | 0.24 | < 0.0001 | 169 | 28 | 498 | | | 0.002 | 2530 | | < 0.005 | | | 1.02 | < 0.001 | 34 | 0.45 | 1.44 | < 0.1 | | 26 | 319 | 253 | | 3.16 |
| S3 | 22-Dec-03 | | 4.2 | 0.019 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S3 | 30-Apr-04 | 264 | 0.45 | 0.002 | 0.17 | 0.12 | < 0.0001 | 135 | 19 | 437 | | | 0.004 | 2100 | | < 0.005 | | | 0.33 | < 0.001 | 20 | 0.22 | 0.93 | < 0.1 | | 8 | 272 | 117 | | 1.06 |
| S3 | 8-Sep-04 | | 0.25 | 0.002 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S3 | 5-Nov-04 | 257 | 0.81 | 0.002 | 0.15 | 0.22 | < 0.0001 | 131 | 28 | 533 | | | 0.002 | 2480 | | < 0.005 | | | 0.55 | < 0.001 | 26 | 0.22 | 1.2 | < 0.1 | | 11 | 311 | 196 | | 1.51 |
| S3 | 27-Apr-05 | 221 | 0.36 | 0.002 | 0.11 | 0.15 | < 0.0001 | 226 | 21 | 440 | | | < 0.001 | 2080 | | < 0.005 | | | 0.23 | < 0.001 | 25 | 0.08 | 1.04 | < 0.1 | | 6 | 253 | 137 | | 0.94 |
| S3 | 24-Aug-05 | | 0.72 | 0.023 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S3 | 28-Nov-05 | 339 | 1.83 | 0.002 | 0.18 | 0.23 | < 0.001 | 189 | 26 | 698 | | | < 0.005 | 3040 | | < 0.005 | | | 1.68 | < 0.01 | 35 | 0.62 | 2.69 | < 0.1 | | 14 | 366 | 204 | | 2.65 |
| S3 | 26-Apr-06 | 258 | 0.68 | 0.002 | 0.16 | 0.51 | < 0.0001 | 141 | 15 | 592 | | | < 0.005 | 2690 | | < 0.005 | | | 0.24 | < 0.001 | 29 | 0.16 | 2.45 | < 0.1 | | 10 | 333 | 186 | | 1.01 |
| S3 | 29-Aug-06 | | 0.31 | 0.003 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S3 | 7-Nov-06 | 388 | 0.44 | 0.002 | 0.23 | 0.23 | < 0.0001 | 194 | 23 | 656 | | | 0.007 | 3040 | | < 0.005 | | | 1.84 | < 0.001 | 32 | 0.7 | 1.43 | < 0.1 | | 12 | 473 | 175 | | 1.15 |
| S3 FD | 7-Nov-06 | 387 | 0.46 | 0.002 | 0.25 | 0.24 | < 0.0001 | 193 | 26 | 686 | | | 0.006 | 3010 | | < 0.005 | | | 2.02 | < 0.001 | 32 | 0.7 | 1.34 | < 0.1 | | 12 | 510 | 165 | | 0.99 |
| S3 | 24-Apr-07 | 309 | 0.58 | 0.002 | 0.19 | 0.3 | < 0.0001 | 155 | 24 | 550 | | | 0.009 | 2570 | | < 0.005 | | | 0.76 | < 0.001 | 30 | 0.47 | 0.94 | < 0.1 | | 10 | 334 | 163 | | 1.05 |
| S3 | 16-Aug-07 | | 0.73 | 0.006 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S3 | 27-Nov-07 | 378 | 0.72 | <0.001 | 0.27 | 0.12 | < 0.0001 | 170 | 23 | 837 | | | 0.001 | 3660 | | 0.007 | | | 1.24 | < 0.001 | 27 | 0.62 | 0.56 | < 0.1 | | 8 | 527 | 124 | | 1.21 |
| S3 | 23-May-08 | 352 | 0.49 | 0.002 | 0.29 | 0.16 | < 0.0001 | 160 | 31 | 690 | | | < 0.005 | 3040 | < 0.002 | | 9.3 | 500 | 1.1 | < 0.0005 | 25 | 0.59 | 0.6 | 0.02 | 8.1 | 6.9 | 400 | 131 | 1810 | 1.2 |
| S3 | 19-Nov-08 | 386 | 1.38 | 0.001 | 0.73 | 0.38 | < 0.0001 | 180 | 67 | 590 | | | < 0.005 | 2910 | < 0.002 | | 17.3 | 510 | 80 | 0.0008 | 31 | 1.7 | 0.8 | 0.02 | 8 | 10 | 370 | 207 | 1820 | < 7 |
| S3 | 29-Apr-09 | 271 | < 0.15 | < 0.002 | 0.2 | 0.3 | < 0.0001 | 160 | 29 | 660 | | | < 0.005 | 2790 | 0.002 | | 11.1 | 440 | 0.46 | < 0.0005 | 24 | 0.16 | 0.3 | 0.01 | 8 | 4.9 | 420 | 100 | 1780 | < 0.7 |
| S3 | 29-Oct-09 | 404 | 0.64 | 0.003 | 0.34 | 0.21 | < 0.0001 | 200 | 30 | 750 | | | < 0.005 | 3460 | < 0.002 | | 10.8 | 590 | 1.1 | < 0.0005 | 33 | 0.69 | 0.7 | 0.02 | 7.9 | 11 | 500 | 170 | 2200 | 1.3 |
| S3 | 28-Apr-10 | 370 | 0.51 | 0.003 | 0.36 | 0.19 | < 0.0001 | 210 | 27 | 820 | | | < 0.005 | 3520 | < 0.002 | | 9.4 | 580 | < 0.1 | < 0.0005 | 33 | 0.67 | 0.6 | 0.03 | 8.1 | 9.2 | 590 | 140 | 2220 | 1.2 |
| S3 | 2-Nov-10 | 396 | 0.65 | 0.008* | 0.3 | 0.2 | < 0.0001 | 200 | 40 | 710 | | | < 0.005 | 3350 | < 0.002 | | 9.5 | 590 | 0.95 | < 0.0005 | 34 | 0.58 | 0.5 | 0.01 | 8.03 | 10 | 520 | 150 | 2020 | 1.4 |
| S3 | 3-May-11 | 235 | < 0.15 | <0.004 | 0.13 | 0.2 | < 0.0001 | 130 | 24 | 420 | | | < 0.005 | 2010 | < 0.002 | | 7.6 | 380 | 0.18 | < 0.0005 | 18 | 0.063 | 0.3 | < 0.01 | 8.18 | 4 | 290 | 99 | 1210 | < 0.7 |
| S3 FD | 3-May-11 | 235 | < 0.15 | <0.004 | 0.13 | 0.16 | < 0.0001 | 130 | 26 | 420 | | | < 0.005 | 2020 | < 0.002 | | 7.9 | 370 | 0.18 | < 0.0005 | 17 | 0.061 | 0.3 | < 0.01 | 8.17 | 3.9 | 280 | 98 | 1220 | < 0.7 |
| S3 | 8-Nov-11 | 384 | 0.6 | 0.002 | 0.3 | 0.2 | < 0.0001 | 190 | 42 | 680 | | | < 0.005 | 3260 | < 0.002 | | 9.2 | 580 | 0.88 | < 0.0005 | 34 | 0.54 | 0.6 | 0.01 | 7.76 | 11 | 480 | 170 | 1830 | 1.4 |
| S3 FD | 8-Nov-11 | 379 | < 0.15 | <0.002 | 0.32 | 0.21 | < 0.0001 | 200 | 45 | 660 | | | < 0.005 | 3260 | < 0.002 | | 8.9 | 580 | 0.94 | < 0.0005 | 35 | 0.57 | 0.6 | < 0.01 | 7.78 | 12 | 510 | 170 | 1920 | 1.2 |
| S3 | 7-May-12 | 350 | 0.27 | 0.002 | 0.28 | 0.22 | < 0.0001 | 190 | 25 | 740 | | | < 0.005 | 3300 | < 0.002 | | 9.1 | 600 | 0.88 | < 0.0005 | 33 | 0.42 | 0.69 | 0.013 | 7.99 | 10 | 460 | 180 | 1890 | 1.2 |
| S3 | 29-Oct-12 | 290 | 0.16 | 0.001 | 0.22 | 0.31 | < 0.0001 | 200 | 26 | 450 | | | < 0.005 | 2900 | < 0.002 | | 8.7 | 640 | 0.32 | < 0.0005 | 45 | 0.26 | 1.9 | 0.044 | 7.94 | 18 | 390 | 360 | 1750 | 0.9 |
| S3 | 24-May-13 | 180 | <0.15 | 0.002 | 0.13 | 0.067 | <0.0001 | 110 | 56 | 260 | | | <0.005 | 1400 | <0.002 | | 13.7 | 310 | 3 | 0.0064 | 16 | 0.15 | 0.13 | <0.01 | 8.26 | 3.2 | 190 | 90 | 864 | 1.9 |
| S3 | 30-Oct-13 | No Sample collected; highway construction | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Appendix A1: SURFACE WATER QUALITY (PIL, SIL)
Waste Management Ottawa Landfill

| Location | Sample Date | Alkalinity mg/L | Ammonia mg/L | Un-ionized ammonia (mg/L) | Barium mg/L | Boron mg/L | Cadmium mg/L | Calcium mg/L | Chemical Oxygen Demand mg/L | Chloride mg/L | Chromium (+3) mg/L | Chromium (+6) mg/L | Chromium (total) mg/L | Conductivity uS/cm | Cyanide (free) mg/L | Cyanide mg/L | Dissolved Organic Carbon mg/L | Hardness mg/L | Iron mg/L | Lead mg/L | Magnesium mg/L | Manganese mg/L | Nitrate mg/L | Nitrite mg/L | pH unitless | Potassium mg/L | Sodium mg/L | Sulphate mg/L | Total Dissolved Solids mg/L | Total Kjeldahl Nitrogen mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S10 | 11-May-01 | 428 | 1.03 | 0.017 | 0.37 | 0.18 | 0.0002 | 201 | 41 | 670 | | | 0.001 | 2880 | | < 0.005 | | | 0.51 | < 0.001 | 36 | 0.83 | 2.53 | < 0.1 | | 14 | 349 | 136 | | 1.78 |
| S10 | 13-Nov-01 | 268 | 5.05 | 0.023 | 0.16 | 0.3 | < 0.0001 | 203 | 35 | 571 | | | < 0.001 | 2580 | | < 0.005 | | | 0.08 | < 0.001 | 45 | 0.2 | 4.2 | < 0.1 | | 24 | 279 | 279 | | 5.28 |
| S10 | 15-May-02 | 224 | 0.7 | 0.003 | 0.11 | 0.07 | < 0.0001 | 108 | 34 | 391 | | | < 0.001 | 1880 | | < 0.005 | | | 0.3 | < 0.001 | 14 | 0.07 | 0.84 | < 0.1 | | 5 | 260 | 105 | | 1.68 |
| S10 | 12-Nov-02 | 402 | 1.34 | 0.002 | 0.26 | 0.12 | < 0.0001 | 223 | 29 | 766 | | | < 0.005 | 3390 | | < 0.005 | | | 0.36 | < 0.001 | 30 | 0.54 | 0.64 | < 0.1 | | 26 | 456 | 166 | | 2.3 |
| S10 | 22-May-03 | 348 | 0.12 | 0.002 | 0.24 | 0.16 | < 0.0001 | 233 | 32 | 722 | | | < 0.005 | 3060 | | < 0.005 | | | 0.34 | < 0.001 | 37 | 0.36 | 2.17 | < 0.1 | | 16 | 439 | 188 | | 0.87 |
| S10 | 15-Aug-03 | | 0.07 | <0.001 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S10 | 5-Nov-03 | 268 | 1.02 | 0.015 | 0.21 | 0.21 | < 0.0001 | 173 | 36 | 545 | | | 0.005 | 2640 | | < 0.005 | | | 1.06 | < 0.001 | 31 | 0.49 | 1.38 | < 0.1 | | 22 | 369 | 247 | | 1.74 |
| S10 | 22-Dec-03 | | 2.87 | 0.021 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S10 | 30-Apr-04 | 269 | 0.21 | 0.002 | 0.16 | 0.12 | < 0.0001 | 138 | 17 | 440 | | | 0.004 | 2170 | | < 0.005 | | | 0.2 | < 0.001 | 21 | 0.16 | 1.06 | < 0.1 | | 8 | 292 | 115 | | 0.82 |
| S10 | 8-Sep-04 | | 0.06 | 0.001 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S10 | 5-Nov-04 | 263 | 0.61 | 0.002 | 0.15 | 0.21 | < 0.0001 | 137 | 27 | 552 | | | 0.002 | 2520 | | < 0.005 | | | 0.32 | < 0.001 | 29 | 0.2 | 1.28 | < 0.1 | | 12 | 327 | 198 | | 1.24 |
| S10 | 27-Apr-05 | 224 | 0.26 | 0.003 | 0.11 | 0.15 | < 0.0001 | 223 | 18 | 432 | | | < 0.001 | 2070 | | < 0.005 | | | 0.2 | < 0.001 | 24 | 0.08 | 0.97 | < 0.1 | | 6 | 251 | 132 | | 0.94 |
| S10 | 24-Aug-05 | | 0.08 | 0.002 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S10 | 28-Nov-05 | 331 | 1.44 | 0.004 | 0.17 | 0.21 | < 0.001 | 187 | 31 | 704 | | | < 0.005 | 3050 | | < 0.005 | | | 1.14 | < 0.01 | 34 | 0.46 | 2.98 | < 0.1 | | 13 | 388 | 208 | | 2.42 |
| S10 | 26-Apr-06 | 265 | 0.35 | 0.001 | 0.17 | 0.47 | < 0.0001 | 149 | 19 | 609 | | | 0.007 | 2750 | | < 0.005 | | | 0.17 | < 0.001 | 30 | 0.14 | 2.48 | < 0.1 | | 10 | 349 | 181 | | 0.63 |
| S10 | 29-Aug-06 | | 0.2 | 0.003 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S10 | 7-Nov-06 | 362 | 0.04 | <0.001 | 0.18 | 0.27 | < 0.0001 | 189 | 27 | 638 | | | 0.005 | 3070 | | < 0.005 | | | 0.6 | < 0.001 | 34 | 0.35 | 1.65 | < 0.1 | | 13 | 484 | 188 | | 0.73 |
| S10 | 24-Apr-07 | 292 | 0.23 | 0.001 | 0.17 | 0.29 | 0.0018 | 144 | 20 | 500 | | | 0.009 | 2440 | | < 0.005 | | | 0.17 | 0.002 | 30 | 0.21 | 1.36 | < 0.1 | | 10 | 292 | 169 | | 0.77 |
| S10 | 16-Aug-07 | | 0.08 | 0.001 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S10 | 27-Nov-07 | 368 | 0.35 | <0.001 | 0.26 | 0.12 | < 0.0001 | 170 | 23 | 778 | | | < 0.001 | 3320 | | 0.005 | | | 0.61 | < 0.001 | 25 | 0.51 | 0.62 | < 0.1 | | 7 | 438 | 123 | | 1.12 |
| S10 | 23-May-08 | 345 | 0.2 | 0.002 | 0.26 | 0.14 | < 0.0001 | 150 | 42 | 670 | | | < 0.005 | 2990 | < 0.002 | | 9.7 | 490 | 0.41 | < 0.0005 | 22 | 0.33 | 0.4 | 0.02 | 8.2 | 5.9 | 390 | 117 | 1810 | 1.1 |
| S10 | 19-Nov-08 | 413 | 0.53 | <0.001 | 0.3 | 0.16 | < 0.0001 | 200 | 34 | 830 | | | < 0.005 | 3620 | < 0.002 | | 10.3 | 630 | 0.46 | < 0.0005 | 34 | 0.58 | 0.7 | 0.04 | 8.2 | 9.2 | 480 | 179 | 2300 | 1 |
| S10 FD | 19-Nov-08 | 411 | 0.53 | <0.001 | 0.31 | 0.22 | < 0.0001 | 200 | 37 | 840 | | | < 0.005 | 3650 | < 0.002 | | 10.2 | 630 | 0.59 | < 0.0005 | 34 | 0.6 | 0.7 | 0.04 | 8.1 | 9.3 | 530 | 179 | 2400 | 1 |
| S10 | 29-Apr-09 | 279 | < 0.15 | <0.002 | 0.21 | 0.28 | < 0.0001 | 170 | 26 | 680 | | | < 0.005 | 2850 | 0.002 | | 10.8 | 440 | 0.39 | < 0.0005 | 25 | 0.18 | 0.3 | 0.01 | 8 | 5.1 | 460 | 100 | 1830 | < 0.7 |
| S10 | 29-Oct-09 | 393 | < 0.15 | <0.002 | 0.34 | 0.15 | 0.0001 | 190 | 34 | 870 | | | < 0.005 | 3750 | < 0.002 | | 11.2 | 590 | 0.82 | < 0.0005 | 30 | 0.6 | 0.6 | 0.01 | 8 | 8.3 | 570 | 140 | 2390 | < 0.7 |
| S10 | 28-Apr-10 | 346 | < 0.15 | <0.004 | 0.36 | 0.11 | < 0.0001 | 210 | 52 | 960 | | | < 0.005 | 3770 | < 0.002 | | 16 | 550 | 0.15 | < 0.0005 | 28 | 0.43 | < 0.1 | < 0.01 | 8.1 | 6.2 | 620 | 100 | 2400 | 1 |
| S10 | 2-Nov-10 | 372 | 0.15 | 0.002* | 0.25 | 0.09 | < 0.0001 | 220 | 56 | 930 | | | < 0.005 | 3970 | < 0.002 | | 16.1 | 620 | 0.36 | < 0.0005 | 28 | 0.8 | 0.1 | < 0.01 | 8.11 | 5.4 | 610 | 160 | 2440 | 1.1 |
| S10 | 3-May-11 | 251 | < 0.15 | <0.002 | 0.15 | 0.14 | < 0.0001 | 130 | < 4 | 470 | | | < 0.005 | 2170 | < 0.002 | | 8.3 | 390 | 0.12 | < 0.0005 | 17 | 0.11 | 0.2 | < 0.01 | 8.09 | 3.7 | 310 | 94 | 1360 | < 0.7 |
| S10 | 8-Nov-11 | 348 | 0.6 | 0.004 | 0.32 | 0.11 | < 0.0001 | 200 | 39 | 930 | | | < 0.005 | 3860 | < 0.002 | | 10.3 | 550 | 0.4 | < 0.0005 | 23 | 0.43 | < 0.1 | < 0.01 | 7.65 | 4.6 | 650 | 140 | 2190 | < 0.7 |
| S10 | 7-May-12 | 320 | < 0.15 | <0.004 | 0.35 | 0.09 | < 0.0001 | 180 | 45 | 800 | | | < 0.005 | 3400 | < 0.002 | | 10.5 | 530 | 1.4 | 0.0006 | 23 | 0.68 | < 0.1 | < 0.01 | 7.87 | 4.1 | 510 | 130 | 1930 | 1.2 |
| S10 | 29-Oct-12 | 320 | 0.55 | 0.001 | 0.31 | 0.28 | < 0.0001 | 220 | 26 | 570 | | | < 0.005 | 3200 | < 0.002 | | 8.7 | 690 | 0.96 | < 0.0005 | 45 | 0.4 | 1.7 | 0.03 | 8.06 | 16 | 460 | 370 | 1760 | 1.4 |
| S10 | 24-May-13 | 210 | < 0.15 | <0.002 | 0.12 | 0.091 | < 0.0001 | 110 | 37 | 300 | | | < 0.005 | 1600 | < 0.002 | | 12.7 | 340 | 0.24 | < 0.0005 | 14 | 0.053 | < 0.1 | < 0.01 | 8.16 | 3 | 220 | 100 | 928 | 0.9 |
| S10 | 30-Oct-13 | 310 | 0.16 | <0.002 | 0.21 | 0.094 | < 0.0001 | 170 | 45 | 560 | < 0.005 | < 0.0005 | < 0.005 | 2700 | < 0.002 | | 17 | 530 | 1.4 | < 0.0005 | 23 | 0.73 | 0.1 | 0.012 | 7.73 | 6 | 390 | 180 | 1470 | 1 |
| SG-M1 | 4-May-11 | 257 | 0.34 | 0.002 | 0.27 | 0.23 | < 0.0001 | 140 | 18 | 530 | | | < 0.005 | 2380 | < 0.002 | | 5.2 | 400 | 12 | < 0.0005 | 24 | 0.33 | 0.4 | < 0.01 | 7.92 | 6.9 | 350 | 80 | 1460 | 0.8 |
| SG-M1 | 8-Nov-11 | 328 | 2.33 | 0.007 | 0.23 | 0.39 | < 0.0001 | 130 | 37 | 370 | | | < 0.005 | 2000 | < 0.002 | | 8.6 | 400 | 3 | < 0.0005 | 28 | 0.46 | < 0.1 | < 0.01 | 7.66 | 10 | 270 | 58 | 1180 | 2.9 |
| SG-M1 | 7-May-12 | 260 | 1.02 | 0.012 | 0.43 | 0.31 | < 0.0001 | 170 | 48 | 660 | | | < 0.005 | 2800 | < 0.002 | | 8.2 | 500 | 12 | 0.0015 | 30 | 0.73 | 0.27 | 0.019 | 7.96 | 9.7 | 380 | 99 | 1610 | 3 |
| SG-M3 | 4-May-11 | 246 | < 0.15 | <0.002 | 0.2 | 0.19 | < 0.0001 | < 0.2 | 12 | 500 | | | < 0.005 | 2250 | < 0.002 | | 4.6 | 380 | < 0.1 | < 0.0005 | < 0.05 | 0.071 | 0.5 | < 0.01 | 8.1 | < 0.2 | 0.63 | 71 | 1450 | < 0.7 |
| SG-M3 | 8-Nov-11 | 271 | < 0.15 | <0.002 | 0.2 | 0.26 | < 0.0001 | 130 | 27 | 450 | | | < 0.005 | 2130 | < 0.002 | | 4.6 | 370 | 0.16 | < 0.0005 | 22 | 0.13 | 0.2 | < 0.01 | 8.08 | 5 | 320 | 64 | 1160 | < 0.7 |
| SG-M3 | 7-May-12 | 220 | < 0.15 | <0.004 | 0.29 | 0.22 | < 0.0001 | 140 | 18 | 650 | | | < 0.005 | 2700 | < 0.002 | | 10.3 | 440 | 0.91 | < 0.0005 | 25 | 0.29 | 0.36 | < 0.01 | 8.13 | 6.3 | 380 | 82 | 1470 | < 0.7 |
| SG-M3 FD | 7-May-12 | 220 | < 0.15 | <0.004 | 0.28 | 0.21 | < 0.0001 | 140 | 19 | 640 | | | < 0.005 | 2700 | < 0.002 | | 7.6 | 440 | 0.65 | < 0.0005 | 24 | 0.22 | 0.37 | < 0.01 | 8.1 | 6.1 | 360 | 80 | 1500 | < 0.7 |
| M4 | 29-Oct-12 | 350 | 3.26 | 0.010 | 0.33 | 0.27 | < 0.0001 | 170 | 27 | 620 | | | < 0.005 | 2900 | < 0.002 | | 8.3 | 540 | 3.3 | < 0.0005 | 33 | 0.55 | < 0.1 | < 0.01 | 8.02 | 10 | 420 | 86 | 1630 | 4.1 |
| M4 FD | 29-Oct-12 | 350 | 3.04 | 0.009 | 0.35 | 0.28 | < 0.0001 | 170 | 26 | 610 | | | < 0.005 | 2900 | < 0.002 | | 8.3 | 530 | 3.4 | < 0.0005 | 34 | 0.57 | < 0.1 | < 0.01 | 8.02 | 11 | 430 | 84 | 1720 | 3.7 |
| M4 | 24-May-13 | 270 | 1.07 | 0.004 | 0.27 | 0.18 | <0.0001 | 160 | 22 | 640 | | | <0.005 | 2700 | <0.002 | | 7.3 | 490 | 0.74 | <0.0005 | 28 | 0.34 | 0.48 | <0.01 | 8.05 | 7.5 | 430 | 110 | 1600 | 1.7 |
| M4 FD | 24-May-13 | 270 | 1.09 | 0.004 | 0.26 | 0.18 | <0.0001 | 160 | 23 | 620 | | | | 2700 | <0.002 | | 7.3 | 490 | 0.7 | <0.0005 | 28 | 0.32 | 0.49 | <0.01 | 8.05 | 7.2 | 420 | 110 | 1630 | 1.7 |
| M4 | 29-Oct-13 | 300 | 0.99 | 0.002 | 0.26 | 0.24 | <0.0001 | 140 | 14 | 510 | < 0.005 | < 0.0005 | <0.005 | 2500 | 0.0025 | | 5.4 | 460 | 0.68 | <0.0005 | 25 | 0.33 | 0.45 | 0.016 | 7.71 | 9 | 370 | 120 | 1320 | 1.5 |
| M5 | 29-Oct-12 | 260 | < 0.15 | <0.004 | 0.26 | 0.07 | < 0.0001 | 160 | 19 | 730 | | | < 0.005 | 3100 | 0.002 | | 6.7 | 480 | 0.85 | < 0.0005 | 26 | 0.26 | 0.27 | < 0.01 | 8.29 | 5.2 | 480 | 67 | 1830 | < 0.7 |
| M5 | 24-May-13 | 250 | 0.28 | 0.002 | 0.23 | 0.094 | < 0.0001 | 150 | 23 | 660 | | | < 0.005 | 2700 | < 0.002 | | 6.5 | 460 | 1 | < 0.0005 | 24 | 0.25 | 0.24 | < 0.01 | 8.18 | 5 | 430 | 80 | 1610 | 0.9 |
| M5 | 29-Oct-13 | 240 | < 0.15 | <0.001 | 0.22 | 0.058 | < 0.0001 | 130 | 8.1 | 620 | < 0.005 | < 0.0005 | < 0.005 | 2600 | 0.0035 | | 3.7 | 440 | 0.22 | < 0.0005 | 21 | 0.054 | 0.37 | < 0.01 | 8.09 | 4 | 420 | 71 | 1350 | < 0.7 |
| M5 FD | 29-Oct-13 | 240 | < 0.15 | <0.001 | 0.22 | 0.057 | < 0.0001 | 120 | 8.5 | 620 | < 0.005 | < 0.0005 | < 0.005 | 2600 | 0.0036 | | 3.7 | 420 | 0.2 | < 0.0005 | 20 | 0.054 | 0.35 | < 0.01 | 8.15 | 4 | 400 | 69 | 1340 | < 0.7 |

Appendix A2: SURFACE WATER QUALITY (VOCs)
Waste Management Ottawa Landfill

| Location | Sample Date | 1,1,1,2-Tetrachloroethane mg/L | 1,1,1-Trichloroethane mg/L | 1,1,2,2-Tetrachloroethane mg/L | 1,1,2-Trichloroethane mg/L | 1,1-Dichloroethane mg/L | 1,1-Dichloroethene mg/L | 1,2-Dichlorobenzene (o) mg/L | 1,2-Dichloroethane mg/L | 1,2-Dichloropropane mg/L | 1,3,5-Trimethylbenzene mg/L | 1,3-Dichlorobenzene (m) mg/L | 1,4-Dichlorobenzene (p) mg/L | Benzene mg/L | Bromodichloromethane mg/L | Bromoform mg/L | Bromomethane mg/L | Carbon Tetrachloride mg/L | Chlorobenzene mg/L | Chlorodibromomethane mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 22-May-03 | < 0.0006 | < 0.0021 | < 0.0034 | < 0.0019 | < 0.0035 | < 0.0016 | < 0.0019 | < 0.0029 | < 0.0024 | < 0.0016 | < 0.0024 | < 0.0024 | < 0.0013 | < 0.002 | < 0.0019 | < 0.0005 | < 0.0013 | < 0.002 | < 0.0023 |
| S1 | 23-May-03 | < 0.0006 | < 0.0004 | < 0.0006 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0007 | < 0.0007 | < 0.0003 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0005 | < 0.0009 | 0.0002 | < 0.0003 |
| S1 | 30-Apr-04 | < 0.0006 | < 0.0021 | < 0.0034 | < 0.0019 | < 0.0035 | < 0.0016 | < 0.0019 | < 0.0029 | < 0.0024 | < 0.0016 | < 0.0024 | < 0.0024 | < 0.0013 | < 0.002 | < 0.0019 | < 0.0005 | < 0.0013 | < 0.002 | < 0.0023 |
| S1 | 27-Apr-05 | < 0.0006 | < 0.0021 | < 0.0034 | < 0.0019 | < 0.0035 | < 0.0016 | < 0.0019 | < 0.0029 | < 0.0024 | < 0.0016 | < 0.0024 | < 0.0024 | < 0.0013 | < 0.002 | < 0.0019 | < 0.0005 | < 0.0013 | < 0.002 | < 0.0023 |
| S1 | 26-Apr-06 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0002 | < 0.0003 |
| S1 | 24-Apr-07 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0002 | < 0.0003 |
| S1 | 23-May-08 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | 0.0001 | < 0.0002 |
| S1 FD | 23-May-08 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S1 | 29-Apr-09 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S1 | 28-Apr-10 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S1 | 3-May-11 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S1 | 07-May-12 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S1 | 24-May-13 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 | 22-May-03 | < 0.0006 | < 0.0021 | < 0.0034 | < 0.0019 | < 0.0035 | < 0.0016 | < 0.0019 | < 0.0029 | < 0.0024 | < 0.0016 | < 0.0024 | < 0.0024 | < 0.0013 | < 0.002 | < 0.0019 | < 0.0005 | < 0.0013 | < 0.002 | < 0.0023 |
| S3 | 30-Apr-04 | < 0.0006 | < 0.0021 | < 0.0034 | < 0.0019 | < 0.0035 | < 0.0016 | < 0.0019 | < 0.0029 | < 0.0024 | < 0.0016 | < 0.0024 | < 0.0024 | < 0.0013 | < 0.002 | < 0.0019 | < 0.0005 | < 0.0013 | < 0.002 | < 0.0023 |
| S3 | 27-Apr-05 | < 0.0006 | < 0.0021 | < 0.0034 | < 0.0019 | < 0.0035 | < 0.0016 | < 0.0019 | < 0.0029 | < 0.0024 | < 0.0016 | < 0.0024 | < 0.0024 | < 0.0013 | < 0.002 | < 0.0019 | < 0.0005 | < 0.0013 | < 0.002 | < 0.0023 |
| S3 | 26-Apr-06 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0002 | < 0.0003 |
| S3 | 24-Apr-07 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0004 | < 0.0005 | < 0.0003 | < 0.0004 | < 0.0005 | < 0.0005 | < 0.0002 | < 0.0003 |
| S3 | 23-May-08 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 | 29-Apr-09 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 | 28-Apr-10 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 | 3-May-11 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 FD | 3-May-11 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 | 07-May-12 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |
| S3 | 24-May-13 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0001 | < 0.0002 |

Appendix A2: SURFACE WATER QUALITY (VOCs)
Waste Management Ottawa Landfill

| Location | Sample Date | Chloroethane mg/L | Chloroform mg/L | Chloromethane mg/L | Cis-1,2-Dichloroethene mg/L | Cis-1,3-Dichloropropene mg/L | Ethylbenzene mg/L | Ethylene Dibromide mg/L | m+p-Xylene mg/L | Methylene Chloride mg/L | o-Xylene mg/L | Styrene mg/L | Tetrachloroethylene mg/L | Toluene mg/L | Trans-1,2-dichloroethene mg/L | Trans-1,3-dichloropropene mg/L | Trichloroethene mg/L | Trichlorofluoromethane mg/L | Vinyl Chloride mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 22-May-03 | < 0.001 | < 0.0014 | < 0.001 | < 0.0012 | < 0.0026 | < 0.0016 | < 0.0038 | < 0.0034 | < 0.0048 | < 0.0027 | | < 0.0022 | < 0.0015 | < 0.0011 | < 0.0021 | < 0.0019 | < 0.002 | < 0.0049 |
| S1 | 23-May-03 | < 0.001 | < 0.0005 | < 0.001 | < 0.0004 | < 0.0002 | < 0.0005 | < 0.001 | < 0.001 | < 0.004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0005 | < 0.0004 | < 0.0002 | < 0.0003 | < 0.0005 | < 0.0005 |
| S1 | 30-Apr-04 | < 0.001 | < 0.0014 | < 0.001 | < 0.0012 | < 0.0026 | < 0.0016 | < 0.0038 | < 0.0034 | < 0.0048 | < 0.0027 | < 0.0042 | < 0.0022 | < 0.0015 | < 0.0011 | < 0.0021 | < 0.0019 | < 0.002 | < 0.0049 |
| S1 | 27-Apr-05 | < 0.001 | < 0.0014 | < 0.001 | < 0.0012 | < 0.0026 | < 0.0016 | < 0.0038 | < 0.0034 | < 0.0048 | < 0.0027 | < 0.0042 | < 0.0022 | < 0.0015 | < 0.0011 | < 0.0021 | < 0.0019 | < 0.002 | < 0.0049 |
| S1 | 26-Apr-06 | < 0.001 | < 0.0005 | < 0.001 | < 0.0004 | < 0.0002 | < 0.0005 | < 0.001 | < 0.001 | < 0.004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0005 | < 0.0004 | < 0.0002 | < 0.0003 | < 0.0005 | < 0.0002 |
| S1 | 24-Apr-07 | < 0.001 | < 0.0005 | < 0.001 | < 0.0004 | < 0.0002 | < 0.0005 | < 0.001 | < 0.001 | < 0.004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0005 | < 0.0004 | < 0.0002 | < 0.0003 | < 0.0005 | < 0.0002 |
| S1 | 23-May-08 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S1 FD | 23-May-08 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | 0.0007 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S1 | 29-Apr-09 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S1 | 28-Apr-10 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S1 | 3-May-11 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S1 | 07-May-12 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S1 | 24-May-13 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 | 22-May-03 | < 0.001 | < 0.0014 | < 0.001 | < 0.0012 | < 0.0026 | < 0.0016 | < 0.0038 | < 0.0034 | < 0.0048 | < 0.0027 | | < 0.0022 | < 0.0015 | < 0.0011 | < 0.0021 | < 0.0019 | < 0.002 | < 0.0049 |
| S3 | 30-Apr-04 | < 0.001 | < 0.0014 | < 0.001 | < 0.0012 | < 0.0026 | < 0.0016 | < 0.0038 | < 0.0034 | < 0.0048 | < 0.0027 | < 0.0042 | < 0.0022 | < 0.0015 | < 0.0011 | < 0.0021 | < 0.0019 | < 0.002 | < 0.0049 |
| S3 | 27-Apr-05 | < 0.001 | < 0.0014 | < 0.001 | < 0.0012 | < 0.0026 | < 0.0016 | < 0.0038 | < 0.0034 | < 0.0048 | < 0.0027 | < 0.0042 | < 0.0022 | < 0.0015 | < 0.0011 | < 0.0021 | < 0.0019 | < 0.002 | < 0.0049 |
| S3 | 26-Apr-06 | < 0.001 | < 0.0005 | < 0.001 | < 0.0004 | < 0.0002 | < 0.0005 | < 0.001 | < 0.001 | < 0.004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0005 | < 0.0004 | < 0.0002 | < 0.0003 | < 0.0005 | < 0.0002 |
| S3 | 24-Apr-07 | < 0.001 | < 0.0005 | < 0.001 | < 0.0004 | < 0.0002 | < 0.0005 | < 0.001 | < 0.001 | < 0.004 | < 0.0005 | < 0.0005 | < 0.0003 | < 0.0005 | < 0.0004 | < 0.0002 | < 0.0003 | < 0.0005 | < 0.0002 |
| S3 | 23-May-08 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 | 29-Apr-09 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 | 28-Apr-10 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 | 3-May-11 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 FD | 3-May-11 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 | 07-May-12 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |
| S3 | 24-May-13 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0005 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0001 | < 0.0002 | < 0.0002 |

# Appendix B

## Mississippi Valley Conservation Authority Review Letter

# Conservation Partners
# Partenaires de conservation

Mississippi Valley Conservation Authority Office de protection de la nature de la vallée Mississippi | OFFICE DE PROTECTION DE LA NATURE DE LA VALLÉE RIDEAU RIDEAU VALLEY CONSERVATION AUTHORITY | SOUTH NATION CONSERVATION DE LA NATION SUD

File: D02-02-14-0015

May 5, 2014

Cheryl McWilliams
City of Ottawa
Planning and Growth Management Department
110 Laurier Avenue West, 4th Floor
Ottawa, ON K1P 1J1

Dear Ms. McWilliams:

Re: Zoning By-law Amendment D02-02-14-0015 2349 TO 2432 Carp Road, City of Ottawa (West Carleton, Huntley)

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Staff of Mississippi Valley Conservation Authority (MVCA) reviewed the application for concerns related to natural heritage, natural hazards, and water quality and quantity. The application will permit the expansion of the existing waste management operation. MVCA participated in the Environmental Assessment related to the expansion of the landfill and reviewed several technical documents associated with the preferred expansion site and impacts to the aquatic and terrestrial environment. The following is offered for your consideration:

Background

As part of the Environmental Site Assessment the MVCA commented on impacts related to surface water, groundwater and the natural environment. We note that the Provincially Significant Goulbourn Wetland is located approximately over 500 m to the west of the proposed expansion. MVCA concurred that the option selected for expansion (current location) would have the least amount of impact on the natural environment. MVCA also identified concerns related to runoff to the tributaries to Huntley Creek. It is MVCA's understanding that City staff will be reviewing impacts to groundwater.

EIS Review

MVCA has reviewed the Environmental Impact Statement for the West Carleton Environmental Centre Landfill Expansion prepared by AECOM.

*Surface Water Features*

The expansion of the landfill zoning as shown on Figure 2, illustrates that the potential interactions with surface water have been minimized. Tributary C has been classified as poor fish habitat and comes closest to the rezoned area crossing William Mooney Road 40m north of the North West corner of the site. The mapping also displays that 4 intermittent streams flow from the northern border through forested land into tributary C. The report indicates that most of these watercourses will not be directly impacted by the development as proposed. A small strip of forest is proposed to be removed along the southern edge of a Green Ash Swamp which is the headwaters for the eastern-most stream. Impacts to the remaining forested land to the north of the site, as well as the intermittent streams, will be reduced from the onsite development activities through the creation of a minimum 5m wide buffer strip along the northern edge and along the western edge at William Mooney Road (Figure 7A, AECOM 2014 report). It is acknowledged that there may be some changes to the surface water drainage patterns that feed these features.

*Wetlands*

There is a cluster of onsite ponds which were created when an aggregate pit was abandoned. These ponds have naturalized into wetland habitat features that support 6 species of amphibians. These ponds will be lost in the development of the site. As part of the mitigation measures for removing these ponds the existing storm water ponds located along Highway 417 will have their shorelines modified to improve access for species, as well having their shorelines enhanced by planting trees and shrubs. As the wetland ponds are drained it has been recommended that any turtles or amphibians found are relocated to the ponds along Hwy 417. No significant anticipated impact to the PSW is anticipated as a result of the expansion.

*Terrestrial Features and Connectivity*

The development of this site will result in the permanent removal of approximately 24.9 ha of natural vegetation. Of note 9.5 ha of forest and 4.0 ha of wetland will be removed. Efforts to restore, create, or enhance features are discussed in the report. The report provides a summary of impacts and mitigation on other features such as forest edges, wildlife corridors and the Bank Swallow colony.

It is proposed that connectivity along the western boundary will be improved by creating a 5 m wide forested buffer strip along William Mooney Road where there had previously been an open agricultural field. This will connect the old storm water ponds proposed for wetland enhancement and forest habitat in the south, to the forest and watercourses in the north that feed the South Branch of Huntley Creek.

*Recommendations and review of the AECOM Report*

Section 8 of the report (page 39-53) discusses the recommended mitigation measures for the construction of the new landfill site as well as suggested habitat enhancements.

MVCA has reviewed the potential impacts and concurs with the proposed mitigation measures as they appear to offset the proposed site alterations.

MVCA recommends the following in addition to the mitigation proposed in the report:

- That the mitigation, enhancement, and monitoring measures discussed in the report be applied.
- MVCA requests that a copy of future monitoring reports be forwarded to our office.
- Natural areas to be retained are to be isolated by sturdy construction fencing or similar barrier at least 1 m in height during construction in order to ensure their retention.
- No woody vegetation should be removed between April 15th and July 31st unless a breeding bird survey is conducted.

Our geographic information systems (GIS) mapping does not identify that there are any potential natural hazards such as floodplain, unstable slopes, or unstable soils associated with the planning area. We therefore do not have any concerns from this perspective.

Water Quality and Quantity

The site servicing and stormwater management report has been reviewed. As outlined in the provided report, there are two separate systems operating on site. One system results in leachate being collected and discharged to the local sanitary sewer, reducing the risk of groundwater and surface water contamination. The second system directs surface runoff from the landfill to the new stormwater facility.

The proposed stormwater facility is intended to capture 100% of the 1:100 year flow coming from the remaining portion of the site, and allow it to infiltrate into the local soils. This will increase base flow in the local tributaries, but would not increase peak flow. The storage capacity is approximately 50% greater than is required for the 1:100 year event. The old storm water ponds that serviced the previous landfill activity are on the south side of the landfill adjacent to Highway 417 and will be altered for habitat mitigation efforts.

Summary

MVCA has no objection to the proposal related to our review of Natural Hazards, Natural Heritage and water quality and quantity.

Please note that MVCA's 120 metre regulation limit for Goulbourn Provincially Significant Wetland Complex (PSW) extends over a portion of site. Under Ontario Regulation 153/06, MVCA's "Development, Interference with Wetlands and Alteration to Shorelines and Watercourses" regulation, written authorization is required from MVCA for any development within the 120 metre regulation limit of the PSW.

Thank you for the circulation. Please advise us of the decisions in these matters.

Yours truly,

Matt Craig
Manager of Planning and Regulations