Sault Ste. Marie Solid Waste Management Environmental Assessment Hydrogeological Impact Assessment and Mitigation Report

January 2017 – 06-6988

Note to Reader:

The attached Report (the “Report”) has been prepared by Dillon Consulting Limited. This report was prepared specifically for the City of Sault Ste. Marie Solid Waste Environmental Assessment.

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1.0 Introduction and Project Description

This document presents the findings of the hydrogeological assessment as part of the Environmental Assessment (EA) of the proposed expansion of the City of Sault Ste. Marie's landfill located on Fifth Line (Figure 1). The hydrogeological assessment examines the potential for impact to the groundwater as a result of the proposed landfill expansion.

The Study Area used for the hydrogeological assessment focuses on the present property owned by the City of Sault Ste. Marie for the existing municipal landfill site. The Study Area is interpreted in the context of the regional geology and hydrogeology.

1.1 Scope of Hydrogeological Assessment

The proposed project includes an expansion of the disposal boundaries to the north and west and a moderate increase in the height of the waste. Landfill mining is also proposed within the western portion of the existing disposal footprint to facilitate the construction of a liner to enhance environmental management at the site. The mining process involves excavation of waste within the existing disposal footprint, removing fines and recyclables, transferring the residual waste to a new lined cell and lining the mined area to accommodate future waste disposal. The planned expansion will be accommodated within existing City owned lands.

The Hydrogeological Assessment assessed the preferred site development alternative which includes landfill "mining" within the existing western fill area and the construction of lined expansion area. The lined expansion area consists of the area that will be "mined", and an area west and north of the present fill area as shown in Figure 2. In addition, a limited amount of waste will be placed on top of the existing landfill. The hydrogeological assessment was completed to fulfill the requirements of Ontario Regulation 232/98 Landfilling Sites which are further documented in the MOE Guideline document entitled Landfill Standards: A Guideline On The Regulatory and Approval Requirements for New or Expanding Landfilling Sites (MOE, 2012) that is hereafter referred to as the "Landfill Standards Guideline". The hydrogeological assessment provides supporting information for the assessment of the preferred alternative in the Environmental Assessment and also supporting information for an Environmental Compliance Approval for the expanded landfill site.

The requirements for a hydrogeological assessment are specified in Section 8 O.Reg. 232/98 as follows:

Hydrogeological Assessment

8. (1) *A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report on the geologic and hydrogeologic conditions of the site and ground water protection for the site has been prepared in accordance with this section.*

(2) *The report must contain,*

(a) *plans, specifications and descriptions of the geologic and hydrogeologic conditions of the site and the area in which the site is located; and*

(b) *an assessment of the suitability of the site for the landfilling of municipal waste, taking into account,*

i) *the design of the site, including existing features and features that will be implemented to control the expected production of leachate and the expected subsurface migration of landfill gas,*

ii) *regional and site specific geologic and hydrogeologic conditions,*

iii) *the ability to identify future impacts on the ground water by monitoring,*

iv) *the feasibility of contingency plans that can be implemented to control leachate produced in a quantity greater than expected or with a quality worse than expected, and*

v) *the feasibility of contingency plans that can be implemented to control landfill gas migrating in the subsurface in a quantity greater than expected or with a quality worse than expected.*

The Landfill Standards Guideline provides additional explanation on what is required in the Hydrogeological Assessment.

1.2 Report Format

This report contains the following sections:

Section 1 – provides an introduction to landfill expansion proposal and describes the scope of the hydrogeological assessment. This section also includes a discussion of the study area for the hydrogeological assessment.

Section 2 – documents the regional geological and hydrogeologic environment. This section also includes a description of the regional hydrostratigraphy, and the significance of groundwater resources and the use made of these resources. In addition, the municipal wellhead protection areas designated in the Sault Ste. Marie Official Plan are discussed.

Section 3 – contains a detailed site-specific description of the geologic and hydrogeologic conditions based on detailed hydrogeological investigations at the site that have occurred over the last 30 years. It also contains a summary of the results of the monitoring program that has been in place at the landfill site over that period.

Section 4 – provides a summary of the proposed landfill design as it relates to groundwater protection and site suitability for landfill expansion.

Section 5 – documents the monitoring and contingency plan proposed for the landfill from a water resource perspective (surface water, groundwater, leachate and landfill gas). It also provides closure plan details associated with environmental protection.

Section 6 – provides a summary of the hydrogeological conditions, and the groundwater protection measures incorporated into the landfill design.

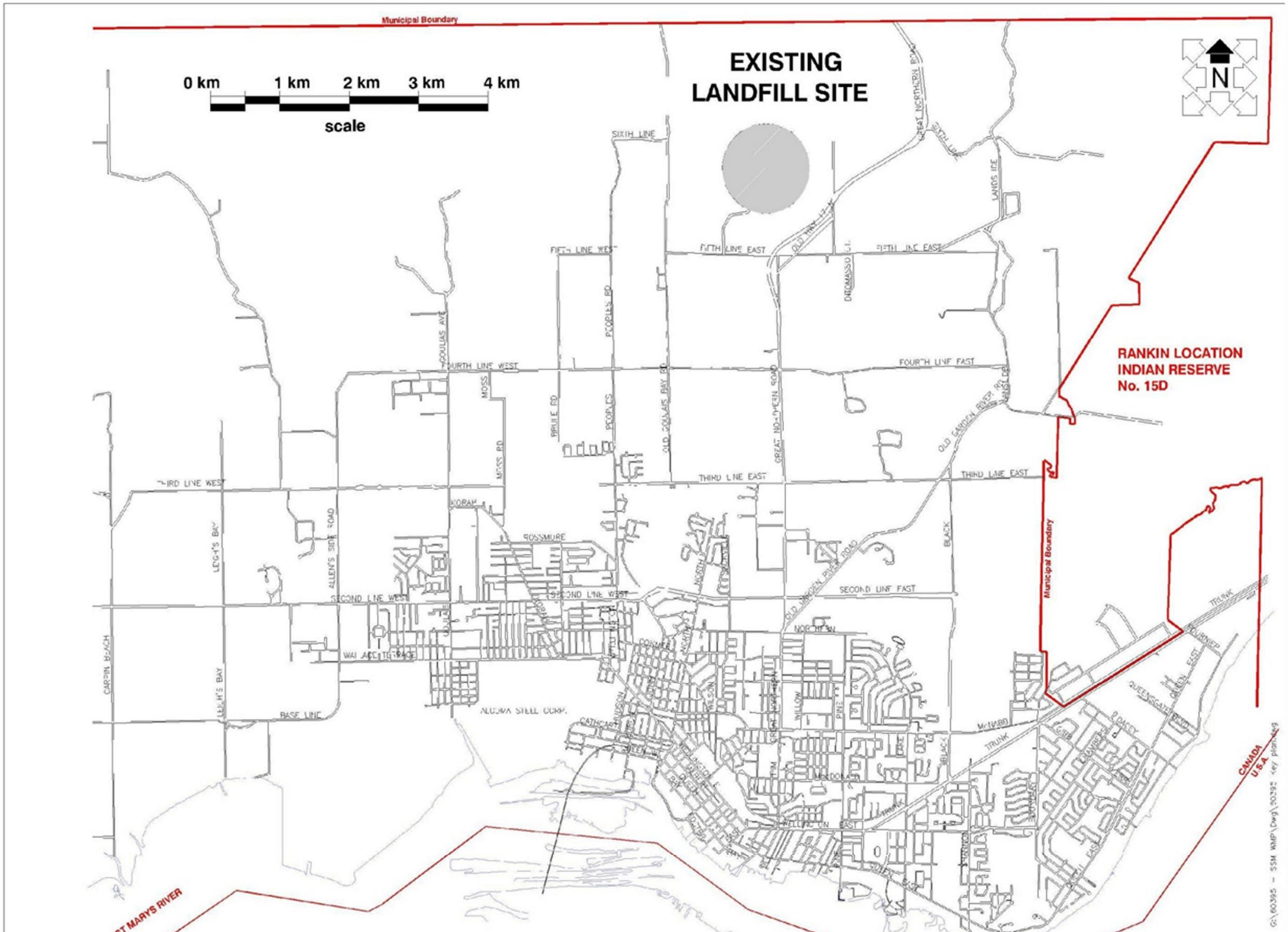

FIGURE 1. CITY OF SAULT STE. MARIE
EXISTING MUNICIPAL LANDFILL SITE
KEY PLAN

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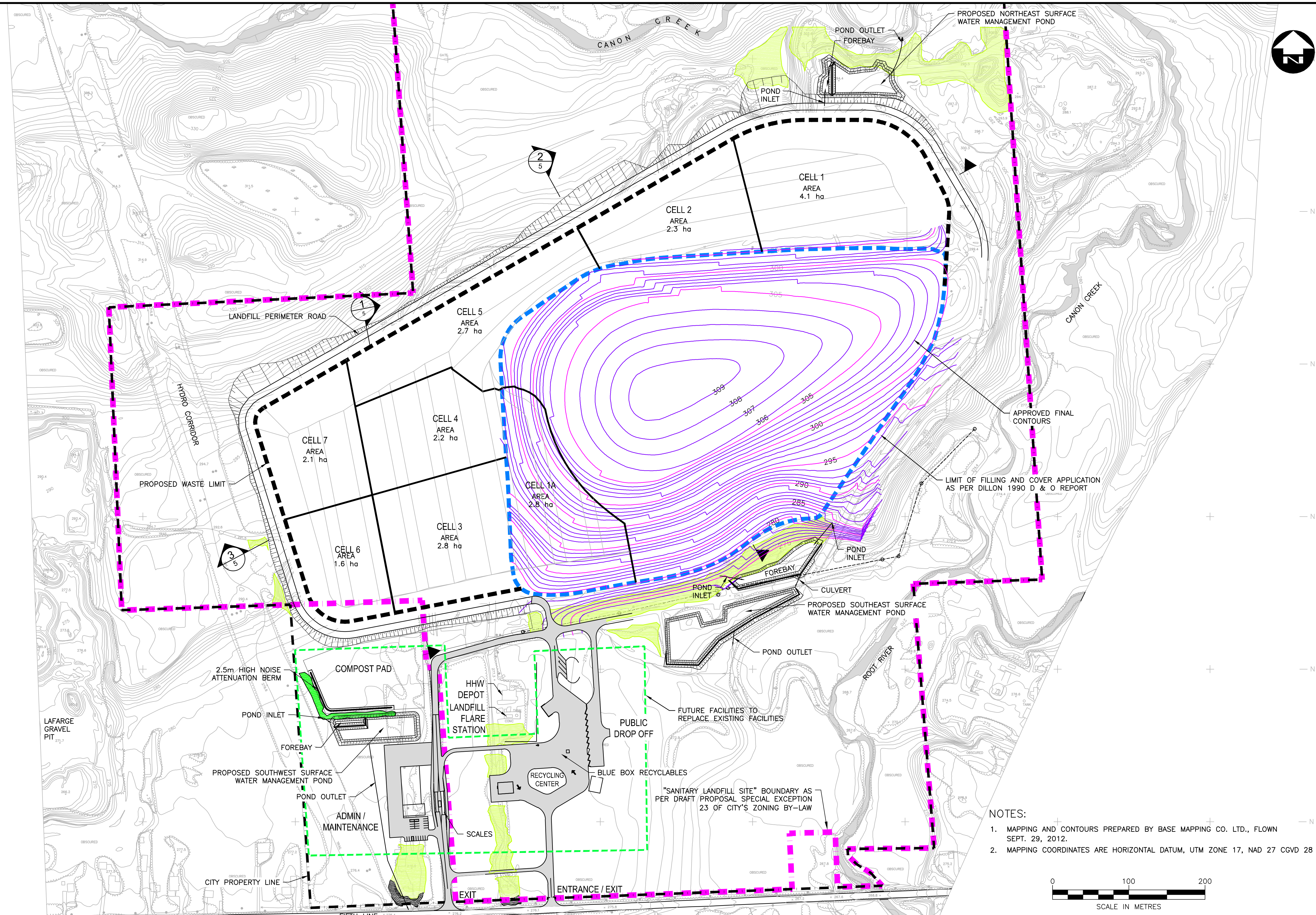

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DRAWN D.B.C./S.K.B. CHECKED BY F.R.G.

DATE MARCH 2015

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SAULT STE. MARIE MUNICIPAL LANDFILL SITE
HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT

PROJECT NO.

LANDFILL DEVELOPMENT PLAN

FIGURE NO. **2**

2.0 Regional Hydrogeological Conditions

2.1 Regional Geology

The Sault Ste. Marie Municipal Landfill site is situated in the northern portion of the city, north of Fifth Line and west of the Great Northern Road. Sault Ste. Marie is located on the north bank of the St. Marys River, which flows from Lake Superior to Lake Huron. Sault Ste. Marie has been described as having "… a veritable smorgasbord of geological environments ranging from Archean to Holocene." (Cowan et al., 1998). The physiography of the city is heavily influenced by both the topography of the bedrock surface and the nature and thickness of the overburden which consists of Quaternary sediments of the most recent Wisconsinan glaciation.

An Archean upland known as the Gros Cap Highland that has rock knob topography occurs in the northern part of the city. The upland bedrock consists of intrusive gneissic granitoid rock which has very thin overburden. South of the exposed bedrock ridges, most of the city is located in a lowland area underlain by Proterozoic bedrock chiefly the red sandstone of the Jacobsville Formation. The Proterozoic bedrock is overlain by thick overburden comprised of glacial and postglacial sediment. A major northeast-trending fault, referred to as the Anderson Fault separates the Jacobsville Formation from the Archean rock to the north (Cowan et al., 1998).

The landfill site occurs immediately south of the bedrock ridge in an area of sand and gravel which were deposited by meltwaters flowing south from glacier ice on the Gros Cap Highland. These deposits are associated with the main Glacial Lake Algonquin shoreline. Underlying the sand and gravel and extending further south from the landfill, fine and medium sand was deposited in a nearshore or deltaic environment. Further south from the sand deposits, deep fine-grained clay was deposited in a deep water environment.

2.2 Regional Hydrogeology

Overburden aquifers have been identified in the City of Sault Ste. Marie. There is a shallow unconfined water table aquifer that residences outside of the municipal services zone use as their groundwater supply source (SSMRSPA, 2011). Additionally, three deep overburden aquifer systems have been identified that correspond to depressions in the bedrock surface in the lowland referred to as the West Basin, Central Basin and East Basin. These aquifer systems are deep confined aquifers that are protected by overlying lower permeability overburden and are located a significant distance south of the landfill site. Municipal groundwater supply wells are located in the Central Basin (Goulais and Steelton Wells) and the Eastern Basin (Shannon and Lorna Wells). There are no municipal groundwater supply wells located in the Western Basin. The municipal wells tap a combination of confined sand and gravel overburden aquifer as well as the upper portion of the sandstone bedrock (SSMRSPA, 2011). The wellhead protection zones identified for the municipal wells are located south of the landfill site. Presently, the Lorna Wells have been removed from active service but remain available for emergency or high demand periods until a replacement source is established. The Sault Ste. Marie Public Utility

Commission (PUC) is assessing increasing the capacity at the Shannon site with the installation of a second well and is actively assessing other potential new well sites.

A large recharge zone occurs at the southern extent of the Gros Cap Highland. The recharge area consists of sand and gravel beaches deposited adjacent to the uplands, and covers an area of 37.5 km² (SSMRSPA, 2011). The landfill site is situated in this recharge zone.

The municipally serviced area extends to the landfill site (extends north along Old Goulais Bay Road and then east along the 5th Line to the site). Water Well Records along 5th Line in the vicinity of the landfill indicate that water wells are more than 40 m deep and are typically installed in sand.

A conceptual hydrostratigraphic model was developed as part of the Source Water Protection studies for the Sault Ste. Marie area and consists of the following (SSMRSPA, 2011):

- Unit 1 – Sand and gravel with high relative hydraulic conductivity and is extensive in the recharge area immediately south of the uplands (e.g., in the area of the landfill) and is absent further south in the city.
- Unit 2 – A sandy silt unit with moderate hydraulic conductivity that varies in thickness and can be combined with Unit 3
- Unit 3 – Lacustrine clay and silt with low hydraulic conductivity and is extensive in the southern parts of the city.
- Unit 4 – Sand and gravel with moderate to high hydraulic conductivity and generally overlies bedrock.
- Unit 5 – Till characterized with low to moderate hydraulic conductivity and is discontinuous throughout the city. Some till was found at depth in previous investigations in the eastern part of the landfill site.
- Unit 6 – Sandstone with moderate hydraulic conductivity.
- Unit 7 – Granite with low hydraulic conductivity.

From the perspective of the landfill site, the most important regional hydrostratigraphic unit is Unit 1 which occurs at surface over the expansion area and occurs to depths of more than 30 m.

2.3 Groundwater and Source Water Protection

The existing and proposed expanded landfill, is located in a Significant Groundwater Recharge Protection Area as documented in the Sault Ste. Marie Official Plan (1996, Office Consolidation 2006, Schedule A). A Significant Groundwater Recharge Protection Area is the area of sand and gravel deposits south of the shield line. The Official Plan sets policies that will apply in reviewing and approving of applications made under the provisions of the Planning Act within this recharge area. These policies apply to non-residential uses that require the use of on-site storage or use of fuel, chemicals or hazardous materials. Storm water management and mitigation related to the safe handling and storage of fuels, chemicals and hazardous materials is required. These policies have been used to help confirm appropriate construction and operation practices for the proposed expansion of the landfill.

Neither the existing landfill nor the proposed expansion is identified to be within a municipal wellhead protection areas in the City's Official Plan schedules.

In March 2015, the Sault Ste. Marie Region Source Protection Plan (SPP) was approved and became effective July 1, 2015. The SPP was prepared to protect existing and future drinking water sources. The plan includes policies to manage land uses within vulnerable areas.

The existing landfill site and proposed expansion are not within a wellhead protection area. They do occupy a small portion of an area identified as a Medium Vulnerability Source Water Protection Area and Significant Groundwater Recharge (SGRA) area as identified on Map 11 of the SPP. The SPP recognizes municipal waste disposal sites as potential threats to sources of drinking water and identifies policy tools to address drinking water threats. As such the site is carefully managed. There is a ground water quality monitoring program that has been completed since 1988 as required by the Environmental Compliance Approval and landfill site's annual progress monitoring reports are presented to council, MOECC and Environmental Monitoring Committee. For the landfill expansion, approval is required under the Environmental Assessment Act and Environmental Protection Act. Obtaining approval under these legislations will require demonstration that the expansion does not pose a threat to the aquifer and drinking water.

The approved Source Water Protection Plan recognizes municipal waste disposal site as moderate threats within a SGRA (section 4.0 Policy Number: SM-SGRA-F-4.0) to sources of drinking water. Policies as indicated in section 4.4 of the SPP will be used to monitor threats in the SGRA. As discussed above, the ECA for the landfill will work to protect groundwater resources in this area.

3.0 Site-Specific Hydrogeological Conditions

This section describes the natural setting of the landfill. It is based on several different hydrogeological investigation and assessment programs spanning from the late 1970's to the present.

3.1 Site-Specific Geology

The landfill site is developed on the northern limit of a stratified glaciolacustrine beach type deposit which is underlain by deltaic sands and gravels (Figure 3). Maximum overburden thickness approaches 36 m below the existing landfill. This deposit ends abruptly to the north where Precambrian Shield bedrock outcrops at Canon Creek. The deposit thins to the south and east where it is underlain by glacial silty sand till. Immediately east of Canon Creek and the Root River, and south to Fifth Line, 3 m to 4 m of sands and gravels overly the till.

Alluvial sands and gravels border Canon Creek and the Root River, and also form the flood plain of the abandoned meander area of the Root River located south of the fill area and north of Fifth Line. Monitoring wells located along the Root River, in the vicinity of Fifth Line, are placed in these alluvial deposits.

3.2 Site-Specific Hydrogeology

Three hydrostratigraphic units have been identified beneath the Site. These include a shallow sand and gravel unit, a less permeable intermediate sand and silty sand unit and a deeper till unit.

There is a groundwater divide located along the western portion of the existing fill area. Groundwater flows both southeast and southwest from this divide. The lateral direction of shallow groundwater flow, beneath the central and eastern portion of the landfill fill area, is south-southeastward with discharge to Canon Creek and the meander area. Intermediate flow, at approximately 10 m in depth in the area of the meander loop, continues southward with ultimate discharge estimated to be into the Root River south of the property boundary.

The till units of the meander area, and east of Canon Creek and the Root River have lower permeability than the sand. This causes preferential lateral flow in the overlying sands and gravels.

Groundwater flows both southwest and west from the groundwater flow divide through a massive, relatively undifferentiated sand deposit. The water table west of the existing flow area is significantly deeper (e.g., typically greater than 15 m) than the water table south and southeast of the existing landfill.

3.3 Site-Specific Hydrology

The landfill site lies within the watershed of the Root River which drains south to the St. Marys River. The landfill site is well drained as a result of the high permeability of the surficial sand deposit. There is a well-defined flood plain along Canon Creek and the Root River, south and east of the landfill. An abandoned meander of the Root River located just south of the active landfill area lies in this flood plain, and is frequently inundated during spring floods.

It has been estimated that the contribution of flow from Canon Creek to the Root River above the meander is approximately 16%, and the contribution of flow from the meander to the Root River ranges between about 0.1% to 1.6%.

3.4 Summary of Existing Monitoring Program

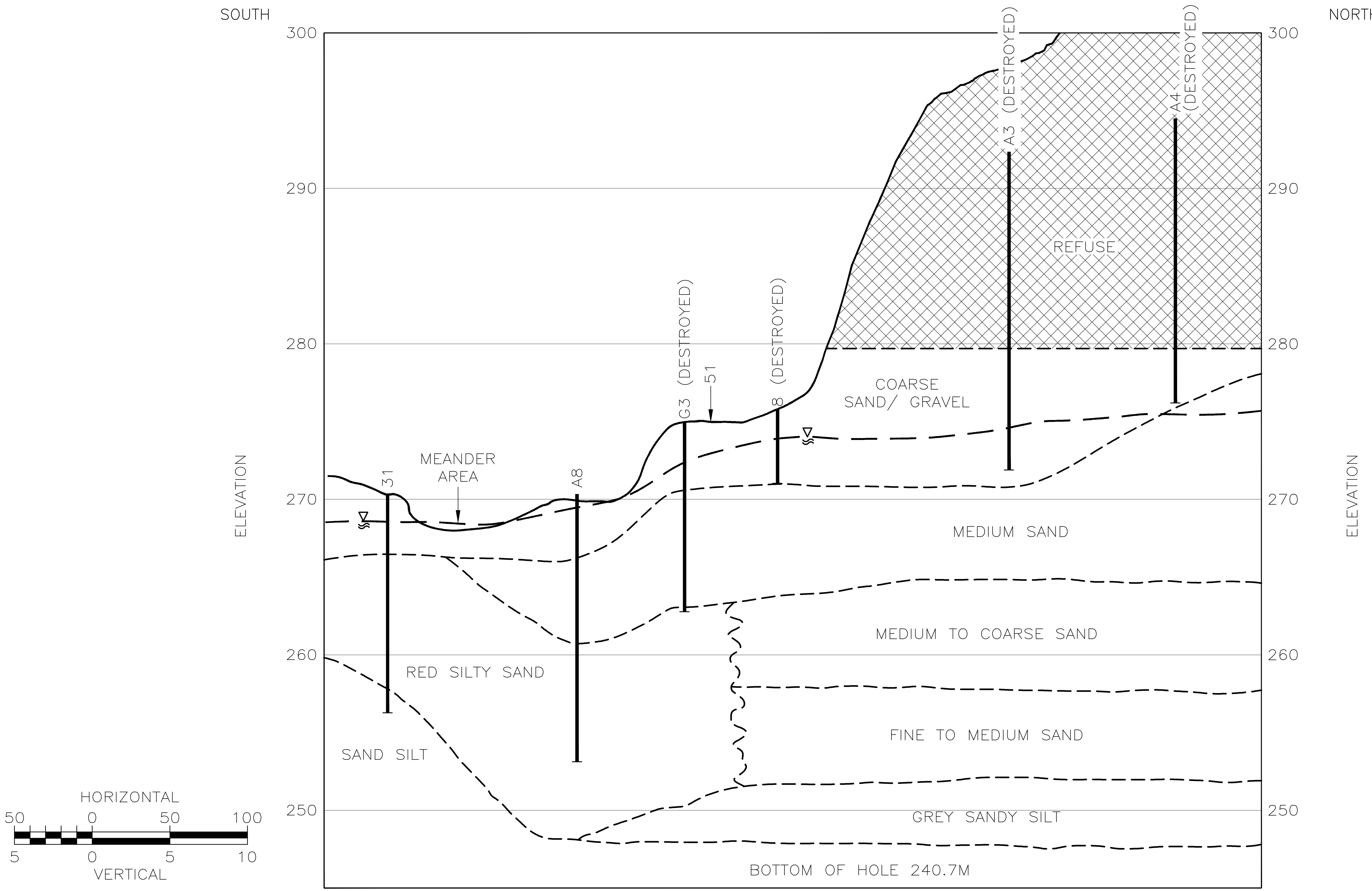
Extensive hydrogeological investigations were completed in the early 1980's as part of the expansion of the landfill at that time. A comprehensive monitoring program has been in place at the site since the mid-1980s and the monitoring well network has expanded through the years. Three principal hydrogeological zones have been assessed as part of the monitoring program: a) an area southeast of the existing landfill and east of Canon Creek b) an area south of the existing landfill in the former meander area of the Root River and c) an area of deep beach sand deposits on the western edge of the landfill site. The existing landfill does not have an engineered liner system but includes leachate collection systems along the south, southeast and western fill boundaries.

The purpose of the monitoring program is to:

- Monitor the quality of groundwater and surface water in the vicinity of the landfill site;
- Monitor the concentration of landfill gas in the vicinity of the landfill site;
- Assess the ability of the leachate controls and natural environment to attenuate contamination from the landfill site;
- Establish whether concentrations of targeted chemical parameters in the groundwater and surface water exceed boundary criteria established by the MOE; and
- Predict future movement of contaminants and therefore predict future compliance with MOE criteria.

Groundwater

The monitoring program identified groundwater impacts in the meander area in the late 1980's resulting from the waste fill located in the eastern portion of the existing site (the existing site was generally developed from east to west). To address these groundwater impacts, a horizontal west-to-east collection system was installed in 1992 south of the existing site. The collection system intercepts leachate impacted groundwater moving south from the waste area and protects groundwater quality in the down gradient meander area. The collection system has been in continuous operation since November 1992. Initially collected water was recirculated back to the waste fill areas but in 1998 the



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SAULT STE. MARIE MUNICIPAL LANDFILL SITE HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT

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GEOLOGICAL CROSS SECTION

FIGURE NO. 3

collection system was connected by forcemain to the City's sanitary sewer system. The leachate impacted groundwater is now treated at the City's west end wastewater treatment facility.

As landfilling progressed to the western portion of the existing site, groundwater quality impacts were identified in down gradient monitoring wells located west of the waste fill area. Additional monitoring wells were installed to further characterize hydrogeological conditions in the western portion of the property. The water table is located at a significant depth (~20 m) in this western portion of the site and the geology of this area of the site was confirmed to be fine-to medium grained beach sand. Groundwater velocities were estimated to be in the 100 to 150 m/year range. In response to the identified deterioration in groundwater quality in the western portion of the site, a purge well system was designed to intercept impacted groundwater moving west and southwest from the existing site. A purge well system was chosen because the groundwater table depth made a horizontal collection system not feasible. Initially three collection wells, referred to as purge wells, were installed in 1996 and became operational in 1997. Water is pumped via submersible pumps in each purge well with discharge to a collection sewer that flows to the on-site waste water pumping station. Thus leachate impacted groundwater from the western portion of the site is also treated off-site at the City wastewater treatment facility. Additional purge wells were installed in the system to improve interception of the groundwater in the area. Significant operational issues were encountered with the purge well system including well fouling and clogged discharge pipes. With experience, a rigorous system of operational monitoring combined with well treatment and well replacement has made the purge well system effective at reducing down gradient groundwater quality impacts. The purge well system has been operating effectively since 2004.

West of the site is an area of remnant groundwater quality impacts down gradient of the purge well system. A Contaminant Attenuation Zone (CAZ) was established in this area to contain impacts within City owned property. Currently, the existing site is in compliance with the MOE Reasonable Use Policy although a relatively thin groundwater plume has been identified southwest of the fill area near the down gradient boundary of the CAZ.

Surface Water

Surface water quality has been monitored at the site since the mid-1980s as part of the site monitoring program. Presently surface water monitoring stations are located in Canon Creek, the Root River (upstream, mid-stream and downstream of the fill area) and in the meander area south of the existing fill area. Surface water quality improved in the meander area after the installation of the horizontal collection system in 1992. Canon Creek, which was formerly located immediately adjacent to the east edge of the fill area had significant aesthetic degradation with some water quality impacts in the area adjacent to the landfill extending to the confluence of Canon Creek with the Root River southeast of the fill area. To address these concerns, the flow channel of Canon Creek was moved to the east which allowed the extension of the horizontal collection system to the northeast, in between the fill area and the new Canon Creek flow channel. The extension of the collection system coupled with the realignment of the creek has significantly improved the aesthetics of the creek and surface water quality. There has not been discernible impact resulting from the landfill on Root River water quality.

Benthic and fish toxicity monitoring was completed for many years at the landfill but was discontinued with the approval of the MOECC in 2011 due to consistently good monitoring results.

Summary

In summary, surface water and groundwater impacts from the eastern portion of the existing site where groundwater flows south into the meander area and easterly towards Canon Creek are controlled very effectively with a horizontal collection system which is located beyond the fill area. This horizontal collection system can be easily maintained or replaced if necessary throughout the contaminating lifespan of the existing fill area. Leachate concentrations will decrease with time as contaminant mass is removed from the landfill. It is possible to calculate the trend in chloride concentrations based on initial chloride concentration, leachate generation and waste loading (Rowe, 2004). The contaminating life span for the existing site can be estimated by calculating the time to reduce the leachate chloride concentrations to the site boundary criteria (126 mg/L). This time is estimated to be in the order of 150 years (based on an average leachate generation rate of between 0.15 m^3/year/m^2 and 0.20 m^3/year/m^2). Groundwater quality impacts in the western portion of the existing site are currently mitigated through a purge well system and the establishment of a down gradient CAZ. The purge well system is more onerous to operate and maintain and requires a vigilant operational monitoring system coupled with well treatment and/or replacement. The existing site is generally in compliance with the MOE Reasonable Use Policy although a relatively thin groundwater plume has been identified southwest of the fill area near the down gradient boundary of the CAZ.

4.0 Landfill Site Expansion – Assessment and Mitigation

This section describes the proposed expansion and provides an impact assessment for both the existing landfill and the expansion area. As discussed in Section 1, Ontario Regulation requires that the groundwater protections features (e.g., leachate collection system, liners, etc.) be designed to protect groundwater quality at adjacent properties. Landfill site impacts and mitigation are discussed both from the perspective of the portion of the existing site that will not be mined and will continue to have groundwater impacts which are mitigated through the existing systems (chiefly the east-west collector) and the mined area of the existing site and new expansion fill area which will be fully engineered with underdrain leachate collection systems and an engineered composite liner system.

4.1 Groundwater Protection and Conceptual Landfill Design

Groundwater quality protection was a critical concern in the development of the landfill expansion conceptual design. The conceptual landfill design not only addressed mitigation of potential groundwater impacts from the expansion fill area, it also mitigates impacts from the western portion of the existing fill area that are currently being mitigated by the purge well system and the CAZ. Groundwater impact control is well established and effective on the south and east sides of the existing fill area through horizontal collection systems and will continue to be maintained throughout the contaminating lifespan of the site and can be easily replaced if necessary. The systems are easy to maintain and replace if necessary since the horizontal collection systems are located beyond the limit of existing fill and are at a depth suitable for replacement if necessary. The impact mitigation that currently occurs on the western portion of the site (purge wells and the CAZ) will be removed and a new system integrated into the design of the expansion. The chief groundwater protection component for mitigation of impacts from the existing site incorporated into the landfill design is landfill mining of a significant area of the western portion of the fill area and the construction of a engineered landfill cell with a full underdrain leachate collection system and a composite liner system. In addition the design allows for the construction of a new north-south horizontal collection system to be installed under the western cells of the expansion area should it be required.

4.2 Summary of Proposed Landfill Expansion Design

The proposed expansion of the landfill will occur on the north and west sides of the existing fill area. The expansion area has been divided into eight engineered cells/stages which will allow for the progressive installation of the leachate collection system and the composite liner system. Development is planned to start in the northeast corner and proceed towards the west along the northern perimeter of the existing fill area and then to the west of the existing fill area as shown in Figure 2. The construction of the expansion will allow for the progressive installation of a full underdrain leachate collection system and a composite liner system. Initially, the composite liner system envisioned was the

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generic single composite liner system developed by the MOECC and incorporated into O.Reg. 232/98. This composite liner system consists of a geomembrane liner underlain by a one metre thick compacted clayey liner. As the conceptual landfill design was advanced, the source of the clay for the clayey liner was assessed and found to be significantly more expensive than an alternate composite liner system consisting of a geomembrane liner underlain by a geosynthetic clay liner (GCL) which consists of a manufactured liner system which has two geotextiles with a layer of low permeability bentonite placed between them. The advective control of the GCL is similar to the MOECC generic composite single liner system. The proposed liner system will also have similar diffusive control since the top of the liner system to the water table is similar (3 metres) for both liner systems.

As shown in Figure 2, a portion of the expansion site will overtop the existing fill area. A geomembrane liner is also proposed in the areas where the expansion will interface with the existing fill. The landfill protection system is designed to perform similarly to the MOECC single composite liner system which provides environmental protection from leachate impacts for more than 150 years.

In addition to effective environmental protection for new waste, the expansion site design significantly enhances environmental protection for the existing landfill site. The major enhancement of the expansion landfill design is the removal of waste ("landfill mining") from the western portion of the existing fill area and the construction of a full leachate underdrain system and composite liner system in the "mined" area. This development method will remove most of the leachate input into the western ground water flow system of the site that is currently being mitigated with the purge well system and CAZ.

The new landfill design also allows for the construction of a north-south collector along the western edge of the new fill area. The new horizontal collection system is made feasible due to the excavation required for the landfill expansion. As a north-south collection system would be underneath or adjacent to the proposed expansion Cells 6 and 7, the City will assess the need for it and the appropriate construction approach prior to construction of Cells 6 and 7. It is anticipated that Cells 6 and 7 would be constructed approximately 25 years into the life of the expansion at which time ground water monitoring should reflect the improvement expected as a result of landfill mining. A supplemental benefit of the north-south collector or purge wells is that it could be an effective contingency if the new landfill cell design does not perform as predicted. After the fill is placed in the expansion area, the north-south collector would be less accessible for replacement than the existing east-west horizontal collection system but can be effectively maintained through an inspection/maintenance program.

4.3 Groundwater Impact Assessment from the Expansion Area

The following four aspects of the design are critical in the evaluation of groundwater impacts at the property.

Underlying Soil Characteristics

The MOECC Generic Single Composite Liner Design requires a 3 m thick attenuation layer that has a hydraulic conductivity of 1×10^{-7} m/s or lower. The chief purpose of the Generic Design attenuation layer is that it provides a diffusion barrier by decreasing the diffusive flux through the landfill base (Rowe et al., 2004). The rationale for specifying the maximum hydraulic conductivity of 1 x 10^{-7} m/s for the attenuation layer is to ensure that there is not a permeable saturated aquifer immediately below the liner with significant horizontal groundwater flow velocities.

The Expansion Site will be underlain by native glaciofluvial sand and gravel and the base of the liner will be more than 3 metres above the water table (~>10 m). Therefore there will be at least 3 m of unsaturated sandy soils beneath the bottom of the liner. Any impacted water migrating from the liner will move vertically downwards through the unsaturated soils to the water table and then migrate within the groundwater system. The zone of unsaturated native sand and gravel beneath the base of the Expansion Site will provide similar reductions in the diffusive flux as the Generic Design attenuation layer.

Leachate Collection System Service Life

O.Reg. 232/98 states that the leachate collection system for the Generic Design has a service life of 100 years and the geomembrane liner has an effective service life of 150 years.

Waste Density per Unit Area

The waste density per unit area (referred to as "waste loading") is an important factor because higher waste loadings will cause an increase in the contaminating lifespan of the landfill. Since there is a finite mass of contaminants in the landfill, as leachate is generated in the landfill, contaminants are removed either through the leachate collection system (>90%) or through leakage out the bottom of the landfill, thereby reducing contaminant concentrations in leachate. A higher waste loading will have more contaminants so it will take longer to reduce concentrations in leachate.

The average waste loading for the proposed expansion area is 90,300 tonnes per hectare (2.33 million tonnes over the landfill area of 25.8 ha).

Leachate Generation Rate

The leachate generation rate is a function of meteorological and landfill cover design factors. The Hydrologic Evaluation of Landfill Performance (HELP) Model (version 3.03) was used as the basis for this evaluation. HELP is an internationally accepted U.S. EPA model used to determine the amount of evapotranspiration, runoff and percolation through the landfill cover (i.e., a water balance). Since HELP was developed in the United States, monthly average precipitation and temperature data were used from the Sault Ste. Marie Michigan (available to be used directly in the HELP model).

Simulations were completed for cover thicknesses of 0.75 m and 1.0 m to allow for comparison and for two hydraulic conductivities (10^{-7} m/s and 10^{-8} m/s). The amount of runoff calculated by the HELP model is based on the USDA Soil Conservation Service (SCS) Curve Number method. Simulations were completed for a curve number of 75.

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4.4 Contaminant Transport Modelling Methodology

Contaminant transport modelling was completed to estimate groundwater quality impacts resulting from the proposed Expansion Site. The modelling was completed with the MOECC single composite liner system. As stated previously the proposed composite liner system (geomembrane underlain by a GCL) will have similar environmental performance. The computer program POLLUTE was used to predict the groundwater quality in time and space as contaminants migrate from the landfill into the groundwater environment. The simulations incorporate the performance of the leachate control system and the hydrogeologic setting. The impact of the landfill on groundwater quality was assessed by comparing the predicted impact to the Ontario Drinking Water Objectives and the Reasonable Use Guideline. The following sections provide further information on the modelling methodology.

Regulatory Context

To determine the significance of an impact on groundwater quality the Ministry of the Environment (MOE) developed Guideline B 7, The Incorporation of the Reasonable Use Concept Into MOEE Groundwater Management Activities (RUG). The essence of this guideline is to establish site specific groundwater quality criteria based on criteria established for the "reasonable use" of the groundwater and background concentrations. These criteria are applicable at the site boundary. The Reasonable Use for groundwater at the CAZ boundary is drinking water and thus groundwater at the site boundary must meet Ontario Drinking Water Objectives.

To undertake the assessment, critical contaminants related to landfills were identified. A critical contaminant is a contaminant that, due to a combination of high expected leachate source concentration, low allowable concentration, and mobility in the environment, will have greater potential impact than other contaminants.

There are two main factors in the selection of critical contaminants:

- the concentration of the contaminant in landfill leachate in relationship to the criteria established by the Reasonable Use Guideline (RUG), and;
- the mobility of the contaminant in groundwater; attenuating mechanisms for contaminants include adsorption and biodegradation.

Critical contaminants typical for landfills and their characteristics are defined in O.Reg. 232/98 and are summarized in Table 1.

Table 1: CONTAMINANT CHARACTERISTICS

Contaminant	Initial Source Concentration (mg/L)	Contaminant Mass as a Proportion of total (wet) mass of waste (mg/kg)	Half-Life in Leachate (years)	Health Related Drinking Water Standard (mg/L)	Aesthetic Drinking Water Standard (mg/L)
Chloride	1,500	1800	n/a	n/a	250
Cadmium	0.05	0.035	n/a	0.005	n/a
Lead	0.6	0.42	n/a	0.01	n/a
Benzene	0.02	0.014	25	0.005	n/a
1,4-Dichlorobenzene	0.01	0.007	50	n/a	0.001
Dichloromethane	3.3	2.3	10	0.05	n/a
Toluene	1	0.7	15	n/a	0.024
Vinyl Chloride	0.055	0.039	25	0.002	n/a

Source: O.Reg. 232/98

The Reasonable Use Guideline specifies that the maximum concentration of a particular contaminant that would be acceptable in groundwater beneath an adjacent property is calculated using the following equation:

$$C_m = C_b + x(C_r - C_b)$$

Where:

Cm: Allowable concentration

Cb: Background concentration

Cr: The particular concentration criterion selected for the Reasonable Use of the groundwater which for this assessment, is the drinking water criteria.

x: A factor that reduces the contamination to a level which is considered by the MOE to have only a negligible effect on the use of the groundwater. For groundwater, "x" is 0.5 for non-health related parameters or 0.25 for health related parameters.

Table 2 summarizes the allowable concentrations for the selected critical contaminants, based on the RUG.

Table 2: Allowable Concentrations at Point of Compliance

Contaminant	Factor	Drinking Water Criterion	Background Concentration	Allowable Concentration
Chloride (mg/L)	0.5	250	1	126
Benzene (µg/L)	0.25	5	0	1.25
1,4-Dichlorobenzene (µg/L)	0.5	1	0	0.25
Dichloromethane (µg/L)	0.25	50	0	12.5
Toluene (µg/L)	0.5	24	0	12
Vinyl Chloride (µg/L)	0.25	2	0	0.5

The computer program POLLUTE was used to simulate contaminant transport in time and space. This program is a finite layer contaminant transport model which is based on the one dimensional advection dispersion equation for porous media (GAEA Technologies et al., 2004). In general, POLLUTE is applicable to situations where the hydrostratigraphy can be idealized as being horizontally layered (with soil properties being the same at any given layer). POLLUTE was used to assess the suitability of the MOE Generic Designs (Dillon, 1997).

The model boundary condition representing the contaminant source (i.e., the waste within the landfill) is derived from a finite mass approach. The finite mass approach assumes that the mass of any potential contaminant within the landfill is finite and that the process of clean water infiltration through the landfill cover coupled with leachate collection removes contaminants from the waste, therefore resulting in a decrease in leachate source strength with time. Loss of contaminants through the landfill base and biological/chemical decay processes, if applicable, also result in a decrease in the mass of contaminants available in the landfill.

Transport mechanisms modelled by POLLUTE are:

- advection – refers to the process whereby the solute is transported as a result of groundwater movement;
- dispersion - refers to the mechanism whereby the solute is transported due to a gradient in its concentration (the diffusion mechanism) and due to mechanical mixing of groundwater arising from heterogeneity in the size and the geometry of the soil pores (the hydrodynamic mechanism). Hydrodynamic dispersion is considered to be negligible due to the very low groundwater velocities (Rowe et al., 2004). ;

- adsorption – into the soil solids which removes the solute from the porewater phase and decreases the net rate of migration; and
- biological/chemical decay – which also removes the solute from the porewater phase and hence decrease the net rate of migration. It is noted that adsorption and biological / chemical decay will not reduce chloride concentrations.

Contaminant concentrations may be obtained from the model at any specified depth at or below the landfill base at any specified times of interest. Table 3 summarizes the various input parameters used in the contaminant transport modelling.

Table 3: Model Input Parameters

Parameter	Value	Source
Area of Expansion Site	25.8ha	Main Report (D&O Report)
Total Mass of waste	2.33 million tonnes	Main Report
Leachate Generation Rate	0.2 $m^3/yr/m^2$	Section 9
Minimum Life of Underdrain LCS Minimum Life of Geomembrane	100 years 150 years	Landfill Standards
Hydraulic Conductivity of Clayey Liner	1×10^{-9} m/s	Landfill Standards
Porosity of Clayey Liner	0.3	Assumed
Hydraulic Conductivity of Unsaturated Sand	9×10^{-4} m/s	Section 4
Effective Porosity of Unsaturated Sand	0.10	Assumed
Dry Soil Density of Clayey Liner Fraction Organic Carbon	1.9 g/cm^3 0.001	Assumed Landfill Standards
Diffusion Coefficient in Geomembrane	1.7×10^{-7} m^2/a (chloride) 6.3×10^{-5} m^2/a (dichloromethane) 1.2×10^{-4} m^2/a (other organic parameters)	Dillon,1997
Diffusion Coefficient in Clayey Liner (all parameters)	0.02 m^2/a	Dillon,1997

Advective Flux Calculations

Table 4 summarizes the advective flux calculations through the liner for the various times. These rates were adopted from the values used in evaluating the Generic Designs (Dillon, 1997). The actual fluxes would be somewhat lower than these since the harmonic mean of the hydraulic conductivity mean of the clayey liner and attenuation layer was used for the Generic Design. At the Expansion Site, the unsaturated sand underlying the composite liner system means that the hydraulic conductivity of the clayey liner alone should be used in the leakage calculations (i.e., the sand will not support the suction forces that are implicit in using the harmonic mean to calculate a representative hydraulic conductivity). After the leachate collection system ceases to function, leachate will mound within the landfill as leachate is generated.

Table 4: Summary of Advective Flux Through Liner

Time Period (years)	Head on Liner (m)	Advective Flux Through Composite Liner ($m^3/m^2/a$)	Leachate Collection Rate by LCS or Perimeter Drain	Comments
0 to 100	0.3	0.000187	0.19981	LCS working
100 to 120	6	0.00908	0	LCS fails, head builds on liner
120 to 150	12	0.01185	0.18815	Maximum head on liner, collection by perimeter drain
150 to 170	6	0.394	0	Geomembrane fails after 150 years, head dissipates
170 -	0	0.15	0	Complete leakage through liner

Source: Dillon (1997)

4.5 Results of Contaminant Transport Modelling

The model predicts chloride concentration immediately under the liner as well as at the water table. Chloride concentrations at the base of the liner increase slowly with time for the first hundred years and then increase more significantly after the leachate collection system is presumed to cease functioning. After the leachate collection system ceases to function, predicted chloride concentration increases are more pronounced resulting in a predicted maximum chloride concentration of 92 mg/L. At the water table the increase only occurs after the leachate collection system is presumed to no longer function reaching a maximum concentration of 74 mg/L. The model also calculates the expected decrease in chloride concentrations in leachate. Leachate chloride concentrations decrease as a function of the finite mass of chloride in the waste and removal of that mass by the LCS.

Table 5 summarizes the predicted maximum concentrations for all of the critical contaminants listed in Table 2. All predicted concentrations are well below the RUG values. Predicted chloride concentrations are the closest to RUG values due to the biodegradation of volatile organic compounds in landfill leachate and adsorption of the organics within the landfill liner.

Table 5: Summary of Predicted Maximum Concentrations

Parameter	Reasonable Use Criteria	Maximum Concentration at Base of Liner	Maximum Concentration at Water Table
Chloride	126 mg/L	87 mg/L (130 years)	74 mg/L (150 years)
Benzene	1.25 µg/L	0.0026 µg/L (60 years)	0.0016 µg/L (135 years)
1,4-Dichlorobenzene	0.5 µg/L	0.0008 µg/L (130 years)	0.0006 µg/L (150 years)
Dichloromethane	12.5 µg/L	0.38 µg/L (35 years)	0.14 µg/L (125 years)
Toluene	12 µg/L	0.15 µg/L (25 years)	0.051 µg/L (115 years)
Vinyl Chloride	0.50 µg/L	0.010 µg/L (40 years)	0.0045 µg/L (130 years)

4.6 Contaminating Lifespan

Regulation O.Reg. 232/98 requires an estimate of the contaminating lifespan of landfills. The contaminating lifespan is defined in the regulations as:

(a) *in respect of a landfilling site, the period of time during which the site will produce contaminants at concentrations that could have an unacceptable impact if they were to be discharged from the site, and*

(b) *in respect of a landfilling site and a contaminant or group of contaminants, the period of time during which the site will produce the contaminant or a contaminant in the group at concentrations that could have an unacceptable impact if they were to be discharged from the site;*

The contaminating lifespan is based on the amount of time it takes for leachate source concentrations to decrease to a level where release to the environment is no longer a concern from a compliance perspective. The two critical factors in predicting leachate concentrations with time are the leachate generation rate and the mass loading (tonnes of waste per hectare of footprint area). The RUG criterion for chloride is predicted to be exceeded if the leachate collection system has a service life of less than

92 years. Therefore, the contaminating lifespan of the landfill is approximately 92 years (leachate generation rate of 0.15 m^3/year/m^2) and 55 years (leachate generation rate of 0.20 m^3/year/m^2).

Overall, it is concluded that the engineered systems incorporated in the design of the Expansion Site will prevent the RUG criteria from being exceeded immediately below the landfill base. The predicted performance of the landfill is better than that of the MOE Generic Design since there is more rapid removal of contaminant mass because the leachate generation rate is predicted to be higher than the minimum 0.15 $m^3/m^2/a$ required by the Generic Design.

4.7 Summary of Impact Assessment

Based on the leachate generation for the site, and the results of the contaminant transport model the site is predicted to meet appropriate criteria and have minimal impacts during the service life of the engineered systems that have been incorporated into the design of the proposed expansion. The minimum service life established by the MOECC for these systems are: leachate collection system – 100 years; geomembrane liner – 150 years, and the clayey liner (indefinite). The service lives of these systems means that potential impacts from the Expansion Site will not occur for many years (150 years plus) and the leachate strength at that time will be significantly diminished. The GCL will also have an infinite service life.

In summary, the impacts from the portion of the existing landfill that will not be mined will continue to be mitigated to the south and east through the use of the existing horizontal collection system which can be easily maintained and replaced if necessary throughout the contaminating lifespan of the existing landfill. Areas where there will be a relatively small amount of waste placed on top of the existing waste will have a liner at the interface between the new waste and existing waste which will provide additional protection.

Waste Impacts from the expansion area (which will include a significant portion of the existing western fill area which will be removed ("mined") and incorporated into the expansion area.) will not occur for some time (more than 150 years and well after the contaminating lifespan of the expansion area landfill) and will be much less than those that are presently occurring within the CAZ caused by the existing landfill. In addition to landfill mining in the west, a new horizontal groundwater collection system will be installed along the western edge of the new fill area which will allow more effective mitigation of remnant impacts from the existing site and provide a contingency protection measure for the expansion fill area.

The proposed expansion based on landfill mining and the placement of a composite liner and underdrain collection system significantly enhances groundwater protection at the site in comparison to the current landfill.

5.0 Landfill Monitoring, Trigger Mechanism and Contingency Measures

The landfill monitoring program established for the existing site will be modified to include the proposed expansion. More monitoring locations are available due to monitoring wells installed as part of the geotechnical investigation completed for the expansion area. Additional replacement monitoring wells may be required if existing monitoring wells are required to be decommissioned as part of the final design of the expansion landfill.

The landfill gas monitoring program will be expanded along the new perimeter of the expanded landfill. No new monitoring wells are required for surface water monitoring at the site since the landfill expansion will not result in proximity to any new surface water that isn't already part of the surface water monitoring system for the existing site.

5.1 Landfill Monitoring Program

The landfill monitoring program will consist of:

- Ground water sampling
- Surface water sampling
- Ground water level monitoring
- Methane gas monitoring
- Pump station sampling.

Table 6 summarizes the sampling/monitoring media and frequency.

Table 6: Summary of Sampling/Monitoring Dates

Monitoring Type	Monitoring Frequency
Surface Water	Quarterly
Ground Water	Spring, Summer and Fall
Leachate	Quarterly
Water Levels	Spring, Summer and Fall
Methane	Monthly

Ground Water Monitoring Program

The ground water monitoring program for the proposed expansion will utilize existing monitoring wells. Additional replacement monitoring wells will be required as existing wells will be required to be decommissioned as a part of the design of the landfill expansion. The locations of the ground water monitoring wells that are available as well as proposed monitoring well locations are shown on Figure 4. Ground water monitoring wells are selected to provide sufficient chemical information to evaluate the impact of the landfill site on ground water quality. Ground water samples will be collected in the spring, summer and fall (Table 5.1) which is consistent with the to coincide with the existing landfill monitoring program. Ground water elevations for all accessible monitoring wells on-site will be obtained in conjunction with ground water sampling events. Categories of chemical parameters included in the analyses undertaken are general chemistry, major and minor ions, trace metals and volatile organic parameters. The target parameter list is based on that recommended in Schedule 5 of O.Reg.232/98.

Currently, there are 38 ground water monitoring wells in the existing sampling program that were chosen for their strategic locations and potential to detect changes in ground water chemistry as a result of leachate generation in the refuse pile. Table 7 summarizes the function of each monitoring well used.

Table 7: Monitoring Wells Used as Indicators of Contaminant Plume Movement

Background Ground Water Quality	23-IV, 72
Western Groundwater Monitoring	29-II (New), 52-I*, 53-I*, 56-I*, 57-I*, 58-I (New), 58-II (New), 61-I, 61-II, 62-I, 62-II, 63-I*, 63-II*, 64-I, 65-I, 65-I (New), 66-I, 67-I, 68-I, 69-I, 70*, 71*, 73, 74, 75, 76, 77, 78 (*some wells will be decommissioned as the expansion landfill is developed)
Eastern Groundwater Monitoring	39-IV (New)
Southern Groundwater Monitoring	31-I, 31-IV, 32-I, 35-III
Source Characterization	51-I, A5-I

Surface Water Monitoring Program

Surface water quality samples are obtained and analysed to provide a general assessment of the surface water quality conditions near the Sault Ste. Marie Municipal Landfill site. The existing surface water monitoring program includes the collection of water samples at sampling points along Canon Creek and the Root River. No new monitoring locations are required for surface water monitoring at the site since the landfill expansion will not result in proximity to any new surface water that isn't already part of the existing surface water monitoring program.

The existing landfill monitoring program has taken surface water quality samples at five locations, stations S-1B, S-2, S-3, S-4 and S-5. These locations and others are described below and shown on Figure 5.

Station	Description
S-IB	Canon Creek upstream
S-2	Root River upstream
S-3	Canon Creek adjacent to the landfill site
S-4	Meander area

S-5	Root River downstream
S-8	Root River at Highway 17
S-9	Root River at Fourth Line
S-10	West Branch of Root River at confluence with East Branch.

The samples collected are analysed for general parameters, nutrients, mercury and trace constituents (metals and phenols). The target surface water parameter list is based on that recommended in Schedule 5 of O.Reg. 232/98.

Methane Gas Monitoring Program

Methane gas is produced as a result of biodegradation of waste. The absence of a low permeability cap on the landfill facilitates the venting of methane gas directly from the waste to the atmosphere. During frozen ground conditions, a build-up of gas pressure will likely occur within the landfill. This will cause the lateral migration of methane gas into the sand and gravel deposits surrounding the waste. The methane gas will migrate until:

- It is able to vent to the atmosphere
- The pressure gradient is reduced at a distance from the source such that lateral migration is negligible
- An effective barrier is encountered.

The water table is known to be an effective natural barrier for methane gas (since methane gas is relatively insoluble in water). Therefore, Canon Creek will effectively retard the lateral migration of methane gas along the north and east boundaries of the fill area. Southern migration of gas will be limited by the high water table in the meander area.

The monitoring program currently consists of measurements of gas in five gas monitors (M3, M4, M5, M6 and M7). Due to the proximity of the expansion landfill to the eastern site boundary, new methane monitors may be required and the need for and location of new methane monitors will be assessed during final landfill design.

Leachate Collection System Monitoring Program

Leachate collection system samples will be collected from the pump station on four occasions during the sampling year (Table 5.1). The target leachate parameter list is based on that recommended in Schedule 5 of O.Reg. 232/98.

Residential Water Well Monitoring

A residential water well monitoring program will be implemented as part of the landfill expansion. The overall purpose of the residential water well monitoring program is to provide residents assurance of the water quality of their domestic water supply. The primary assurance of the protection of groundwater resources is the extensive monitoring program in place at the landfill site. While there is no guideline on how water wells are chosen to be included in a monitoring program, a 500 m "rule of thumb" is often used for landfill sites, quarries and other land uses/activities that may impact residential water well quality. Residences along the Fifth Line from Highway 17 to about 400 m east of Old Goulais Bay Road are within 500 m of existing or proposed fill areas. Therefore, it is recommended that the residential water well monitoring program extend along the Fifth Line from Highway 17 in the east to Old Goulais Bay Road in the west.

There are some residences on Old Goulais Bay Road northwest of the landfill which are slightly more than 500 m from the northwest corner of the westerly expansion area. Given that groundwater does not flow in a northwest direction, it is not considered necessary to monitor residential water wells in this area.

The first component of the water well monitoring program will be a water well survey consisting of a questionnaire that will be provided to residents with questions regarding their well such as location, depth and existing water quantity or quality issues. It will also ask if the residence wants to be included in the water well monitoring program.

For those residences who volunteer to have their well included in the monitoring program, a baseline water well assessment is recommended. The water well assessment will be completed by a licenced Water Well Contractor under Reg. 903 who will document the depth and type of well at each location. Where possible this information will be correlated with Water Well Records. The Ontario Water Well Record database is incomplete and location information is prone to error but efforts will be made to match well information to available water well records.

Water samples from the residential wells included in the monitoring program will be taken on an annual basis. Where possible, samples will be taken from the wells prior to any treatment systems such as water softeners. Water samples will be analyzed for the parameters included in the indicator and comprehensive list of Schedule 5, of the Landfill Standards (the same target parameter list for on-site monitoring wells).

5.2 Contingency Measures

A contingency plan is required by O.Reg. 232/98 which is defined as "an organized set of procedures for identifying and reacting to an unexpected, but possible occurrence" (MOE, 2012). The contingency plan consists of a predictive monitoring program (see above), establishing trigger levels for investigation and response and a description of potential contingency measures. The new landfill system is predicted to have maximum impacts well below allowable RUG concentrations immediately below the landfill.

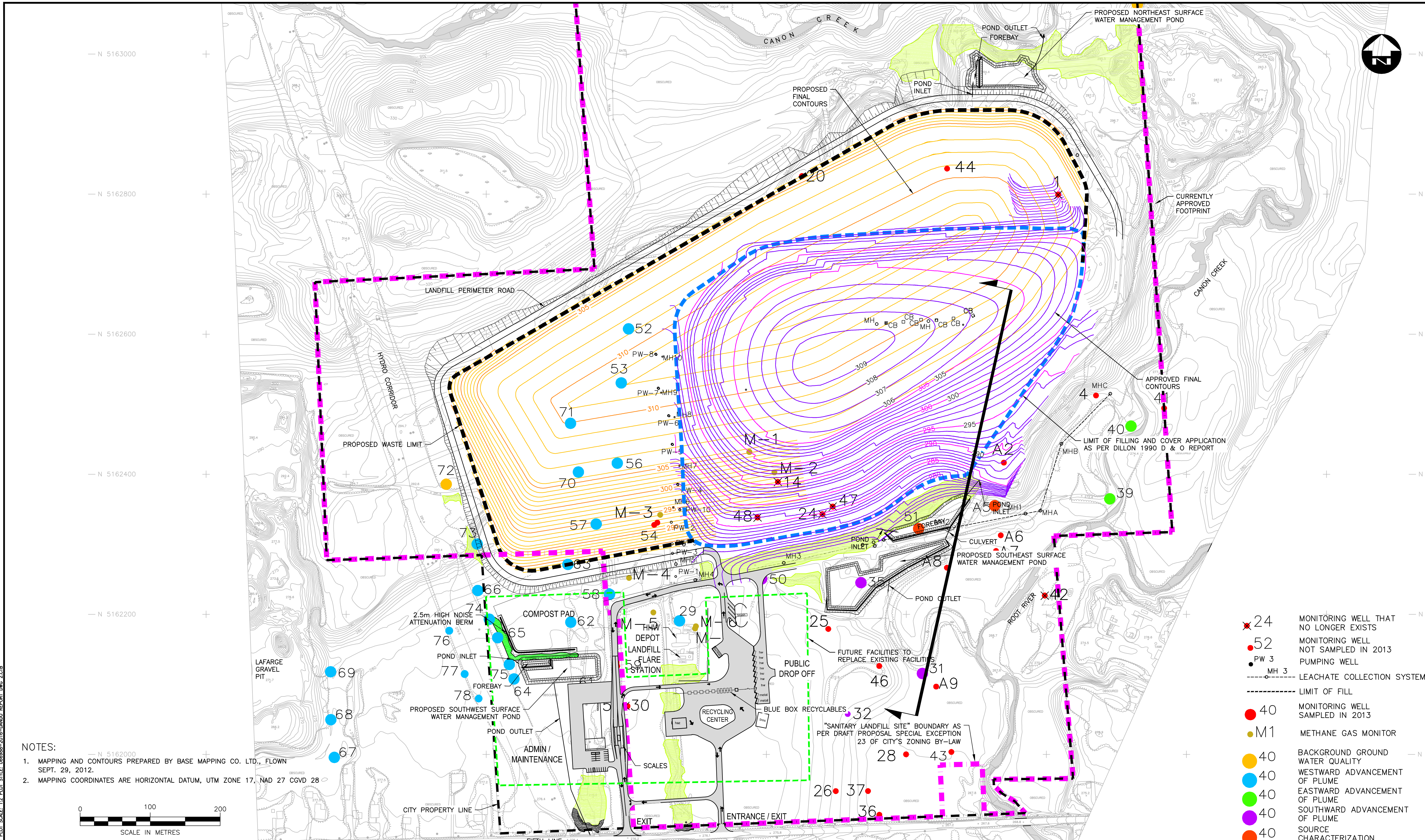
Contingency measures for the eastern portion of the existing site consist of the maintenance and replacement, if necessary, of the existing horizontal collection system. The horizontal collection system is located beyond the fill area and can be easily maintained or replaced if necessary throughout the contaminating lifespan of the existing fill area.

Residents south and east of the site remain on private wells. Impacts are not presently occurring to the south and east of the landfill based on the monitoring program data. Extension of the municipal water system to residents south and east of the site could be completed as a contingency measure if monitoring data indicates the potential for water quality impacts in this area.

For the area southwest of the landfill, a typical contingency measure for a landfill would be to establish a CAZ to mitigate impacts and prevent off-site impacts. While there is an existing CAZ established for the existing landfill, the landfill expansion will occupy a significant portion of it. Current down gradient land use immediately west of the site consists of a hydroelectric transmission corridor with an aggregate extraction pit down gradient of the transmission line. Both of these land uses are conducive to the establishing of a CAZ in the unlikely event that such a contingency is required.

Another typical contingency measure is the provision of alternative water supplies to adjacent and nearby properties that may be affected by the landfill such as residences located on the Fifth Line southwest of the site. Municipal water may be made available to current residences along Fifth Line to the west of the site.

Additional potential contingency measures include the new north-south collection system if installed as a contingency for the expansion site or a new purge well system constructed to provide groundwater protection to the area southwest of the new fill area.



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DATE: MARCH 2015
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SAULT STE. MARIE MUNICIPAL LANDFILL SITE
HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT

PROJECT NO. 06-6988

GROUNDWATER MONITORING PLAN

FIGURE NO. 4

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HYDROGEOLOGICAL IMPACT ASSESSMENT REPORT

PROJECT NO. 06-6988

SURFACE WATER MONITORING PLAN

FIGURE NO. 5

6.0 Summary

- The landfill design for the expansion which incorporates both a complete underdrain leachate collection system and a composite liner system will effectively protect water resources for the site beyond the contaminating lifespan of the expansion landfill area.
- The proposed landfill complies with both the Official Plan and the Source Protection Plan for Sault Ste. Marie.
- Groundwater protection for the western portion of the existing site will be significantly enhanced through the mining of the existing waste and providing a leachate collection system and liner system underneath the mined portion of the site.
- Prior to construction of Cells 6 and 7 of the expansion the City will assess the need for a north-south collection system to control impacted groundwater migration from the existing fill area.
- The existing landfill monitoring program will be expanded to include the new landfill expansion area. A residential water well monitoring program will be incorporated into the monitoring program.
- The contingency plan includes many components that will effectively mitigate unexpected issues that are identified.
- The landfill is outside of the wellhead protection zones established for the municipal groundwater supply.
- Contaminant transport modeling confirms that it is important to not significantly limit the generation of leachate so that the contaminating lifespan of the landfill is not extended. In the expansion area, it is important to remove a significant portion of the contaminant mass when the underdrain leachate collection system and the liner system are functional.
- Official Plan policies regarding ground water protection and the Source Protection Plan have been considered and included in the landfill expansion assessment.

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