ONTARIO CASE STUDIES:
WATER SUPPLY AND AGGREGATE EXTRACTION

Prepared for:

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ONTARIO STONE, SAND & GRAVEL ASSOCIATION

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March 2013

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ONTARIO STONE, SAND
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Essential materials for building a strong Ontario

Foreword to the Reader:

The Ontario Stone, Sand & Gravel Association is pleased to provide this copy of the report "**Ontario Case Studies - Water Supply and Aggregate Extraction"**. OSSGA commissioned SENES Consultants Limited to carry out this research on its behalf. OSSGA also commissioned a separate, professional peer review by Stephen C. Hollingshead, P. Eng., which supported the main findings and conclusions presented here.

In our view, this report is an important adjunct to an earlier study published by the Ontario Ministry of Natural Resources[i]. Its worldwide literature review on aggregate extraction and water supplies found almost no documented scientific evidence that the extraction and processing of stone, sand and gravel represents a threat to drinking water sources.

This present study expands on that work by examining five case histories in Ontario where aggregate operations have been carried out in close proximity to municipal water wells. In each case there is no evidence to suggest that the aggregate operations have contaminated or depleted these important drinking water sources.

The results of these studies, combined with the fact that few, if any, instances can be found of a pit or quarry causing significant contamination of a municipal water supply in Ontario, supports our belief that these two essential resources are compatible.

Cynthia Robinson
Environment & Education Manager
Ontario Stone, Sand & Gravel Association

[i] Blackport Hydrogeology Inc. & Golder Associates; *Applied Research on Source Water Protection Issues in the Aggregate Industry; Phase I Findings*; November, 2006

EXECUTIVE SUMMARY

BACKGROUND

SENES Consultants (SENES) was retained by Ontario Stone, Sand and Gravel Association (OSSGA) to complete the *Ontario Case Studies – Water Supply and Aggregate Extraction* in response to recommendations from a literature review (Blackport and Golder, 2006) conducted by the Ontario Ministry of Natural Resources (MNR) to assess the role of the aggregate industry and associated lands in the context of Source Water Protection programs undertaken under the direction of the Ontario Ministry of the Environment (MOE).

OBJECTIVES

The MNR study identified that each aggregate activity could have a varying impact on the hydrogeologic and hydrologic system in its vicinity, which would also be affected by its intrinsic vulnerability, and thus recommended case studies of aggregate sites where extraction and processing occurs in the vicinity of drinking water supplies. With a view to understanding the effect of aggregate operations to potential public water quality and quantity concerns, the major objectives for the present study were:

- To identify and select aggregate site locations in Ontario where pits and quarries are, or have been, operated in close proximity to municipal water supplies;
- To review available evidence related to selected examples to document whether water supplies have been depleted or contaminated by the aggregate activities; and
- To develop "case studies" summarizing water quality and quantity impacts due to activities associated with aggregate extraction operations.

CASE STUDY SITE SELECTION

Identification of Aggregate Sites in Vulnerable Areas

As an initial step, aggregate site boundaries were mapped on an Ontario base map, using Aggregate Site Authorized GIS Data received from the MNR. Information regarding vulnerable areas (e.g., Wellhead Protection Areas around groundwater supplies and Intake Protection Zones around surface water intakes) around municipal water supply systems was obtained based on preliminary draft data provided by the MOE and Conservation Authorities as part of the *Vulnerability Analysis* for Source Water Protection studies.

It was identified that very few aggregate sites have the potential, if at all, to impact municipal groundwater supplies. Of the 5951 aggregate sites recorded in Ontario, only 57 are located in vulnerable WHPAs (i.e., 2-year time of travel) of municipal water supplies.

Site Selection Criteria

In order to further refine the site selection process from the maps produced, several site screening criteria were developed based on 1) Vulnerability of Municipal Wells and 2) Proximity to Municipal Wells. Sites were then ranked through the developed priority criteria.

Case Study Sites Selected

The final five case studies selected for this report were based on the developed screening criteria and available municipal data and response from the aggregate producer:

Case Study #	ALPS ID	Final Selected Aggregate Case Study Sites	Municipality
1	3796	Dufferin Aggregates Simcoe/Jaworski Pit	Haldimand-Norfolk
2	4391	Trudeau Tweed Pit	Tweed
3	5623	Rockway Woolner Pit	Kitchener
4	2081	Lafarge Talbot Pit	London
5	6506	Lafarge Caledon Pit	Caledon

CASE STUDY METHODOLOGY

The case studies presented in this report are based on a desktop data collection, review and analysis of information and data made available at the time of the study by municipal agencies, regulatory sources, as well as aggregate sites. The present study focused on determining any *significant drinking water quality threats* that may be posed by aggregate extraction operations and associated activities, as set out by Ontario Ministry of Environment's (MOE) Source Water Protection regulations, pursuant to the *Clean Water Act, 2006*.

Two questionnaire surveys were also designed and conducted with the support of OSSGA in order to collect site specific information and data regarding activities conducted on the case study aggregate sites relevant to the 21 land-use activities that have been prescribed by the MOE's *Clean Water Act,* 2006, as *Drinking Water Threats* for Source Water Protection. The impact of any significant threats was assessed by comparing water quality data of *potential contaminants of concern* at municipal well water supplies, as relevant to Ontario Drinking Water Quality Standards (O.Reg. 169/03). The impact of water quantity was discussed based on regulated water taking volumes by aggregate sites.

CONCLUSIONS

The following overall conclusions may be drawn from this review:

- Fewer than 1% of pits and quarries in Ontario lie within the two-year time of travel Wellhead Protection Area (WHPA) for a municipal water well.
- Aggregate extraction and processing is NOT a prescribed drinking water threat as *per* the Ministry of the Environment's (MOE) Source Water Protection regulations. This is mainly related to the fact that aggregate production is chiefly a mechanical process that involves little or no use of chemicals aside from the fuel and lubricants in the machinery.
- Some pits and quarries can include ancillary land-use activities that would qualify as potential *significant drinking water threats* as per MOE's *Clean Water Act* Source Water Protection regulations. In this review:
    - One of the five sites reported a Class 4 - septic wastewater system for the use of the workers, which is considered a potential source of pathogens of concern (i.e., *E.coli*);
    - Two of the five sites reported on-site fuel storage tanks for machinery, which is considered a potential source of petroleum hydrocarbons (i.e., Benzene).
- The Provincial Standards regulating aggregate licences in Ontario prescribe that all fuel storage tanks must be maintained in accordance with the *Technical Standards and Safety Act*, and that there must also be a Spills Contingency Program in place. Several survey respondents in this study noted their Spills Contingency Plan as a risk reduction measure, along with related training programs for their site staff.
- Available data from all municipal water supplies (generally from 2005 to 2010) near the case study sites indicated no adverse impact from the aggregate production operations.
- Where relevant data were available, there is no evidence that the presence of a septic system or fuel storage at any of these aggregate sites has had any effect on the municipal water well quality, despite their relatively close proximity in the WHPA.
- Four out of the five sites were present in the WHPA of municipal water supply systems classified as GUDI (groundwater under the direct influence of surface waters). Thus, the drinking water quality and quantity at those systems also had the potential to be impacted by adjacent land uses and discharges into surface waters unrelated to aggregate operations. Assessing the potential impact of non-aggregate related surface waters (e.g. rivers) on these GUDI systems were beyond the scope of the current study.
- Relevant Source Water Protection reports prepared by local Conservation Authorities and Source Water Protection Committees for all five case study sites identified no existing water quality or quantity conditions (i.e., no known instances of degradation or declining trend of water quality/quantity) in the WHPA or municipal drinking water associated with aggregate extraction operations.

- Where applicable, aggregate sites extracting water for operations are regulated through Permits to Take Water issued by the MOE where pumping rates typically remain within a set maximum allowable limit and therefore are expected to have no adverse impact on municipal water supply quantities.

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1.0 INTRODUCTION

SENES Consultants (SENES) was retained by Ontario Stone, Sand and Gravel Association (OSSGA) to complete the Ontario Case Studies – Water Supply and Aggregate Extraction.

1.1 AGGREGATE INDUSTRY AND SOURCE WATER PROTECTION

In response to the Ontario Ministry of the Environment's (MOE) *Clean Water Act*, *2006* regarding Source Water Protection (SWP)*,* OSSGA supported a literature review study by the Ontario Ministry of Natural Resources (MNR) to assess the role of the aggregate industry and associated lands in the context of source water programs. The MNR study *Applied Research on Source Water Protection Issues in the Aggregate Industry* (Blackport and Golder, 2006) did not find any documented scientific evidence linking the extraction and processing of stone, sand and gravel as a threat to drinking water sources in its Phase I findings.

With regard to effects on water supply quantity, the study found that only large scale unmitigated quarry dewatering may affect nearby drinking water supplies. Dewatering in Ontario, is however subject to detailed investigation and controls as per Ontario Ministry of the Environment (MOE) regulations for Water Taking (O.Reg. 387/04). The effects of aggregate extraction, either above or below the water table, were found to be minor and localized. On the other hand, post-extraction lakes were seen to offer the potential to increase aquifer storage and enhance yields. In Ontario, these lakes can be and are rehabilitated to a natural state as a functional lake or wetland. As a result, many jurisdictions permit aggregate operations adjacent to water supply wells.

With regard to water quality, controlling runoff from adjacent land-uses was seen to be critical in preventing urban, industrial and agricultural contaminants from accessing groundwater aquifers. The water directly discharged from quarries containing high suspended solids was not seen to be of concern since solids are easily removed. Best management practices used in Ontario pits and quarries remove suspended solids before discharge and the discharge of water is also regulated through an Environmental Compliance Approval for Industrial Sewage Works pursuant to Section 53 of the Ontario Water Resources Act.

Furthermore, aggregate is processed mechanically by crushing, screening and washing; no chemicals are added to the products or to the water. The MOE has also confirmed that aggregate extraction is not a threat of provincial concern to drinking water sources.

Additional information regarding water use and aggregate operations can be found in the fact sheet publications "Water Management at Ontario Pits and Quarries" and "Groundwater in the Aggregate Industry" provided in Appendix A (newer versions and other related information may also be available at www.ossga.com/publications).

1.2 STUDY CONTEXT

Overall, the MNR study identified that each aggregate activity could have a varying impact on the hydrogeologic and hydrologic system in its vicinity, which would also be affected by its intrinsic vulnerability. It thus recommended case studies of aggregate sites where extraction and processing occurs in the vicinity of drinking water supplies, to verify the findings in the literature review and to determine if any further scientific research is needed.

1.3 STUDY GOALS AND OBJECTIVES

With a view to understanding the effect of aggregate operations to potential public water quality and quantity concerns, the major objectives for this study were:

- To identify and select aggregate site locations in Ontario where pits and quarries are, or have been, operated in close proximity to municipal water supplies;
- To review available evidence related to selected examples to document whether these water supplies have been depleted or contaminated by the aggregate activities; and
- To develop "case studies" summarizing water quality and quantity impacts due to activities associated with aggregate extraction operations.

1.4 STUDY SCOPE AND LIMITATIONS

The present study will focus mostly on defining any significant drinking water quality threats that may be posed by aggregate extraction operations and associated activities, as set out by Ontario Ministry of Environment's (MOE) Source Water Protection guidelines, pursuant to the *Clean Water Act, 2006*. The impact of any such significant threats were assessed by comparing water quality monitoring data for potential contaminants of concern from municipal well water supplies against the *Safe Drinking Water Act,* 2002, Ontario Drinking Water Quality Standards (O.Reg. 169/03). The impact of water quantity will be discussed based on regulated water taking volumes by aggregate sites.

It should be noted that a separate study was conducted by Golder Associates to address the effect of removal of material as a filtering substance.

1.5 STUDY LIMITATIONS

The case studies presented in this report are based on a desktop data collection, review and analysis of information and data made available at the time of the study by municipal agencies, regulatory sources, as well as aggregate sites.

2.0 SITE SELECTION

This section of the report describes how sample sites were selected for case history review in this assessment.

As of June 2011, there were 5951 aggregate licences and permits in Ontario. In order to study site-specific characteristics of aggregate site water use and their effects on water supplies, it was important to identify select aggregate sites in Ontario where pits and quarries are, or have been, operated in close proximity to municipal water supplies.

The MNR study highlighted that potential concerns to water quality and quantity due to aggregate operations were mainly focussed on *groundwater* sources. Therefore, the site selection for case studies was focused on identifying aggregate sites in the vicinity of the most vulnerable municipal groundwater well supplies.

2.1 IDENTIFICATION OF AGGREGATE SITE LOCATIONS

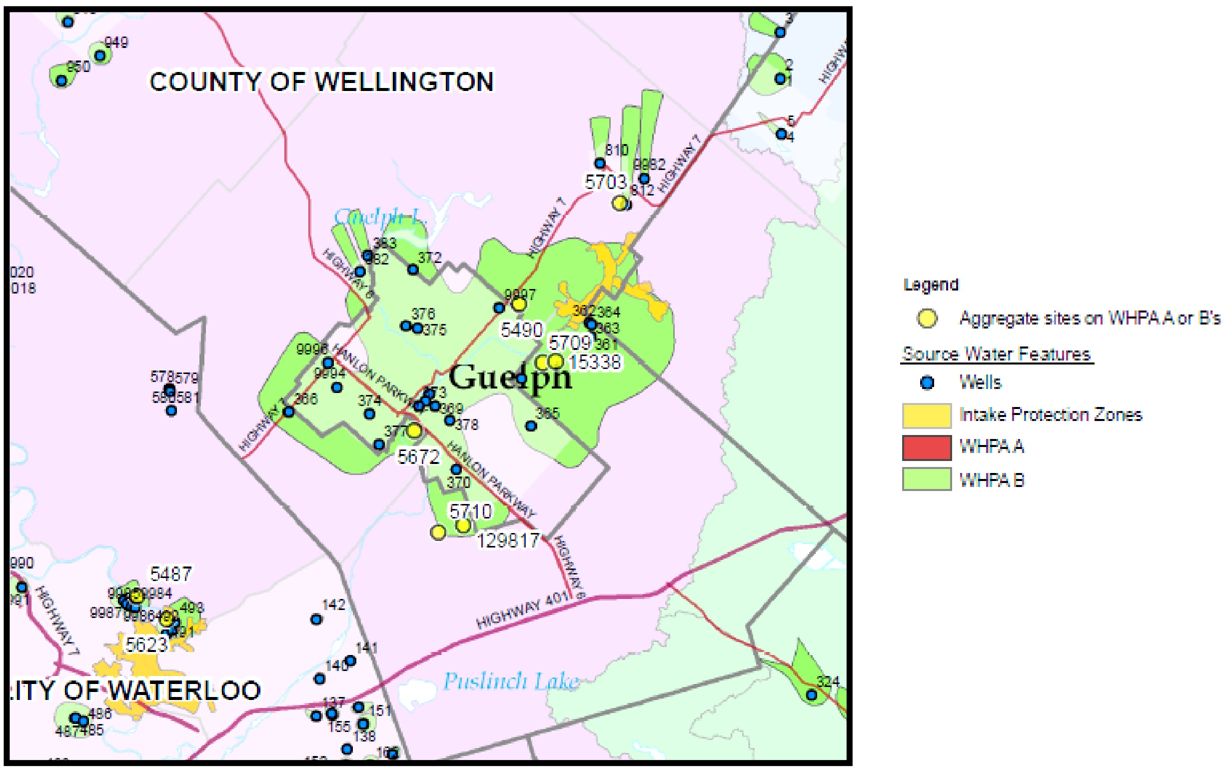
As an initial step, aggregate site boundaries were mapped on Ontario base maps, using Aggregate Site Authorized GIS Data received from the MNR. MNR's Lands and Non-Renewable Resources Section then assisted in overlaying the aggregate site maps with Source Water Protection areas (MNR, 2011) showing the following features (example shown in Figure 1):

- Municipal Water Wells & Surface Water Intakes;
- Vulnerable Areas:
  - Wellhead Protection Areas (WHPA);
  - Intake Protection Zones (IPZ);
- Hydrologic features (e.g. streams, rivers).

Areas that are most vulnerable to land-use activities that may cause potential impacts to groundwater supplies are called Wellhead Protection Areas (WHPA). These WHPA's were delineated through modelling conducted as part of the *Vulnerability Analysis* of Source Water Protection studies for each municipal groundwater water supply as directed by the MOE. Similarly, Intake Protection Zones (IPZs) are the areas near surface water intakes that are most likely to impact source water, and were delineated through modelling conducted for the preparation of draft Source Water Protection reports.

Information regarding vulnerable areas (e.g., WHPAs and IPZ) was obtained through the MNR based on preliminary data provided to them by the MOE and Conservation Authorities. It should be noted that, at the time of the study, mapping data were provided to the MNR in ***draft form only*** while awaiting MOE review and approval.

Figure 2-1 Example of Aggregate Site In Source Water Protection Area



The MNR identified 57 aggregate sites (55 pits, two quarries), out of 5951 in Ontario, that actually touch or are within a WHPA A and/or B. Of these, 21 aggregate sites were found to intersect more than one WHPA, while 36 sites touched or were located within a single WHPA only. Similarly, at least 39 WHPAs were found to have aggregate sites within them. None of the 57 sites are located within or touching an IPZ.

Due to the hydrogeological nature of dewatering operations, quarries are generally not located within the WHPA of municipal wells and are therefore not considered relevant for the purposes of the present case studies. Most quarries undertake dewatering activities that create a drawdown cone or groundwater "sink". Any groundwater within the perimeter of a quarry flows *inward* into the quarry and is subsequently pumped out to the surface. Therefore, if a quarry is being dewatered and is located in the same aquifer as a municipal well, the resultant

WHPA will appear to be "deflected" around the quarry, rather than passing through it. As a consequence, quarries cannot directly introduce any contaminants of potential concern to municipal water well supplies via groundwater pathways.

2.2 Development of Site Screening Criteria

In order to further refine the site selection process from the maps produced, several site screening criteria were developed based on the following rationale:

- Vulnerability of Municipal Wells;
- Proximity to Municipal Wells.

2.2.1 Vulnerability of Municipal Wells

Site selection was primarily based on the vulnerability of groundwater supplies in the vicinity of aggregate sites:

- Sites were selected based on their relative location with respect to Wellhead Protection Areas (WHPAs):
  - Sites affecting more than one WHPA were prioritized.
- All sites, located within WHPA A and B, were prioritized as they are in closest proximity to the source water for municipal water supplies. WHPAs are the areas within the aquifer that contributes groundwater to the municipal well over a specific time period. Four WHPAs were available from Source Water Protection studies, *from highest to lowest* vulnerability:
  - WHPA A – 100m radius from wellhead;
  - WHPA B – 2-year Time of Travel (TOT) capture zone;
  - WHPA C – 5-year TOT capture zone;
  - WHPA D – 25-year TOT capture zone.

2.2.2 Proximity of Municipal Wells

Further site screening was conducted based on the following proximity criteria to municipal wells:

- All sites within 1 km of a municipal well (approximation based on GIS spatial analysis of distance from centroid of aggregate site licensed boundary polygon and municipal well coordinates) were included in preliminary screening;
- Where more than one site was identified in a single geographic location (i.e., municipality, district), the site closest to the well was prioritized to allow for greater geographic variability in the site selection process; and
- All sites containing municipal wells within their property boundaries were prioritized.

It should be noted that the coordinates and shape polygons used in the MNR-conducted GIS spatial analysis provide approximations only. The calculated distances between aggregate sites and municipal wells therefore provide an appropriate screening level criterion for the purpose of this study.

2.2.3 Additional Considerations

Certain sites were seen to affect more than one WHPA. Therefore, sites in proximity to a greater number of municipal wells were also prioritized.

2.3 PRELIMINARY SITES FOR CASE STUDIES

Based on the Site Screening Criteria identified in Section 2.2, the preliminary list of sites that were considered is summarized in Table 2-1. Sites were also ranked through the priority criteria mentioned above. The first 10 sites listed in Table 2-1 have a municipal well located within the licenced boundary, whereas the remaining sites do not. Therefore, for the purpose of this investigation these 10 sites were selected to be included in the study.

Table 2-1 Preliminary Prioritized Screening List

Rank	ALPS ID	Municipality
1	**5867**	**North Stormont Township**
2	**3796**	**Norfolk County**
3	**4391**	**Tweed M**
4	**5703**	**Guelph/Eramosa Township**
5	**5487**	**Woolwich Township**
6	**5623**	**Kitchener**
7	**2081**	**London**
8	**15586**	**Brant County (City)**
9	**5868**	**North Dundas Township**
10	**6506**	**Caledon**
11	172	Sudbury R
12	5757	North Dundas Township
13	2267	Middlesex Centre Township
14	2149	South-West Oxford Township
15	5507	Milton
16	4193	Ottawa
17	19909	West Grey Township
18	3607	Midland
19	5814	Russell Township
20	6512	Caledon
21	6528	Brock Township
22	2090	London
23	2238	South-West Oxford Township
24	5619	Milton
25	5615	Kitchener
26	3813	Norfolk County
27	16724	Ottawa
28	5490	Guelph/Eramosa Township
29	5815	North Dundas Township
30	2147	South-West Oxford Township
31	3794	Norfolk County
32	5922	North Dundas Township
33	2150	South-West Oxford Township
34	3768	Norfolk County
35	19708	North Dundas Township
36	2152	South-West Oxford Township

3.0 APPROACH TO CASE STUDIES

Site specific case studies were conducted for *each aggregate site that was "screened in"* through the site selection process as discussed in Section 2.0. For each case study, the following process was applied:

- Information Gathering and Data Review;
- Water Quality Analysis;
- Water Quantity Analysis.

3.1 INFORMATION GATHERING AND DATA REVIEW

In order to collect and review site specific data and information regarding water quality and quantity, various sources were inquired:

- **Aggregate Site Questionnaire Surveys –** With input from OSSGA, two surveys (see Appendix B) were designed and administered for each case study: *1) Preliminary Aggregate Producers' Survey*; and *2) Defining Drinking Water Threat Activities and Circumstance*. The goal of these surveys was to collect site-specific information including site characteristics, site history, land use, operation and land activities as well as relevant water quality and quantity over the period of time of operation.

- **Drinking Water Annual Reports –** As part of Ontario's Drinking Water Systems Regulation O.Reg. 170/03, all municipal drinking water systems have been required to monitor water quality and comply with Ontario Drinking Water Quality Standards (O.Reg. 169/03) since 1993. These reports were accessed through relevant municipal websites for the respective case study aggregate site. The goal of these reports as an information source was to determine whether any deleterious impacts, trends or issues to water quality or quantity have been noted in the past.

- **Draft SWP Assessment Reports –** SWP Assessment reports are available for each Source Water Protection Area as per the *Clean Water Act*, 2006. These reports include watershed characterization, vulnerability assessment and drinking water quality and quantity threats and issues for all municipal drinking water sources. Relevant draft reports were obtained from publically available sources for the respective case study aggregate sites.

3.2 WATER QUALITY ANALYSIS

In order to assess water quality at aggregate sites and municipal wells, for *each case study* the following analysis was conducted:

- **Identification of Potential Water Quality Threat Activities -**
  - Pursuant to the *Clean Water Act, 2006*, 21 land use activities have been prescribed by the MOE as *Drinking Water Threats* for Source Water Protection (MOE, 2009). These activities were used to formulate a questionnaire survey (see Appendix B) which served to identify whether any of these prescribed land use activities occur within the licenced boundary of an aggregate operation and if so, whether these activities fall within the vulnerable areas on that property as delineated in the Assessment Report.
  - To determine whether an activity could be considered a *significant* drinking water threat, MOE defined criteria (MOE, 2008; see summary table for present study in Appendix C) were compared to aggregate survey responses which described the circumstances under which an activity existed at an aggregate site.

- **Identification of Potential Contaminants of Concern**
  - Where an activity was considered to pose a *significant* water quality threat, the *potential contaminants of concern* associated with that threat activity (see Appendix C) were identified as those relevant to safe drinking water only. Therefore, only common parameters listed in the Ontario Drinking Water Quality Standards (O.Reg. 169/03; see Appendix D) in the *Safe Drinking Water Act, 2002* (MOE, 2002) were considered.

- **On-site Water Quality Monitoring**
  - In order to assess the impact of significant threat activities at the aggregate site, on-site groundwater quality monitoring data (where available) of potential contaminants of concern were compared to maximum acceptable concentrations (i.e., Ontario Drinking Water Quality Standards) for safe drinking water.

- **Impact on Municipal Water Quality**
  - Historical water quality data were obtained from Drinking Water Annual Reports available until 2010 (see Appendix E for data summary and limitations). Under O.Reg. 170/03, municipalities are required to monitor parameters in treated water ensuring safe drinking water quality.

- No negative impact to municipal water quality was concluded if the data supported the following:
  - If potential contaminants of concern were below maximum acceptable concentrations in on-site water quality monitoring data (i.e., clean at site);
  - If potential contaminants of concern were below the Ontario Drinking Water Standards in municipal water quality monitoring data (i.e., safe for drinking);
  - If Ontario Drinking Water Standards are met for safe drinking *at all times*;

- In addition, a summary of water quality concerns and issues noted from existing Source Water Protection studies were also noted.

3.3 WATER QUANTITY ANALYSIS

In order to assess water quantity at aggregate sites and municipal wells, for each case study the following analysis was conducted:

- Available water taking/usage data from aggregate producer (e.g., Permit to Take Water (PTTW), annual reporting) was reviewed and compared to allowable pumping rates. Allowable water taking rates are approved by the MOE through PTTW for >50,000 L/day, following detailed hydrogeological studies.
  - In general, if water taking rates are below MOE approved allowable rates, no impact to municipal wells are expected.
  - For the purposes of this review, water takings within the rates approved and permitted by the MOE are assumed not to cause significant depletion of municipal water well supplies.
- Since no time series data on groundwater static levels are available for aggregate sites, Annual Reports will be used to note any water shortage periods; and
- Summary of any water quantity issues noted from existing Source Water Protection studies, as well as other high demand water taking activities nearby.

3.4 CASE STUDIES CONDUCTED

Of the final 10 sites chosen for case studies, there was insufficient information regarding municipal water monitoring for the following 4 aggregate sites:

- ALPS# 5478 - Woolwich Township
- ALPS# 5867 - North Stormont Township;
- ALPS# 5868 - North Dundas Township; and
- ALPS# 15586 - Brant County.

Furthermore, following preliminary data collection efforts, it was found that the Guelph/Eramosa site (ALPS# 5703) was used only for a short period of time with very low quantities of aggregate extracted. Due to its limited scope in aggregate operations and general lack of availability of site-specific data, the site was not included for a comprehensive case study.

Therefore, based on available survey information and acquired municipal monitoring water data, detailed case studies were conducted on the aggregate sites shown in Table 3-1, which are described in greater detail in the following sections.

Table 3-1 Case Study Sites

Case Study #	ALPS ID	Aggregate Site	Municipality
1	3796	Dufferin Aggregates Simcoe/Jaworski Pit	Haldimand-Norfolk
2	4391	Trudeau Tweed Pit	Tweed
3	5623	Rockway Woolner Pit	Kitchener
4	2081	Lafarge Talbot Pit	London
5	6506	Lafarge Caledon Pit	Caledon

4.0 CASE STUDY #1: DUFFERIN AGGREGATES SIMCOE/JAWORSKI PIT

4.1 SITE CHARACTERIZATION

4.1.1 Background

The Dufferin Aggregates site (ALPS#3796, 3813) is located in the Regional Municipality of Haldimand-Norfolk. The aggregate site (Dufferin Aggregates Simcoe/Jaworski Pit) contains two sand and gravel pits operating on adjacent lands year round, and also contains asphalt production facilities that operates year round. The total area of the site is 87.43 hectares. The site has a Class A licence for the Simcoe Pit (54.23 ha) to produce up to a maximum annual tonnage of 318,000, and a Class A license for the Jaworski Pit (33.2 ha) to produce up to a maximum annual limit of 325,000 tonnes.

The Dufferin Aggregates Simcoe/Jaworski Pit is currently extracting *below* the water table using a free-draining dragline; the site is not being dewatered. The aggregate site commenced operations in the early 1960s. The plant operates year round with extraction beginning at spring thaw. Prior to aggregate extraction the land was used for agriculture. Currently areas adjacent to the aggregate site consist of mostly agricultural and low-density residential land-use. The Dufferin Aggregates Jaworski Pit is also in operation in lands immediately adjacent to the current case study site. Some progressive rehabilitation and shoreline restoration work has been conducted at both the Simcoe and Jaworski properties.

4.1.2 Proximity to Municipal Well and Vulnerability

The Dufferin Aggregates Simcoe/Jaworski Pit site was selected for the case study due to its close proximity to municipal wells belonging to the Simcoe Well Supply System (Drinking Water System #220000371), owned by the Corporation of Norfolk County. The municipal wells are located within the licensed boundary and are located directly on the aggregate site property. In addition, portions of the aggregate site are located within delineated vulnerable areas: the 100-m buffer zone of the municipal well (i.e., WHPA A), as well as the 2-year time of travel (i.e., WHPA B) for the Simcoe Well Supply System, which was reported as a highly vulnerable area in the *Approved Assessment Report* for the Long Point Region Source Protection Area (LERSPC, 2011a).

The closest wellfield to the Dufferin Aggregates Simcoe/Jaworski Pit is the Northwest wellfield which consists of three wells. Screens for these three wells begin at 19-20 m below ground surface, and extend to 22-26 m below ground surface. Since aggregate activity is occurring within the highly vulnerable 100-m buffer zone (i.e., WHPA A) and the 2-year time of travel for the Northwest wellfield (i.e., WHPA B), the Dufferin Aggregates Simcoe/Jaworski Pit was selected for the case study to investigate whether activities at the aggregate operation have any impacts on water quality or quantity on the Northwest wellfield of the Simcoe Well Supply System.

It should be noted that the wells in the Northwest wellfield have been classified as GUDI (groundwater under the direct influence of surface waters), and thus the drinking water quality and quantity from the municipal wells also have the potential to be impacted by adjacent land uses and discharges into surface waters which are unrelated to aggregate operations. Assessing the potential impact of non-aggregate related surface waters (e.g. rivers) on the GUDI system is however considered beyond the scope of the current study.

Figure 4-1 shows maps indicating the location of the aggregate site within the source water protection area.

4.1.3 On-site Risk Reduction and Mitigation Measures

The Dufferin Aggregates Simcoe/Jaworski Pit has risk reduction strategies and mitigation measures to ensure minimal impact to the environment, which include:

- Standard Operating Procedures for the proper monitoring and storage of fuel as well as spill prevention and response;
- Spill Management Plan (including above-grade double-walled tanks located on a concrete pad for the storage and spill prevention of fuels);
- Environmental Management System;
- Sewage Pump Out Schedule (i.e., on-site portable toilet pumped once a week and hauled off-site for disposal);
- Progressive rehabilitation; and
- Setback and berms to prevent runoff from or into site.

Figure 4-1 Location of Dufferin Aggregates Simcoe/Jaworski Pit in WHPA

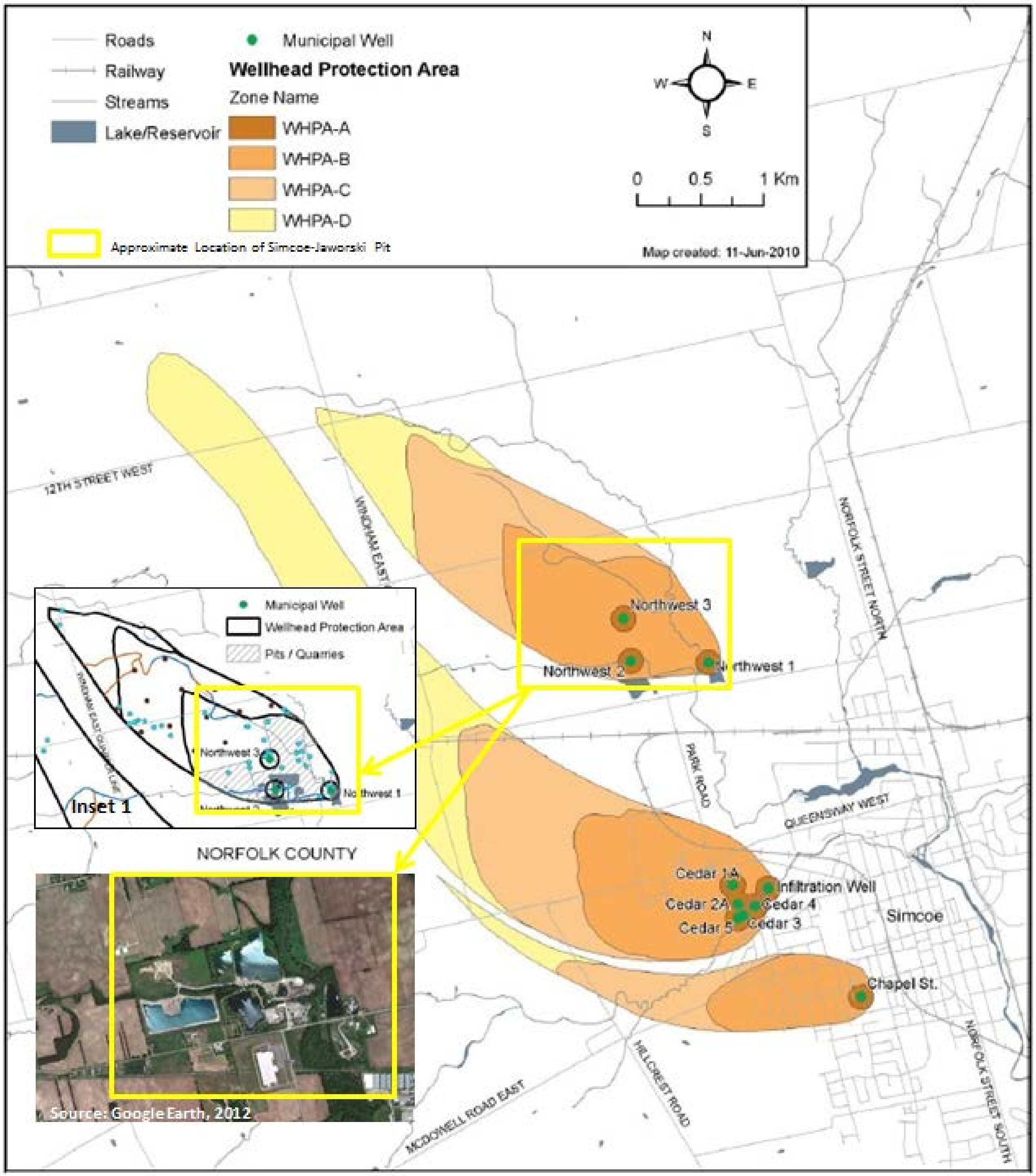


Figure for illustrative purposes only; adapted from WHPA maps in LERSPC (2011a)
Inset 1: WHPA showing aggregate pit boundary;
Inset 2: Satellite imagery of aggregate site location; Google Earth, 2012

4.2 WATER QUALITY ANALYSIS

4.2.1 Identification of Potential Water Quality Threat Activities

Pursuant to the *Clean Water Act* 2006, 21 land use activities have been prescribed by the MOE as *Drinking Water Threats* for Source Water Protection (see Appendix C). These activities were used to formulate a questionnaire which serves to identify whether any of these prescribed land use activities occur within the licenced boundary of an aggregate operation, but may or may not fall within the WHPA.

Of the applicable land use activities that are prescribed as drinking water threats, only 2 activities were identified to exist at the aggregate site and could be considered a potential threat, as shown in the Table 4-1.

Table 4-1 List of Applicable On-Site Potential Threat Activities on Aggregate Sites for Dufferin/Jaworski Aggregates Simcoe Pit

Threat Type	Potential Drinking Water Threat Activity	Threat Type	Activity Present On-Site?
Fuel	Handling and Storage of Fuels	Chemical	**Yes**
Wastewater System	Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Chemical/ Pathogen	**Yes**
Dense Non-Aqueous Phase Liquids (DNAPLs)	Handling and Storage of DNAPLs	Chemical	No
Organic Solvent	Handling and Storage of Organic Solvents	Chemical	No
Road Salt	Application of Road Salt	Chemical	No
	Handling and Storage of Road Salt	Chemical	No
Waste Disposal	Establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	Chemical/ Pathogen	No
Snow	Handling and Storage of Snow	Chemical	No

Of the 2 activities identified above, a further assessment was carried out to determine whether the activity could be considered a *significant* drinking water threat *under specific circumstances*. Activities are only considered a significant threat if they are conducted within the delineated WHPA (LERSPC, 2011) of the Northwest wellfield, as per the Approved Assessment Report for the LERSPC, and if the threatening activity occurs in the quantities and/or circumstances which would classify the threat level as significant as identified by the MOE Tables of Significant Threats.

Based on MOE regulations and circumstances under which the 2 identified activities exist on site (see Table 4-2):

- The handling and storage of fuels at the Dufferin Aggregates Simcoe/Jaworski Pit does not pose a significant threat to drinking water since these items are stored *outside* the delineated boundary of the WHPAs.
- The presence of portable toilets on-site do not pose a significant threat to drinking water since portable toilets are not regulated wastewater systems under the *Clean Water Act*'s Drinking Water Table of Threats (see Appendix C). In addition these portable toilets are located *outside* the delineated boundary of the WHPAs.

Table 4-2 List of Potential Significant Threat Activities for Dufferin Aggregates Simcoe/Jaworski Pit

Potential Drinking Water Threat Activity	Circumstance	Located in WHPA?	Significant Threat?
Handling and Storage of Fuels	Above Ground Storage; 4,500 L	Outside WHPA [1]	No
Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Portable Toilets only; not regulated under *Clean Water Act*	Outside WHPA [1]	No

1 – Location confirmed to be outside of WHPA by aggregate site staff

4.2.2 Identification of Potential Contaminants of Concern

No potential contaminants of concern were identified since *no* potential significant threats to drinking water were determined to exist at the Dufferin Aggregates Simcoe/Jaworski Pit, as per MOE's *Clean Water Act* Source Water Protection regulations.

4.2.3 On-Site Water Quality Monitoring

On-site groundwater quality monitoring data for the Dufferin Aggregates Simcoe/Jaworski Pit were available from 4 sampled days in 2009 and 2010. No significant threat activities were determined to exist at site therefore there are no identified potential contaminants of concern; however, the data confirmed that *all tested water quality* parameters (i.e., metals and petroleum hydrocarbons) in samples were safe for drinking water, as per Ontario Drinking Water Quality Standards.

4.2.4 Impact on Municipal Water Quality

Historical water quality data were obtained for the Northwest wellfield Simcoe Well Supply System from Drinking Water Annual Reports during the period 2005 – 2010 (see Appendix E for data summary and limitations). *Raw water* data available at the municipal wells showed at all times that *E.coli* was not detected. In addition, testing for inorganics and organics in the *treated* municipal waters showed no exceedances relevant to Ontario Drinking Water Quality Standards (O.Reg 169/03) during the 2005 to 2010 period.

The analysis shows that land use activities at the Dufferin Aggregates Simcoe/Jaworski Pit have had no negative impacts on drinking water quality for the 5 years of available data (2005-2010), while the site was operating within the WHPA.

4.3 Water Quantity Analysis

4.3.1 Water Extraction & Water Use

Historically water was used at the site for the wash plant, where aggregates were washed before being sorted and stockpiled for shipping. The wash plant has not been in operation since 2006 and will be removed from the site in the future. Water for the washplant was obtained from a well. The site operates under a Permit to Take Water (#99-P-2003) issued to the neighbouring Dufferin Aggregates-owned Jaworski Pit, which specifies a maximum allowable water taking limit of 109.1 m^3/day.

The water source for the Jaworski Pit is a nearby surface water body. Although annual water taking data are not available for this site, the aggregate producer survey indicates that water has not been pumped since 2006.

4.3.2 Impact on Municipal Water Supply

Limited water quantity data were available for the Northwest wellfield. However, since the water taking was carried out in accordance with a Permit to Take Water, water taking at the Dufferin Aggregates Simcoe/Jaworski Pit is not expected to have any impacts on water supply at the municipal wellfield. Furthermore, the Tier 2 water budget assessment for the Lynn River (where this pit and wellfield are located) indicates a low potential surface water stress classification, and a moderate groundwater stress classification; however, industrial consumption is only identified as 2% of the total groundwater demand (LERSPA, 2011).

4.4 OVERALL SUMMARY

4.4.1 Water Quality Impacts

- Aggregate extraction operations at the Dufferin Aggregates Simcoe/Jaworski Pit are not a MOE prescribed drinking water quality threat.
- As per MOE source water protection rules, *no potential significant threats* to the wells in the Northwest wellfield were identified based on land use activities at the Dufferin Aggregates Simcoe/Jaworski Pit;
- Available on-site water quality monitoring data for metals and hydrocarbons support that maximum allowable concentrations for safe drinking water are met at source.
- In order to further reduce any potential impact to water quality, the aggregate site has a Spill Management Plan and Environmental Management System in place.
- The Approved Assessment Report for the Long Point Region Source Protection Area (LERSPC, 2011a) identified no existing water quality or quantity conditions (i.e., no known instances of degradation or declining trend of water quality/quantity) for the Simcoe Well Supply System.
- Drinking water quality at the Northwest wellfield over the period from 2005 to 2010 has met all required drinking water standards for the protection of human health.
- Water quality analysis at the Northwest wellfield shows that land use activities at the Dufferin Aggregates Simcoe/Jaworski Pit have had no negative impacts on drinking water quality for the monitored data period, while the site was operating within the WHPA.

4.4.2 Water Quantity Impacts

- In regards to water quantity, water taking activities at the Dufferin Aggregates Simcoe/Jaworski Pit are regulated to be within the maximum allowable limit permitted by the MOE at all times, and therefore is expected to have no adverse impact on municipal water supply quantities. Furthermore, no water taking activities are currently occurring on the Dufferin Simcoe Pit property.

5.0 CASE STUDY#2: TRUDEAU TWEED PIT

5.1 SITE CHARACTERIZATION

5.1.1 Background

The aggregate site (ALPS#4391) owned by Kevin Trudeau (ownership since 1989) is located in the Municipality of Tweed. The aggregate site (Trudeau Tweed Pit) contains a sand and gravel pit that has been developed along the Tweed esker. The core of the esker is composed of coarse material, and its flanks are composed of sand (Rowell, 2010). The total area of the site is 16 hectares. The site has a Class B licence and produces a maximum annual limit of 20,000 tonnes.

The Trudeau Tweed Pit has been in operation for nearly 50 years, is licensed to extract *above water* and is currently operating above the water table. Prior to aggregate extraction the land was used for agriculture. Currently, areas adjacent to the aggregate site consist of mostly agricultural land-use.

5.1.2 Proximity to Municipal Well and Vulnerability

The Trudeau Tweed Pit was included here due to its close proximity to municipal wells belonging to the Tweed Well Supply System (Drinking Water System #220003092) owned by the Corporation of the Municipality of Tweed. The Tweed Well Supply system is comprised of two wells (i.e. Well #1 and Well #3) located on the western edge of the community: Well #1 is a well, drilled through 12.5 m of sand and gravel into the underlying Precambrian bedrock, intercepting water at a depth of 130.5 m, while Well #3 is located approximately 700 m to the south of Well #1 installed to a depth of 122.2 m through 10.1 m of sand and gravel into Precambrian bedrock, intercepting water bearing zones at depths of 15.5 and 47.2 m.

The aggregate site is located directly adjacent to the 2-year time of travel (i.e., WHPA B) for the Tweed Well Supply System, which was reported as a highly vulnerable area in the *Source Protection Assessment Report* for the Quinte Region (QRSPC, 2011). In addition, Well #3 has been classified as GUDI (groundwater under direct influence of surface water) due to the shallow depth of the aquifer. The drinking water quality and quantity from the well therefore has the potential to be impacted by adjacent land uses and discharges into surface waters unrelated to aggregate operations. Assessing the potential impact of non-aggregate related surface waters (e.g. rivers) on the GUDI system is considered beyond the scope of the current study.

Due to its vulnerable location, this case study for the Trudeau site is thus appropriate to show if aggregate activities have any effects on water quality or quantity on the Tweed Well Supply System. Figure 5-1 indicates the location of the aggregate site in relation to the source water protection area .

5.1.3 On-site Risk Reduction and Mitigation Measures

No specific risk reduction strategies or mitigation measures were reported for the Trudeau Tweed Pit for the period 2005 - 2010. Since that time period the following measures have been implemented:

- Location of fuel storage is outside the vulnerable area;
- Quantity of fuel stored has been reduced to 500 gallons;
- Fuel storage tank has spill prevention measures.

In keeping with the purpose of this report, water quality data for the period 2005 – 2010 was examined, corresponding with the time period prior to these more recent risk reduction measures being implemented.

Figure 5-1 Location of Trudeau Tweed Pit in WHPA

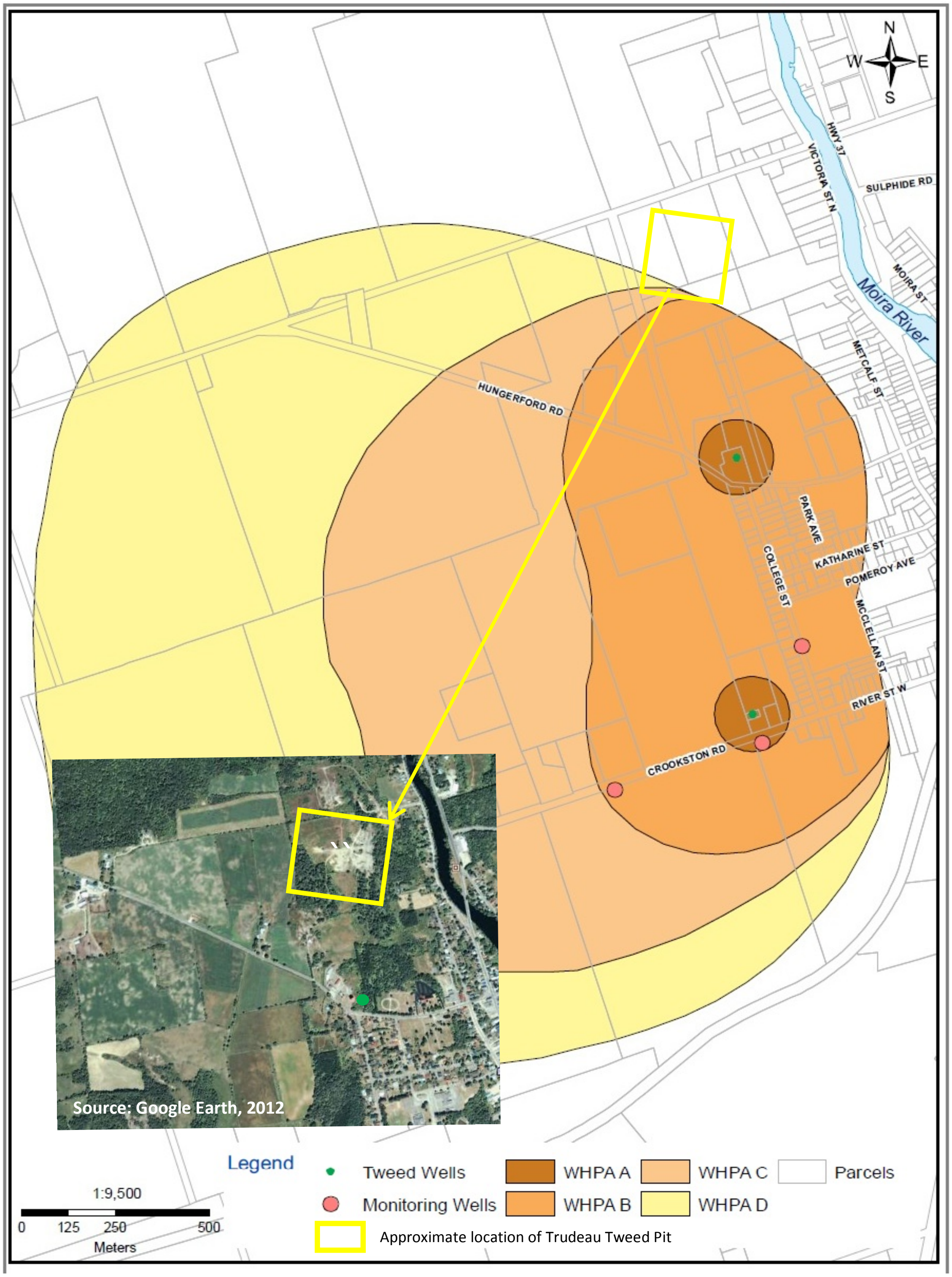


Figure for illustrative purposes only; adapted from WHPA maps in QRSPC (2011)
Inset: Satellite imagery of aggregate site location; Google Earth, 2012

5.2 WATER QUALITY ANALYSIS

5.2.1 Identification of Potential Water Quality Threat Activities

Pursuant to the *Clean Water Act*, 2006, 21 land use activities have been prescribed by the MOE as *Drinking Water Threats* for Source Water Protection (see Appendix C). These activities were used to formulate a questionnaire which serves to identify whether any of these prescribed land use activities occur within the licenced boundary of an aggregate operation, but may or may not fall within the WHPA.

Of the applicable land use activities that are prescribed as drinking water threats, only 2 activities were identified to exist at the aggregate site and could be considered a potential threat, as shown in the Table 5-1.

Table 5-1 List of Applicable On-Site Potential Threat Activities on Aggregate Sites at Trudeau Tweed Pit

Threat Type	Potential Drinking Water Threat Activity	Threat Type	Activity Present On-Site?
Fuel	Handling and Storage of Fuels	Chemical	**Yes**
Wastewater System	Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Chemical/ Pathogen	**Yes**
Dense Non-Aqueous Phase Liquids (DNAPLs)	Handling and Storage of DNAPLs	Chemical	No
Organic Solvent	Handling and Storage of Organic Solvents	Chemical	No
Road Salt	Application of Road Salt	Chemical	No
	Handling and Storage of Road Salt	Chemical	No
Waste Disposal	Establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	Chemical/ Pathogen	No
Snow	Handling and Storage of Snow	Chemical	No

Of the 2 activities identified above, a further assessment was carried out to determine whether the activity could be considered a *significant* drinking water threat *under specific circumstances*. Activities are only considered a significant threat if they are conducted within the delineated WHPA.

Based on MOE regulations and circumstances under which the 2 identified activities exist on site (see Table 5-2):

- The handling and storage of fuels on-site has the *potential* to pose a *significant threat* by introducing chemicals to the drinking water, since the *above-grade* gas, diesel and hydraulic oil storage tanks (capacity 3 x 4500 L) exceed the MOE threshold of 2500 L for significant threat;

The presence of a portable toilet on-site does not pose a significant threat to drinking water since portable toilets are not regulated wastewater systems under the *Clean Water Act*'s Drinking Water Table of Threats (see Appendix C).

Table 5-2 List of Potential Significant Threat Activities at Trudeau Tweed Pit

Potential Drinking Water Threat Activity	Circumstance	Located in WHPA?	Significant Threat?
Handling and Storage of Fuels	Above Grade Storage; Gas 4,500 L; Diesel 4,500 L; Hydraulic Oil 4500 L;	Outside WHPA [1]	**No**
Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Portable Toilet only; not regulated under *Clean Water Act*	Inside WHPA [1]	No

1 - Assumption based on the proximity to municipal well

5.2.2 Identification of Potential Contaminants of Concern

As per the MOE's *Clean Water Act* Source Water Protection regulations, *none of the activities* at the Trudeau Tweed Pit pose a significant risk to drinking water. Nevertheless, given the presence of liquid fuel storage adjacent to the WHPA, water quality data were reviewed with respect to the following *potential contaminants of concern*, as relevant to Ontario Drinking Water Quality Standards (O.Reg. 169/03; see Appendix D):

- Hydrocarbons (i.e., Benzene);

5.2.3 On-Site Water Quality Monitoring

No on-site monitoring data were available to assess the impact of the potential threat of the identified potential contaminants of concern on drinking water quality.

5.2.4 Impact on Municipal Water Quality

Historical water quality data were obtained for the Tweed Well Supply System from Drinking Water Annual Reports during the period 2005 – 2010 (see Appendix E for data summary and limitations).

Water Quality data available at the municipal wells (Well#1 and Well#3) showed the following:

- Testing for organics, in particular petroleum additives such as Benzene, in the *treated* municipal waters showed no exceedances relevant to Ontario Drinking Water Quality Standards (O.Reg 169/03) during the 2005 to 2010 period.
- *Raw water* data available at the municipal wells showed at all times that *E.coli* was not detected.

The analysis shows that land use activities at the Trudeau Tweed Pit identified as drinking water threat activities (as per MOE regulations) have had no negative impacts on drinking water quality for the 5 years of available data (2005-2010), while the site was operating within the WHPA.

5.3 Water Quantity Analysis

There are no activities (e.g. wash plant) that require water use on site and, therefore, no Permits to Take Water have been issued.

5.4 Overall Summary

5.4.1 Water Quality Impacts

- Aggregate extraction operations at the Trudeau Tweed Pit are not a MOE prescribed drinking water quality threat;
- As per MOE source water protection rules, one (1) *potential significant threat* was identified based on land use activities at the Trudeau Tweed Pit:
    - Storage of Liquid Fuels;
- The *Source Protection Assessment Report* for the Quinte Region (QRSPC, 2011) identified no existing water quality or quantity conditions (i.e., no known instances of degradation or declining trend of water quality/quantity), apart from elevated levels of naturally

occurring uranium in groundwater for the Tweed Well Water System which is not associated with aggregate extraction operations.

- Drinking water quality at the Tweed Well Water System over the period from 2005 to 2010 has met all required drinking water standards for the protection of human health.
- Water quality analysis of a potential contaminant of concern (i.e., Benzene) shows that land use activities at the Trudeau Tweed Pit which were identified as drinking water threat activities (as per MOE regulations) have had no negative impacts on drinking water quality for the 5 years of available data, while the site was operating within the WHPA.

5.4.2 Water Quantity Impacts

- This above-water pit does not involve any water takings, therefore there is no potential for any related effects on water quantity.

6.0 CASE STUDY#3: ROCKWAY WOOLNER PIT

6.1 SITE CHARACTERIZATION

6.1.1 Background

The Rockway Holdings Ltd aggregate site (ALPS#5623) is located in the City of Kitchener. The site contains a sand and gravel pit (Rockway Woolner Pit) that was operated on a seasonal basis. The total area of the site is 46 hectares. The site had a Class A licence to produce up to a maximum annual limit of 750,000 tonnes; the licence was surrendered in 2012.

The aggregate site commenced operations in 1995 and ceased operations in 2008. Although the Rockway Woolner Pit was initially licensed to extract below water, no extraction activities ever took place below the water table. Current land use in areas adjacent to the aggregate site consists mostly of mid-high density residential land-use with 5% parkland.

6.1.2 Proximity to Municipal Well and Vulnerability

The Rockway Woolner Pit was included here due to its close proximity to municipal wells belonging to the Woolner Well Supply System, which is part of the larger Kitchener Water Supply System (Drinking Water System #220003092). The Woolner Well Supply system is comprised of three wells (i.e., K80, K81 and K82) which combine in a common header prior to entering a water treatment facility. The wells are screened within the Deep Overburden Aquifer at depths between about 6 to 12 m, although this aquifer is relatively close to the surface in this location (LERSPC, 2011b).

The aggregate site is within within the 2-year time of travel (i.e., WHPA-B) for the Woolner Well Supply System, which was reported as a highly vulnerable area in the *Amended Draft Assessment Report* for the Grand River Source Water Protection Area (LERSPC, 2011b). In addition, the Woolner well field has been classified as GUDI (groundwater under direct influence of surface water) and as such a WHPA-E capture zone has also been delineated for this well field, which implies that the groundwater has a direct hydraulic connection with Grand River in the area. It should be noted that the Grand River bounds the site along its eastern border and that 85% of the water at Woolner wells K80 and K81 and 14% of the water from production well K82 comes from the Grand River (LERSPC, 2011b). The drinking water quality and quantity from the system thus has the potential to be impacted by adjacent land uses and discharges into surface waters unrelated to aggregate operations. Assessing the potential impact of non-aggregate related surface waters (e.g. rivers) on the GUDI system is however considered beyond the scope of the current study.

Due to its vulnerable location, this case study for Rockway Woolner Pit is thus appropriate to show if past aggregate activities had any effects on water quality or quantity on the Woolner Well Supply System. Figure 6-1 show maps indicating the location of the aggregate site and the surrounding source water protection areas.

Figure 6-1 Location of Rockway Woolner Pit in WHPA

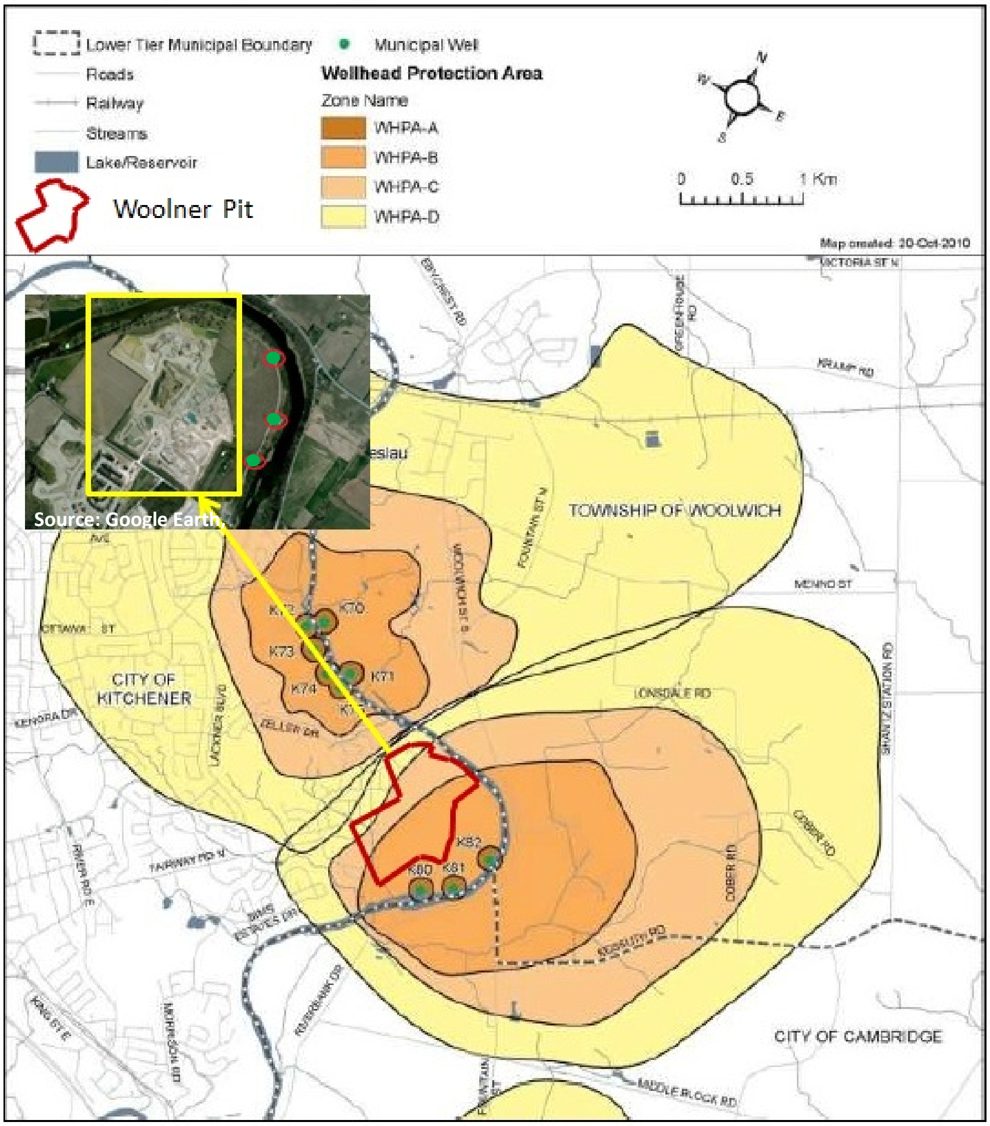


Figure for illustrative purposes only; adapted from WHPA maps in LERSPC (2011b)
Inset: Satellite imagery of aggregate site location; Google Earth, 2012

6.1.3 On-site Risk Reduction and Mitigation Measures

The Rockway Woolner Pit had, at the time of operation, risk reduction strategies and mitigation measures to ensure minimal impact to the environment, which include:

- Spill Contingency Plan;
- Spill kits;
- No on-site fuel storage (only mobile fueling).

6.2 WATER QUALITY ANALYSIS

6.2.1 Identification of Potential Water Quality Threat Activities

Pursuant to the *Clean Water Act,* 2006, 21 land use activities have been prescribed by the MOE as *Drinking Water Threats* for Source Water Protection (see Appendix C). These activities were used to formulate a questionnaire which serves to identify whether any of these prescribed land use activities occur within the licenced boundary of an aggregate operation, but may or may not fall within the WHPA. Of the applicable land use activities that are prescribed as drinking water threats, only one activity was identified to have existed at the aggregate site and could have been considered a potential threat, as shown in the Table 6-1.

Table 6-1 List of Applicable On-Site Potential Threat Activities on Aggregate Sites at Rockway Woolner Pit

Threat Type	Potential Drinking Water Threat Activity	Threat Type	Activity Present On-Site?
Wastewater System	Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Chemical/ Pathogen	**Yes**
Dense Non-Aqueous Phase Liquids (DNAPLs)	Handling and Storage of DNAPLs	Chemical	No
Fuel	Handling and Storage of Fuels	Chemical	No
Organic Solvent	Handling and Storage of Organic Solvents	Chemical	No
Road Salt	Application of Road Salt	Chemical	No
	Handling and Storage of Road Salt	Chemical	No
Waste Disposal	Establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	Chemical/ Pathogen	No
Snow	Handling and Storage of Snow	Chemical	No

A further assessment was carried out to determine whether the activity could be considered a *significant* drinking water threat *under specific circumstances*. Activities are only considered a significant threat if they are conducted within the delineated WHPA.

Based on MOE regulations and circumstances under which the identified activity exists on site (see Table 6-2), the presence of portable toilets on-site do not pose a significant threat to drinking water since portable toilets are not regulated wastewater systems under the *Clean Water Act*'s Drinking Water Table of Threats (see Appendix C).

Table 6-2 List of Potential Significant Threat Activities at Rockway Woolner Pit

Potential Drinking Water Threat Activity	Circumstance	Located in WHPA?	Significant Threat?
Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Portable Toilet only; not regulated under *Clean Water Act*	Inside WHPA [1]	No

1 - Assumption based on the proximity to municipal well

6.2.2 Identification of Potential Contaminants of Concern

No potential contaminants of concern were identified since *no* potential significant threats to drinking water were determined to exist at the Rockway Woolner Pit, as per MOE's *Clean Water Act* Source Water Protection regulations.

6.2.3 On-Site Water Quality Monitoring

No on-site monitoring data were available.

6.2.4 Impact on Municipal Water Quality

As per MOE source water protection regulations, land use activities at the Rockway Woolner Pit pose no significant threats to municipal water quality. Even so, historical water quality data were obtained for the Woolner Well Supply System from Drinking Water Annual Reports during the period 2005 – 2010 (see Appendix E for data summary and limitations). Water quality data available at the municipal wells showed the following:

- In the raw water, *E.coli* was detected in approximately 5% of samples in at least 4 of the monitored years. In the treated water, *E.coli* was not detected at all times.
- Testing for inorganics and organics in the *treated* municipal waters showed no exceedances relevant to Ontario Drinking Water Quality Standards (O.Reg. 169/03) during the 2005 to 2010 period.

The analysis shows that drinking water quality standards were met at the Woolner Well Supply System during the time period investigated, while the aggregate site was operating within the WHPA until operations ceased in 2008. Although the presence of *E.coli* in the raw water was documented, there were no potential sources of *E.coli* identified at the Rockway Woolner Pit. It should also be noted that no significant drinking water *conditions* or *issues* were identified for the Woolner well field during the recent source water assessment (LESPC, 2011b).

6.3 Water Quantity Analysis

6.3.1 Water Extraction & Water Use

Primarily water was used at the site for the wash plant, where aggregates were washed before being sorted and stockpiled for shipping. The site operated under a Permit to Take Water which specified a maximum allowable water taking limit of 12 m^3/min. Data records from 2006 and 2008 indicate that water taking rates from the aggregate site was between 1.5 m^3/min and 13.6 m^3/min[1].

6.3.2 Impact on Municipal Water Supply

Since the water taking during operation was carried out in accordance with a Permit to Take Water, water taking at the Rockway Woolner Pit is not expected to have had any impacts on the Woolner Water Supply System. The source water assessment classifies this sub-watershed as having a low stress level for surface water quantity, but that the groundwater stress in this area is significant owing largely to the high demand created by servicing the urban areas of Kitchener-Waterloo primarily with groundwater supplies. However, monitoring has demonstrated that groundwater levels in the associated aquifers have been maintained and that the municipal groundwater wells provide sufficient yield. A Tier 3 water budget assessment is in progress (LESPC, 2011b).

[1] The site operator noted that the reported upper limit of 13.6 m^3/min was the maximum output of the pump. However, the pump was throttled back so the actual water taking rate was less.

6.4 OVERALL SUMMARY

6.4.1 Water Quality Impacts

- Aggregate extraction operations at the Rockway Woolner Pit are not a MOE prescribed drinking water quality threat.
- As per MOE source water protection rules, *no potential significant threats* to the Woolner Water Supply System were identified based on land use activities at the Rockway Woolner Pit;
- In order to further reduce any potential impact to water quality, the aggregate site has a Spill Contingency Plan in place and does not store any fuels on-site.
- The Amended Draft Assessment Report for the Grand River Source Water Protection Area (LERSPC, 2011b) identified no existing water quality or quantity conditions (i.e., no known instances of degradation or declining trend of water quality/quantity) for the Woolner Water Supply System.
- Drinking water quality at the Woolner Water Supply System over the period from 2005 to 2010 has met all required drinking water standards for the protection of human health.
- As per MOE source water protection regulations, land use activities at the Rockway Woolner Pit pose no significant threats to the municipal water quality. In addition, there is no evidence linking the aggregate site activities to any negative impacts to drinking water quality over the period from 2005 to 2010.

6.4.2 Water Quantity Impacts

- In regards to water quantity, water taking activities at the Rockway Woolner Pit were carried out in accordance with a Permit to Take Water, and therefore are expected to have had no adverse impact on municipal water supply quantities.

7.0 CASE STUDY#4: LAFARGE TALBOT PIT

7.1 SITE CHARACTERIZATION

7.1.1 Background

The Lafarge Talbot Pit (ALPS#2081) is located in the City of London. The site is part of the Fanshawe Delta Outwash sand and gravel deposit. Lafarge operates the site on an intermittent, seasonal basis. The site is licensed to extract *below water* and is currently operating below the water table. The aggregate site commenced operations in 1989. The site has a Class A licence to produce up to a maximum annual limit of 453,500 tonnes.

The total licenced area of the site is 42.09 hectares, with a maximum extraction area of 40.44 ha. The aggregate site was previously used for agricultural purposes. Currently land use adjacent to the aggregate site includes a golf course, rural and agricultural uses, along with several other aggregate pits nearby.

7.1.2 Proximity to Municipal Well and Vulnerability

The Lafarge Talbot Pit site was selected for the case study due to its close proximity to a backup municipal well field (Fanshawe wellfield) belonging to the London Water Supply (Drinking Water System #260004917) owned by the Corporation of the City of London.

The aggregate site is located within the 2-year time of travel (i.e., WHPA B) for the London Water Supply System (TSRSPC, 2011). The Fanshawe wellfield consists of 6 wells classified as groundwater under the direct influence of surface water (GUDI) thus the drinking water quality and quantity from the system also has the potential to be impacted by adjacent land uses and discharges into surface waters unrelated to aggregate operations. Assessing the potential impact of non-aggregate related surface waters (e.g. rivers) on the GUDI system is however considered beyond the scope of the current study.

Due to its vulnerable location, this case study for the Lafarge Talbot Pit is appropriate to evaluate if aggregate activities have any effects on water quality or quantity on the Fanshawe wellfield. Figure 7-1 shows the location of the aggregate site and the surrounding source water protection areas.

Figure 7-1 Location of Lafarge Talbot Pit in WHPA

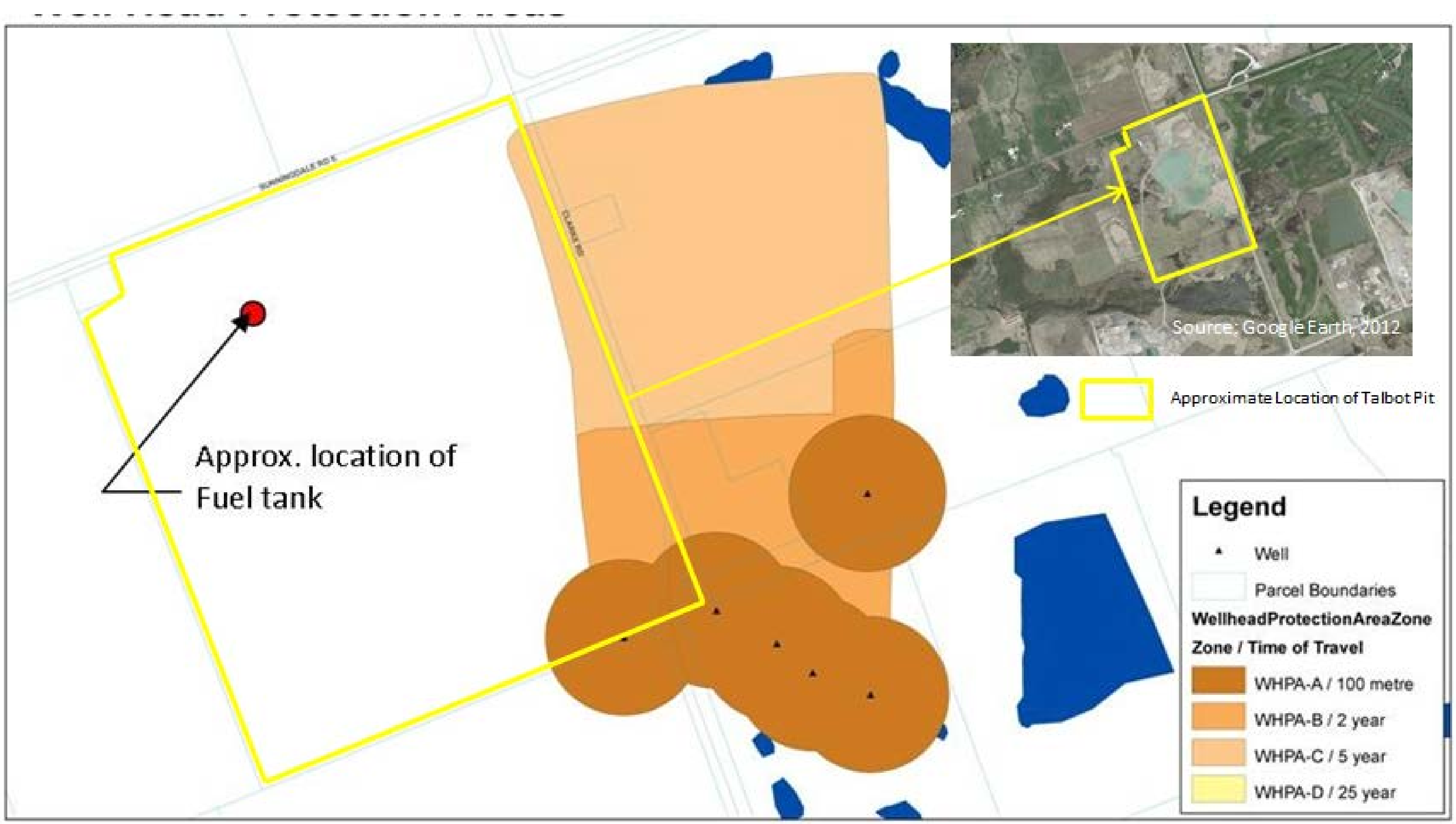


Figure for illustrative purposes only; adapted from WHPA maps in TSRSPC (2011)
Inset: Satellite imagery of aggregate site location; Google Earth, 2012

7.1.3 On-site Risk Reduction and Mitigation Measures

Due to its vulnerable location in the WHPA of the Fanshawe wellfield, the Lafarge Talbot Pit has risk reduction strategies and mitigation measures to ensure minimal impact to the environment, which include:

- Spills Action Plan posted at site;
- Spill kit (e.g., 45 gal drum with absorbent pads, booms, clay based absorbent); and
- A yearly spill training refresher.

7.2 Water Quality Analysis

7.2.1 Identification of Potential Water Quality Threat Activities

Pursuant to the *Clean Water Act,* 2006, 21 land use activities have been prescribed by the MOE as *Drinking Water Threats* for Source Water Protection (see Appendix C). These activities were used to formulate a questionnaire which serves to identify whether any of these prescribed land use activities occur within the licenced boundary of an aggregate operation, but may or may not fall within the WHPA. Of the applicable land use activities that are prescribed as drinking water threats, only 2 activities were identified to exist at the aggregate site and could be considered a potential threat, as shown in the Table 7-1.

Table 7-1 List of Applicable On-Site Potential Threat Activities on Aggregate Sites at Lafarge Talbot Pit

Threat Type	Potential Drinking Water Threat Activity	Threat Type	Activity Present On-Site?
Fuel	Handling and Storage of Fuels	Chemical	**Yes**
Wastewater System	Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Chemical/ Pathogen	**Yes**
Dense Non-Aqueous Phase Liquids (DNAPLs)	Handling and Storage of DNAPLs	Chemical	No
Organic Solvent	Handling and Storage of Organic Solvents	Chemical	No
Road Salt	Application of Road Salt	Chemical	No
	Handling and Storage of Road Salt	Chemical	No
Waste Disposal	Establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	Chemical/ Pathogen	No
Snow	Handling and Storage of Snow	Chemical	No

Of the 2 activities identified above, a further assessment was carried out to determine whether the activity could be considered a *significant* drinking water threat *under specific circumstances*. Activities are only considered a significant threat if they are conducted within the delineated WHPA. Based on MOE regulations and circumstances (see Appendix C) under which the 2 identified activities exist on site (see Table 7-2):

- The handling and storage of fuels on-site is *not* considered a significant threat since there is *no on-site storage of fuel* for aggregate extraction operations; rather, the use of a mobile fuelling truck is noted. Although, a 15,000 L storage tank is reported to be stored on aggregate site lands *leased by its tenant*, the location of the storage tank is *outside* the WHPA (see Figure 8-2) and is therefore *not* considered a significant threat.

The presence of portable toilets on-site do not pose a significant threat to drinking water since portable toilets are not regulated wastewater systems under the *Clean Water Act*'s Drinking Water Table of Threats (see Appendix C).

Table 7-2 List of Potential Significant Threat Activities at Lafarge Talbot Pit

Potential Drinking Water Threat Activity	Circumstance	Located in WHPA?	Significant Threat?
Handling and Storage of Fuels	No on-site storage of fuels by aggregate producer, i.e., mobile fuelling only; Tenant stores 15,000 L fuel tank	Outside of WHPA [1]	No
Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Portable Toilet only; not regulated under *Clean Water Act*	Potentially Inside WHPA [2]	No

1 – Confirmed by aggregate producer; see Figure 7-1
2 - Based on the assumption that portable toilets can be moved around the site.

7.2.2 Identification of Potential Contaminants of Concern

No potential contaminants of concern were identified since *no* potential significant threats to drinking water were determined to exist at the Lafarge Talbot Pit, as per MOE's *Clean Water Act* Source Water Protection regulations.

7.2.3 On-Site Water Quality Monitoring

No on-site monitoring data were available.

7.2.4 Impact on Municipal Water Quality

As per MOE source water protection regulations, land use activities at the Lafarge Talbot Pit pose no significant threats to the municipal water quality. Even so, historical water quality data were obtained for all 6 wells (Well#1 to Well# 6) at the Fanshawe wellfield from Drinking Water Annual Reports during the period 2006 – 2010 (see Appendix E for data summary and limitations).

Water quality data available at the municipal wells showed that *E.coli*, was detected in 2006 in the *raw water;* however, subsequent testing showed that *E.coli* was not detected from 2007 to 2010. Although the presence of *E.coli* in the raw water was documented, there are no potential sources of *E.coli* identified within the WHPA at the Lafarge Talbot Pit. In addition, testing for petroleum additives such as Benzene, Toluene, Ethylbenzene and Total Xylene in the *raw* municipal waters showed no exceedances relevant to Ontario Drinking Water Quality Standards (O.Reg. 169/03), nor were they detected in any sample, during the 2006 to 2010 period.

7.3 WATER QUANTITY ANALYSIS

There are no activities at this below-water extraction site that require water use and, therefore, the site does not have a Permit to Take Water. Furthermore groundwater levels at the Fanshawe wellfield were not available. As such, a water quantity analysis was not possible at the Lafarge Talbot Pit.

7.4 OVERALL SUMMARY

7.4.1 Water Quality Impacts

- Aggregate extraction operations at the Lafarge Talbot Pit are not a MOE prescribed drinking water quality threat.
- As per MOE source water protection rules, *no potential significant threats* to the Fanshawe wellfield were identified based on land use activities at the Lafarge Talbot Pit.
- In order to further reduce any potential impact to water quality, the aggregate site has a Spill Action Plan along with spill kits and on-site training refreshers in place.

- TSRSPC (2011) identified no existing water quality or quantity conditions (i.e., no known instances of degradation or declining trend of water quality/quantity) in the WHPA or municipal drinking water associated with aggregate extraction operations.
- Drinking water quality at the Fanshawe wellfield over the period from 2006 to 2010 has met all required drinking water standards for the protection of human health.
- As per MOE source water protection regulations, land use activities at the Lafarge Talbot Pit pose no significant threats to the municipal water quality. In addition, there is no evidence linking the aggregate site activities to any negative impacts to drinking water quality over the period from 2006 to 2010.

7.4.2 Water Quantity Impacts

This below-water pit does not involve any water takings, therefore any potential effects of below-water extraction at the Lafarge Talbot Pit are expected to be minor and localized.

8.0 CASE STUDY#5: LAFARGE CALEDON PIT

8.1 SITE CHARACTERIZATION

8.1.1 Background

The aggregate site operated by Lafarge Canada (ALPS#6506) is located in the Town of Caledon. The site contains a sand and gravel pit (Lafarge Caledon Pit) that is operated on a seasonal basis, but ships year round. The aggregate site has been in operation since 1957. The site is licensed to extract *below water* and is currently operating below the water table. The site has a Class A license to produce greater than 20,000 tonnes per year.

The site covers a total area of 570.9 hectares. The aggregate site was previously used for agricultural purposes. Currently, land use adjacent to the aggregate site includes rural, agricultural and recreational use, along with several other aggregate pits nearby. Progressive rehabilitation is on-going.

8.1.2 Proximity to Municipal Well and Vulnerability

The Lafarge Caledon Pit site was selected for the case study due to its close proximity to municipal wells belonging to the Caledon Village Well Supply system (Drinking Water System #220004000) owned by the Region of Peel. The Caledon Village Well Supply System is comprised of two drilled wells: Well #3 and Well #4. Well #3 is located within the aggregate site boundaries. Therefore, the Lafarge Caledon Pit is also located within the 2-year time of travel (i.e., WHPA B) for the Caledon Village Well Supply System, which was reported as a highly vulnerable area in the *Updated Assessment Report* for the Credit Valley Source Protection Area (CVCA, 2011). The well is constructed in an unconfined sand and gravel aquifer and the Region of Peel annual water quality reports list the well depth as 32 m, with a screen length of 6.1 m.

The vulnerability of the WHPA around this well was determined to be moderate, but was raised to highly vulnerable in recognition that the extraction from both the Lafarge and Caledon Sand & Gravel pits have removed overburden and thereby potentially enhanced the vulnerability (CVCA, 2011). Due to its vulnerable location, this case study for the Lafarge Caledon Pit site is appropriate to show if aggregate activities have any effects on water quality or quantity on the Caledon Village Well Supply System. Figure 8-1 shows the location of the aggregate site and the surrounding source water protection areas.

Figure 8-1 Location of Lafarge Caledon Pit in WHPA

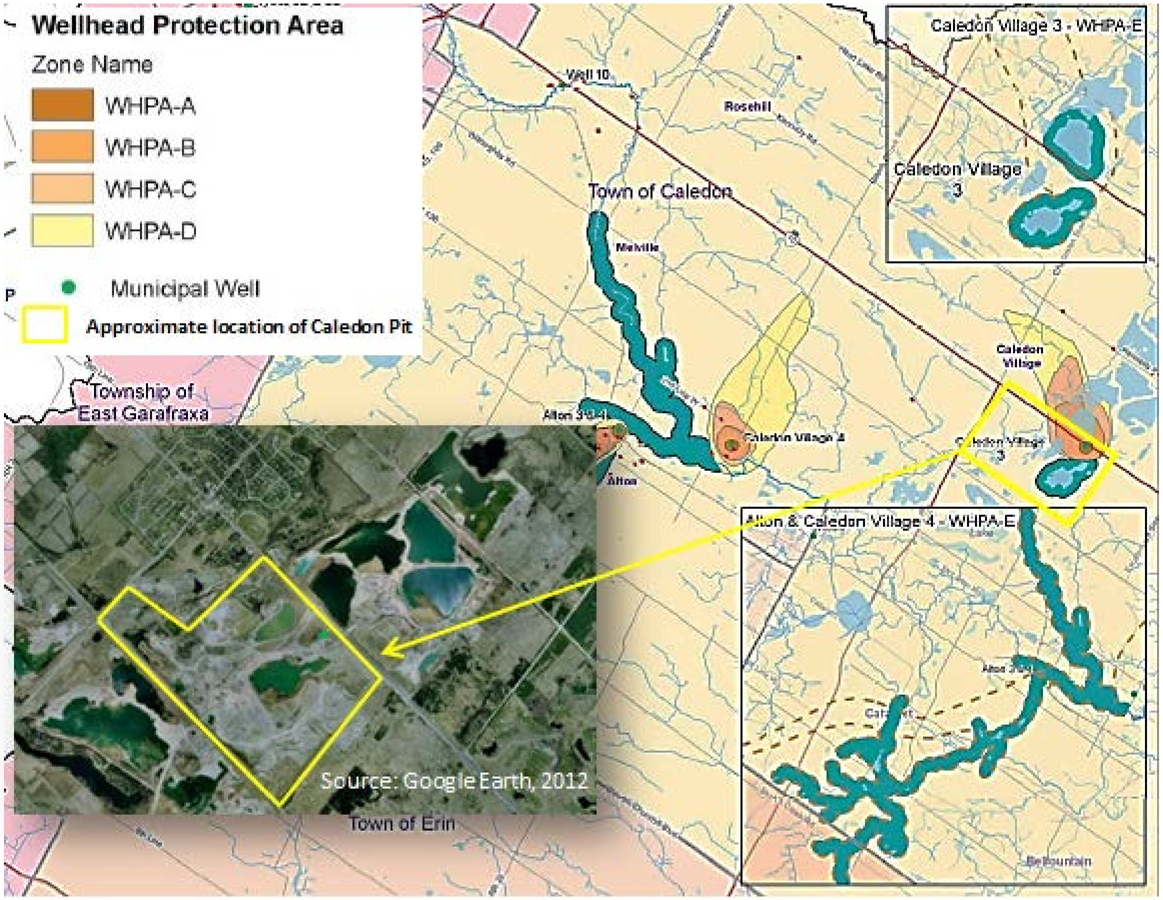


Figure for illustrative purposes only; adapted from WHPA maps in CVCA (2011)
Inset: Satellite imagery of aggregate site location; Google Earth, 2012

8.1.3 On-site Risk Reduction and Mitigation Measures

Due to its vulnerable location in the WHPA of the Caledon Village Well Supply System, the Lafarge Caledon Pit has risk reduction strategies and mitigation measures to ensure minimal impact to the environment, which include:

- Spills Action Plan posted at site;
- Spill kits (a kit consists of a 45 gal drum with absorbent pads, booms, clay based absorbent); and
- At Spring start-up spill training refresher provided.

8.2 Water Quality Analysis

8.2.1 Identification of Potential Water Quality Threat Activities

Pursuant to the *Clean Water Act,* 2006, 21 land use activities have been prescribed by the MOE as *Drinking Water Threats* for Source Water Protection (see Appendix C). These activities were used to formulate a questionnaire which serves to identify whether any of these prescribed land use activities occur within the licenced boundary of an aggregate operation, but may or may not fall within the WHPA. Of the applicable land use activities that are prescribed as drinking water threats, only 2 activities were identified to exist at the aggregate site and could be considered a potential threat, as shown in the Table 8-1.

Table 8-1 List of Applicable On-Site Potential Threat Activities on Aggregate Sites at Lafarge Caledon Pit

Threat Type	Potential Drinking Water Threat Activity	Threat Type	Activity Present On-Site?
Fuel	Handling and Storage of Fuels	Chemical	**Yes**
Wastewater System	Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Chemical/ Pathogen	**Yes**
Dense Non-Aqueous Phase Liquids (DNAPLs)	Handling and Storage of DNAPLs	Chemical	No
Organic Solvent	Handling and Storage of Organic Solvents	Chemical	No
Road Salt	Application of Road Salt	Chemical	No
	Handling and Storage of Road Salt	Chemical	No
Waste Disposal	Establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	Chemical/ Pathogen	No
Snow	Handling and Storage of Snow	Chemical	No

Of the 2 activities identified above, a further assessment was carried out to determine whether the activity could be considered a *significant* drinking water threat *under specific circumstances*. Activities are only considered a significant threat if they are conducted within the delineated WHPA. Based on MOE regulations and circumstances under which the 2 identified activities exist on site (see Table 8-2):

- The handling and storage of fuels on-site has the *potential* to pose a *significant threat* by introducing chemicals to the drinking water since the *below grade* storage tank (capacity 55,000 L) exceeds the MOE threshold of 250 L for significant threat; in addition, the *above grade* storage tanks (capacity 2 x 2,250 L) and waste oil tank (capacity 4000 L) have capacities greater than the MOE threshold of 2500 L for above grade storage;
- The presence of a Class-4 Wastewater System (Septic System with a Below Ground Septic Tank and Weeping Tile) on-site has the potential to *pose a significant threat* by introducing pathogens to the drinking water.

Table 8-2 List of Potential Significant Threat Activities at Lafarge Caledon Pit

Potential Drinking Water Threat Activity	Circumstance	Located in WHPA?	Significant Threat?
Handling and Storage of Fuels	Fuelling Station – Below Grade Tank 55,000 L 2 x Above Grade Tanks 2,250 L Waste Oil Tank 4,000 L (double-walled, on concrete pad)	Outside of WHPA [1]	**Yes**
Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage (i.e., stormwater management facility, wastewater collection system)	Class 4 – Wastewater System; Septic System with Below Ground Septic Tank and Weeping Tile	Inside WHPA [1]	**Yes**

1 - Confirmed location with Lafarge

8.2.2 Identification of Potential Contaminants of Concern

As per the MOE Source Water Protection regulations, *most activities* at the Lafarge Caledon Pit do not pose a significant risk to drinking water, however, the presence of a Class 4 - Wastewater System may introduce the following *potential contaminants of concern*, as relevant to Ontario Drinking Water Quality Standards (O.Reg. 169/03; see Appendix D):

- Pathogens (i.e., *E.coli*)

Furthermore, despite the location of the fuel storage outside of the WHPA, due to its size and proximity to the WHPA, water quality data were also reviewed with respect to hydrocarbons (i.e., as indicated by the petroleum additive Benzene).

8.2.3 On-Site Water Quality Monitoring

No on-site monitoring data were available to assess the impact of the potential threat of the identified potential contaminants of concern on drinking water quality.

8.2.4 Impact on Municipal Water Quality

Historical water quality data were obtained for Well#3 of the Caledon Village Well Supply from Drinking Water Annual Reports during the period 2003 – 2010 (see Appendix E for data summary and limitations).

Water Quality data available at the municipal wells showed the following:

- *E.coli*, an identified potential contaminant of concern, was not at detected at all times, indicating that the Class 4 - Wastewater System (i.e., Septic System) at the aggregate site did not introduce *E.coli* to municipal drinking waters. Furthermore, a 2002 study by Stantec Consulting found no detections of E.coli or Total Coliforms in 152 raw water samples from Wells #3 and #3A (adjacent) dating back to the period from 1996 to 2001 (as reported by Geo Kamp Limited "Well Construction Program, Caledon Village Well 3B, May 2011).
- Testing for organics, in particular petroleum additives such as Benzene, in the *treated* municipal waters showed no exceedances relevant to Ontario Drinking Water Quality Standards (O.Reg 169/03) during the 2005 to 2010 period.

In addition, testing for all other inorganics and organics in the *treated* municipal waters showed no exceedances relevant to Ontario Drinking Water Quality Standards (O.Reg 169/03) during the 2003 to 2010 period.

The analysis shows that land use activities at the Lafarge Caledon Pit identified as significant drinking water threat activities (as per MOE regulations) have not had a negative impact on drinking water quality for the years monitored , while the site was operating within the WHPA.

8.3 WATER QUANTITY ANALYSIS

8.3.1 Water Extraction & Water Use

Primarily water is used at the site for the wash plant, where aggregates are washed before being sorted and stockpiled for shipping. The site operates under a Permit to Take Water which specifies a maximum allowable water taking limit of 26.2 m^3/day. Data records from 2007 and 2010 indicate that water taking rates from the aggregate site varied between 6.8 m^3/day and 12.5 m^3/day.

8.3.2 Impact on Municipal Water Supply

Since the water taking was carried out in accordance with a Permit to Take Water, water taking at the Lafarge Caledon Pit is not expected to have any impacts on Caledon Village Well Supply System. Furthermore, the source water assessment report for this region identifies this area as having a low water quantity stress for both surface water and groundwater takings (CVCA, 2011).

8.4 OVERALL SUMMARY

8.4.1 Water Quality Impacts

- Aggregate extraction operations at the Lafarge Caledon Pit are not a MOE prescribed drinking water quality threat.
- As per MOE source water protection rules, 2 *potential significant threats* were identified based on land use activities at the Lafarge Caledon Pit:
    - Storage of *Below Grade* and *Above Grade* Liquid Fuels
    - A Class 4 - Wastewater System (i.e., Septic System)
- In order to further reduce any potential impact to water quality, the aggregate site has a Spill Action Plan along with spill kits and on-site training refreshers in place.
- CVCA (2011) identified no existing water quality or quantity conditions (i.e., no known instances of degradation or declining trend of water quality/quantity) in the WHPA or municipal drinking water associated with aggregate extraction operations.
- Drinking water quality at the Caledon Village Well Supply System over the period from 2003 to 2010 has met all required drinking water standards for the protection of human health.
- Water quality analysis of the potential contaminants of concern (i.e., *E.coli*, Benzene) shows that land use activities at the Lafarge Caledon Pit which were identified as

drinking water threat activities (as per MOE regulations) have had no negative impacts on drinking water quality from 2003 to 2010, while the site was operating within the WHPA.

8.4.2 Water Quantity Impacts

- In regards to water quantity, water taking activities at the Lafarge Caledon Pit are regulated to be within the maximum allowable limit permitted by the MOE at all times, and therefore is expected to have no adverse impact on municipal water supply quantities.

8.4.3 Testimonial

Several other studies and investigations have been conducted over the years to assess the impact of aggregate extraction activities on water quality and quantity at the Caledon Village Well System. Findings of one such study conducted by Geo Kamp Limited (2011) for the Village of Caledon indicate no impact due to activities at the Lafarge Caledon Pit. Relevant extracts from the study referring to water quality in Well#3 (PW3) are provided below:

> *Water samples collected from the pumped wells at the end of the aquifer performance test and submitted for the complete suite of the Ontario Drinking Water Standards (Ont. Reg. 169/03), except for radionuclides, dioxins and furans, bromate, chloramines microcystin-LR, NTA and NDMA, indicated that the overall raw water quality of the PW3 Well Field is excellent and essentially meets all Ontario Drinking Water Standards except for hardness (which is an operational aesthetic guideline) and total coliform (the presence of one total coliform [org/100 ml] could be from water sampling techniques and is not considered an issue).*
>
> *Overall, the particle count data collected from PW3 indicates that the water clarity of PW3 was acceptable and satisfied the MOE particle size criteria. Based on the PW3 data collected, the aquifer at PW3 provided effective in situ filtration as per MOE terms of reference with PW3 in service at 22.7 L/sec.*

Correspondence during the environmental assessment (Hatch Mott MacDonald, May, 2011) for the new well at this location also makes reference to the historical presence of the adjacent sand and gravel pits:

"[O]ver the previous 26 years (since Well 3 was constructed) the water quality from Well 3 has been excellent and the analytical results of the ground water samples obtained throughout the 72-hour pumping test of Test Well 2-05 (TW2-05) again indicated excellent water quality…The fact that the operation of the aggregate extraction from the Aecon/Lafarge site over the last 26 years has in no way impacted existing Peel Region-owned Well 3 indicates that water taking from an aquifer adjacent to an aggregate extraction site, when operated with "due diligence" (as has been the case for the previous 26 years) can co-exist."
(Appendix E; Letter from Region of Peel Water & Wastewater Treatment Division, May 5, 2006.)

"Well 3 was constructed in 1982. During the 26-year operating period to date, the quality of the ground water from Well 3 has been excellent and the quality of the ground water samples analyzed during the 72-hour pumping test at the Well 3 site was again considered to be excellent. Peel Region has encountered no issues with the aggregate operation to the west with regards to ground water quality."
(Appendix E; Letter from Simcoe Engineering Group Limited April 25, 2006.)

9.0 CONCLUSION

The following overall conclusions may be drawn from this review:

- Fewer than 1% of pits and quarries in Ontario lie within the two-year time of travel Wellhead Protection Area (WHPA) for a municipal water well.
- Aggregate extraction and processing is NOT a prescribed drinking water threat as *per* the Ministry of the Environment's (MOE) Source Water Protection regulations. This is mainly related to the fact that aggregate production is chiefly a mechanical process that involves little or no use of chemicals aside from the fuel and lubricants in the machinery.
- Some pits and quarries can include ancillary land-use activities that would qualify as potential *significant drinking water threats* as per MOE's *Clean Water Act* Source Water Protection regulations. In this review:
    - One of the five sites reported an on-site Class-4 septic wastewater system for the use of the workers, which is considered a potential source of pathogens of concern (i.e., *E.coli*);
    - Two of the five sites reported on-site fuel storage tanks for machinery, which is considered a potential source of petroleum hydrocarbons (i.e., Benzene).
- The Provincial Standards regulating aggregate licences in Ontario prescribe that all fuel storage tanks must be maintained in accordance with the *Technical Standards and Safety Act*, and that there must also be a Spills Contingency Plan in place. Several survey respondents in this study noted their Spills Contingency Plan as a risk reduction measure, along with related training programs for their site staff.
- Available data from all municipal water supplies (generally from 2005 to 2010) near the case study sites indicated no adverse impact from the aggregate production operations.
- Where relevant data were available, there is no evidence that the presence of a septic system or fuel storage at any of these aggregate sites has had any effect on the municipal water well quality, despite their relatively close proximity in the WHPA.
- Four out of the five sites were present in the WHPA of municipal water supply systems are classified as GUDI (groundwater under the direct influence of surface waters). Thus, the drinking water quality and quantity at those systems also had the potential to be impacted by adjacent land uses and discharges into surface waters unrelated to aggregate operations. Assessing the potential impact of non-aggregate related surface waters (e.g. rivers) on these GUDI systems were beyond the scope of the current study.
- Relevant Source Water Protection reports prepared by local Conservation Authorities and Source Water Protection Committees for all five case study sites identified no existing water quality or quantity conditions (i.e., no known instances of degradation or

declining trend of water quality/quantity) in the WHPA or municipal drinking water associated with aggregate extraction operations.

- Where applicable, aggregate sites extracting water for operations are regulated through Permits to Take Water issued by the MOE where pumping rates typically remain within a set maximum allowable limit and therefore are expected to have no adverse impact on municipal water supply quantities.

10.0 REFERENCES

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11.0 KEY DEFINITIONS

ENVIRONMENTAL MANAGEMENT SYSTEM (EMS) is a framework that helps companies achieve their environmental goals through consistent control of its operations. An EMS helps a company address its regulatory demands in a systematic and cost-effective manner.

LICENSES are issued to extract from private land and permits are issued to extract from Crown land. There are two types of licences issued under the Aggregate Resources Act:

- *Class "A"* licence which allows for the removal of more than 20,000 tonnes annually (usually a specified amount indicated at the time of application).
- *Class "B"* licence which allows for the removal of 20,000 tonnes or less annually;

MAXIMUM ALLOWABLE CONCENTRATION is the concentration standard for a prescribed drinking water parameter *below* which it is considered to be **SAFE DRINKING WATER**. The Ontario Drinking Water Quality Standards (O.Reg. 169/03; see Appendix D) sets out maximum allowable concentrations for microbiological and chemical parameters which must be met otherwise the medical officer of health should be alerted.

PIT and **QUARRY** are defined in the Aggregate Resources Act as land or land under water, from which unconsolidated (e.g. sand, gravel) /consolidated (bedrock) aggregate is being or has been excavated, and has not been rehabilitated.

POTENTIAL CONTAMINANTS OF CONCERN in the current study are those chemicals or pathogens associated with a significant drinking water threat activity (see Appendix C) which are relevant to safe drinking water only. Therefore, only common parameters listed in the Ontario Drinking Water Quality Standards (O.Reg. 169/03; see Appendix D) in the *Safe Drinking Water Act, 2002* (MOE, 2002) were considered.

SIGNIFICANT DRINKING WATER THREAT is a prescribed activity that occurs within a delineated vulnerable area (i.e., Wellhead Protection Area) in quantities and/or circumstances as identified by the Ministry of the Environment's *Tables of Significant Threats* (MOE 2008; see Appendix C for summarized table for current study), as per Source Water Protection regulations (MOE, 2009) in the *Clean Water Act, 2006*.

APPENDIX A

RELEVANT OSSGA PUBLICATIONS

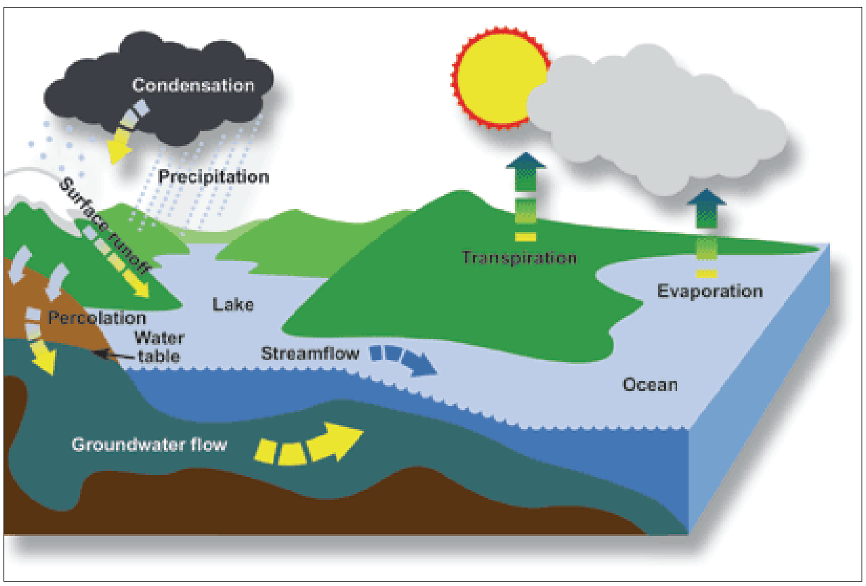
Newer versions and other related information may also be available at www.ossga/publications.ca

ONTARIO STONE, SAND & GRAVEL ASSOCIATION

Essential materials for building a strong Ontario

GROUNDWATER IN THE AGGREGATE INDUSTRY

Groundwater is a renewable resource that is in constant motion as part of the hydrologic cycle. Above-water pits and quarries have little or no effect on water levels or the flow of groundwater.



What is Groundwater?

Just as the name implies, groundwater is water contained in the pores and fissures of the earth. Groundwater is a renewable resource. It is in constant motion, part of the hydrologic cycle (see Hydrologic Cycle on the cover page). Rainfall and snowmelt infiltrate into the earth to recharge groundwater, which then flows as baseflow into streams and lakes. Evaporation from open water, and transpiration from plants, returns water to the atmosphere to complete the cycle.

A common misconception is that groundwater flows in underground rivers and lakes like surface water. Instead, groundwater seeps very slowly through the pore spaces and small fissures in the soil and rock. Materials such as clay have a low permeability, and hence very slow groundwater flow, while sand and gravel, or highly fractured rock, have high permeability and permit groundwater to flow faster. These more permeable layers are called aquifers.

The water table is the depth at which the soils or rock become completely saturated with groundwater. If a hole were dug, and left to stand for a while for groundwater to seep in, the water level in the hole would represent the water table. The water table elevation is not static, though, and it can fluctuate in different seasons and from year-to-year, depending on the amount of recharge. Natural depressions can intersect the water table to form lakes, ponds and wetlands.

Water Wells

Groundwater is a critical resource in Ontario - nearly one quarter of us rely on wells for our water supply. Some of these are municipal wells serving urban communities, but the vast majority are private water wells, mainly in the rural parts of the province. Two common types of wells are shallow dug wells which draw water from the water table, and bored or drilled wells which draw water from deeper aquifers.

The *Ontario Water Resources Act* and the *Environmental Protection Act* both serve to protect the quality and quantity of groundwater. They are administered by the Ontario Ministry of the Environment, which will respond to public complaints regarding interference with water wells. The Ministry has several excellent publications available to homeowners on subjects including proper water well construction and maintenance, protecting water quality in wells and managing water shortages (1-800-565-4923 or www.ene.gov.on.ca).

Wells and their associated equipment require ongoing maintenance. Even with the best maintenance, though, they still tend to degrade naturally over a period of years, through mechanical wear and clogging of the well screen, pump and pipes, .

Fact Sheet

Groundwater at Pits and Quarries

- *Groundwater is a renewable resource.*
- *Water wells are protected under provincial legislation.*
- *Above-water pits and quarries can have a beneficial effect on groundwater and aquatic resources.*
- *Below-water pits and quarries can be operated without significant groundwater impacts if they are carefully designed and operated.*
- *Permits to Take Water ensure that aggregate wash plants do not harm water resources.*

Aggregate extraction and processing is a clean industry that does not provide groundwater contaminants.

Can Pits and Quarries Affect the Flow of Groundwater?

The answer depends on the type of pit or quarry.

Above-Water Pits and Quarries

Most of Ontario's sand and gravel pits, and a few of its rock quarries, are excavated entirely above the water table. This type of operation has little or no effect on water levels or the flow of groundwater because there is no direct, physical alteration of the water table or any aquifers. Monitoring programs at above-water pits and quarries across Ontario have confirmed that groundwater is unaffected.

In some ways, above-water pits and quarries can actually be beneficial to groundwater. They create a "bowl" that captures and infiltrates all rainfall and snowmelt rather than allowing some of it to run off across the ground surface. A study on the Oak Ridges Moraine documented a number of benefits related to this extra groundwater recharge (Hunter/Raven Beck, 1996). One of the important benefits is to reduce direct run-off to surface water streams and increase cold groundwater baseflow which is critical to fish habitat.

Below-Water Pits

Below-water pits usually use large excavators or draglines to dredge sand and gravel from the *pit ponds* that form below the water table level. Generally, this type of extraction does not have major impacts because most of the groundwater remains in the pit, or drains back into the pit. This type of pit also captures surface water run-off and promotes more groundwater recharge, but these benefits are offset by the increased evaporation that will occur from the surface of a pit pond. Minor water losses also occur due to residual moisture contained in the aggregate products that are shipped from the site. Finally, the removal of solid sand and gravel particles from below the water table has the effect of temporarily lowering the water level in a pit pond (imagine removing a rock from a bucket of water).

The water surface in very large below-water pit ponds will stabilize at a uniform level, whereas the groundwater table before extraction may have been irregular or sloping. Therefore, the water table around the pit will have to "adjust" to the water level in the pit pond, possibly resulting in slightly different groundwater flow patterns. Fortunately, there is a simple solution where this may be a problem – digging several smaller pit ponds rather than one large pond (Ostrander *et al*, 1998).

When all of these factors are combined, the net effects of below-water extraction are normally minor and very localized. However, in certain circumstances they could still be significant if there are sensitive features such as wetlands or shallow wells in close proximity. As a result, a detailed and careful hydrogeological study is necessary when licencing this type of pit (Ministry of Natural Resources, 1997), and mitigation (solutions) to any negative impacts will be required. An ongoing groundwater monitoring program may be required.

Below-Water Quarries

Most quarries that extract from below the water table pump water out of the excavation so that the work of blasting and recovering the bedrock can be done on a dry floor. *Dewatering* usually does affect groundwater levels and flow patterns around the site, since it artificially lowers the water table to at least the base of the quarry. Hydrogeologists call the area around the quarry that is affected by the dewatering the *drawdown cone* or the *radius of influence*. Wells, streams, wetlands, or other sensitive features within this area must be carefully studied to predict the impacts and devise mitigation measures before the quarry can be licenced (Ministry of Natural Resources, 1997) and a groundwater monitoring program will normally be required.

There are many locations in Ontario where below-water quarries are successfully operated while sensitive water uses continue nearby – it depends very much on the specific hydrogeological setting. Recently, some innovative technologies have been introduced in Ontario to lessen the effects of quarry dewatering, such as pumping the water from the quarry back into the groundwater system around the quarry to artificially recharge the water table. This has so far proven to be quite successful (Gartner Lee Limited, 2001).

Other Water Takings

Pits and quarries have uses for water, similar to other businesses, such as supplying offices and shops with drinking water, watering lawns and gardens, etc., but these tend to be relatively minor. Most types of aggregate processing, such as crushing and screening, are dry operations and do not require water supply.

However, to minimize dust (which is a byproduct of excavation in a pit or quarry) spray water is used on internal haul roads, processing equipment, stockpiles and trucks.

One exception is aggregate washing plants, which are used at some sites, and do require relatively large quantities of water. Most plants recycle wash water through a "closed loop" series of holding ponds and settling ponds (i.e., the water is re-circulated, with no off-site discharge), so that the amount of water actually consumed in the process is usually less than about 10%. This *make-up water* normally comes from local groundwater or surface water sources. A common configuration would be to have a well that would be used occasionally during the production season to "top up" the ponds.

These water takings are regulated separately from the pit licence under the *Ontario Water Resources Act*, and controlled through Permits to Take Water. The applications and related hydrogeological studies are carefully reviewed by the Ministry of the Environment, other government agencies, and the interested public through the Environmental Bill of Rights process to ensure there will be no unacceptable impacts from these water takings, before the permit is issued.

GROUNDWATER IN THE AGGREGATE INDUSTRY

Can a Pit or Quarry Contaminate Groundwater?

It surprises some people to learn that aggregate extraction is a clean industry. Processing aggregates is a purely mechanical process of crushing, screening, blending, and sometimes washing (with water), without the need for chemicals. At most sites, fuels and lubricants for the equipment are the only potential sources of groundwater contamination, and these are closely regulated under the *Technical Standards and Safety Act*. A spills contingency plan is a standard condition of every new aggregate licence.

Bacteriological contamination of the type responsible for the Walkerton tragedy comes from human and animal wastes. Aggregate extraction and processing is not a source of this type of contamination.

As a result, water quality in and around pits and quarries is not normally an issue. This was confirmed through a study in 1989 as part of the Ontario government's MISA program, where monitoring at a selected number of pits and quarries found good water quality, with only sporadic traces of organic compounds at some sites that might indicate the use of petroleum products (SENES, 1989). In addition, there are many site specific monitoring programs in place at aggregate operations.

What About Water Temperature?

Water temperature concerns are occasionally raised in conjunction with below-water pits. A pit pond warmed through the summer months could result in a flow of warmer groundwater to nearby points of baseflow discharge and, in turn, affect cold water fisheries resources. An analysis conducted on behalf of the Credit Valley Conservation Authority in 1998 concluded that pit ponds have minimal impact on groundwater temperatures, and that these minor effects are completely dissipated within a few hundred metres from a pit (Ostrander *et al*, 1998). Field monitoring has also confirmed that groundwater returns to its normal background temperature within tens of metres of pit ponds (Harden Environmental, 1995).

As a result of the research to-date, thermal effects of pits and quarries is not considered to be a major issue in most cases. However, where there are cold water fisheries close to a pit pond, appropriate investigations and studies are required, and the setbacks and buffer zones will be adjusted accordingly.

For further information, please contact the OSSGA Environment and Education Manager, at (905) 507-0711 or visit the OSSGA website at www.ossga.com.

Prepared by Gartner Lee Limited in consultation with OSSGA's Environment Committee.

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The "About Aggregates" series:

1. Aggregates and the Law
2. Bronze Plaque Award
3. Rehabilitation of Pits and Quarries
4. Being a Good Neighbour
5. Importance of Aggregates
6. Geology and Aggregate Extraction
7. Controlled Blasting at Quarries
8. Groundwater in the Aggregate Industry
9. Management of Abandoned Aggregate Properties (MAAP) Program

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Water Management at Ontario Pits and Quarries

Stone, sand and gravel producers are primarily ***water handlers*** *not consumers*. **We are a clean industry.** We are a **highly regulated industry.** **We are *compatible with the goals of* source water protection.**

We are primarily water handlers, not consumers.

- Above-water pits create an increase in groundwater recharge.
- Below-water aggregate dredging leaves the water in the pit. Any effects on the adjacent water table tend to be relatively small and close to the pit.
- Quarry dewatering is usually released into nearby streams and/or recharged into the groundwater system. Virtually all of the water stays in the local watershed(s).
- Water used for aggregate washing is fully recycled.
- Products shipped to our customers generally contain less than 10% water by weight.
- Overall water losses are quite small. Most aggregate operations consume less than 15% of the rain that falls on their site.

We are a clean industry.

- Fuels and lubricants are the only chemicals used or stored at most pits, under strict provincial regulations.
- Aggregate is processed mechanically by crushing, screening and washing; no chemicals added to the products or to the water.
- Water quality testing in the late 1980's, at a wide variety of pits and quarries, found the water quality to be good. MISA regulations requiring ongoing effluent testing for aggregate extraction and processing were not deemed necessary.

[1]*Aggregate Industry MISA Preregulation Monitoring Program Results. SENES Consultants Limited, May 1998.*

We are a highly regulated industry.

- More than 25 Provincial and Federal Acts govern environmental protection at aggregate sites.
- In addition to the *Planning Act* requirements for an aggregate extraction operation, groundwater and surface water must be intensively studied in accordance with the Provincial Standards before the Ministry of Natural Resources will issue an *Aggregate Resources Act* licence.

- The volume of water managed for quarry dewatering or aggregate washing is governed by a Permit to Take Water issued by the Ministry of the Environment. In the aggregate industry, there is a critically important difference between three types of *water takings*:

Maximum Permitted Amount	The maximum daily amount that can be pumped, according to the Permit to Take Water (PTTW).
Actual Water Taking	The actual amount of water pumped at the site. Usually substantially less than the maximum permitted amount listed in the PTTW because of actual operational requirements, seasonal shutdown, and demand.
Water Consumption	The amount of water that actually leaves the local watershed. It is only a small fraction of the maximum permitted amount listed in the PTTW since the industry recycles extensively (e.g., aggregate washing), or simply transfers water within the local watershed (e.g., quarry dewatering)

- The *Liquid Fuels Handling Code* administered by the Technical Safety and Standards Authority places strict controls on the storage and use of fuels and lubricants. These controls are also noted on the operational site plan and administered by MNR inspectors.

- Certificates of Approval are required under the *Ontario Water Resources Act* for discharging water from a pit or quarry. Both the quality and quantity must be acceptable.

- The *Ontario Water Resources Act* also protects neighbours from the depletion or contamination of their water wells. The Ministry of the Environment investigates and resolves complaints.

- The *Environmental Protection Act* sets out very strict standards for inert fill. Operation of a waste disposal site to accept any other type of backfill requires a Certificate of Approval from the Ministry of the Environment. These sites no longer treated as pits and quarries for the purposes of source water protection planning, rather they are treated as waste management operations.

We are compatible with the goals of source water protection.

- Ontario's stone, sand and gravel producers have stated their support for clean drinking water sources for the citizens of the province.

- Both water and mineral aggregates are recognized as essential resources in the Provincial Policy Statement. OSSGA representatives have been actively engaged with the government in the planning and development of the source water legislation.

- Aggregates are essential to construct and maintain the province's drinking water infrastructure. Our products pack water wells screens, build water treatment plants, supply the raw materials for concrete water pipe, and backfill the pipe trenches.

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- The Ministry of the Environment has confirmed that aggregate extraction is not a threat of provincial concern to drinking water sources.

- There are many examples of municipal water works and wells in, or adjacent to, pits and quarries in Ontario, but no record of significant problems. Some of the advantages of locating a municipal well in a gravel pit can include: lower drilling costs; enhanced recharge; softer, less mineralized water; and a lower risk of fertilizer, pesticide or bacteriological contamination (which are not associated with aggregate extraction or processing).

- Many other jurisdictions that have already implemented source water protection programs have concluded that aggregate extraction represents a low or negligible risk, including: Louisiana; New York State; Dayton, Ohio; and Kitsap County, Washington.[2]

- A conclusion reached recently in New York State is that "… *more than 300 sand and gravel mines operating in the State mine aggregate below the water table. In its experience, no such mining activity has ever resulted in the contamination of a drinking water supply. … a comprehensive review of the scientific literature, field interviews with water supply managers, and an examination of case studies from New Hampshire, Ohio and New York, concluded that they had "found no scientific documentation containing evidence that excavating gravel above or below the water table was detrimental to an underlying aquifer"*.[3]

We can create water assets through rehabilitation.

- Pits & quarries afford excellent opportunities for water-based rehabilitation.

- Lakes formed in pits and quarries can be used for drinking water reservoirs.

- Pit and quarry lakes increase water storage in the watershed, which can help regulate stream baseflow and shorten natural drought cycles.

2. *Applied Research on Source Water Protection in the Aggregate Industry; Blackport Hydrogeology Inc. & Golder Associates, (in preparation);*

3. *State of New York Department of Environmental Conservation, April 2005.*

APPENDIX B

QUESTIONNAIRE SURVEY FOR SCREENED IN AGGREGATE SITES

Aggregate Producers' Questionnaire
OSSGA Source Water Protection Case Studies

In response to the Ontario Ministry of the Environment's *Clean Water Act, 2006* regarding Source Water Protection, OSSGA supported a literature review study by the Ontario Ministry of Natural Resources (Blackport and Golder 2006) to assess the role of the aggregate industry and associated lands in the context of source water programs. The MNR study did not find any documented scientific evidence linking the extraction and processing of stone, sand and gravel as a threat to drinking water sources but however identified that the each aggregate activity may have a varying impact on the hydrogeologic and hydrologic system in its vicinity. The study therefore, recommended investigations to examine actual aggregate extraction sites in the vicinity of drinking water supplies, to verify the findings in the literature review. As part of this investigation, SENES Consultants Limited (www.senes.ca) was retained by OSSGA to collect background information from select sites across Ontario based on a primary screening criterion (i.e., proximity to public water supplies), using the survey below. Through this survey we are requesting any water taking and/or water quality records you may have for the past 5 years. SENES will review water supply (e.g., quantity) and water quality information from these sites and compare them to municipal well records to determine evidence, if any, of impacts to water supplies and quality from aggregate activities. A profile and summary case study for each site will be prepared. Your participation in this study is greatly appreciated.

Aggregate Producer Activity and Information			
License ID	Click here to enter text.	**Municipality**	Click here to enter text.
Name of Operation	Click here to enter text.		
Operation Period	☐ Year Round ☐ Seasonal ☐ Other; *Specify* – Click here to enter text.		
Licensed to Extract Below Water?	☐ Yes ☐ No	**Currently Operating Below Water Table?**	☐ Yes ☐ No
On-site Features	*Check all that apply* ☐ Pit ☐ Quarry ☐ Ready Mix Concrete ☐ Asphalt		
Wastewater System (e.g., Septic) Onsite?	☐ Yes; *Specify components* – ☐ Septic Tank ☐ Leaching Bed ☐ Pit Privy ☐ No		
Chemicals Used or Stored On-Site	*Check all that apply* ☐ Petroleum Products ☐ Fuel or Brake/Transmission Fluids ☐ Road Salt ☐ Cleaning Solutions ☐ Chlorinated Solvents	☐ Other Solvents ☐ Acids/Bases/Caustics ☐ Others; *List* – Click here to enter text.	

Site Information	
Licensed Site Area [ha]	Click here to enter text.
Adjacent Land Use and Percentage Land Use	*Check all that apply* ☐ Agricultural (Click here to enter text.%) ☐ Residential (Click here to enter text.%) ☐ Commercial (Click here to enter text.%) ☐ Industrial (Click here to enter text.%) ☐ Other; *Specify* – Click here to enter text. (Click here to enter text.%)
Previous Site Use	☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial ☐ Unknown ☐ Other; *Specify* – Click here to enter text.
Overburden Soil Type	*Check all that apply* ☐ Clay ☐ Silt ☐ Loam ☐ Sand
Hydrologic Features	*Check all that are within 100 m of site boundary* ☐ Lakes, Rivers or Streams ☐ Wetlands ☐ Ditches or Channels ☐ Catch basins and Sewers ☐ Culverts ☐ Other; *Specify* – Click here to enter text.
Attachments	*Please attach an electronic copy of your ARA site plan, if possible* Attached? ☐ No ☐ Yes *Please attach site electronic photos of processes and on-site activities, if possible*

Questions or Comments? Cynthia Robinson, Environment and Education Manager, Ontario Stone, Sand & Gravel Association
5720 Timberlea Blvd., Unit 103 Mississauga, ON L4W 4W2 | Tel - 905-507-0711 (Ext 6) | E-mail: crobinson@ossga.com

	Attached? ☐ No ☐ Yes
Your Operation's Water Supply	
Company Owned Water Supply for Industrial Usage	☐ Surface Water Intakes; *If so, how many?* Click here to enter text. ☐ Groundwater Wells; *If so, how many?* Click here to enter text.
Permit To Take Water #	*Provide PTTW# for all wells currently in operation, if possible* Click here to enter text.
Water Extraction Amounts	*Provide approximate numbers based on monitoring data and PTTW limits* Average Daily Volume: Click here to enter text. Maximum Allowable Limit: Click here to enter text.
Other Water Supply Sources?	*i.e., for potable, domestic use?* ☐ No ☐ Yes; *Specify source* – ☐ Municipal ☐ Other – Click here to enter text.
Water Usage Activities	*List all activities or processes for which water is required to run your business:* Click here to enter text.
Annual Water Taking Reports Available?	☐ No ☐ Yes; *Please provide records from past 5 years; Electronic copies are preferred.*
Historical Issues or Concerns in Water Quantity	*E.g., Depletion in supply, neighbor/public complaints etc.* Click here to enter text.

Water Quality Information	
Is there a CofA for industrial discharge for the site?	*i.e., Certificate of Approval under OWRA Section 53* ☐ No ☐ Yes; *Provide CofA#:* Click here to enter text.
Any *Groundwater* Quality Monitoring?	☐ N/A ☐ No ☐ Yes; *List monitored parameters:* Click here to enter text.
Any *Surface Water* Quality Monitoring?	☐ N/A ☐ No ☐ Yes; *List monitored parameters:* Click here to enter text.
Annual Groundwater Monitoring Reports?	☐ N/A ☐ No ☐ Yes; *Please provide records from past 5 years; Electronic copies are preferred.*
Annual Surface Water Monitoring Reports?	☐ N/A ☐ No ☐ Yes; *Please provide records from past 5 years; Electronic copies are preferred.*
Historical Issues or Concerns in Water Quality	*E.g., Exceedances of limits, neighbor/public complaints etc.* Click here to enter text.

Additional Information? Comments? Supporting Documentation?

Click here to enter text.

Please return completed form and all supporting data and information by e-mail (preferred) OR by regular mail to:

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Aggregate Producers' Questionnaire
OSSGA Source Water Protection Case Studies
Drinking Water Threats Activities and Circumstances

This survey was created to augment existing information on aggregate site activities related to water use and discharge and their potential impacts nearby drinking water supply quality/quantity. As part of the Clean Water Act for Source Water Protection, the Ontario Ministry of Environment (MOE) has developed ***Tables of Drinking Water Threat*** in order to assess the risks associated with *21 prescribed* drinking water quality threats. The MOE tables of drinking water threats provide the circumstances under which an activity may be categorized as a low, moderate or significant threat. Hence, the circumstances of the activity are considered to determine the level of risk associated with a water threat. As per the MOE, a drinking water threat is an "activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as source of drinking water".

As part of this investigation, SENES Consultants Limited (www.senes.ca) was retained by OSSGA to collect background information from select sites across Ontario based on a primary screening criterion (i.e., proximity to public water supplies), using the survey below. Although these 21 prescribed threats are *not directly related* to aggregate operations, this survey will focus on collecting information specific to other activities and circumstances that *may* occur at aggregate sites. SENES will also review municipal drinking water supply data to determine evidence, if any, of impacts to water supplies and quality from aggregate site activities.

Your participation in this study is greatly appreciated.

Aggregate Producer Activity and Information			
License ID	Click here to enter text.	**Municipality**	Click here to enter text.
Name of Operation	Click here to enter text.		
Current State	☐ Active ☐ Inactive ☐ Rehabilitated site; *If so, current land use:* Click here to enter text.		
Period of Operation	From Click here to enter text. To Click here to enter text.		
Predominant Land Uses in Adjacent	☐ Rural ☐ Low Density Residential ☐ Industrial	☐ Agricultural ☐ High Density Residential ☐ Commercial	

A. Road Salt Application and Storage	
% of Impervious (i.e., concrete, paved) Surface Area of Total Site	☐ 0 % ☐ < 50% ☐ 50% – 80% ☐ > 80%
Application of Road Salt?	☐ Yes ☐ No
On-site Storage of Road Salt?	☐ Yes ☐ No
Storage Details	☐ *Not Applicable* ☐ Exposed to Environment ☐ Sheltered Storage

Please return completed form and all supporting data and information by e-mail (preferred) OR by regular mail to:

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B. Fuel and Chemical Storage

Check all stored chemicals used, handled and stored on site. For each applicable chemical, specify storage location and quantity kept in storage

Stored Chemical	***Storage Location***	***Quantity Kept in Storage***
☐ **Liquid Fuel**	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***Coal Tar***	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***Chlorinated Solvents*** (degreasers, cleaning solutions, thinning solutions etc.)	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***Organic Solvents*** (detergents, dry cleaning agents, glue solvents etc.)	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***Polychlorinated Biphenyls (PCBs)***	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***Extra Heavy Crude Oil***	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***Other*** *Specify:* Click here to enter text.	☐ Above Grade ☐ Below Grade	☐ < 250 L ☐ 250 – 2500 L ☐ > 2500 L
☐ ***None***		
Any Spill Management Measures or Plans?	☐ Not Applicable - No Fuels/Chemicals Stored; ☐ None; ☐ Yes; *Specify:* Click here to enter text.	

C. Stormwater

Any Stormwater Management Measures?	☐ Yes; ☐ No;	
Stormwater Management Components?	☐ Not Applicable; ☐ Stormwater Pond; ☐ Storage Tanks;	☐ Sewer Systems; ☐ Berms ☐ Other; *Specify:* Click here to enter text.
Stormwater Discharge To	☐ Directly Surface Waters; ☐ Municipal Storm Sewers; ☐ Other; *Specify:* Click here to enter text.	

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D. Waste Disposal and Snow Storage	
Site Used For Waste Disposal?	☐ Yes ☐ No
Type of Waste Disposed	☐ *Not Applicable* ☐ Ashes, Garbage, Refuse, Municipal Refuse ☐ Industrial Waste ☐ Hauled Sewage
Site Used For Storage of Snow from Public Road Plowing?	☐ Yes; ☐ No;
Snow Storage Area	☐ *Not Applicable* ☐ 0.01 – 0.5 ha ☐ 0.5 – 1 ha ☐ 1 – 5 ha ☐ > 5 ha
Snow Storage Location	☐ *Not Applicable* ☐ Above Ground ☐ Below Ground

E. On-site Wastewater System	
Sewage System Usage	☐ How many people are typically on site requiring washroom facilities?: Click here to enter text. ☐ Sewage System Design Capacity: Click here to enter text. ☐ Not Applicable; No Sewage System On-Site
Any Direct Wastewater Discharge to Surface Water or Land?	☐ Yes; ☐ No;
Type of Sewage System	☐ Chemical Toilet, Incineration Toilet, Recirculating Toilet, Self-contained Portable Toilet, Portable Privy, Earth Pit Privy, Pail Privy, Vault Privy, or Composting Toilet, receiving only Human Waste ☐ A Greywater System, receiving only greywater waste ☐ A Cesspool, receiving waste from toilets/privies ☐ A Septic System, consisting of Septic Tank and Leaching Bed system, receiving human and greywater waste ☐ An On-Site Holding Tank for sanitary sewage produced on-site, prior to removal by a haulage service provider; receiving both human waste and greywater ☐ None of the Above; Other: Click here to enter text.
Any Wastewater Treatment Technology Used?	☐ Yes; *Specify:* Click here to enter text. ☐ No;
Treatment Tank or Storage Tank Location	☐ Above Grade; ☐ Below Grade;

Please return completed form and all supporting data and information by e-mail (preferred) OR by regular mail to:

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F. Application, Storage and Handling of Agricultural/Non-Agricultural Source Materials and Pesticides	
Direct Application to Aggregate Lands?	*Check all that apply* ☐ Agricultural Source Material (e.g., manure, compost) ☐ Non-Agricultural Source Material (i.e., yard waste, vegetable peels, food processing waste, pulp and paper biosolids and sewage biosolids) ☐ Pesticides ☐ Fertilizers ☐ *None of the Above*
Area of Land Applied To	☐ *Not Applicable* ☐ < 1 ha ☐ 1 – 10 ha ☐ > 10 ha
Storage and Handling of Materials?	*Check all that apply* ☐ Agricultural Source Material (e.g., manure, compost) ☐ Non-Agricultural Source Material (i.e., yard waste, vegetable peels, food processing waste, pulp and paper biosolids and sewage biosolids) ☐ Pesticides ☐ Fertilizers ☐ *None of the Above*
Agricultural Activities Occur on the Following:	*Check all that apply* ☐ Future extraction phases ☐ Rehabilitated land ☐ Licenced buffers/setbacks ☐ *Not Applicable*

Additional Information

Provide any supporting water quality or quantity data or information (e.g., any monitored water quality issues? spills? complaints from adjacent land owners?)

Click here to enter text.

Please return completed form and all supporting data and information by e-mail (preferred) OR by regular mail to:

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APPENDIX C

MOE DRINKING WATER THREATS AND CIRCUMSTANCE SUMMARY

For the purposes of this study, Table of drinking water threats, circumstances and contaminants of potential concern were extracted and summarized from "Tables of Drinking Water Threats" (MOE, 2008) as relevant to aggregate site operations.

							Significant Threat to WHPA (A, B, C/C1, D)							
Threat Category	Starting Reference #	Page	Drinking Water Threat		Factor	Threat Type	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5	Condition 6	Condition 7	Condition 8
Agricultural Source Material to Land	1	1	Application of agricultural source material		Quantity of agricultural source material applied (kg)	Pathogen	Any quantity							
					Percentage of Managed Lands (%)	Chemical	< 40	40 - 80	> 80	> 80				
					Livestock density (NU/acre)		> 1	> 1	< 0.5	> 1				
	1201	264	Storage of agricultural source material		Type of facility used to store agricultural source material	Pathogen	Any type							
					Type of facility used to store agricultural source material	Chemical	Permanent nutrient storage facility	Permanent nutrient storage facility						
					Location of storage facility		Above grade	Below grade						
Non-Agricultural Source Material to Land	37	10	Application of non-agricultural source material		Percentage of Managed Lands (%)	Chemical	< 40	40 - 80	> 80	> 80				
					Livestock density (NU/acre)		> 1	> 1	< 0.5	> 1				
	1409	310	Storage of non-agricultural source material		Mass of nitrogen in non-agricultural source material stored (tonnes)	Chemical	0.5 - 5	> 5	> 5	> 5				
					Type of facility used to store agricultural source material		Permanent nutrient storage facility	Permanent nutrient storage facility	Temporary field nutrient storage site	Permanent nutrient storage facility				
					Location of storage facility		Above grade	Above grade	Above grade	Below grade				
Pesticide	55	14	Application of pesticide		Area of land to which pesticide is applied (ha)	Chemical	1 - 10	> 10						
	1113	247	Handling & storage of pesticide		Total mass of all stored materials containing pesticide [that is for use in extermination, as per Pesticides Act] (kg)	Chemical	> 2,500							
Road Salt	88	23	Application of road salt		Percentage of Total Impervious Area (%)	Chemical	> 80							
	1433	315	Handling & storage of road salt		Quantity of road salt stored (tonnes)	Chemical	> 5,000							
					Type of facility used to store road salt		Exposed to precipitation/runoff							
Waste Disposal Site	96	25	Establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		Quantity of hauled sewage to land (ha)	Pathogen	Any quantity							
					Application area of hauled sewage to land (ha)	Chemical	> 10							
Dense Non-Aqueous Phase Liquid (DNAPL)	102	27	Handling of DNAPL		Handling of DNAPL in relation to its storage	Chemical	Above grade	Below grade						
	1098	245	Storage of DNAPL		Storage of DNAPL	Chemical	Above grade	Below grade	Partly below grade					
Fuel	112	29	Handling of fuel	'Facility'	Handling of liquid fuel in relation to its storage at a facility ('Fuel Oil' as defined in O.Reg.213/01, 'facility' as defined in O.Reg.217/01)	Chemical	Above grade	Below grade						
					Quantity of liquid fuel stored		> 2500 L	> 2500 L						
				Bulk Plant	Handling of liquid fuel in relation to its storage at a bulk plant ('Fuel Oil' as defined in O.Reg.213/01)	Chemical	Below grade							
	1289	282	Storage of fuel	Facility'	Storage of liquid fuel in a tank at a facility ('Fuel Oil' as defined in O.Reg.213/01, 'facility' as defined in O.Reg.217/01)	Chemical	Below grade	Partly below grade	Above grade	Below grade	Partly below grade			
					Quantity of liquid fuel stored (L)		250 - 2500	250 - 2500	> 2500	> 2500	> 2500			
				Bulk Plant	Storage of liquid fuel in a tank at a bulk plant (as defined in O.Reg.217/01)	Chemical	Below grade	Partly below grade	Below grade	Partly below grade				
					Quantity of liquid fuel stored (L)		250 - 2500	250 - 2500	> 2500	> 2500				
Wastewater System	277	69	Establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	Stormwater Mgmt Facility	Drainage area associated with storm water management facility (ha)	Chemical	> 100	> 100	10 - 100	> 100				
					Predominant land uses in area		Rural, agricultural, low density residential	High density residential	Industrial, commercial	Industrial, commercial				
	631	140		Wastewater Collection Facility	Type of wastewater collection facility	Pathogen	Any type							
					Design capacity of wastewater collection facility (m^3 sewage/day)	Chemical	10,000 - 100,000	> 100,000						
	695	153		Class 1 - 5 Sewage System *	Type of sewage system (Class 1 - 5)	Chemical	Class 1	Class 2	Class 3	Class 4	Class 5			
					Type of sewage system (Class 1 - 5)	Pathogen	Class 1	Class 2	Class 3	Class 4	Class 5			
	719	158		Wastewater Treatment Facility	Type of wastewater treatment facility that discharges to surface water through a means other than a design bypass	Pathogen	Any type							
					Design discharge rate of treated sanitary sewage that is discharged directly to land/surface water through a means other than a designed bypass (av. m^3/day, calculated on an annual basis)	Chemical	17,500 - 50,000	> 50,000						
	904	196		Wastewater Treatment/Storage Tank	Type of wastewater treatment tank or storage tank	Pathogen	Any type							
					Design discharge rate of treated sewage of associated WW treatment facility (av.	Chemical	2,500 - 17,500	2,500 - 17,500	17,500 - 50,000	17,500 - 50,000	> 50,000	> 50,000	> 50,000	
					Location of storage tank	Chemical	Below grade	Partly below grade	Below grade	Partly below grade	Above grade	Below grade	Partly below grade	
Organic Solvent	1225	269	Handling & storage of organic solvent		Quantity of organic solvent stored (L)	Chemical	25 - 250	25 - 250	250 - 2,500	250 - 2,500	250 - 2,500	> 2,500	> 2,500	> 2,500
					Storage location of organic solvent		Below grade	Partly below grade	Above grade	Below grade	Partly below grade	Above grade	Below grade	Partly below grade
Commerical Fertilizer	1273	279	Handling & storage of commercial fertilizer		Total mass of all stored materials containing fertilizer (kg)	Chemical	> 2,500							
Snow	1445	317	Storage of snow		Area upon which snow is stored (ha)	Chemical	0.01 - 0.5	0.5 - 1	1 - 5	1 - 5	> 5	> 5		
					Location of snow storage		Below grade	Below grade	Above grade	Below grade	Above grade	Below grade		

Adapted and summarized for the purposes of this study based on MOE (2008) *Table of Drinking Water Threats*

* Under the Clean Water Act (CWA) 2006 Tables of Drinking Water Threats, Sewage System Or Sewage Works - Septic System include earth pit privy, privy vault, greywater system, cesspool, or a leaching bed system and its associated treatment unit, where the system is subject to the Ontario Building Code Act, 1992. All forms of "privy" were not included under the DWTs. In particular, "portable privy" and "self-contained portable toilets" were not specified by the MOE. It was therefore concluded that portable toilets are not regulated under the CWA.

On a similar note, hauled sewage (also known as septage) refers to waste from portable toilets, holding tanks, septic and aerobic systems that are regulated under Part 8 of the OBC. Under the CWA, the application of untreated septage to land is addressed as a provincial threat under Waste Disposal Sites. The storage (or temporary storage) of hauled sewage is not addressed under the CWA.

Drinking Water Threat		MOE Contaminants of Potential Concern
Road Salt		Chloride
		Sodium
Waste Disposal Site		Nitrogen
Handling & Storage of DNAPL		Dioxane-1,4
		Polycyclic Aromatic Hydrocarbons
		Tetrachloroethylene
		Trichloroethylene
		Vinyl chloride
Handling & Storage of Fuel		BTEX
		Petroleum Hydrocarbons F1 (nC6-nC10)
		Petroleum Hydrocarbons F2 (nC10-nC16)
		Petroleum Hydrocarbons F3 (nC16-nC34)
Wastewater Collection/Treatment/Storage/Disposal	Stormwater Facility	Arsenic
		Chromium VI
		Mecoprop
		Cadmium
		Nitrogen
		Aluminum
		Lead
		Polycyclic Aromatic Hydrocarbons
	Class 1 - 5 Sewage System	Acetone
		Chloride
		Dichlorobenzene-1,4 (para)
		Nitrogen
		Sodium
Organic Solvent		Carbon tetrachloride
		Chloroform
		Methylene chloride
		Pentachlorophenol
Storage of Snow		Lead
		Nitrogen
		Chloride
		Cyanide
		Sodium
		Copper
		Petroleum Hydrocarbons F1 (nC6-nC10)
		Petroleum Hydrocarbons F2 (nC10-nC16)
		Petroleum Hydrocarbons F3 (nC16-nC34)
		Petroleum Hydrocarbons F4 (> nC34)
		Zinc

APPENDIX D

ONTARIO DRINKING WATER STANDARDS

Safe Drinking Water Act, 2002

ONTARIO REGULATION 169/03

ONTARIO DRINKING WATER QUALITY STANDARDS

Consolidation Period: From December 1, 2008 to the e-Laws currency date.

Last amendment: O. Reg. 327/08.

This is the English version of a bilingual regulation.

Standards

1. The standards set out in Schedules 1, 2 and 3 are prescribed as drinking water quality standards for the purposes of the Act. O. Reg. 169/03, s. 1.

Deemed compliance

2. (1) A person who, pursuant to section 10 of the Act or otherwise, has an obligation to ensure that water meets a standard set out in Schedule 1, 2 or 3 shall be deemed not to have contravened the obligation if, in circumstances where the water does not meet the standard, the person immediately contacts the medical officer of health and takes such other steps as are directed by the medical officer of health. O. Reg. 169/03, s. 2 (1).

(2) Despite subsection (1), the owner or operating authority of a drinking water system that provides water that does not meet a standard set out in Schedule 1, 2 or 3 shall be deemed not to have contravened paragraph 1 of subsection 11 (1) of the Act only if the owner or operating authority ensures that the appropriate corrective action is taken under Schedule 17 or 18 to Ontario Regulation 170/03 (Drinking Water Systems). O. Reg. 169/03, s. 2 (2); O. Reg. 255/05, s. 1; O. Reg. 327/08, s. 1.

3. Omitted (provides for coming into force of provisions of the English version of this Regulation). O. Reg. 169/03, s. 3.

SCHEDULE 1
MICROBIOLOGICAL STANDARDS

Item	Microbiological Parameter	Standard (expressed as a maximum)
1.	*Escherichia coli* (E. coli)	Not detectable
2.	Revoked: O. Reg. 248/06, s. 1.	
3.	Total coliforms	Not detectable
4.	Revoked: O. Reg. 248/06, s. 1.	
5.	Revoked: O. Reg. 248/06, s. 1.	

O. Reg. 169/03, Sched. 1; O. Reg. 248/06, s. 1.

SCHEDULE 2
CHEMICAL STANDARDS

Item	Chemical Parameter	Standard (expressed as a maximum concentration in milligrams per litre)
1.	Alachlor	0.005
2.	Aldicarb	0.009
3.	Aldrin + Dieldrin	0.0007
4.	Antimony	0.006
5.	Arsenic	0.025
6.	Atrazine + N-dealkylated metabolites	0.005
7.	Azinphos-methyl	0.02
8.	Barium	1.0
9.	Bendiocarb	0.04
10.	Benzene	0.005
11.	Benzo(a)pyrene	0.00001
12.	Boron	5.0
13.	Bromate	0.01
14.	Bromoxynil	0.005
15.	Cadmium	0.005
16.	Carbaryl	0.09
17.	Carbofuran	0.09
18.	Carbon Tetrachloride	0.005
19.	Chloramines	3.0
20.	Chlordane (Total)	0.007
21.	Chlorpyrifos	0.09
22.	Chromium	0.05
23.	Cyanazine	0.01
24.	Cyanide	0.2
25.	Diazinon	0.02
26.	Dicamba	0.12
27.	1,2-Dichlorobenzene	0.2
28.	1,4-Dichlorobenzene	0.005
29.	Dichlorodiphenyltrichloroethane (DDT) + metabolites	0.03

30.	1,2-dichloroethane	0.005
31.	1,1-Dichloroethylene (vinylidene chloride)	0.014
32.	Dichloromethane	0.05
33.	2,4-Dichlorophenol	0.9
34.	2,4-Dichlorophenoxy acetic acid (2,4-D)	0.1
35.	Diclofop-methyl	0.009
36.	Dimethoate	0.02
37.	Dinoseb	0.01
38.	Dioxin and Furan	0.000000015 [a]
39.	Diquat	0.07
40.	Diuron	0.15
41.	Fluoride	1.5
42.	Glyphosate	0.28
43.	Heptachlor + Heptachlor Epoxide	0.003
44.	Lead	0.010
45.	Lindane (Total)	0.004
46.	Malathion	0.19
47.	Mercury	0.001
48.	Methoxychlor	0.9
49.	Metolachlor	0.05
50.	Metribuzin	0.08
51.	Microcystin LR	0.0015
52.	Monochlorobenzene	0.08
53.	Nitrate (as nitrogen)	10.0
54.	Nitrite (as nitrogen)	1.0
55.	Nitrate + Nitrite (as nitrogen)	10.0
56.	Nitrilotriacetic Acid (NTA)	0.4
57.	N-Nitrosodimethylamine (NDMA)	0.000009
58.	Paraquat	0.01
59.	Parathion	0.05
60.	Pentachlorophenol	0.06
61.	Phorate	0.002
62.	Picloram	0.19
63.	Polychlorinated Biphenyls (PCB)	0.003
64.	Prometryne	0.001
65.	Selenium	0.01
66.	Simazine	0.01
67.	Temephos	0.28
68.	Terbufos	0.001
69.	Tetrachloroethylene (perchloroethylene)	0.03
70.	2,3,4,6-Tetrachlorophenol	0.1
71.	Triallate	0.23
72.	Trichloroethylene	0.005
73.	2,4,6-Trichlorophenol	0.005
74.	2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0.28
75.	Trifluralin	0.045

76.	Trihalomethanes	0.100 [b]
77.	Uranium	0.02
78.	Vinyl Chloride	0.002

Footnotes:

[a] Total toxic equivalents when compared with 2,3,7,8-TCDD (tetrachlorodibenzo-p-dioxin).

[b] This standard is expressed as a running annual average.

O. Reg. 169/03, Sched. 2; O. Reg. 268/03, s. 1; O. Reg. 248/06, s. 2; O. Reg. 242/07, s. 1.

SCHEDULE 3
RADIOLOGICAL STANDARDS

Item	Radiological Parameter	Standard (expressed as a maximum in becquerels per litre)
Natural Radionuclides		
1.	Beryllium-7	4000.0
2.	Bismuth -210	70.0
3.	Lead-210	0.1
4.	Polonium-210	0.2
5.	Radium-224	2.0
6.	Radium-226	0.6
7.	Radium-228	0.5
8.	Thorium-228	2.0
9.	Thorium-230	0.4
10.	Thorium-232	0.1
11.	Thorium-234	20.0
12.	Uranium-234	4.0
13.	Uranium-235	4.0
14.	Uranium-238	4.0
Artificial Radionuclides		
15.	Americium-241	0.2
16.	Antimony-122	50.0
17.	Antimony-124	40.0
18.	Antimony-125	100.0
19.	Barium-140	40.0
20.	Bromine-82	300.0
21.	Calcium-45	200.0
22.	Calcium-47	60.0
23.	Carbon-14	200.0
24.	Cerium-141	100.0
25.	Cerium-144	20.0
26.	Cesium-131	2000.0
27.	Cesium-134	7.0
28.	Cesium-136	50.0
29.	Cesium-137	10.0
30.	Chromium-51	3000.0

31.	Cobalt-57	40.0
32.	Cobalt-58	20.0
33.	Cobalt-60	2.0
34.	Gallium-67	500.0
35.	Gold-198	90.0
36.	Indium-111	400.0
37.	Iodine-125	10.0
38.	Iodine-129	1.0
39.	Iodine-131	6.0
40.	Iron-55	300.0
41.	Iron-59	40.0
42.	Manganese-54	200.0
43.	Mercury-197	400.0
44.	Mercury-203	80.0
45.	Molybdenum-99	70.0
46.	Neptunium-239	100.0
47.	Niobium-95	200.0
48.	Phosphorus-32	50.0
49.	Plutonium-238	0.3
50.	Plutonium-239	0.2
51.	Plutonium-240	0.2
52.	Plutonium-241	10.0
53.	Rhodium-105	300.0
54.	Rubidium-81	3000.0
55.	Rubidium-86	50.0
56.	Ruthenium-103	100.0
57.	Ruthenium-106	10.0
58.	Selenium-75	70.0
59.	Silver-108m	70.0
60.	Silver-110m	50.0
61.	Silver-111	70.0
62.	Sodium-22	50.0
63.	Strontium-85	300.0
64.	Strontium-89	40.0
65.	Strontium-90	5.0
66.	Sulphur-35	500.0
67.	Technetium-99	200.0
68.	Technetium-99m	7000.0
69.	Tellurium-129m	40.0
70.	Tellurium-131m	40.0
71.	Tellurium-132	40.0
72.	Thallium-201	2000.0
73.	Tritium	7000.0
74.	Ytterbium-169	100.0
75.	Yttrium-90	30.0
76.	Yttrium-91	30.0
77.	Zinc-65	40.0
78.	Zirconium-95	100.0

Notes:

Radionuclide concentrations that exceed the standard may be tolerated for a short period, as long as the annual average concentrations remain below the standard and the restriction (see immediately below) for multiple radionuclides is met.

Restrictions for multiple radionuclides: If two or more radionuclides are present, the following relationship, based on International Commission on Radiological Protection (ICRP) Publication 26, must be satisfied and, if not satisfied, the standard shall be considered to have been exceeded:

$$\frac{c_1}{C1} + \frac{c_2}{C2} + \dots\dots\dots\dots \frac{c_i}{Ci} \leq 1$$

where

c_1, c_2 and c_i are the observed concentrations, and C_1, C_2 and C_i are the maximum acceptable concentrations for each contributing radionuclide.

O. Reg. 169/03, Sched. 3.

Français

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APPENDIX E

MUNICIPAL WATER QUALITY DATA SUMMARY AND LIMITATIONS

Historical water quality data were obtained from available Drinking Water Annual Reports (up until 2010) for relevant municipal well systems for each case study. The data presented in this appendix provides a summary of available data (raw and treated, as monitored) metals, organics, inorganics and microbiological parameters. Drinking Water Annual Reports of municipal systems provide greater detail. Of particular importance to this study were microbiological parameters (i.e., E.coli), as well as Benzene.

#	Site	Data Range	Municipal Well Considered	Raw Water Turbidity	Raw Water Microbiology	Inorganics	Nitrate	Organics
1	Dufferin Simcoe Pit	2005 - 2010	Northwest well field, Simcoe Well Supply System (Microbiology data was available for Northwest Wells #1 - #3 separately. Inorgnics, Organics data was collected from Northwest Booster Station)	No raw water data available	Raw water was available for Well # 1 - #3 separately	Only treated water data available		Only treated water data available
2	Trudeau Tweed Pit	2005 - 2010	Tweed Well Supply System (Turbidity and Microbiology data was available for Wells #1 and #3 separately. Drinking Water Annual Reports did not specify which well(s) the Inorganics, Organics data was collected from)	2005 - 2007 : No indication of which well the raw water samples were obtained from 2008 - 2010 : Raw water data was available for Well #1 and #3 separately	Raw water was available for Well # 1 and #3 separately	Only treated water data available		Only treated water data available

<table>
<tr><th>#</th><th>Site</th><th>Data Range</th><th>Municipal Well Considered</th><th>Raw Water Turbidity</th><th>Raw Water Microbiology</th><th>Inorganics</th><th>Nitrate</th><th>Organics</th></tr>
<tr><td>3</td><td>Rockway Woolner Pit</td><td>2005 - 2010</td><td>Woolners Well Supply System (Drinking Water Annual Reports did not indicate the specific well(s) from which they obtained water quality data)</td><td>No data available for 2008 since the system was offline that year</td><td>Drinking Water Annual Reports only provided the total # of samples collected as well as the # of positive samples for each year. Trend analysis was conducted using the % positive samples each year</td><td colspan="2">Only treated water data available;

No data available for 2008 since the system was offline that year</td><td>Only treated water data available</td></tr>
<tr><td>4</td><td>Lafarge Talbot Pit</td><td>2006 - 2010</td><td>Wells #1 - #6, Fanshawe well field</td><td>No raw water data available</td><td>No graphical/trend analysis since most microbiological results were not detected</td><td colspan="2">Raw water trend analysis was conducted for 28 inorganic parameters (including Nitrate + Nitrite)</td><td>Only treated water data available</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Caledon</td><td rowspan="2">2003 - 2010</td><td rowspan="2">Caledon Village Well #3</td><td rowspan="2">Insufficient raw water data available to conduct analysis (only 2005, 2010)</td><td rowspan="2">Maximum reported values of HPC bacteria used to construct time-series plot</td><td>Only treated water data available</td><td rowspan="2">Only treated water data available</td><td rowspan="2">Only treated water data available</td></tr>
<tr><td>Parameter values for years 2008 - 2010 were presented as ranges (min-max). Mid-range values were used to conduct the trend analysis.</td></tr>
</table>

Microbiological Parameters

Drinking Water Annual Reports only provide a range (min-max) of values for *E. coli,* Total Coliform and HPC bacteria results for every year. Maximum reported values of *E. coli,* Total Coliform and HPC bacteria were presented and analyzed in the case studies.

Trend Analysis was not conducted for HPC bacteria values since the variability in HPC bacteria concentration is very high during any given year. Since HPC bacteria concentration depends on many factors (including temperature, time & location of sampling collection etc.), it is difficult to estimate a representative HPC concentration value for each year.

CASE STUDY#1 – DUFFERIN AGGREGATES SIMCOE PIT

SIMCOE WELL SUPPLY SYSTEM (DRINKING WATER SYSTEM #220000371), NW WELLFIELD

[Concentrations in mg/L]

METALS

Year	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Mercury	Selenium	Uranium
2005	0	0	77	10	0	0	0	0	0	0.7
2006	0	0	69.6	14	0	1.3	3.79	0	0	0.56
2007	0.2	0.3	67.4	14	0	0.8	0.28	0	0	0.4
2008	0	0.3	91.1	15.9	0	0	6.885	0	0	0.399
2009	0.06	0.5	70.9	13.9	0	0	6.885	0	0	0.671
2010	0.04	0.3	70.3	16.9	0	1	-	0	0	0.675

NITRATES + THMs

Year	Nitrite	Nitrate	THMs
2005	0	1.6	0.0240
	0	1.8	0.0546
	0	1.5	0.0480
	0	2.4	0.0876
2006	0	1.7	0.11
	0	2.41	0.079
	0	1.94	0.074
	0	2.27	0.072
2007	0	2.41	0.034
	0	2.4	0.061
	0	2.43	0.11

Year	Nitrite	Nitrate	THMs
	0	2.3	0.109
2008	0	2.18	0.049
	0	0.745	0.083
	0	2.12	0.026
	0	1.98	0.034
2009	0	2.1	0.036
	0	2.44	0.03
	0	2.23	0.061
	0	2.19	0.056
2010	0	2.18	0.048
	0	2.32	0.072
	0	1.27	0.044
	0	1.16	0.026

SODIUM

Year	Sodium
2005	14.00
2010	9.25

TURBIDITY *TREATED WATER*

Year	# Samples	Max	Min
2006	8760	0.42	0.02
2007	8760	0.38	0.01
2008	8760	0.42	0.05
2009	8760	0.38	0.05
2010	8760		

MICROBIOLOGY

RAW – WELL#1

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	# Background Samples	Max Value Background
2003	52	**0**	0	-	-	52	0
2004	50	**0**	1	9	710	-	-
2005	43	**0**	0	43	2	-	-
2006	52	**0**	0	-	-	-	-
2007	52	**0**	0	-	-	-	-
2008	53	**0**	0	-	-	-	-
2009	53	**0**	15	-	-	-	-
2010	52	**0**	0	-	-	-	-

RAW – WELL#2

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	# Background Samples	Max Value Background
2003	51	**0**	0			51	53
2004	52	**0**	0	-	-		
2005	48	**0**	0	48	360		
2006	52	**0**	0	-	-		
2007	52	**0**	0	-	-		
2008	52	**0**	0	-	-		
2009	52	**0**	1	-	-		
2010	52	**0**	0	-	-		

RAW – WELL#3

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	# Background Samples	Max Value Background
2003	52	**0**	0	-	-	52	13
2004	52	**0**	0	4	30		
2005	47	**0**	0	47	640		
2006	53	**0**	0	-	-		
2007	53	**0**	0	-	-		
2008	54	**0**	0	-	-		
2009	54	**0**	0	-	-		
2010	52	**0**	0	-	-		

ORGANICS

	2005	2006	2007	2008	2009	2010
Alachlor	0	0	0	0	0	0
Aldicarb	0	0	0	0	0	0
Aldrin + Dieldrin	0	0	0	0	0	0
Atrazine + N-dealkylated metabolites	0	0	0	0	0	0
Azinphos-methyl	0	0	0	0	0	0
Bendiocarb	0	0	0	0	0	0
Benzene	**0**	**0**	**0**	**0**	**0**	**0**
Benzo(a)[yrene	0	0	0	0	0	0
Bromoxynil	0	0	0	0	0	0
Carbaryl	0	0	0	0	0	0
Carbofuran	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0

	2005	2006	2007	2008	2009	2010
Chlordane (Total)	0	0	0	0	0	0
Chlorpyrifos	0	0	0	0	0	0
Cyanazine	0	0	0	0	0	0
Diazinon	0	0	0	0	0	0
Dicamba	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
Dichlorodiphenyltrichloroethane (DDT) + metabolites	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0
Dichloromethane	0	0	0	0	0	0
2,4 Dichlorophenol	0	0	0	0	0	0
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	0	0	0	0	0
Diclofop-methyl	0	0	0	0	0	0
Dimethoate	0	0	0	0	0	0
Dinoseb	0	0	0	0	0	0
Diquat	0	0	0	0	0	0
Diuron	0	0	0	0	0	0
Glyphosate	0	0	0	0	0	0
Heptachlor + Heptachlor Epoxide	0	0	0	0	0	0
Linadane (Total)	0	0	0	0	0	0
Malathion	0	0	0	0	0	0
Methoxychlor	0	0	0	0	0	0
Metolachlor	0	0	0	0	0	0
Metribuzin	0	0	0	0	0	0
Monochlorobenzene	0	0	0	0	0	0
Paraquat	0	0	0	0	0	0
Pentachlorophenol	0	0	0	0	0	0

	2005	2006	2007	2008	2009	2010
Phorate	0	0	0	0	0	0
Picloram	0	0	0	0	0	0
Polychlorinated Biphenyls (PCBs)	0	0	0	0	0	0
Prometryne	0	0	0	0	0	0
Simazine	0	0	0	0	0	0
Temephos	0	0	0	0	0	0
Terbufos	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0
2,3,4,6-Tetrachlorophenol	0	0	0	0	0	0
Triallate	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0
2,4,6-Trichlorophenol	0	0	0	0	0	0
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0	0	0	0	0	0
Trifluralin	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0

CASE STUDY#2 – TRUDEAU TWEED PIT

TWEED WELL SUPPLY SYSTEM (DRINKING WATER SYSTEM #220003092)

[Concentrations in mg/L]

METALS

Year	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Mercury	Selenium
2005	0	3	302	29.000	0	6	0.2	0	0
2006	0	0	378.00	28	0	0	0.3	0	0
2007	0.3	2.1	385	26.000	0	1.5	0.36	0	0
2008	0.44	0.6	323	38	0	0.8	0.36	0	0
2009	0.33	0.9	340	25.3	0.003	1.1	0.32	0	0
2010	0.28	1.9	326	25	0	1	0.32	0	0

URANIUM

RAW WATER – WELL#1

Year	Month	Uranium Raw (W1)
2007	Jan	243
	Apr	271
	Jul	292
	Oct	251
2008	Jan	262
	Apr	271
	Jul	273
	Oct	250
2009	Jan	217
	Apr	269

	Jul	266
	Oct	278
2010	Jan	244
	Apr	267
	Jul	248
	Oct	234

RAW WATER – WELL#3

Year	Month	Uranium Raw (W3)
2007	Jan	13.7
	Apr	15.3
	Jul	21.5
	Oct	21.2
2008	Jan	19.1
	Apr	18.4
	Jul	19
	Oct	14.9
2009	Jan	18.7
	Apr	21.6
	Jul	20.9
	Oct	19.8
2010	Jan	17.4
	Apr	17.8
	Jul	19
	Oct	11.7

TREATED WATER

Year	Month	Uranium Treated (W3)
2005	Jan	7.92
	Apr	6.5
	Jul	6.73
	Oct	3.55
2006	Jan	6.23
	Apr	5.68
	Jul	4.36
	Oct	4.89
2007	Jan	6.89
	Mar	3.9
	Apr	4.17
	Jul	3.92
	Oct	4.75
	Nov	3.94
	Nov	5.63
	Nov	6.04
2008	Jan	7.52
	Mar	10.7
	Apr	8.25
	Jul	9.08
	Aug	5.18
	Oct	3.7
2009	Jan	9.52
	Mar	10.4
	Apr	8.66
	Jul	9.82
	Oct	10.8

2010	Jan	9.43
	Mar	10.6
	Apr	11
	Jul	10.4
	Oct	11.4

NITRATE + NITRITE

RAW WATER – WELL#1

Year	Nitrite	Nitrate
2006	0.019	0.212
	0.036	0.33
	0.008	0.737
2007	0.013	0.11
	0.011	0.143
	0.009	0.064
	0.000	0.117

RAW WATER – WELL#3

Year	Nitrite	Nitrate
2006	0	5.38
	0	4.81
	0	4.16
2007	0	4.89
	0.008	5.06
	0	3.54
	0.000	3.12

TREATED WATER

Year	Nitrite	Nitrate
2005	0	3.84
	0	2.56
	0	3.59
	0	3.47
2006	0	3.06
	0	4.19
	0	2.38
	0	3.2
2007	-	-
	-	-
	0	3.31
	0.006	4.07
2008	0	2.78
	0	3.17
	0	3.66
	0	1.28
2009	0	2.25
	0	1.39
	0	2.96
	0	1.65
2010	0	1.41
	0	3.03
	0	3.42
	0	1.72

AMMONIA

RAW WATER

Year	RAW (W1)	RAW (W3)
2006	0.24	0.08
	0.06	0.24
	0.36	0.2
2007	0	0
	0.07	0.11
	0	0
	0	0
2008	0.29	0.25
	0	0
	0.13	0
	0	0
2009	0.07	0.06
	0.04	0
	0.14	0.12
	0	0
2010	0.48	0.19
	0.05	0.07
	0	0
	0.06	0.46

SODIUM

Year	Sodium
2003	13.9
2008	19.2

TURBIDITY

RAW WATER

Year	# Grab Samples	Max	Min
2005	12	0.31	0.08
2006	12	0.48	0.20
2007	12	0.44	0.14
2008 (W1)	12	0.40	0.18
2008 (W3)	12	0.25	0.09
2009 (W1)	11	0.54	0.22
2009 (W3)	11	0.27	0.11
2010 (W1)	12	0.37	0.22
2010 (W3)	12	0.31	0.14

TREATED WATER

Year	# Samples	Max	Min
2005	8760	3.78	0.00
2006	8760	2.00	0.00
2007	8760	2.00	0.00
2008	8760	2.00	0.00
2009	8760	2.00	0.00
2010	8760	1.99	0.00

MICROBIOLOGY

RAW WATER – WELL#1

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC
2005	52	**0**	0	52	21
2006	52	**0**	10	44	580
2007	52	**0**	280	-	-
2008	53	**0**	1	3	19
2009	52	**0**	0	-	-
2010	52	**0**	111	-	-

RAW WATER – WELL#3

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	
2005	52	**0**	0	52	2000	
2006	52	**0**	0	44	22	
2007	52	**0**	0	-	-	
2008	53	**0**	0	3	4	
2009	52	**0**	0	-	-	
2010	52	**0**	0	-	-	

TREATED WATER

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	
2005	52	**0**	0	52	5	
2006	52	**0**	0	52	3	
2007	55	**0**	0	53	8	
2008	53	**0**	0	53	2	
2009	52	**0**	0	52	4	
2010	52	**0**	0	52	1	

ORGANICS

	2005	2006	2007	2008	2009	2010
Alachlor	0	0	0	0	0	0
Aldicarb	0	0	0	0	0	0
Aldrin + Dieldrin	0	0	0	0	0	0
Atrazine + N-dealkylated metabolites	0	0	0	0	0	0.05
Azinphos-methyl	0	0	0	0	0	0
Bendiocarb	0	0	0	0	0	0
Benzene	**0**	**0**	**0**	**0**	**0**	**0**
Benzo(a)[yrene	0	0	0	0	0	0
Bromoxynil	0	0	0	0	0	0
Carbaryl	0	0	0	0	0	0
Carbofuran	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlordane (Total)	0	0	0	0	0	0
Chlorpyrifos	0	0	0	0	0	0
Cyanazine	0	0	0	0	0	0
Diazinon	0	0	0	0	0	0
Dicamba	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
Dichlorodiphenyltrichloroethane (DDT) + metabolites	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0
Dichloromethane	0	0	0	0	0	0
2,4 Dichlorophenol	0	0	0	0	0	0
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	0	0	0	0	0
Diclofop-methyl	0	0	0	0	0	0

	2005	2006	2007	2008	2009	2010
Dimethoate	0	0	0	0	0	0
Dinoseb	0	0	0	0	0	0
Diquat	0	0	0	0	0	0
Diuron	0	0	0	0	0	0
Glyphosate	0	0	0	0	0	0
Heptachlor + Heptachlor Epoxide	0	0	0	0	0	0
Linadane (Total)	0	0	0	0	0	0
Malathion	0	0	0	0	0	0
Methoxychlor	0	0	0	0	0	0
Metolachlor	0	0	0	0	0	0
Metribuzin	0	0	0	0	0	0
Monochlorobenzene	0	0	0	0	0	0
Paraquat	0	0	0	0	0	0
Pentachlorophenol	0	0	0	0	0	0
Phorate	0	0	0	0	0	0
Picloram	0	0	0	0	0	0
Polychlorinated Biphenyls (PCBs)	0	0	0	0	0	0
Prometryne	0	0	0	0	0	0
Simazine	0	0	0	0	0	0
Temephos	0	0	0	0	0	0
Terbufos	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0
2,3,4,6-Tetrachlorophenol	0	0	0	0	0	0
Triallate	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0
2,4,6-Trichlorophenol	0	0	0	0	0	0
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0	0	0	0	0	0
Trifluralin	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0

CASE STUDY#3 – ROCKWAY WOOLNER PIT

WOOLNER WELL WATER SUPPLY SYSTEM (DRINKING WATER SYSTEM #220003092)

[Concentrations in mg/L]

METALS

Year	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Mercury	Selenium	Uranium
2005	0	0	0.019	0.030	0	0		0	0	0
2006	0	0	0.02	0.01	0	0		0	0	0
2007	0	0	0.017	0.02	0	0		0	0	0
2008										
2009	0	0	0.017	0.02	0	0		0	0	0
2010	0	0	0.02	0	0	0		0	0	0

NITRATE + NITRITE

Year	Nitrite	Nitrate
2005	0	5.66
	0	5.17
	0	4.66
	0	4.77
	0	3.74
	0	2.63
	0	2.73
2006	0	4.72
	0	4.02
	0	2.47
	0	2.25

	0	6.66
2007	0	3.43
	0	2.39
	0	2.36
	0	1.94
	0	1.93
	0	1.58
	0	2.05
2008	0	
	0	
2009	0	1.79
	0	1.85
	0	1.52
2010	0	2.11
	0	2.33
	0	2.13

SODIUM

Year	Sodium
2004	30.1
2009	23.6

TURBIDITY

RAW WATER

Year	# Grab Samples	Max	Min
2005	24	1.30	0.07
2006	28	0.80	0.02
2007	17	0.50	0.10
2008			
2009	12	0.70	0.10
2010	14	0.80	0.10

TREATED WATER

Year	# Samples	Max	Min
2005	8760	1.06	0.01
2006	8760	2.00	0.00
2007	8760	0.715	0.002
2008	0		
2009	8760	1.995	0.035
2010	8760	1.994	0.043

MICROBIOLOGY

RAW WATER

Year	# Samples Taken	# E.coli/Fecal Detections	# Total Coliform Detections
2005	107	**5**	50
2006	105	**6**	38
2007	101	**5**	29
2008			
2009	35	**2**	10
2010	46	**1**	13

ORGANICS

	2005	2006	2007	2008	2009	2010
Alachlor	0	0	0	0	0	0
Aldicarb	0	0	0	0	0	0
Aldrin + Dieldrin	0	0	0	0	0	0
Atrazine + N-dealkylated metabolites	0.1	0.1	0	0	0	0
Azinphos-methyl	0	0	0	0	0	0
Bendiocarb	0	0	0	0	0	0
Benzene	**0**	**0**	**0**	**0**	**0**	**0**
Benzo(a)[yrene	0	0	0	0	0	0
Bromoxynil	0	0	0	0	0	0
Carbaryl	0	0	0	0	0	0
Carbofuran	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0
Chlordane (Total)	0	0	0	0	0	0
Chlorpyrifos	0	0	0	0	0	0

	2005	2006	2007	2008	2009	2010
Cyanazine	0	0	0	0	0	0
Diazinon	0	0	0	0	0	0
Dicamba	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0
Dichlorodiphenyltrichloroethane (DDT) + metabolites	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0
Dichloromethane	0	0	0	0	0	0
2,4 Dichlorophenol	0	0	0	0	0	0
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	0	0	0	0	0
Diclofop-methyl	0	0	0	0	0	0
Dimethoate	0	0	0	0	0	0
Dinoseb	0	0	0	0	0	0
Diquat	0	0	0	0	0	0
Diuron	0	0	0	0	0	0
Glyphosate	0	0	0	0	0	0
Heptachlor + Heptachlor Epoxide	0	0	0	0	0	0
Linadane (Total)	0	0	0	0	0	0
Malathion	0	0	0	0	0	0
Methoxychlor	0	0	0	0	0	0
Metolachlor	0	0	0	0	0	0
Metribuzin	0	0	0	0	0	0
Monochlorobenzene	0	0	0	0	0	0
Paraquat	0	0	0	0	0	0
Pentachlorophenol	0	0	0	0	0	0
Phorate	0	0	0	0	0	0
Picloram	0	0	0	0	0	0

	2005	2006	2007	2008	2009	2010
Polychlorinated Biphenyls (PCBs)	0	0	0	0	0	0
Prometryne	0	0	0	0	0	0
Simazine	0	0	0	0	0	0
Temephos	0	0	0	0	0	0
Terbufos	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0
2,3,4,6-Tetrachlorophenol	0	0	0	0	0	0
Triallate	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0
2,4,6-Trichlorophenol	0	0	0	0	0	0
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0	0	0	0	0	0
Trifluralin	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0

CASE STUDY#4 - LAFARGE TALBOT PIT

London Water Supply (Drinking Water System #260004917), Fanshaw Wellfield (6 WELLS)

[Concentrations in mg/L]

MICROBIOLOGY (ALL WELLS)

RAW WATER

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	#Bkgrd Samples	Max Value Bkgrd
2006	28	**1**	2	-	-	-	-
2007	28	**0**	0	-	-	-	-
2008	22	**0**	0	22	0	-	-
2009	28	**0**	1	28	260	-	-
2010	28	**0**	2	28	30	-	-

TREATED WATER

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC	#Bkgrd Samples	Max Value Bkgrd
2006	-	**-**	-	-	-	-	-
2007	-	**-**	-	-	-	-	-
2008	-	**-**	-	-	-	-	-
2009	-	**-**	-	-	-	-	-
2010	-	**-**	-	-	-	-	-

METALS

WELL#1

	2006	2007	2008	2009	2010
Antimony	0.2	0	0.41	0.06	0.05
Arsenic	0.8	0.2	0.3	0.6	0.3
Barium	35.2	32.4	33.9	36.1	35.2
Boron	52	46	62	74	59
Cadmium	0	0	0.008	0.01	0.004
Uranium	0.83	0.77	0.589	0.568	0.55
Aluminum	0.9	0	0.3	10	1.1
Cobalt	0.1	0.15	0	0.296	0.085
Copper	0.9	0.9	1.6	10	1.1
Iron	63	191	41	63	343
Manganese	0.7	1.28	0.72	0.78	3.44
Nickel	0	0	0.5	1.8	0.3
Zinc	0.6	1.6	0	17	1

WELL#2

	2006	2007	2008	2009	2010
Antimony	0	0	0.34	0.3	0.05
Arsenic	0.6	0.2	0.4	0.6	0.3
Barium	32.3	30.2	31.2	36.3	33.6
Boron	35	34	44	45	31
Cadmium	0	0	0.013	0.011	0.007
Uranium	0.71	0.68	0.57	0.618	0.566
Aluminum	0.7	1.5	1.6	6.1	0.9
Cobalt	0.15	0.163	0.193	0.265	0.136

Copper	1.2	1.1	1.9	7.5	1.9
Iron	55	87	95	143	149
Manganese	41.3	34.9	51	59.6	49.5
Nickel	0	0	0.8	2.5	0.7
Zinc	0	0	0	6	2

WELL#3

	2006	**2007**	**2008**	**2009**	**2010**
Antimony	0	0	0.31	0.07	0.04
Arsenic	0	0.3	0.3	0.8	0.3
Barium	36	36.6	37.5	37.6	38.3
Boron	37	32	41	34	31
Cadmium	0	0	0.012	0	0.006
Uranium	0.81	0.72	0.663	0.642	0.64
Aluminum	0.4	0	0	3.9	1.5
Cobalt	0.36	0.339	0.361	0.456	0.384
Copper	0.8	0.7	1.8	3.6	1.4
Iron	99	99	215	141	273
Manganese	233	202	243	259	246
Nickel	1.4	1.2	1.6	2.8	1.4
Zinc	3.3	0.7	3	4	2

WELL#4

	2006	2007	2008	2009	2010
Antimony	0	0	0.25	0.07	0.03
Arsenic	0	0.2	0.3	0.9	0.3
Barium	30.3	29.3	29.2	32.4	33.4
Boron	20	18	22	17	17
Cadmium	0	0	0.011	0	0.006
Uranium	0.89	0.82	0.837	0.646	0.817
Aluminum	0	0	0	3.1	0.6
Cobalt	0.17	0.193	0.202	0.182	0.161
Copper	1.1	1	2.6	2	1.5
Iron	159	30	220	116	205
Manganese	128	95.1	150	126	139
Nickel	0	0	1.1	1.8	0.8
Zinc	1.2	0	0	2	2

WELL#5

	2006	2007	2008	2009	2010
Antimony	0	0	0.18	0.04	0
Arsenic	0	0.2	0.3	0.7	0.3
Barium	47.4	18.7	38.9	42.4	46.8
Boron	66	12	87	99	74
Cadmium	0	0	0.009	0	0.009
Uranium	0.67	0.38	0.589	0.604	0.581
Aluminum	1.4	0	0	3.7	2.6
Cobalt	0.1	0.191	0.149	0.143	0.115
Copper	3.4	10.5	2.4	2.8	1.9
Iron	0	14	18	45	44

Manganese	0.85	42.9	0.52	1.59	1.68
Nickel	0	0	0.7	1.8	0.4
Zinc	0	0.7	0	2	2

WELL#6

	2006	**2007**	**2008**	**2009**	**2010**
Antimony	0	0	0.23	0.09	0.07
Arsenic	0	0.3	0	0.4	0.3
Barium	20.1	41.3	17.8	18.6	28
Boron	16	87	16	14	18
Cadmium	0	0	0	0	0.009
Uranium	0.42	0.6	0.359	0.387	0.511
Aluminum	0.2	0	1.7	2.9	1
Cobalt	0.14	0.155	0.173	0.212	0.344
Copper	20.7	1.3	14.1	6.7	8.5
Iron	0	22	14	17	20
Manganese	42.7	0.78	56.6	70.2	107
Nickel	0	0	0.8	1.4	0.8
Zinc	1.2	0.8	0	0	2

ORGANICS (ALL WELLS)

NO ORGANICS DETECTED IN WELLS#1 – 6

INORGANICS (ALL WELLS)

RESULTS NOT INCLUDED FOR CURRENT STUDY

CASE STUDY#5 - LAFARGE CALEDON PIT

CALEDON VILLAGE WELL SUPPLY SYSTEM (DRINKING WATER SYSTEM #220004000), WELL#3

[Concentrations in mg/L]

METALS

Year	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Lead	Mercury	Selenium	Uranium	Sodium
2003	0	0.004	0.034	0.009	0	0	0	0.00022	0	0.0002	-
2004	0	0	0.042	0.013	0	0	0	0	0	0.0002	34.2
2005	0	0	0.045	0.022	0	0.0048	0	0.0001	0	0	34.5
2006	0	0.001	0.043	0.012	0.0005	0	0	0	0	0	35.5
2007	0.000529	0	0.04	0.014	0	0.002	0	0	0	0.0002	37.3
2008	0	0	0.060	0.038	0	0	0.000449	0	0	0	28.8
2009	0	0	0.0605	0.0395	0	0	0	0	0	0	25.15
2010	0	0	0.0635	0.028	0	0	0	0	0	0	22.4

NITRATE + NITRITE

Year	Nitrite	Nitrate
2003	0	0
2004	0	0
2005	0	-
2006	0	0.203
2007	0	0.146
2008	0	0.1495
2009	0	0.11
2010	0	0.092

TURBIDITY

RAW WATER

Year	# Grab Samples	Max	Min
2003			
2004			
2005	51	0.32	0.05
2006			
2007			
2008			
2009			
2010	107	0.39	0.00

TREATED WATER

Year	# Continuous Samples	Max	Min
2003	8760	0.32	0.01
2004	151	1.05	0.01
2005			
2006	8760	0.31	0.03
2007	8760	0.37	0.00
2008	8760	3.69	0.00
2009	8760	0.55	0.08
2010	8760	2.55	0.00

MICROBIOLOGY

RAW WATER

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC
2003	52	**0**	0	31	21
2004	52	**0**	0	52	1
2005	52	**0**	0	52	0
2006	52	**0**	0	52	2
2007	52	**0**	0	52	33
2008	53	**0**	0	53	2
2009	52	**0**	1	52	0
2010	51	**0**	1	1	0

TREATED WATER

Year	# EC/TC Samples	Max Value E. Coli/Fecal	Max Value Total Coliform	# HPC Samples	Max Value HPC
2003	52	**0**	0	31	0
2004	52	**0**	0	39	0
2005	52	**0**	0	52	0
2006	52	**0**	0	52	1
2007	52	**0**	0	52	0
2008	53	**0**	0	53	0
2009	52	**0**	0	52	2
2010	48	**0**	0	48	7

ORGANICS

Year	2003	2004	2005	2006	2007	2008	2009	2010
Alachlor	0	0	0	0	0	0	0	0
Aldicarb	0	0	0	0	0	0	0	0
Aldrin + Dieldrin	0	0	0	0	0	0	0	0
Atrazine + N-dealkylated metabolites	0	0	0	0	0	0	0	0
Azinphos-methyl	0	0	0	0	0	0	0	0
Bendiocarb	0	0	0	0	0	0	0	0
Benzene	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benzo(a)[yrene	0	0	0	0	0	0	0	0
Bromoxynil	0	0	0	0	0	0	0	0
Carbaryl	0	0	0	0	0	0	0	0
Carbofuran	0	0	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0	0	0
Chlordane (Total)	0	0	0	0	0	0	0	0
Chlorpyrifos	0	0	0	0	0	0	0	0
Cyanazine	0	0	0	0	0	0	0	0
Diazinon	0	0	0	0	0	0	0	0
Dicamba	0	0	0	0	0	0	0	0
1,2-Dichlorobenzene	0	0	0	0	0	0	0	0
1,4-Dichlorobenzene	0	0	0	0	0	0	0	0
Dichlorodiphenyltrichloroethane (DDT) + metabolites	0	0	0	0	0	0	0	0
1,2-Dichloroethane	0	0	0	0	0	0	0	0
1,1-Dichloroethylene	0	0	0	0	0	0	0	0
Dichloromethane	0	0	0	0	0	0	0	0
2,4 Dichlorophenol	0	0	0	0	0	0	0	0
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	0	0	0	0	0	0	0

Year	2003	2004	2005	2006	2007	2008	2009	2010
Diclofop-methyl	0	0	0	0	0	0	0	0
Dimethoate	0	0	0	0	0	0	0	0
Dinoseb	0	0	0	0	0	0	0	0
Diquat	0	0	0	0	0	0	0	0
Diuron	0	0	0	0	0	0	0	0
Glyphosate	0	0	0	0	0	0	0	0
Heptachlor + Heptachlor Epoxide	0	0	0	0	0	0	0	0
Linadane (Total)	0	0	0	0	0	0	0	0
Malathion	0	0	0	0	0	0	0	0
Methoxychlor	0	0	0	0	0	0	0	0
Metolachlor	0	0	0	0	0	0	0	0
Metribuzin	0	0	0	0	0	0	0	0
Monochlorobenzene	0	0	0	0	0	0	0	0
Paraquat	0	0	0	0	0	0	0	0
Pentachlorophenol	0	0	0	0	0	0	0	0
Phorate	0	0	0	0	0	0	0	0
Picloram	0	0	0	0	0	0	0	0
Polychlorinated Biphenyls (PCBs)	0	0	0	0	0	0	0	0
Prometryne	0	0	0	0	0	0	0	0
Simazine	0	0	0	0	0	0	0	0
Temephos	0	0	0	0	0	0	0	0
Terbufos	0	0	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0	0	0
2,3,4,6-Tetrachlorophenol	0	0	0	0	0	0	0	0
Triallate	0	0	0	0	0	0	0	0
Trichloroethylene	0	0	0	0	0	0	0	0
2,4,6-Trichlorophenol	0	0	0	0	0	0	0	0
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0	0	0	0	0	0	0	0

Year	2003	2004	2005	2006	2007	2008	2009	2010
Trifluralin	0	0	0	0	0	0	0	0
Vinyl Chloride	0	0	0	0	0	0	0	0