Hydrogeological Work Plan

St. Marys Future Solid Waste Disposal Needs Environmental Assessment

Town of St. Marys

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1.0 Introduction

The Town of St. Marys is conducting an Individual Environmental Assessment under the *Environmental Assessment Act* to review alternative means to managing solid waste in the town over a forty year planning period. The existing St. Marys landfill site (the Site), Environmental Compliance Approval (ECA) Number A150203, is located at 1221 Water St. South, St. Marys, Ontario. The 37 ha Site was part of a former clay barrow pit that was used by St. Marys Cement in cement manufacturing and contains an approved fill area of 8 ha. The landfill is nearing its approved fill capacity and a new means to manage post-diversion solid waste is required. The location of the existing landfill is illustrated on Figure 1.

Terms of Reference (TOR) were approved by the Minister of Environment and Climate Change on December 29, 2014. The TOR laid out a strategy for completing the EA. The TOR also included a summary of pre-planning work which had been done to eliminate a number of *Alternatives to the Undertaking*. Those *Alternatives* which were eliminated due to a variety of technical, financial and environmental criteria included:

- Do Nothing;
- Energy From Waste;
- Enhanced waste diversion, and,
- Constructing a new landfill site at a new location in the Town.

A further assessment is currently being conducted to evaluate transporting waste to a landfill in another jurisdiction or expanding the current landfill site. This assessment is not yet complete.

Included in the TOR was a requirement to develop Work Plans should Expansion of the Existing Landfill be identified as the preferable *Alternative to the Undertaking*. Work Plans are to provide a detailed methodology for completing the evaluation of *Alternative Methods for Carrying out the Undertaking*, the next step in the EA process. Work Plans are to be prepared for a variety of disciplines, including:

- Terrestrial and Aquatic Ecology;
- Hydrogeology;
- Socio-Economic Environment;
- Air Quality; and,
- Others.

This Work Plan provides the framework for evaluating the *Alternative Methods for Carrying out the Undertaking* based on factors associated with the hydrogeological environment.

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A preferred *Alternative to the Undertaking* has not yet been identified (i.e., whether waste will be transported to another landfill or whether the St. Marys site will be expanded). The work outlined in this work plan will only be required if the landfill expansion option is selected. Nonetheless, the Town has elected to be proactive and prepare for possible fieldwork in 2015.

2.0 Study Parameters

The Study will be completed using the parameters described in the following sections.

2.1 Study Purpose

If it is decided to expand the existing landfill, the Undertaking will be defined as:

> *The expansion of the St. Marys landfill in order to provide the necessary capacity to fulfill the Town's post-diversion solid waste disposal needs for the next 40 years.*

The purpose of this study is, therefore:

> *To evaluate a variety of Alternative Methods for expanding the St. Marys landfill in order to fulfill the Town's post-diversion solid waste disposal needs for the next 40 years.*

2.2 Alternatives to be Assessed

Alternative Methods are technically, economically and environmentally feasible ways of doing, or implementing, the same activity. Assuming that the preferred *Alternative to the Undertaking* is to expand the existing landfill, the *Alternative Methods* will include various design options associated with the expansion. Increased waste diversion will be considered for the preferred *Alternative Method* but will not constitute part of the undertaking.

Therefore, the *Alternative Methods* to be reviewed will include those identified in Table 1.

Table 1: *Alternative Methods* for Carrying Out the Undertaking

Method		**Description**
1	Vertical Expansion of the Existing Landfill	This *Method* involves an expansion in the vertical direction within the existing footprint of the landfill.
2	Horizontal Expansion of the Existing Landfill	This involves an expansion outside of the existing landfill footprint. There may be a number of options as to the direction of the horizontal expansion (i.e., expansion could occur to the north, west or east).

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Method		Description
3	A Combination of Vertical and Horizontal Expansion	This *Method* would involve partial vertical expansion along with some horizontal expansion of the landfill footprint, basically a mixture of Methods 1 and 2.
4	Other Options Which May be Identified During the EA Process	Other *Methods* may be identified during public, Aboriginal and agency consultation.

2.3 Study Area

Two specific Study Areas have been identified which will be used as the basis for defining and characterizing the hydrogeological environment which may be potentially affected by the expansion.

The Study Areas are as follows:

- On-site Study Area - includes all lands associated with the existing St. Marys landfill, the 37 ha site located as 1221 Water St. South, St. Marys; and,
- Study Area Vicinity - all lands within a 1,000 m radius of the On-site Study Area.

Both Study Areas are shown on Figure 2.

2.4 Study Timeframe

The EA will consider the potential effects on various environmental components over two time periods:

- Construction and operation of the expanded landfill:
  - Construction is currently anticipated to commence in 2018[1]; and,
  - Operations would then occur over a 40 year period, ending around 2058.

  This may be revised and updated as the EA process progresses.
- Closure and post-closure of the landfill.

2.5 Features of the Environment to be studied

Section 1(1) of the *EA Act* broadly defines the environment as:

> *(a) air, land or water,*
> *(b) plant and animal life, including human life,*
> *(c) the social, economic and cultural conditions that influence the life of humans or a community,*
> *(d) any building, structure, machine or other device or thing made by*

[1] This timeframe is preliminary and will be updated to consider EA study results and subsequent approval requirements.

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humans,
(e) any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from human activities, or
(f) any part or combination of the foregoing and the interrelationships between any two or more of them.

This portion of the study will focus primarily on the land and water component of the environment. The study will expand the understanding of the geology and hydrogeology of the On-Site Study Area and Study Area Vicinity. Climate change has also been included at the request of the MOECC. Components of the environment that need to be considered include:

- Regional geology and hydrogeology;
- On-site soil (depth, texture, stratification);
- On-site bedrock (depth, characterization);
- Occurrence and movement of water in the soil and shallow bedrock;
- Local and regional aquifer(s) and water use, and,
- Groundwater / surface water interaction.

3.0 Current Landfill Monitoring

3.1 Monitoring Program

The first hydrogeological work was done on the site in 1980 in preparation for the design of the landfill. Geologic boreholes were drilled and observation wells were installed in the boreholes. Since that time, other wells have been installed around the landfill foot print. These wells have provided further geologic information and are currently used for water quality monitoring of the existing landfill.

The ECA for the current landfill requires semi-annual monitoring of groundwater and surface water for the existing landfill. This includes:

- Water samples and water levels at existing on-site groundwater monitoring wells;
- Water samples and water levels at specific surface water stations in the stormwater ponds and the existing watercourse;
- Water samples from selected private wells located northwest of the landfill, and,
- Leachate samples from the existing leachate collection system.

The current monitoring locations are shown on Figure 3. A summary of groundwater monitoring wells is contained in Table 2 and surface water stations in Table 3.

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Table 2: Current Monitoring Wells

Observation Well	*Ground Surface (m amsl)*	Monitoring Interval		*Hydrogeologic Location*
		Depth (mbgs)	*Elevation (m amsl)*	
Intra-Till Seams				
sand and gravel				
OW2-84	322.19	8.10 to 9.60	314.09 to 312.59	Up-Gradient
OW15-91	317.82	3.90 to 5.50	313.92 to 312.32	Up-Gradient
OW9B-91	317.74	4.60 to 6.60	313.14 to 311.14	Up-Gradient
OW25-91	322.86	7.00 to 10.40	315.86 to 312.46	Cross-Gradient
silt and clay				
OW4-84	314.52	1.80 to 3.10	312.72 to 311.42	Down-Gradient
OW21-91	319.99	5.30 to 7.70	314.69 to 312.29	Up-Gradient
OW32-96	322.54	6.10 to 11.60	316.44 to 310.94	Up-Gradient
Overburden Aquitard Unit (Till)				
OW33-96	320.66	9.90 to 13.60	310.76 to 307.06	Cross-Gradient (deep)
OW34-96	320.77	4.40 to 9.10	316.37 to 311.67	Cross-Grad (shallow)
OW6-841	313.93	2.00 to 3.20	311.93 to 310.73	Down-Gradient
OW8B-912	313.72	4.00 to 6.10	309.72 to 307.62	Down-Gradient
OW8B-10	314.39	5.50 to 6.40	308.89 to 307.99	Down-Gradient
Deep Sand and Gravel				
OW5-84	313.93	12.20 to 14.30	301.73 to 299.63	Down-Gradient
OW3-841	314.58	11.10 to 13.90	303.48 to 300.68	Down-Gradient
Bedrock Aquifer				
OW7-91	314.50	33.80 to 39.20	280.70 to 275.30	Up-Gradient
OW32A-02	322.63	40.23 to 43.28	282.40 to 279.35	Down-Gradient
OW8A-91	314.00	26.40 to 32.10	287.60 to 281.90	Up-Gradient
OW9A-91	317.75	37.20 to 40.40	280.55 to 277.35	Down-Gradient
Residential Well – Intra Till Sand and Gravel				
PW2	321.54	12.40	309.14	Up-Gradient
Residential Wells - Bedrock Aquifer				
PW13				Down-Gradient
PW31	317.60	48.77	268.83	Down-Gradient
PW4	322.00	54.86	267.14	Down-Gradient
PW5	323.50	56.39	267.11	Down-Gradient

Notes: Elevations and depths are from the 2012 Monitoring and Operations Report: Table 3.3
1 - Historically Dry
2 - Replaced by OW8B-10 in 2010
3 - Replaced the original shallow well in 2011
m amsl - metres above mean sea level
m bgs - metres below ground surface

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Table 3: Surface Water Monitoring Stations

Location	Description
Watercourse	
SP1-10[1]	Upstream (background conditions)
SP2-93	Midstream (between Pond A & B outlets)
SP3-93	Downstream (Site discharge)
Stormwater Pond B (Phase 2/3)	
SP1B-94	Pond B inlet
SP2B-94	Pond B outlet
Stormwater Pond A (Phase 1)	
SP3A-94	Pond A south inlet
SP5A-94	Pond A north inlet
SP4A-94	Pond A outlet

Note: [1]SP1-10 replaced SP1-93 in 2009

The analytical parameters were established in the ECA and have been adjusted through monitoring reports and correspondence with the MOECC. The current parameters are outlined in Table 4.

Table 4: Current Analytical Parameters

Parameters		Wells	
Field pH	Sulphate	OW2-84	
Field conductivity	Boron	OW4-84	
Chloride	Iron	OW5-84	
Hardness	Manganese	OW8B-10	
Alkalinity	Phenols	OW15-91	
DOC	BTEX	OW21-91	
Sodium		OW32-96	
Calcium		OW32A-02	
Magnesium		OW34-96	
Field pH		OW3-84	PW1
Field conductivity		OW6-84	PW2
Chloride		OW7-91	PW3
Hardness		OW8A-91	PW4
DOC		OW9A-91	PW5
Calcium		OW9B-91	
Magnesium		OW25-91	
Phenols		OW33-96	

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Parameters		Surface Water Station
Field pH	Ammonia	SP1-10
Field conductivity	Un-ionized ammonia	SP2-93
Field temperature	BOD5	SP3-93
Chloride	Total phosphorus	SP1B-94
Hardness	Turbidity	SP2B-94
Calcium	TSS	SP3A-94
Magnesium	TDS	SP5A-94
Iron	Phenols	SP4A-94
Manganese		

3.2 Monitoring Results

The general geological and hydrogeological information that has come from previous site work and from the monitoring to date has created an understanding of how the site works (i.e., a conceptual hydrogeologic model of the site). This model includes the following points:

- The soil over the bedrock is primarily silt till.
- The till was overlain by shallow outwash or glaciolacustrine deposits that were partially removed by a previous borrow pit. Some isolated areas of silt or sand remain east of Phase 1 and below the east end of Phase 2/3.
- The till also contains thin, localized silt, sand or gravel seams.
- Some of the intra-till silt, sand or gravel seams contain water resulting in sporadic perched water conditions (e.g., a shallow monitoring well in a seam contains water while a deeper well in the till below is dry).
- The hydraulic conductivity of the unweathered till has been estimated to be 1x10-9 m/s.
- The on-site groundwater flow in the shallow overburden and intra-till seams is toward the east and may discharge to the watercourse that crosses the site.
- The bedrock below the site is limestone of the Dundee Formation. Drilling onsite reported the bedrock surface at elevations varying from 296 to 300 m amsl. This compares to a ground elevation of approximately 324 m amsl along Water Street S. and approximately 309 m amsl along the existing watercourse.
- The bedrock is the primary aquifer in the region.
- The groundwater flow in the bedrock below the site is toward the northwest.

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- The groundwater in the bedrock is used by private wells in the area and may discharge to the Thames River or to the quarries to the north and northwest.

- Reasonable Use criteria for the existing landfill are not exceeded in the down-gradient wells.

4.0 Study Methodology

The study has been designed to look at various hydrologic features to evaluate the potential impact of the alternative methods. As noted in Section 2.2, the alternative methods could include vertical expansion, horizontal expansion or a combination of both.

Preliminary landfill expansion concepts have been developed for the site in order to allow comparisons with the preferred waste export options (ToR Phase 1). These concepts must be developed further to allow (ToR Phase 5) assessment of the Alternative Methods. Briefly however, the hydrogeological component of the assessment will proceed on the basis of the results collected during this Work Program. In general:

- Vertical expansion would add contaminant loading to the existing footprint and the existing infrastructure (i.e., the leachate collection system); and,
- A horizontal expansion would require construction of an additional footprint area, shifting the contaminant load to another part of the site. A horizontal expansion may also make it necessary to alter or re-align the existing watercourse.

Therefore, the study will collect data to evaluate the following:

- Leachate production and collection;
- Occurrence of surficial shallow sand and gravel in the potential footprint;
- Depth and character of till above the bedrock;
- Depth to water (including perched conditions);
- Shallow groundwater movement across the potential footprint;
- Influence of the watercourse on shallow groundwater movement ;
- Potential for landfill contaminants to reach the realigned watercourse;
- Potential for landfill contaminants to reach the bedrock aquifer;
- Potential for mutual interference with licenced aggregate operations;
- Characteristics of the existing cement kiln dust stockpile; and,
- Modifications required to the current monitoring program.

The study will follow the steps outlined below.

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4.1 Step 1 – Background Data Collection

The property is currently an operating landfill. Therefore, some background data has already been collected. The purpose of this step is to update the data already in files and reports, and to search for recent data collected by others. Sources of data to be explored include:

- Environmental Assessment Act and Environmental Protection Act documents related to the creation and development of the existing landfill site. This would include documents in Schedule A of the site's Environmental Compliance Approval, number A150203 (landfill investigation, design, and monitoring reports specific to the existing site) ;
- Published soils, geology and hydrogeology maps and reports;
- Aerial photography and satellite imagery (current and historic);
- Drainage and topographic mapping;
- Ministry of the Environment and Climate Change Water Well Information Service;
- Source water protection assessment reporting and planning policies;
- Conservation authority regulated areas mapping;
- Groundwater data available from St. Marys Cement;
- Climate and weather data;
- St. Marys Cement and public data available for the site's former borrow pit and quarrying operations (On-site Study Area), and related data for the Study Area Vicinity;
- Ministry of Natural Resources aggregate resource information (existing aggregate licenses and aggregate potential within the On-Site Study Area and the Study Area Vicinity); and,
- Information obtained from First Nations and stakeholders through the consultation process.

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4.2 Step 2 – Field Data Collection

The background data collection will be used in evaluating the alternative methods, but it will also be used to determine if there are gaps in the existing field data. All of the field data collected at this point will be needed for future landfill design and EPA application if landfill expansion is the selected alternative. The field data that will be collected includes:

Test pits

- Excavate test pits in the potential horizontal expansion footprint to determine the presence of surficial granular soil and saturated soil.

- Excavate test pits near the existing watercourse to determine the presence of saturated shallow granular soils intersecting the channel. Test pit locations will be

limited by the presence of site infrastructure (leachate collection system sewer line, stormwater ponds and pond outlets), nature features and natural hazards.

- Excavate test pits along the potential re-alignment of the watercourse to determine the soil type, depth, water table conditions, and the potential for contaminated soil.

Cement Kiln Dust Pile

- Excavate test pits into the surface of the cement kiln dust pile to collect samples and characterize the material.

- Locate and assess monitoring wells believed to have been installed in the cement kiln dust.

Drill Boreholes and Install Groundwater Wells

Documents associated with the creation and monitoring of the existing site have provided geologic and hydrogeologic data for the existing landfill. However, the data is limited to the existing footprint and buffer, and to date there does not appear to have been investigation into the conditions on the remainder of the site. Therefore, we are including some intrusive investigation at this stage to verify that the conditions on the remainder of the property are similar to the existing property. Details collected will be required for the design of an expanded footprint. This will include the following:

- Install four to five shallow wells/nests strategically placed around the potential horizontal expansion footprint and along the potential re-alignment of the watercourse. These wells will address MOECC concerns for the existing landfill footprint plus provide geological and hydrogeological data for the eastern and northern parts of the property that were not included in previous studies. They will also serve as long-term monitoring wells around an expanded landfill footprint. Two or three of these wells/nests will be installed into the deeper overburden and bedrock, strategically placed around the potential horizontal expansion footprint.

- Complete grain-size distribution testing on representative soil samples and record all findings in well logs.

Collect Data at New On-Site Wells

- Develop the new wells by pumping. Field pH, conductivity and temperature will be recorded during the development.

- Conduct falling and/or rising head slug tests to obtain hydraulic conductivity values. The testing will be carried out using groundwater data loggers and slugs of known volume.

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- Collect one water sample from each new well to be analyzed for the parameters in the current monitoring program

- Manually measure water levels in all on-site wells (new and existing) monthly for a minimum of six months. Continue to measure water levels in new wells during the semi-annual monitoring.

- Install groundwater data loggers in up to three wells for continuous water level measurements. The wells instrumented will be of varying depths. The data will be analyzed for seasonal variations, response to rainfall events and external pumping by others (principally St. Marys Cement dewatering). Initial frequency will be hourly, but may be reduced depending on variability of water levels recorded in the first month. Loggers will be left in place during the EA/EPA process or up to 15 months. We understand additional data may be obtained from an existing logger installed by St. Marys Cement in a bedrock well.

Groundwater-Surface Water Interaction

- Install shallow drive points into the bottom of the existing watercourse in the areas of SP1, SP2, and SP3. Up to four drive points will be installed with the possibility of one location having a nested pair. The drive points will measure the hydraulic pressure below the watercourse. The water levels in the drive points, compared to the water level in the watercourse, will determine if the existing watercourse is gaining or loosing water through the site.

- Measure water levels in the drive points and any nearby monitoring wells monthly for a minimum of six months. Continue to measure water levels in the drive points during the semi-annual monitoring.

- The data collected will be used in conjunction with water levels in the watercourse and at nearby monitoring wells, as well as the soils information from test pits and boreholes, to determine if the shallow groundwater flow direction on the site is influenced by the existing watercourse and what impact moving the watercourse may have on shallow groundwater flow.

Surface Water Flow Data

- Measure flow in the watercourse up-gradient (near SP1) and down-gradient (near SP3) monthly through the spring, summer and fall. These measurements will only be possible if there is a sufficient section of the channel that is well-defined and has vegetation free flow.

- A detailed assessment of the watercourse is being completed as a decision to expand the landfill horizontally could entail altering or re-aligning the watercourse.

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The current geomorphology of the watercourse (i.e., shape, materials and flow characteristics) is to be determined by a sub-consultant (Parish Geomorphic) as part of the Ecological Work Plan. Data collected is to include bank-full channel dimensions, areas of bank erosions and instability, characteristics of the bed and banks and other features that affect flow and sediment movement.

Elevations

- Survey ground and measuring point elevations of all test pits, monitoring wells and drive points.

4.3 Step 3 – Data Analysis and Existing Conditions Review

All of the data collected to this point will be tabulated and analyzed. In addition, the geologic data will be used to develop cross-sections of the study area vicinity and the on-site study area (existing and proposed), and to update the geology and groundwater mapping. This analysis will result in an updated conceptual hydrogeologic model of the site.

At this point, the data will be analyzed to identify knowledge gaps and to determine if the new data significantly changes the conceptual model (Section 3.2). Significant knowledge gaps or changes to the conceptual model may impact the selection of alternatives or the design of the alternatives.

A decision will be made at this stage whether there is sufficient data to complete the EA before moving to the final steps. There may be some overlap with addition data requirements for an EPA application.

4.4 Step 4 - Evaluate Alternatives and Assess Potential Impacts

4.4.1 Evaluation of Alternative Methods for Landfill Expansion

Geological and hydrogeological data will be used in the evaluation of alternative methods for landfill expansion. The advantages and disadvantages of the alternatives described in Section 2.2 will be determined based on their potential impact on hydrogeological features in the On-Site Study Area and Study Area Vicinity.

A list of potential impacts and mitigation measures will be prepared to assist in evaluating the alternatives. Potential impacts could include:

- Construction Phase(s):
  - Encountering silt, sand or gravel seams during cell construction;
  - Encountering shallow saturated soil during cell construction; and,
  - Encountering contaminated soil during re-alignment of the watercourse.

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- Active Filling Phase:
  - Leachate mounding and outbreaks;
  - Surface water control;
  - Change in shallow groundwater flow direction due to watercourse re-alignment;
  - Contaminant migration away from the landfill in shallow groundwater toward surface water feature; and,
  - Downward contaminant movement into till.
- Closure and Post-Closure Phase:
  - Change in leachate production over time;
  - Leachate mounding and outbreaks;
  - Contaminating life span; and,
  - Aggregate resource.

Impacts will be evaluated using the data collected in the study and past experience with the site. Input from agencies, stakeholders and First Nations will also be documented and considered.

An overall preferred alternative will be determined based on a review of the advantages and disadvantages of a broader set of criteria, including factors associated with the natural, cultural, social, economic and built environments.

4.4.2 Impacts and Mitigation

Once the preferred alternative is selected, a comprehensive list of potential impacts and proposed mitigation specific to that alternative will be described. The likely effectiveness of mitigation measures, to eliminate or minimize potential impacts, would be considered. We may then make recommendations to implement mitigation measures during the design of the selected alternative. Impacts that cannot be mitigated will also be documented.

Recommendations will also be made for additional instrumentation and data collection should they be required for the preferred alternative design or for development of the mitigation measures.

4.4.3 Permits and Authorizations

A list of permits or authorizations which may be required prior to construction will be included. Permits and authorizations often associated with hydrogeology include:

- Environmental Compliance Approval (monitoring, trigger mechanisms and contingency planning);
- Conservation Authority Regulations;

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- Source Water Protection (risk management plan)[2]; and,
- Others to be determined.

5.0 Public and First Nation Input

It is recognized that local landowners and First Nation communities may have specific knowledge of the site and surrounding area. Local and Aboriginal knowledge can positively contribute to studies such as this by adding observations and historical information which may not be included in public records. Public and First Nation input will be obtained in the following manner:

- The Work Plan will be posted to the Town's website for public comment prior to initiating field work;
- The Work Plan will be sent to First Nation who have expressed an interest in the project for comment prior to initiating fieldwork;
- First Nation communities with an interest in the project will be invited to observe field activities, where practical and safe.

6.0 Conclusions

The preferred method for managing post-diversion solid waste within the Town of St. Marys will be determined through an evaluation of a number of social, environmental, technical and financial criteria. Potential impacts to groundwater and surface water are an important component of the environmental evaluation. Monitoring of the existing landfill has provided a conceptual hydrogeological model of the site and several years of water level, water quality and leachate quality data. Additional work will be conducted to verify or update this model and identify potential impacts. This information will be used to determine the best alternative and provide background information for future design.

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[2] Information obtained to date indicates that the landfill site is not located within a municipal wellhead protection area (WHPA) and therefore a plan will not be required. However, this will be confirmed with Source Protection.

7.0 References

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[THE DIFFERENCE IS OUR PEOPLE]

Figures

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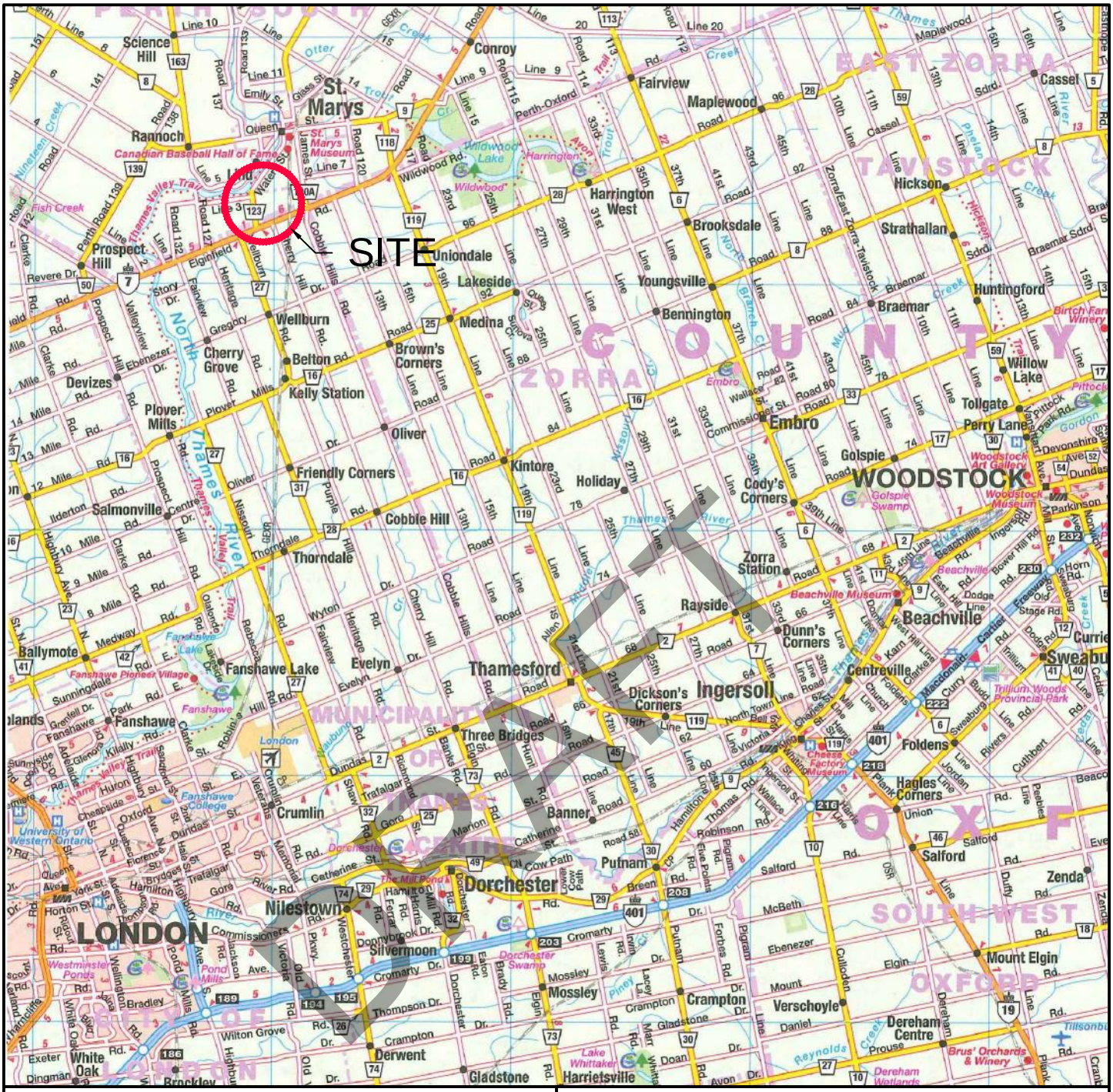

KEY MAP OF ONTARIO

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THE CORPORATION OF THE TOWN OF ST. MARYS

Figure Title

SITE LOCATION

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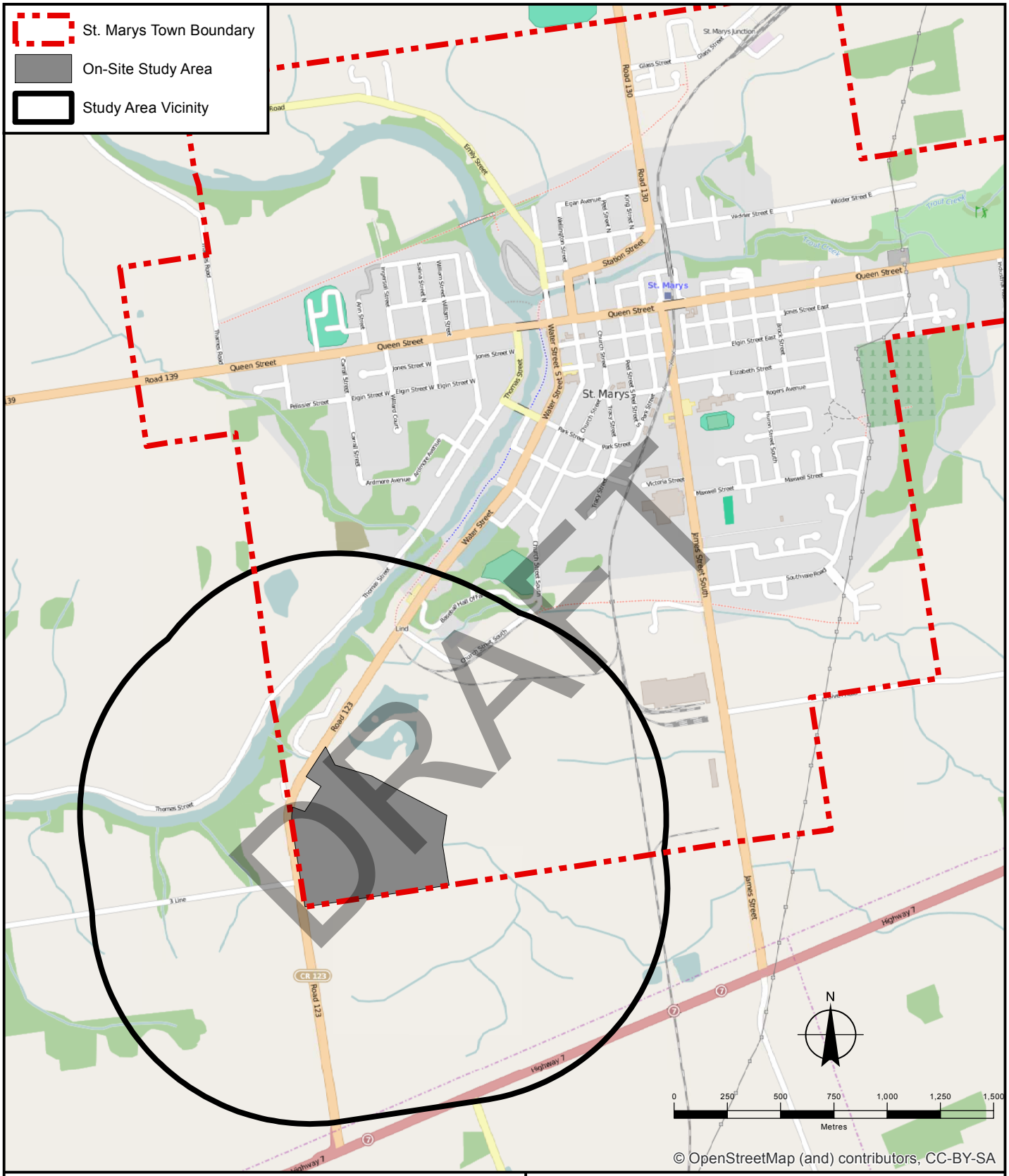

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Map Title

STUDY AREA

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THE CORPORATION OF THE TOWN OF ST. MARYS

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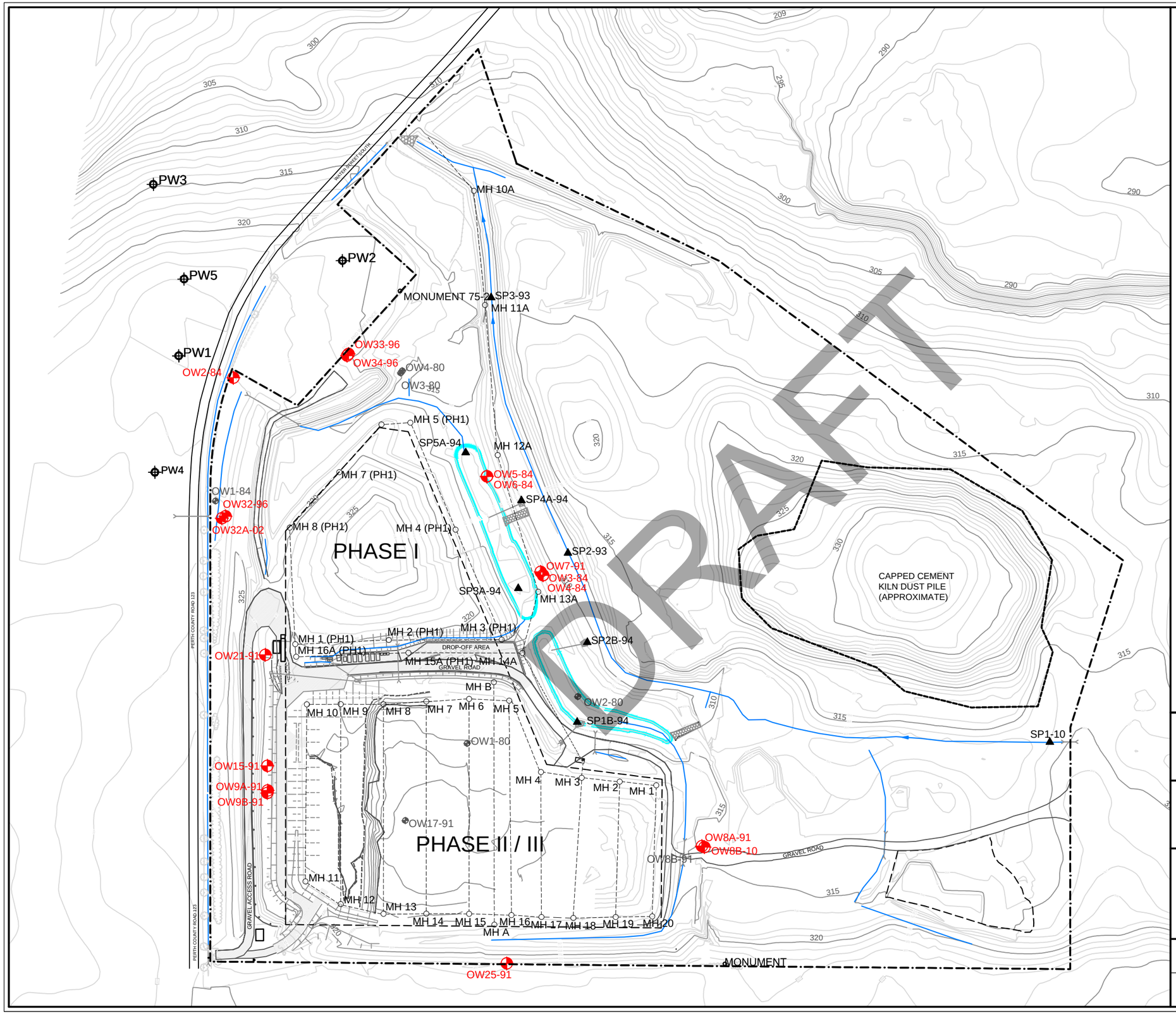

LEGEND

- PROPERTY BOUNDARY
- LIMIT OF REFUSE DISPOSAL
- DRAINAGE SWALE
- LEACHATE COLLECTION SYSTEM
- OBSERVATION WELL
- OBSERVATION WELL (ABANDONED AND SEALED)
- BOREHOLE
- PRIVATE DOMESTIC WELL (APPROXIMATE LOCATION)
- SURFACE WATER MONITORING LOCATION
- STORM WATER MANAGEMENT BASIN

N

0 60 120 180 240

Metres

BURNSIDE

Client

CORPORATION OF THE TOWN OF ST. MARYS

Figure Title

SITE PLAN

DRAFT

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S.K.	J.R.	July 2015	3
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