The results of the vertical hydraulic conductivity testing indicate the silty clay has a consistently low permeability at the various depths sampled. Based on the hydraulic conductivity of the silty clay, the formation is referred to as an aquitard and serves as a confining stratigraphic unit to the underlying glacial till and upper bedrock. Groundwater flow is assumed to predominantly occur in the vertical direction within the silty clay aquitard, and based on estimates of the vertical hydraulic conductivity there is minimal groundwater flow in this material.

Based on the results of the in-situ hydraulic conductivity testing completed at the Site, assumed horizontal to vertical anisotropy in the silty clay and measured horizontal hydraulic gradients, the ranges in horizontal hydraulic conductivity and average linear groundwater velocity were determined for the various overburden and upper bedrock formations as shown in Table 8.5.2-1.

Table 8.5.2-1: Hydraulic Conductivity and Groundwater Velocity

Formation	Horizontal Hydraulic Conductivity Range (m/s)	Average Linear Groundwater Velocity Range at the CRRRC Site (m/year)
Surficial Silty Sand	9×10^{-8} to 2×10^{-5} (moderate hydraulic conductivity)	<0.01 to 1.8
Shallow Clay with Silty Layer	3×10^{-8} to 3×10^{-6} (moderate hydraulic conductivity)	<0.01 to 0.2
Silty Clay	7×10^{-9} to 2×10^{-8} (low hydraulic conductivity)	<0.01
Glacial Till	8×10^{-9} to 2×10^{-4} (variably low to high hydraulic conductivity)	<0.01 to 9
Upper Bedrock Zone	2×10^{-8} to 2×10^{-5} (low to moderate hydraulic conductivity)	<0.01 to 4.4

In summary, groundwater flow is generally in an easterly direction across the Site. Groundwater movement is quite slow. The groundwater table is close to the ground surface and has a tendency to move vertically downwards. The silty clay does not allow water to flow easily and is therefore seen as a confining layer to the underlying glacial till and upper bedrock.

8.5.2.3 Background Groundwater Quality

Based on the results of the groundwater quality sampling program, groundwater quality at the Site varies from fresh to brackish and deteriorates with depth. The groundwater within the surficial silty sand and the silty layer typically exceed the Ontario Drinking Water Quality Standards (ODWQS; MOE, 2003a) for total dissolved solids (TDS) and manganese, and occasionally for dissolved organic carbon (DOC). Within the glacial till and upper bedrock, elevated concentrations of barium, chloride, sodium and TDS and occasionally manganese are observed compared to the applicable ODWQS. Groundwater quality samples collected in the upper bedrock were also analyzed for dissolved methane, which consistently exceeded the ODWQS at several monitoring wells. These elevated concentrations are interpreted to be naturally occurring.

Two residential water supply wells and one commercial water supply well were sampled in January 2013. Residential water supply wells are situated along Frontier Road (two: Frontier-1 and Frontier-2) within the northeast limits of the CRRRC Site and one commercial supply well (Boundary-1) is situated west of the CRRRC

Site. The residential water supply wells are shown in Figure 8.5-1. The results of the water supply sampling program indicate that most parameters analyzed were below the respective ODWQS (MOE, 2003a). Parameters exceeding the ODWQS include DOC and manganese at all three water supply locations, along with TDS and iron at the commercial water supply well only. The results of the residential water supply wells sampling program indicate that groundwater quality at the private well locations is comparable to the groundwater quality observed at monitoring wells screened within the surficial silty sand at the Site, with the exception of chloride, chemical oxygen demand (COD), total phosphorus, sodium, TDS and total Kjeldahl nitrogen (TKN) that are generally observed at higher concentrations in the Site monitoring wells.

8.5.3 Geotechnical

This section presents information on the geotechnical parameters of the subsurface materials encountered at the Site. These materials were described in Section 8.5.1.2.

Below the topsoil layer (measuring between 0.05 and 0.3 metres in thickness) is between 0 to 2.7 metres of sand, silty sand and/or sandy silt with trace to some clay. Standard penetration tests indicated a very loose to compact state of packing for the sandy soils.

The surficial silty sand soils are underlain by a thick deposit of silty clay. The upper 0.1 to 1.3 metres of the silty clay at most of the investigation locations has been weathered to a red brown crust (referred to as 'weathered crust'). Layers and seams of silty sand, sand and clayey silt were also encountered within the weathered portion of the silty clay. Standard penetration tests carried out in the weathered material indicated a stiff consistency.

The silty clay below the surficial silty sand and silt or weathered crust (where present) is unweathered. The results of *in-situ* vane testing in this unweathered material indicated that undrained shear strengths generally increase with depth, with a generally soft consistency to about 9 to 10 metres depth, followed by a firm consistency to about 15 to 18 metres depth, followed by stiff to very stiff for the remainder of the deposit. The measured sensitivity of the unweathered silty clay deposit indicates a medium sensitive to extrasensitive soil. The results of Atterberg limit testing carried out on several samples of the unweathered silty clay indicate a relatively high plasticity soil. The water content above about 20 metres depth is typically in the range of 65% to 85%, while the water content below about 20 metres depth is generally slightly less, being typically in the range of 60% to 70%.

The silty clay is underlain by a deposit of glacial till. Based on the retrieved samples and observations of the sampler/drilling resistance, the glacial till is considered to generally consist of a heterogeneous mixture of gravel, cobbles and boulders in a matrix of sand and silt with a trace to some clay. Standard penetration tests indicate a loose to very dense state of packing. However, the higher standard penetration test results encountered in the glacial till likely reflect the presence of cobbles and boulders in the deposit.

The boreholes cored into bedrock beneath the Site all encountered the Carlsbad Formation. The Rock Quality Designation (RQD) values measured on recovered bedrock core samples typically range from about 59% to 100%, indicating a fair to excellent quality rock. However, two lower RQD values of 12% and 29% were measured within the upper portion of the bedrock at borehole locations 12-3-3 and 12-2-3, respectively, indicating poorer quality bedrock.

The results of geophysical testing that was carried out in two boreholes at the Boundary Road Site indicate measured average shear-wave velocity that corresponds to the Site being a Class E site, as related to design of structures as set out in the National Building Code of Canada (NRC, 2010) and the Ontario Building Code (MMAH, 2012). This agrees with the published seismic site class map of the Ottawa area (Hunter et. al., 2012).

In summary, based on geotechnical testing at the Site, the surficial silty sand layer is considered to be loosely packed, followed by a limited thickness of stiff weathered silty clay "crust" (in some areas). The unweathered silty clay which underlies the Site has a soft consistency at shallower depths and becomes stiff below about 15 to 18 metres depth. The underlying glacial till is a mixture of gravel, cobbles, boulders, sand and silt. The upper portion of the bedrock is considered to generally have a fair to excellent quality (i.e., it has a low degree of fracturing).

8.6 Surface Water

This section presents the existing surface water conditions in and around the Site. The study area for this component is provided in Section 2.3. The information and assessments presented in this section have been compiled from more detailed information contained in Volume IV.

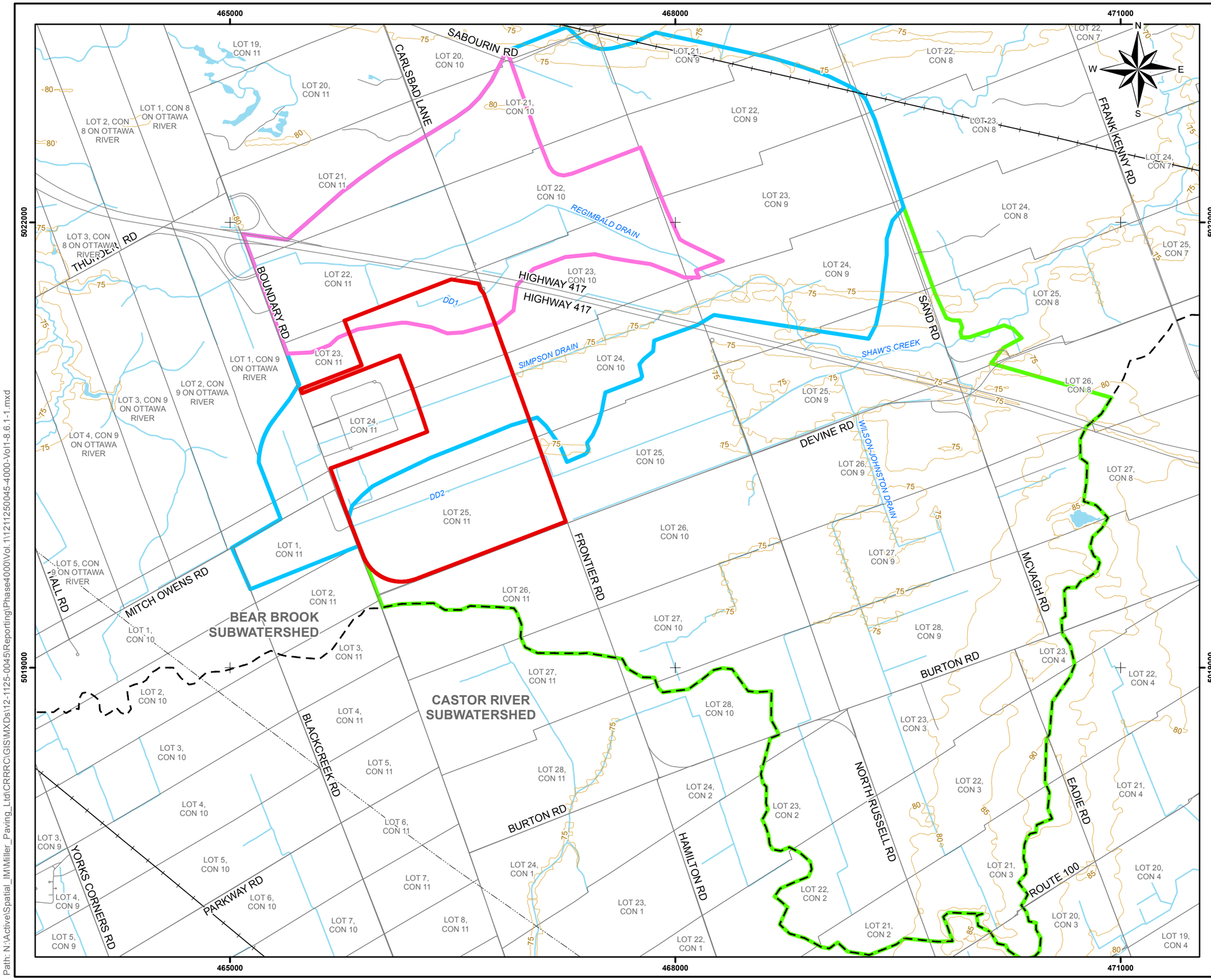
In order to assess the existing surface water conditions, a field monitoring program was initiated to capture seasonal changes that exist at the Site and surrounding area. Data regarding the existing surface water flow and quality representative of conditions upstream and downstream of the proposed CRRRC were collected and other resources such as municipal waterway monitoring reports were reviewed. Because of the intermittent to stagnant nature of surface water flow in the area of the Site, a hydrological model was used to calculate surface water runoff and peak flows in the area of the Site under existing conditions, using 2, 5, 25 and 100 year design storms.

8.6.1 Natural Watercourses

There are four natural watercourses within 5 kilometres of the Site. Bear Brook Creek is 3.4 kilometres to the northwest of the property boundaries and Shaw's Creek is 1.6 kilometres to the east. Bear Brook Creek is a major tributary of the South Nation River. The North Castor River is 4.7 kilometres to the southwest of the property, while Black Creek is approximately 2.5 kilometres to the southeast. Both the North Castor River and Black Creek are part of the Castor River subwatershed and, as such, are isolated by the subwatershed boundary from receiving potential drainage from the Site. The approximate boundary between the Bear Brook Creek subwatershed and the Castor River subwatershed is shown on Figure 8.6.1-1. There are no municipal surface water intakes located along tributaries or sections of Bear Brook Creek, with communities primarily relying on groundwater or municipal systems for their water supply (South Nation Conservation Authority, 2012).

The water quality in Bear Brook Creek is reflective of the rural, agricultural population in its vicinity. According to the City of Ottawa Water Environment Protection Program (WEPP) 2008 to 2014 data for Bear Brook Creek (City of Ottawa, 2014), 0% to 44% of the phosphorus, E.*coli* and copper inwater quality samples meet provincial and federal targets and 95% to 100% of zinc samples meet provincial and federal targets.

The average daily discharge at HYDAT station 02LB008 for 2001 to 2010 is 7.42 m^3/s (HYDAT: Environment Canada, 2010). This represents seven years of data as the records were incomplete for 2001, 2004 and 2007.



LEGEND

- POPULATED PLACENAME
- ROAD
- RAIL ROAD
- CONTOUR LINE, (5m)
- UTILITY LINE
- REGIMBALD MUNICIPAL DRAIN BOUNDARY
- SIMPSON MUNICIPAL DRAIN BOUNDARY
- WILSON-JOHNSTON MUNICIPAL DRAIN BOUNDARY
- SURFACE WATER FEATURE
- WATER AREA
- SUBWATERSHED DIVIDE
- LOT/CONCESSION
- PROPERTY BOUNDARY

NOTE

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

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT
ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
SURFACE WATER FEATURES

Golder Associates

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	DEC. 2013		
GIS	BR	DEC. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

FIGURE 8.6.1-1

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Reporting\Phase4000Vol.1\1121125045-4000-Vol1-8.6.1-1.mxd

8.6.2 Existing Drainage

Drainage in the vicinity of the Site is mainly by means of a network of agricultural ditches and three municipal drains. Ditches that cross the Site, some of which are old farm field drainage, have not been maintained. There are roadside ditches along Boundary, Devine and Frontier Roads that eventually all drain eastward. At present, drainage on the Site is not well established and the land is poorly drained. Delineated pre-development drainage catchments are presented in Figure 8.6.2-1.

The Site is divided into three sub-catchment areas with discharge to the eastern boundaries of the Site. The discharge ditches of the three sub-catchments all eventually tie into municipal drains. Summaries for each of these Site drainage areas are provided below.

8.6.2.1 Regimbald Municipal Drain

The northern Site sub-catchment area primarily drains to two on-Site agricultural ditches. One ditch segment drains northerly from the Site while another drains easterly towards Frontier Road. Both ditch segments eventually become part of the Regimbald Drain, the first about 200 metres north of the northern property limit, while the second is on the east side of Frontier Road. The portion of the Site draining to the Regimbald Drain is about 21 hectares, or about 11% of the Site.

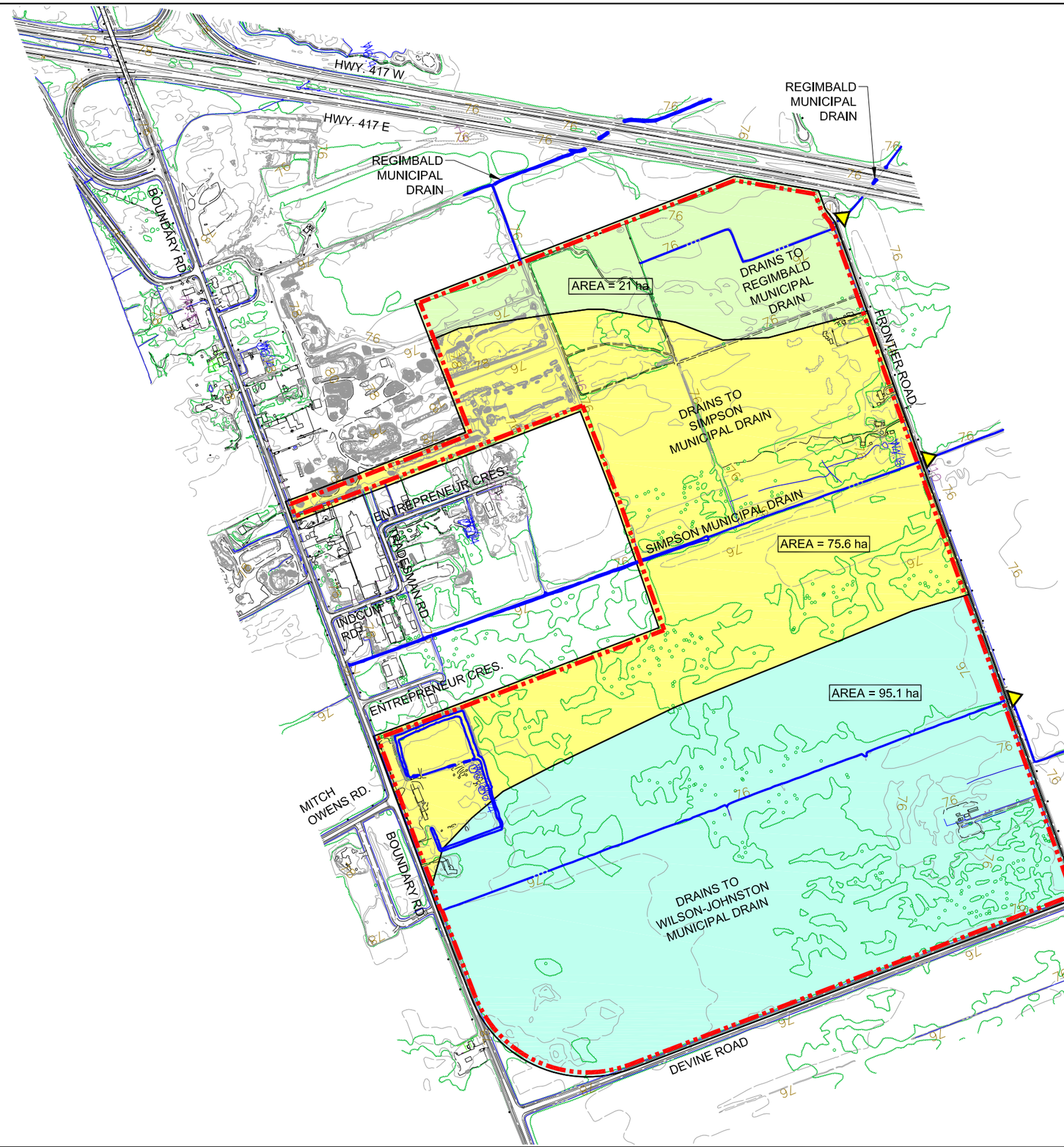
8.6.2.2 Simpson Municipal Drain

The Simpson Municipal Drain bisects the Site and drains from west to east. An upstream drainage area drains to the Simpson Drain segment through the Site, extending to the west of Boundary Road, along Mitch Owens Road to Black Creek Road.

The runoff from the central portions of the Site is directed to the Simpson Municipal Drain and is conveyed off-Site and then discharges through a culvert under Frontier Road. Downstream, the Simpson Drain continues under Highway 417 and then as Shaw's Creek, which eventually feeds Bear Brook Creek. The portion of the Site draining to the Simpson Drain is about 75.6 hectares, or about 39% of the Site.

8.6.2.3 Wilson-Johnston Municipal Drain

The southern portion of the Site is primarily drained by a ditch flowing west to east across the entire width of the Site. This ditch extends west to Boundary Road but only receives runoff from the eastern half of the road allowance as the western portion connects to the Simpson Drain at Mitch Owens Road. This ditch continues to flow east and eventually becomes part of the Wilson-Johnston Municipal Drain. The portion of the Site draining to the Wilson-Johnston Drain is about 95.1 hectares, or about 50% of the Site.



N
W E
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LEGEND:

- PROPERTY BOUNDARY
- SURFACE WATER
- OUTLET
- DRAINAGE AREA BOUNDARY

NOTE

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

REFERENCES:

1. BASE DRAWING PROVIDED IN A DIGITAL FORMAT BY BASE MAPPING CO. LTD., CONTRACT No. 2517-12, PHOTO DATE: NOVEMBER 7, 2012, DATE RECEIVED: JANUARY 9, 2013.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18.
3. MUNICIPAL DRAIN BOUNDARIES FROM TOWNSHIP OF CUMBERLAND MUNICIPAL DRAIN & MUTUAL AGREEMENT PREPARED BY STANTEC, REVISED MARCH 2000.

200 0 200 400
SCALE 1:10,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

PRE-DEVELOPMENT DRAINAGE AREAS

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045	FILE No.	1211250045-V1 Figure 8.6.2-1.dwg	
DESIGN	D.H.	22 Jan, 2013	SCALE	AS SHOWN	REV. 0
CAD	M.L.F.	23 Jan, 2013	FIGURE No.		
CHECK	D.V.K.	Aug, 2014		8.6.2-1	
REVIEW	P.A.S.	Aug, 2014			

PLOT DATE: September 5, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 1 (Report Figures)\Chapter 8\1211250045-V1 Figure 8.6.2-1.dwg

8.6.3 Surface Water Quantity

The collection, conveyance and detention of runoff through the Site were modelled. The modelling data denotes the extent of knowledge on the quantity of surface runoff water from the Site. The values from the hydrological modelling are presented in Table 8.6.3-1.

Table 8.6.3-1: Estimated Pre-Development Peak Flow Rates

Peak Flow (Litres per second)				
24 Hour Design Storm				
Sub-Catchment Area	**1:2 Year**	**1:5 Year**	**1:25 Year**	**1:100 Year**
Regimbald (northern)	86	298	471	538
Simpson (central)	35	284	585	732
Wilson-Johnston (southern)	40	345	715	898

The Regimbald sub-catchment experiences the highest peak flows for the 1:2 year event, while the Wilson-Johnston Drain experiences the highest peak flows in all the other design storm events.

8.6.4 Surface Water Quality

Surface water monitoring was conducted in December 2012, May 2013, July 2013, October 2013 and November 2013. Many samples were found to have elevated levels of phosphorus and iron, and dissolved oxygen lower than the Provincial Water Quality Objective (PWQO) (MOE, 1994a) range. The elevated phosphorus levels, and possibly in part the lower dissolved oxygen, are expected due to the mainly agricultural land use in the area and the accompanying fertilizer use. Iron levels were observed within the range of 110 micrograms per litre (µg/L) and 3,100 µg/L for the majority of the stations and are common in the Ottawa urban environment. A single one time exceedance of the PWQO for copper and chromium were also noted. Phenolics were detected at elevated levels in the fall 2013 sampling event for all but one station; an additional winter sampling event confirmed the elevated levels of phenolics at most locations.

A comparison of stations upstream and downstream of drainage ditches that cross the Site reveals decreases of phosphorus levels and improving dissolved oxygen levels downstream of the Site. Iron levels were observed to decrease along the Wilson-Johnston Municipal Drain to Shaw's Creek reach, but they also increased along the Simpson Municipal Drain and Shaw's Creek reach.

8.7 Biology

This section presents the existing aquatic and terrestrial biology environment conditions in and around the Site. The study area for this component is provided in Section 2.3. The information and assessments presented in this section have been compiled from more detailed information contained in TSD #4.

The existing conditions were assessed using both a desktop review of existing data and data collected through field surveys. The background information search and literature review were used to gather data about the local area, provide context for the evaluation of the natural features, and facilitate gap analysis/identification and field scoping.

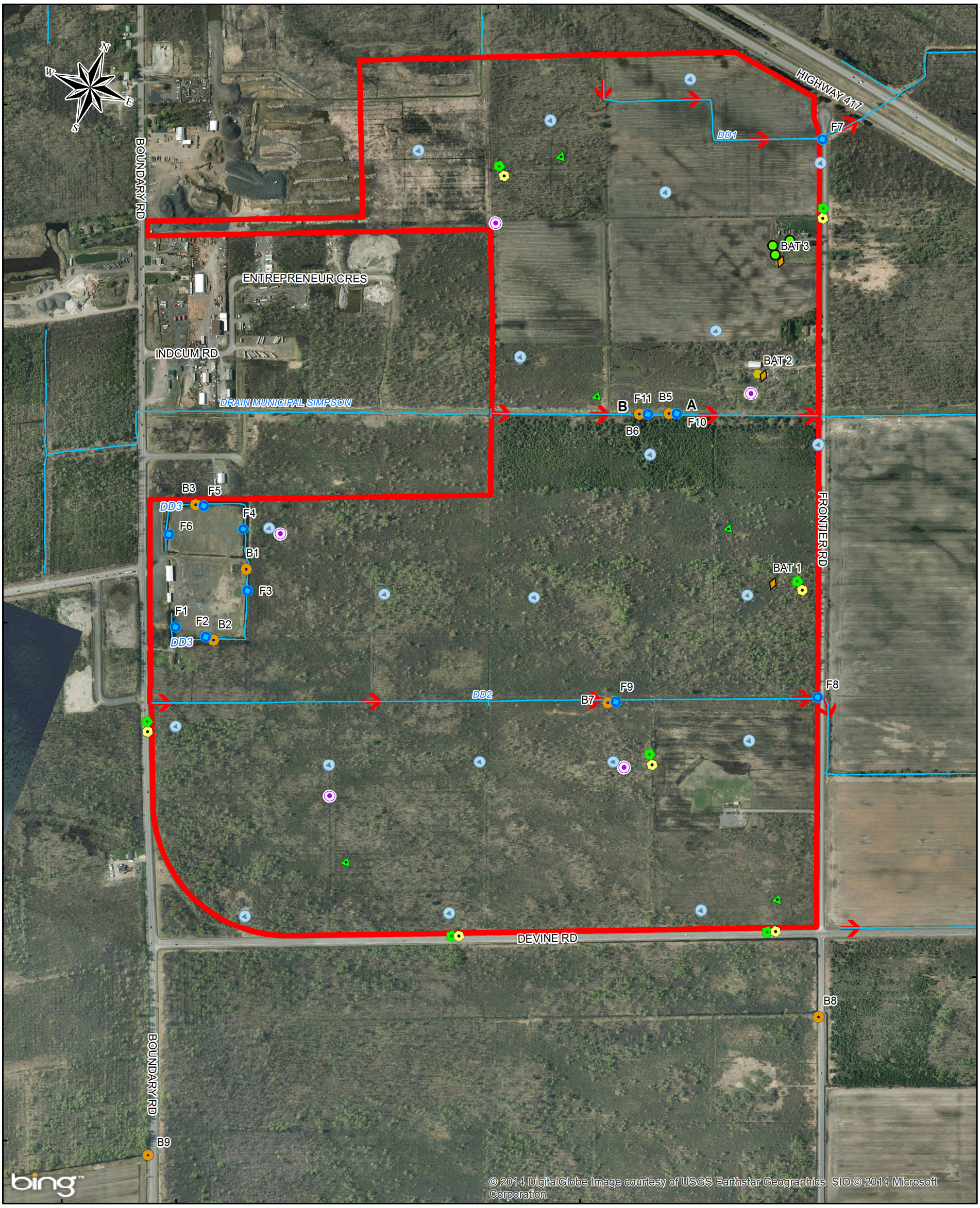
SAR considered for this report include those species listed in the *Ontario Endangered Species Act* (ESA) and the federal *Species at Risk Act* (SARA), as well as species ranked S1-S3 (MNR, 2013a)) and regionally rare species. An assessment was conducted to determine which SAR had potential habitat on the Site. A screening

of all SAR that have the potential to be found in the vicinity of the Site was conducted first as a desktop exercise. Species with geographic ranges overlapping the Site, or recent occurrence records in the Site-vicinity, were screened by comparing their habitat requirements to existing habitat conditions. The Kemptville district MNRF also provided a list of SAR that have potential to be on the Site or in the Site-vicinity. These species were also considered in the assessment.

The habitats and communities on the Site were characterized through field surveys. During all surveys, area searches were conducted and additional incidental wildlife, plant and habitat observations were recorded. Searches were also conducted to document the presence or absence of suitable habitat, based on habitat preferences, for those species identified in the desktop SAR screening described above. The dates when all surveys were conducted are included in Table 8.7-1. Survey locations are indicated on Figure 8.7-1.

Table 8.7-1: Summary of Natural Environment Field Surveys

Year	Date	Type of Survey
2012	Sept 20, Oct 1	Ecological Land Classification and vegetation survey
	Sept 20	Mammal area search/visual encounter survey
	Sept 20	Aquatic (fish and fish habitat) survey at DD1, DD2 and Simpson Drain
	Oct 11	Benthic survey at DD2 and Simpson Drain
2013	Apr 21, May 22, Jun 20	Nocturnal amphibian survey
	Apr 21	Salamander habitat assessment and egg mass survey
	Apr 21, Jun 6, Jun 20, Jun 26, Aug 29, Sept 13, Sept 20, Sept 21, Oct 15	Herpetile area search/visual encounter survey
	Apr 21	Mammal area search/visual encounter survey
	Apr 21	Snake emergence survey
	Apr 21, May 22, Jun 20	Owl and crepuscular/nocturnal breeding bird survey
	Apr 21	Raptor nesting survey
	Apr 21, Jun 6, Jun 26, July 13, Aug 29, Sept 13, Sept 20, Sept 21	Ecological Land Classification and vegetation survey
	May 16	Aquatic (fish habitat) survey DD1, DD2 and Simpson Drain.
	Jun 6, Jun 26	Breeding bird and marsh bird playback survey
	Jun 14	Mobilization of bat detectors BAT1 and BAT2
	Jun 14	Bat habitat survey
	Jun 14, Jun 26, Aug 29, Sept 13, Sept 20, Sept 21, Oct 15	Area search/visual encounter survey for all wildlife, including butterflies and dragonflies
	Jul 3	Mobilization of bat detector BAT3
	Jul 13	Demobilization of bat detectors
	Aug 26	Fish habitat mapping at DD1, DD2 and Simpson Drain
	Sept 6	Fish community inventory survey at DD1, DD2 and Simpson Drain
	Sept 13	Fish habitat mapping at DD3
	Sept 20	Fish community survey at DD3
	Oct 15	Benthic survey at DD3
	Oct 18	Benthic survey at off-Site reference stations (B7 and B8 on Figure 8.7-1)



LEGEND

- SURFACE WATER FEATURE
- PROPERTY BOUNDARY

SURVEY STATIONS

- AMPHIBIAN SURVEY
- BAT ACOUSTIC SURVEY
- NOCTURNAL BIRD SURVEY
- WILDLIFE MOTION CAMERA
- BREEDING BIRD SURVEY
- MARSH BIRD SURVEY
- BENTHICS SURVEY
- FISH SURVEY

SPECIES AT RISK

- BARN SWALLOW
- LITTLE BROWN MYOTIS

230 115 0 230

SCALE 1:8,000 METRES

NOTE

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

REFERENCE

BACKGROUND IMAGERY - BING MAPS AERIAL (C) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
AERIAL PHOTOGRAPHS PURCHASED FROM THE CITY OF OTTAWA.
LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

ENVIRONMENTAL ASSESSMENT OF THE CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

SPECIES AT RISK AND SURVEY LOCATIONS

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0.0
DESIGN	FN	DEC. 2013		
GIS	BR/PM	DEC. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

FIGURE 8.7-1

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