Chapter 4

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4 Drinking Water Quality Threats and Issues Approach

Introduction

This chapter gives an overview of the methodology and definitions developed by the Province of Ontario's Ministry of the Environment (MOE) to identify drinking water quality issues and threats in all source protection regions. These processes are important components in the multi-barrier approach to protecting drinking water sources from contamination. The specific approaches or methods used to identify drinking water threats and issues in the MRSPR are also discussed in this chapter.

Source protection technical work is focused on the identification and assessment of drinking water quality and quantity threats and issues affecting four different types of vulnerable areas, three of which are associated with groundwater and one with surface water. The four types of vulnerable areas are:

- Wellhead Protection Areas (WHPAs);
- Highly Vulnerable Aquifers (HVAs);
- Significant Groundwater Recharge Areas (SGRAs); and
- Intake Protection Zones (IPZs).

A number of terms are defined:

- **Drinking water threats** are land use activities which may adversely affect the quality or quantity of a source of drinking water and relate to the past, present and future.
- **Issues** are defined as documented water quality problems.
- **Conditions** are past land use activities which may pose a problem to water quality due to their nature.

The three possible approaches to identifying drinking water threats are:

- the issues approach;
- the event-based approach; and
- the vulnerability scoring/threats-based approach.

A combination of the three approaches has been used in the MRSPR.

Land use activities have been inventoried in vulnerable areas of the MRSPR and potential significant threats have been identified.

The provincial Technical Rules provide defined parameters for identifying threats and issues. In the MRSPR, these rules have been applied utilizing the information available, and limitations and data gaps have been identified.

Sections 4.1 through 4.5 provide general information on methodology and section 4.6 discusses how the methodology has been used in the MRSPR.

The results of the processes are outlined in Chapters 5 and 6, wherein vulnerable areas are mapped and assigned scores, drinking water issues are listed, and counts of significant drinking water threats are provided. By assessing and ranking 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 water supplies for the future. Further information on these processes may be found in technical studies listed in Appendix A-1.

4.1 Delineating and Scoring Vulnerable Areas

Source protection technical work is focused on the identification and assessment of drinking water quality threats and issues affecting four different types of vulnerable areas, three of which are associated with groundwater and one with surface water.

The four types of vulnerable areas are:

- **Wellhead Protection Area (WHPA)**: A WHPA is the area surrounding a municipal well where land use activities have the potential to affect the quality of water flowing into the well. The WHPA is divided into four or more zones representing different amounts of time it takes for water to travel to the well.
- **Significant Groundwater Recharge Area (SGRA):** A SGRA is an area where a relatively large percentage of water recharges from the ground surface to an aquifer. SGRAs represent important areas for groundwater to recharge aquifers. These areas are not necessarily associated with individual aquifers, but are considered to be areas where groundwater recharge is important at a regional scale.
- **Highly Vulnerable Aquifer (HVA**): A HVA is an aquifer that, based on a number of factors, is very susceptible to contamination from the surface. The more easily water or other fluids can flow through the ground to the aquifer, the more vulnerable the aquifer is to contamination. As specified

by the Technical Rules, HVAs generally define the first, or shallowest, aquifer. This may or may not represent the aquifer being used as a municipal drinking water source.

- **Intake Protection Zone (IPZ):** An IPZ is the area of land and water mainly upstream of a drinking water surface intake where land use activities have the potential to affect the quality of water flowing into the surface water intake. The IPZ is divided into 3 zones representing the amount of time it takes for water to travel to the water intake.

Specific descriptions of how each type of vulnerable area is delineated are included in Chapter 5 for groundwater and Chapter 6 for surface water.

4.2 Drinking Water Issues

A drinking water issue is a documented problem with the quality of the source water. The following information must be considered in order to identify issues:

- Issues must be identified at an intake, well, or monitoring well;
- For drinking water systems included in the Terms of Reference, issues can be identified for water quality factors in Schedules 1, 2 or 3 of the Ontario Drinking Water Quality Standard (ODWQS) or in Table 4 of the Technical Support Document. The contaminant must be present at a concentration that may result in the deterioration of the quality of water for use as a source of drinking water or it must be shown that there is a trend of increasing concentrations of the parameter;
- For any other drinking water systems as defined under the Safe Drinking Water Act (SDWA), only chemical drinking water issues may be included (Schedules 2 and 3 of the ODWQS or Table 4 of the Technical Support Document); and
- The definition of a drinking water system under the SDWA means any system that takes water for drinking water purposes. This includes any private well or intake.

Every elevated parameter in the raw water is not necessarily considered an issue. When identifying issues, it is necessary to consult with the operators of the

system, and the municipality if they are not the operator, to determine if the raw water quality presents a problem for them. Elevated parameters are not considered to be an issue when they are known to be naturally occurring and do not present a problem for the water treatment plant operator.

For issues caused by human activities, the Assessment Report must include a plan schedule to delineate the area contributing to an issue at the water treatment plant. Additional information about issue contributing areas is included in Section 4.4.1 below.

4.3 Drinking Water Threats

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)).

Land Use Activities

Section 1.1 of Ontario Regulation 287/07, made under the *Clean Water Act* lists 21 broad land use activities as '*prescribed drinking water threats*'. The 21 prescribed drinking water threats follow. Note that 19 of the 21 relate to water quality threats and two of them relate to water quantity threats. Water quality threats identify contaminants which, if released into the source water, may affect the quality of the municipal source water at the intake or well. Water quantity threats may affect how much water is available to the municipal water intake or well through removal of water from the source or through preventing water from recharging municipal source water aquifers.

Prescribed Drinking Water Threat Category	
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.
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.

Prescribed Drinking Water Threat Category	
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.
	*DNAPLs are chemicals that are heavy and sink in water (e.g. trichloroethylene)
	**Water quantity threats are evaluated as part of Water Budget studies

Table 4-i. List of Prescribed Drinking Water Threats.

Conditions

Threats can also be identified if conditions relating to a past activity (e.g. a contaminated site) have resulted in;

- the presence of non-aqueous phase liquid in groundwater (e.g. gasoline) in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area;
- the presence of a single mass of 100 litres of one of more dense non-aqueous phase liquids in surface water in a surface water intake protection zone;
- the presence of a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or a wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table;
- the presence of a contaminant in surface soil in a surface water intake protection zone if, the contaminant is listed in Table 4 of the Soil, Ground Water and Sediment Standards and is present at a concentration that

exceeds the surface soil standard for industrial/commercial/community property use set out for the contaminant in that Table; or

- the presence of a contaminant in sediment, if the contaminant is listed in Table 1 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the sediment standard set out for the contaminant in that Table.

If a condition is identified as per above, it must be assigned a Hazard Rating (Hazard Ratings are discussed in Section 4.4.3) as follows:

- the Hazard Rating is 10 if there is evidence of off-site contamination;
- the Hazard Rating is 10 if the condition is located on a property where there is a well, intake or monitoring well related to a drinking water system; or,
- the Hazard Rating is 6 if the condition is not located on a property where there is a well, intake or monitoring well related to a drinking water system.

4.4 Approaches for Identifying Drinking Water Threats

The MOE has ranked drinking water threats as being significant, moderate, or low. There are three possible approaches to identifying drinking water threats:

- the issues approach;
- the event-based approach; and
- the vulnerability scoring/threats-based approach.

4.4.1 The Issues Approach

Once a drinking water issue is identified (see Section 4.2 above), then any activities or conditions that may be causing that issue need to be identified. This is called the issues approach to identifying drinking water threats.

The first step is to identify an “issue-contributing area” in the vicinity of the location at which the issue has been observed. The issue-contributing area may be different than the vulnerable area (IPZ or WHPA) around the drinking water system. In the second step, specific drinking water threats that could reasonably be expected to contribute to the issue are identified. All such threats are

automatically classified as significant. For each issue identified in this Assessment Report, there is a plan schedule through which issue-contributing areas and related drinking water threats will be identified in future editions of this document.

4.4.2 The Event-Based Approach

The event-based approach was designed to address threats to drinking water in systems drawing water from larger surface water bodies where the vulnerability scores are generally low. This approach is only applicable for surface water intakes in Lake Nipissing, Lake Simcoe, Lake St. Clair, and the Ottawa River. The approach uses modelling to identify existing or future activities or existing conditions as significant drinking water threats if the modelling results indicate that there would be a drinking water issue at an intake if chemicals or pathogens were released from the location under an extreme event.

4.4.3 The Vulnerability Scoring/Threats-Based Approach

In this approach, activities are compared against thousands of circumstances prescribed by the MOE.

The vulnerability scoring approach relies upon the extensive *Tables of Drinking Water Threats* (MOE, 2008a), referred to as Threats Tables, that were created to identify and rank drinking water threats. A variety of circumstances are outlined in the Threats Tables for each of the 21 prescribed drinking water threats, 19 related to water quality and two to water quantity. The Threats Tables were created to provide a consistent approach to similar situations across Ontario.

The Threats Tables provide the list of circumstances where provincially prescribed activities are drinking water threats. These Threats Tables can be used to identify circumstances where activities are significant, moderate, or low drinking water threats and to identify areas where activities are significant, moderate, or low drinking water threats. To determine these circumstances and areas, it is necessary to understand how the Threats Tables were set up.

The Threats Tables link the hazard rating of an activity under a specific circumstance and for a specific source of water, and the vulnerability scores needed to make the activity/circumstance a significant, moderate, or low drinking water threat.

The risk score is determined through the use of the following equation;

R = V x HR

Where;

R is the Risk Score

V is Vulnerability of the source water (scale of 1 to 10)

HR is the Hazard Rating of the threat (scale of 1 to 10)

The risk score range is between 1 and 100. As shown, MOE has assigned the following ranges and associated drinking water threat classifications.

Risk Score Range	***Drinking Water Threat Classification***
80-100	*Significant*
60-<80	*Moderate*
>40 and <60	*Low*

Table 4-ii. Drinking Water Threat Classification.

*Note: Risk Scores below 40 are considered negligible and do not require further consideration.

The hazard ratings are not provided in the Threats Tables, but are available within the lookup table database that generated the Threats Tables. The chemical hazard ratings are determined by considering factors such as toxicity, environmental fate, quantity and method of release. The lookup table database has been provided to the MRSPR and is available upon request.

The vulnerability scores are calculated by taking the hazard rating for each activity and back calculating the vulnerability scores necessary for the activity to fall into the risk score ranges shown above.

The Threats 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 identified into activities that could produce specific chemicals (such as arsenic or zinc), and have over 1,900 unique combinations of circumstances. The pathogen-based circumstances include the presence of any pathogen and have approximately 30 unique combinations of

circumstances. It should be noted that the presence of DNAPLs are considered significant threats if they occur anywhere within the five year Time of Travel (ToT).

The Threats Tables have been modified into summary tables for each type of vulnerable area and possible vulnerability score. The summary tables are provided via the following web link; http://www.ene.gov.on.ca/en/water/cleanwater/provincialTables.php.

The summary tables provide the required documentation of lists of potential circumstances that address the terminology “is or would be a significant, moderate or low drinking water threat”. The summary tables have been organized by the MOE into 76 different tables, as presented in Table 4-2. These tables are organized into sections for chemical, pathogen, or DNAPL contamination which occurs in the sensitive areas (HVA, SGRA, or WHPA). Table 4-1 provides a classification of possible drinking water threats and can assist with which of the 76 different tables to look at based on a number of criteria. The tables are used after the vulnerability score is determined, through referencing vulnerability score maps which have been developed for a site or area.

A drinking water threat can be identified by the Source Protection Committee even if the activity is not included in the provincial list of 19 prescribed drinking water quality threats. This can only occur if a hazard assessment confirms that the activity is a threat, and this assessment is approved by the MOE.

Any conditions resulting from a past activity and listed as drinking water threats can be classified as significant, moderate or low in the following areas.

Hazard Rating for Condition	Area with Vulnerability Score	Drinking Water Threat Classification
10	> or = 8	Significant
	> or = 6 and < 8	Moderate
	> or = 4 and <6	Low
6	10	Moderate
	> or = 6.7 and <10	Low

Table 4-iii. Hazard Ratings, Vulnerability Scores, and Threat Classifications.

4.5 Enumerating Drinking Water Threats

The minimum requirement for the preparation of this Assessment Report is the counting of the potential significant drinking water threats within intake protection zones and wellhead protection areas, using best available information.

Table 4-3 shows which of the 21 prescribed drinking water threats have circumstances that pose a significant threat within an intake protection zone for each vulnerability score. The table shows that the majority of threats must occur in areas with a vulnerability score of 9 or 10 to be classed as significant. Only two can be significant in areas with a vulnerability score of 8.

Table 4-4 indicates which of the 21 prescribed drinking water threats has one or more circumstances that pose a significant threat within a wellhead protection area for each vulnerability score. The table shows that the majority of threats must occur in areas with a vulnerability score of 10 to be classed as significant; only three can be significant in areas with a vulnerability score of 8.

According to the Technical Rules, all highly vulnerable aquifers (HVA) and significant groundwater recharge areas (SGRA), outside of a WHPA and IPZ, have a vulnerability score of 6 or lower. Land use activities in these areas are categorized as low or moderate threats in the provincial threats tables. No activities can score (or be labelled) as significant threats within an HVA or SGRA.

4.6 Application of Provincial Threats and Issues Methodology in the Mississippi-Rideau Source Protection Region

This section provides information on how issues and potential threats have been identified in the MRSPR.

4.6.1 Issues

In the MRSPR, issues have been evaluated for the source water in each of the four vulnerable areas. The issues for each drinking water system were compiled based on the Mississippi-Rideau Watershed Characterization Report, the Annual Reports for each water-distribution system, the Engineer's Reports, raw water quality analyses and interviews with operators and managers. All data is compared against ODWS. Where there is sufficient data, the data is plotted, analyzed for trends and compared against ODWS as required in the Technical Rules.

The issues assessment was done for non-municipal drinking water sources as well as municipal drinking water sources. Non-municipal drinking water issues refer to issues that are associated with a private drinking water system (e.g., a

private well) and the results are presented in Section 5.1.5 under Highly Vulnerable Aquifers.

Uncertainty

The drinking water issues work is considered to have low uncertainty.

4.6.2 Threats

Land Use Activity Inventory

An inventory of conditions and land use activities was completed within the vulnerable areas in the MRSPR. The inventory was only required within wellhead protection areas and intake protection zones where vulnerability scores are high enough to pose significant threats, not significant groundwater recharge areas or highly vulnerable aquifers. The inventory was completed via existing data review, windshield survey, general research, and agricultural assessment.

The land use inventory is based entirely on a review of publicly-available information and field reconnaissance work completed from public right-of-ways. The limitations to this approach are that some activities may be taking place that were not inventoried, or an activity may be categorized as a threat because the specific circumstance (volume of a contaminant, method of storage, etc) is currently unknown. Since no specific site verification has been conducted, it is important to note that the current inventory identifies locations where potential significant threats to water quality exist.

The land use inventory included:

- Use of provincial database containing a list of standard land use activity names for categorizing activities;
- Collection and review of existing data (e.g., municipal and provincial records, air photographs);
- Windshield survey or visual inventory, taken from public right-of-ways; and
- Agricultural assessment to identify potential agricultural land uses that may involve the handling and/or storage of chemicals of concern. This was done primarily by air photo interpretation and windshield survey.

During the land use inventory point locations of activities such as gasoline storage are identified and coordinates mapped as a point. Other activities such as sanitary sewer lines are identified as a line. Where a line crosses from one

WHPA to another (i.e. from a Zone A to a Zone B) the line is considered to be two threats, one in each zone.

Activities which cover a larger area such as the application of agricultural materials on a field are identified as a polygon. A polygon is also used to group areas such as dense residential areas where there are likely a large number of septic systems. Therefore, it should be noted that, under certain circumstances, polygons may actually represent numerous potential threats but have been enumerated as one due to the lack of availability of specific data.

For groundwater threats assessments in areas with a vulnerability score of 10, there was a requirement to identify which buildings store heating/furnace oil fuel. In the absence of public records that show how buildings are heated (e.g., fuel oil, natural gas, electric, etc.), it had to be assumed that all buildings store heating/furnace oil fuel. These landowners were provided the opportunity to correct this assumption by responding to a questionnaire sent out on October 8, 2010 or to contact MRSPR staff.

Threats Assessment

At this stage, each inventoried land use activity in the wellhead protection areas and intake protection zones was compared against the Threats Tables. Not all inventoried activities appear in the tables. Activities which matched were assigned their associated threat risk level.

In order to complete the threats assessment, some general assumptions were made to complete the enumeration of certain prescribed activities and circumstances. These assumptions were made according to local knowledge and professional judgement. In some cases, the assumptions will be refined at a later date, when site visits and contact with property owners occurs.

Conditions

In the MRSPR, the review of the MOE data provided indicated very few activities or conditions that had not already been identified through other exercises. The reporting requirements for spills and other contamination is well legislated and regulated, with some exceptions, and as a result there are many sources for identifying even minor spills and leaks. However, the ensuing clean-up activities are not required to be as equally well documented. Therefore, the information on the current status of these potential conditions is not available.

It is important to note that it is possible that other circumstances exist in the vulnerable areas that cannot be identified through this exercise based on the limitations of the data available. If a spill or other contamination has not been

reported through proper channels there is no way for this process to identify the condition.

Uncertainty

For the reasons stated above, the drinking water threats work undertaken is considered to have high uncertainty.

4.7 References

Conservation Ontario. November 2007. Wellhead Protection Areas.

Conservation Ontario. November 2007. Intake Protection Zones.

Ontario Ministry of the Environment. February 2010. Technical Bulletin: Threats Assessment and Issues Evaluation.

Ontario Ministry of the Environment. November 2009. Table of Drinking Water Threats, *Clean Water Act, 2006*, amended November 16, 2009.