

## Chapter 4 – Source Water Quality Issue Evaluation and Threat Assessment

### Purpose

This chapter of the *Assessment Report* is intended to explain the process that has been used to assess *risks* to water quality in the Cataraqui Source Protection Area (CSPA) and elsewhere in Ontario. By protecting and improving the cleanliness of our *source water*, we can reduce the cost and complexity of treatment, prevent the need to find alternatives to contaminated supplies, and enjoy other benefits of clear, clean and cool water.

*Risks* to *drinking water* quality can be thought of in different ways. Some *risks* are ongoing, in that the quality of the water may be continuously degraded by surface *runoff* or by the underground leaching of *chemicals* or *pathogens*. Conversely, event-based *risks* occur during a short period of time, when emergencies and/or large storms result in pollution. These *risks* can result in longer-term problems if it is not feasible to clean up the resulting *contamination*.

*Risks* can also be given a status. Inherent *risks* are assessed apart from any actions taken to contain them – by their very existence they pose a problem to the *source water*. Mitigated *risks* have been addressed through some kind of physical or administrative action (for example, a containment system has been installed around an industrial site to capture spilled material). As prescribed by the Ontario government, this *Assessment Report* assesses only the inherent *risks*; the *source protection plan* process will account for past actions taken to reduce them.

The *water quality risk assessment* process is prescribed by the Ontario government for all source protection areas and regions through the Ontario Clean Water Act, 2006, regulations and Technical Rules: Assessment Report (MOE, 2009a)(see **Appendix ‘L-1’**). The results of the process are outlined in Chapters 5 and 6, wherein *vulnerable areas* are mapped and assigned scores, *drinking water issues* are evaluated, and *drinking water threats* are assessed and counted. By learning about the past, present and future *activities* that could harm the quality of *source water*, local communities can make informed decisions about how best to protect their supplies for the future.

### 4.1 Delineating and Scoring Vulnerable Areas

Rather than looking at all water everywhere, the source protection initiative in Ontario focuses attention on specific places where the *source water* is deemed most vulnerable to pollution and/or overuse. These places are called *vulnerable areas*. For the purpose of the *Act*, they are either related to groundwater resources on a broad *scale*, or to groundwater and *surface water* around municipal water treatment plants (WTP). The *Act* does make provision for other areas to be classified as *vulnerable areas* in the future, for example, areas around wells and intakes that serve public facilities.

The *vulnerable areas* are defined as:

- *Highly vulnerable aquifers* (HVA) and *significant groundwater recharge areas* (SGRA)

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are intended to protect groundwater across larger areas of land (see Chapter 5). In the CSPA and other parts of eastern Ontario with shallow soils and fractured *bedrock*, these types of *vulnerable areas* occupy a large proportion of the landscape.

- *Wellhead protection areas* (WHPA) are delineated around the wellhead (top of the well), for municipal WTPs (see Chapter 5).
- *Surface water intake protection zones* (IPZ) are delineated around the end of the intake pipes for municipal WTPs in lakes and *rivers*, including those in Lake Ontario and the St. Lawrence River (see Chapter 6).

Specific descriptions of how each type of *vulnerable area* is delineated are included at the start of Chapters 5 and 6. A map showing all of the *surface water intake protection zones* and *wellhead protection areas* in the CSPA is shown in **Map 4-1**.

The vulnerability to *contamination* of the lands and waters within each of the areas identified above varies depending on proximity to the WTP, the degree to which the intake or well is protected from pollution and other factors. For the purpose of the *risk assessment*, vulnerability scores have therefore been assigned within each *vulnerable area*. The scores are between one and ten. Specific direction on how to assign them is included within the Technical Rules: Assessment Report (MOE, 2009a). In general, vulnerable scores are highest near WTP intakes and wells and lowest at the edge of the *vulnerable area*.

### 4.2 Drinking Water Issue Evaluation

Another aspect of drinking water source protection research is the identification of *drinking water issues* in the untreated *source water* within each *vulnerable area*. As defined by the Technical Rules: Assessment Report (MOE, 2009a), a *drinking water issue* occurs at the well or intake being studied when (selected) *chemicals* or *pathogens* are “...present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water...” or “...there is a trend of increasing concentrations” of the *chemical* or *pathogen* (see Rule 114).

Two examples of *chemical* parameters that can become *drinking water issues* are sodium and chloride (salt). Salt comes from both natural and human sources; it is used to melt ice on roads, soften groundwater, and sterilize swimming pools.

The purpose of evaluating *drinking water issues* in this *Assessment Report* is to set a baseline for the quality of the *source water*, and to begin to learn about the *drinking water threats* (see Section 4.3 below) or natural phenomena that may be causing a *drinking water issue*. It is important to remember that this discussion refers to raw, untreated water prior to its entry into a WTP.

Allowable limits for *chemicals* and *conditions* in Ontario drinking water are identified in Schedules 1, 2 or 3 of the Ontario Drinking Water Quality Standards (MOE, 2003a) and Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (MOE, 2003b).

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The MOE has set specific rules for identifying *drinking water issues* (see the [Technical Rules: Assessment Report](#), 2009). *Drinking water issues* are to be identified from available source (raw) water quality data, related to the above standards, when an allowable limit is exceeded. This can occur either at the well or intake that is used for the system, and/or at an associated *monitoring* station. A *drinking water issue* may also be identified where a parameter (for a *chemical* or *condition*, such as *hardness*) occurs at a concentration that is below the allowable limit, but there is an increasing trend that appears to be headed above that limit. Attention is given to the ability of a WTP to remove the *contaminant* from the water.

In the Cataraqui area, *drinking water issues* have been evaluated for the *source water* around the 12 municipal residential *drinking water systems*. Data from the province of Ontario (Annual Inspection Reports, Drinking Water Information System, Drinking Water Surveillance Program, Provincial Groundwater Monitoring Network (PGMN), and Provincial Water Quality Monitoring Network (PWQMN)), municipal utilities (consultant's reports, engineer's reports), public health units (beach *monitoring* data) and the CRCA were used in the analyses.

Where a *drinking water issue* has been identified in the *source water* for a WTP, it may not pose an immediate problem for the municipality or to the people who consume the water. Some *drinking water issues* are caused by natural phenomena, and water treatment methods are normally employed to respond to them. Some *drinking water issues* are easily corrected by standard WTP technologies, while others require additional treatment methods, or are not treatable.

For *drinking water issues* caused by human *activities*, this *Assessment Report* includes a plan to delineate an *issue contributing area* upstream of the WTP. Additional information about *issue contributing areas* is included in Section 4.3.1 below.

### 4.3 Threat Assessment

A *drinking water threat* is defined in the Ontario [Clean Water Act, 2006](#) to be:

“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 a source of drinking water, and includes an *activity* or *condition* that is prescribed by the regulations as a drinking water *threat*” (Section 2(1)).

The Ontario government has prescribed a list of types of *drinking water threats* that must be considered in each source protection area. Of the 21 *activities* prescribed to be *drinking water threats*, 19 relate to the quality of *source water*, while two relate to the amount of water that is available for drinking. The *water budget* findings in Chapter 3 of this report indicate there are no significant threats of water quantity in the CRCA thus, only quality-related threats will be considered in the CSPA.

The Cataraqui Source Protection Committee received approval in June 2010 from the Ontario Ministry of Environment to add two local *drinking water threats* for the Cataraqui area. The two local *drinking water threats* include: (1) the *discharge* of water containing conditioning salts from water softeners and (2) transportation of fuels, *organic solvents*, dense non-aqueous phase liquids (*DNAPLs*), and *pesticides* along highways, roads, railways and navigation channels

(corridors) within *vulnerable areas*. The final approval letters are included in **Appendices ‘F-2’** and **‘F-3’**, respectively.

As described below, *drinking water threats* relate to the past, present, and future.

- Past. *Drinking water threats* that relate to the past are called *conditions*. These are problems in the land or water that have resulted from an *activity* in the past. A *condition* is the presence of a *contaminant* (in the *surface water*, *groundwater*, surface soil, or *sediment*) resulting from past *activities*. To be identified as a *drinking water threat* through the source protection initiative, a *condition* must meet criteria that are referenced in Section 4.3.3.2 below. An example of a *condition* is the presence of gasoline (with *contaminants* such as benzene, toluene, ethyl benzene and xylene) in the soil surrounding a leaking underground tank at a gasoline station.
- Present. *Drinking water threats* can also be identified from *activities* that exist in the present. An example of a present *threat* is a gasoline station that is in active operation.
- Future. An *activity* “would be” a *threat* if it emerged in the future and the underlying vulnerability score was high enough for it to be listed in the Tables of Drinking Water Threats (MOE, 2009d) as a significant, moderate, or low *threat*. It is important to note that the identification of such *threats* does not depend on whether or not the *activity* is permitted within the scope of municipal official plans and zoning by laws.

As part of the methods prescribed by the MOE, all “would be” *threats* may only be enumerated for *assessment reports* where infrastructure is now in place to facilitate them. An example is a farm without livestock, but with a barn and a fenced livestock paddock in place. More information on enumerating *drinking water threats* is provided below in Section 4.3.4.

To assist source protection committees with ranking *drinking water threats*, each one is classed as being significant, moderate or low. Section 22 of the *Act* requires that each source protection plan include policies to ensure the removal of existing significant *threats*, and to prevent other significant drinking water threats from emerging in the future. Over the past few years, the Cataraqui Region Conservation Authority (CRCA) and its partners have worked to learn as much as possible about regional *drinking water threats*. This will aid in the preparation of the forthcoming *source protection plan* for the Cataraqui area.

Each of the following three approaches to identifying *drinking water threats* within a source protection area are described below:

- the *issues* approach
- the event-based approach
- the *threats* approach.

#### **4.3.1 The Issues Approach**

Once a *drinking water issue* has been identified in accordance with provincial standards (see Section 4.3 above) and it is deemed to have been caused wholly or partially by human means,

then any *activities* or *conditions* that may be contributing to that *drinking water issue* need to be identified. This is called the *issues* approach to identifying *drinking water threats*.

The first step is to delineate an *issue contributing area* upstream of the location at which the *drinking water issue* has been observed. The *issue contributing area* may be different than the *vulnerable area* (*intake protection zone*) around the *drinking water system*. For each *drinking water issue* identified in the *Assessment Report*, a plan to gather the necessary information to delineate *issue contributing areas* has been prepared. These plans are given in **Appendix ‘E-3’**.

In the second step, specific *drinking water threats* that could reasonably be expected to contribute to the *drinking water issue* are identified. All such *threats* are automatically classified as significant. The *issue contributing areas* and related *drinking water threats* will be identified in future editions of this document.

### **4.3.2 The Event – Based Approach**

The event-based approach is a *modeling* exercise for Great Lakes and *connecting channel surface water* IPZs. The approach is associated with an area of interest known as IPZ 3 (see Chapter 6).

In this approach, pollution from a given *discharge* point must be shown to be able to travel over land and in the water to the intake during or just after a large (e.g. one in a hundred year) storm. This storm is sometimes called an *extreme event* since it only has a one per cent probability of occurring. *Drinking water threats* associated with the *contaminants* that are found to be able to reach the intake, and deteriorate the *raw water* there, are automatically classified as significant. For example, if wastewater from a combined sewer overflow was found to reach a nearby *surface water* intake at a harmful concentration after an *extreme event*, then the overflow would be ranked as a significant *drinking water threat*.

As described in Chapter 6 and 8, some initial research in support of the event-based approach has been completed for the CSPA. Chapter 6 describes the research completed by the Queen’s University Department of Civil Engineering to *model* the flow of water using 2006 data. Chapter 8 describes the preliminary work completed by the Cataraqui Region Conservation Authority to assess related significant *drinking water threats*. Further research is warranted to determine whether or not specific *activities* and potential *conditions* will result in related *contaminants* deteriorating the *source water* quality at one or more municipal residential *drinking water system* intakes during or after an *extreme event*.

### **4.3.3 The Threats Approach**

The *threats* approach is being used to identify the majority of *drinking water threats* in the CSPA. In this approach, activities are compared against circumstances prescribed by the Ontario government in the Tables of Drinking Water Threats (MOE, 2009d) while *conditions* are compared against standards defined in the Technical Rules: Assessment Report (MOE, 2009a).

#### **4.3.3.1 Activities**

The Tables of Drinking Water Threats (MOECC, 2009d), were created to identify and rank *drinking water threats*. A variety of circumstances are outlined in the Tables for each of the

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prescribed *drinking water threats*. The Tables were created to provide a consistent approach to similar situations across Ontario.

The Tables are based upon a calculated *hazard rating* (for each circumstance of an *activity*) and the locally-determined vulnerability of the *drinking water source*. For *chemicals*, the overall *hazard rating* is affected by the toxicity and quantity of the substance and how it can be expected to behave in the environment. For *pathogens*, the *hazard rating* is determined by the likelihood that contaminated material will be associated with an activity and the likelihood that the material could *impact* the *drinking water source*.

The Tables separate circumstances into *chemical* and *pathogen* based contaminants, and are outlined for each of the *drinking water quality threats*. The *chemical contaminants* have been linked to *activities* that could produce specific *chemicals* (such as arsenic or zinc), and have many unique combinations of circumstances. The *pathogen* based circumstances include the presence of any *pathogen*; and have fewer unique combinations of circumstances.

The circumstances in the Tables are used to rank *activities* as significant, moderate, or low within a given type of *vulnerable area*.

A Source Water Protection Threats Tool, accessible via the source protection homepage of ontario.ca, provides a platform by which the Tables can be searched to determine which threat circumstances have been ranked as significant, moderate, or low based on a given vulnerability score (MOECC, 2017). Appendix ‘G’ provides a more detailed description of how to use this search tool.

Table 4-1 and 4-2 below list the circumstances where the vulnerability score is high enough to produce a significant *drinking water threat* for a WHPA and an IPZ based on the Tables of Drinking Water Threats (MOECC, 2009d). Activities that are not *significant drinking water threats* are generally ranked as moderate and low threats with a few exceptions. Additionally, the *drinking water threat*-related maps in Chapters 5 and 6 provide a general indication of where *drinking water threats* can be significant, moderate or low.

Appendix ‘H’ is a *detailed drinking water threat* inventory for *vulnerable areas* within the Cataraqui Source Protection Area.

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**Table 4-1: Significant Threat Categories in a Wellhead Protection Area**  
(MOE, 2009d)

Contaminant released		Wellhead Protection Area Vulnerability Scoring									
		Chemical					Pathogen				
Prescribed Drinking Water Threat Category		10	8	6	4	2	10	8	6	4	2
1	The establishment, operation or maintenance of a waste disposal site	✓	✓				✓				
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	✓	✓				✓				
3	The application of agricultural source material to land	✓					✓				
4	The storage of agricultural source material	✓					✓				
5	The management of agricultural source material										
6	The application of non-agricultural source material to land	✓					✓				
7	The handling and storage of non-agricultural source material	✓					✓				
8	The application of commercial fertilizer to land	✓									
9	The handling and storage of commercial fertilizer	✓									
10	The application of pesticide to land	✓									
11	The handling and storage of pesticide	✓									
12	The application of road salt	✓									
13	The handling and storage of road salt	✓									
14	The storage of snow	✓									
15	The handling and storage of fuel	✓									
16	The handling and storage of a dense non-aqueous phase liquid (DNAPLs)*	✓	✓	✓	✓	✓					
17	The handling and storage of an organic solvent	✓									
18	The management of runoff that contains chemicals used in the de-icing of aircraft	✓									
19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body**										
20	An activity that reduces the recharge of an aquifer**										
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	✓					✓				
local	The use of water softeners	✓									
local	The transportation of specified substances along corridors	✓	✓	✓	✓	✓					

\*DNAPLs are chemicals that are heavy and sink in water (example: trichloroethylene)

\*\*Water quantity threats were evaluated as part of the water budget studies

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**Table 4-2: Significant Threat Categories in an Intake Protection Zone**  
(MOE, 2009d)

Contaminant released		Intake Protection Zone Vulnerability Scoring							
		Chemical				Pathogen			
Prescribed Drinking Water Threat Category		10	9	8.1	7-3.6	10	9	8.1	7-3.6
1	The establishment, operation or maintenance of a waste disposal site	✓	✓			✓	✓	✓	
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	✓	✓	✓		✓	✓	✓	
3	The application of agricultural source material to land	✓	✓			✓	✓	✓	
4	The storage of agricultural source material	✓	✓			✓	✓	✓	
5	The management of agricultural source material								
6	The application of non-agricultural source material to land	✓	✓			✓	✓	✓	
7	The handling and storage of non-agricultural source material	✓	✓			✓	✓	✓	
8	The application of commercial fertilizer to land	✓	✓						
9	The handling and storage of commercial fertilizer	✓							
10	The application of pesticide to land	✓	✓	✓					
11	The handling and storage of pesticide	✓	✓						
12	The application of road salt	✓	✓						
13	The handling and storage of road salt	✓	✓						
14	The storage of snow	✓	✓						
15	The handling and storage of fuel	✓							
16	The handling and storage of a dense non-aqueous phase liquid (DNAPLs)*	✓							
17	The handling and storage of an organic solvent	✓							
18	The management of runoff that contains chemicals used in the de-icing of aircraft	✓	✓						
19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body**								
20	An activity that reduces the recharge of an aquifer**								
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	✓	✓			✓	✓	✓	
local	The use of water softeners	✓							
local	The transportation of specified substances along corridors	✓							

\*DNAPLs are chemicals that are heavy and sink in water (example: trichloroethylene)

\*\*Water quantity threats were evaluated as part of the water budget studies

#### **4.3.3.2 Conditions**

*Threats* related to *conditions* may also be identified using the *threats* approach. A *condition* represents the *contamination* of rock, soil or water resulting from a past activity such as a spill of fuel. A *condition* must be within a *vulnerable area* (IPZ, WHPA, HVA or SGRA) and meet certain criteria in Technical Rule 126 to be considered a *threat*. For some types of *contamination*, the presence of a *contaminant* on an associated site must exceed the Soil, Ground Water, and Sediment Standards (MOE, 2004).

The occurrence of sites and areas that may include *conditions* has been investigated by the Cataraqui Region Conservation Authority on a preliminary basis. The following data sets were reviewed to locate sites and areas of interest: Occurrence Reporting and Information System, National Analysis of Trends in Emergencies System, National Environmental Emergencies System, National Pollutant Release Inventory, Contaminated Sites on Federal Land, and Ontario Spills databases. Historical atlases, municipal insurance plans and maps were also reviewed.

The lack of available data to demonstrate where *contamination* has actually occurred, and similarly has not been cleaned up, has prevented the identification of *conditions* in this report. As described in Chapter 8, continued research will be needed to determine how many *conditions* are present, and whether or not they in fact pose a *drinking water threat*.

#### **4.3.4 Enumerating Drinking Water Threats**

In preparing a *source protection plan*, it is useful to know the number, location and specific details about *drinking water threats*. The minimum requirement for the preparation of this *Assessment Report* was the counting of the existing significant *drinking water threats* within IPZs and WHPAs. The authors of this report also find merit in learning as much as possible about current *drinking water threats* within the CSPA. Therefore, moderate and low *drinking water threats* have also been enumerated and are provided for the reader within this report and relevant appendices. The knowledge of these additional threats may help prevent them from becoming significant.

The first step for this task was to prepare a list of existing *activities* that might be ranked as *drinking water threats*. The *activities* were first inventoried using field observations, along with a review of photographs and satellite images, by accessing existing databases. Then, where there was uncertainty about the circumstances on a given property, CRCA staff and consultants contacted individual property owners for more information. The contacts were made in writing, over the telephone and in-person. They were conducted in accordance with protocols that were developed by the CRCA and endorsed by the Cataraqui Source Protection Committee. The direct contact helped to determine which specific circumstances (see Section 4.3.3 above) were present at the time of the inventory, in order to rank the *threat* as significant, moderate or low.

The tables in **Appendix ‘H’** assist the reader to identify which *threat* circumstances have been ranked by the province as significant, moderate, or low based on the vulnerability score (“VS”) for each IPZ and WHPA in the CSPA.

We have chosen to count threats in two ways: by the number of relevant locations (parcels of land) and as an overall count for a given IPZ or WHPA. Each location with one or more *activities* was given an identification number indicated by “threat ID”. For example, a location

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with one or more *threats* in the Cana Wellhead Protection Area is called “cs.1” in this report to protect the privacy of the owner.

The 14 tables in **Appendix ‘H’** each include the following information:

- All confirmed (or assumed) *threats* are listed for each location of interest within the IPZ or WHPA, sorted by the “threat ID” for that location (for example: for the Cana Subdivision, the locations are sorted in order from cs.1 to cs.45)
- The relevant circumstances (and their reference numbers) are taken from the Tables of Drinking Water Threats (MOE, 2009d). For local drinking water *threats* (conditioning salts and the transportation of specified substances), the circumstances are taken from the MOE approval letters in **Appendices ‘F-2’** and **‘F-3’**, respectively.
- The number of locations where the circumstance occurs within each area of vulnerability scoring is included in the “affected parcels” column. The *threats* are listed in order of the prescribed *drinking water threats* (from one to 21, as per the list in **Appendix ‘F-1’**) in the “PDWT No.” column
- More than one circumstance can be listed per threat with the presence of *chemical* and *pathogen* based circumstances, handling and storage, and/or multiple sources of the same threat. The threat is ranked in the “threat class” column as significant (S), moderate (M) or low (L). Only the circumstance producing the highest ranking is used for parcel enumeration and is illustrated in table with a shaded and bolded “X”.
- Each location identified with *threats* is counted only once regardless of the number of *threats* or circumstances present.
- There is one count for every transportation corridor (for example: road, railway, navigation channel) present within the vulnerable area for which road salt application and/or the transportation of specified substances are identified *activities*.
- Each sewer network is considered to be a single threat activity in the highest ranking circumstance.
- The approved circumstances related to conditioning salt are assumed to be occurring at each location where there is a *drinking water system* that is supplied by groundwater. The rationale for this approach is based on the high *hardness* of the groundwater throughout the CSPA (see Section 2.2.2.2), anecdotal evidence of widespread water softener use and the inefficiency of attempting to enumerate each water softener in the applicable vulnerable areas.

The summary reference chart under the enumeration table provides the reader with the total number of parcels and *threats* per zone/area. These reference charts are also included in Chapters 5 and 6. Overall counts for the CSPA are shown in **Table 9-1** within Chapter 9.

For a more detailed summary of the assessment of *drinking water threats*, please refer to the “meta data” spreadsheet in **Appendix ‘H’**.