Nova Scotia Treatment Standards for Municipal Drinking Water Systems

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- Treatment Standard for Municipal Surface Source Water Treatment Facilities, December 2002
- Treatment Standard for Municipal Groundwater Source Water Facilities, May 2003
- Guidelines for the Determination of Natural Filtration Log Removal Credit for Giardia, January 20, 2006
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PART I - INTRODUCTION

1.0 Preamble

1.1 Purpose

The purpose of this document is to set out the minimum requirements that apply to municipal drinking water systems in Nova Scotia.

It is considered unacceptable for systems capable of exceeding this standard to allow their water quality to degrade in quality to only meet the minimum requirements.

1.2 Authority

Nova Scotia Environment (NSE) has been designated as the lead agency to take such measures as are reasonable to provide access to safe, adequate and reliable municipal drinking water supplies (Environment Act, Section 104(c)). To carry out this mandate, Section 105(3)(c) of the Environment Act states:

(3) The Minister may

(c) establish or adopt water-quality guidelines, objectives and standards;

In addition, Section 35 of the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations, made pursuant to the Environment Act, requires that an owner of a public drinking water supply provide safe drinking water that meets the latest version of the Guidelines for Canadian Drinking Water Quality (GCDWQ) as published by Health Canada. As the GCDWQ specify treatment goals for protection against pathogenic organisms, such as protozoa and viruses, these treatment standards specify minimum requirements for Nova Scotia.

1.3 Background

The first Nova Scotia drinking water treatment standards were developed in the Fall of 2002 and finalized in early 2003. Since 2003, there have been a number of changes recommended by Health Canada. Health Canada recommends that treatment for surface water and groundwater under the direct influence of surface water (GUDI) be based on a minimum 3-log reduction of Cryptosporidium and Giardia and 4-log reduction for viruses unless source water quality requires a higher log reduction; for groundwater not under the direct influence of surface water (non-GUDI), Health Canada recommends that treatment be based on a minimum 4-log reduction for viruses.
Cryptosporidium cannot be inactivated with chlorine whereas a minimum of 0.5-log reduction can be achieved for Giardia. The first Nova Scotia treatment standards for surface water and GUDI sources only referenced Giardia. Minimum treatment requirements for both Cryptosporidium and Giardia for surface water and GUDI sources are now included in Nova Scotia’s updated treatment standards. The treatment standards for non-GUDI sources in Nova Scotia remains unchanged at 4-log reduction for viruses.

Historically, municipal drinking water systems in Nova Scotia have used chlorine for primary and secondary disinfection. A number of alternate primary disinfectants, such as ultraviolet (UV) light, chlorine dioxide and ozone, and alternate secondary disinfectants, such as chloramines, are now included in Nova Scotia’s updated treatment standards.

Additionally, the use of membrane technology has become common in recent years. Nova Scotia’s updated treatment standards set out minimum requirements for the use of membrane technology, as well as the management of waste streams for all filtration technologies.

1.4 Application

These standards apply to municipal drinking water systems in Nova Scotia that utilize any of the following water sources:

- surface water - means water that is found in lakes, rivers, streams, ponds, surface water impoundments and other natural watercourses.

- groundwater under the direct influence of surface water or “GUDI” - means any water beneath the surface of the ground with:
  
  i) significant occurrence of insects or other macro-organisms, algae, organic debris, or large-diameter pathogens such as Giardia lamblia or Cryptosporidium; or
  
  ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

- non-GUDI - means a well that has been classified as not under the direct influence of surface water (i.e. non-GUDI) based on the Protocol for Determining Groundwater Under the Direct Influence of Surface Water and has been accepted as such in writing by the NSE regional hydrogeologist.

Municipal water utilities that purchase treated water from an adjoining system shall obtain water from a municipal drinking water system that complies with Nova Scotia’s Treatment Standards.
1.5 Document Layout

These treatment standards are structured into five parts. Part I provides an overview and compliance timelines. Parts II, III and IV detail the minimum requirements of the treatment standard components that apply to municipal drinking water systems. Part V includes a glossary and references. Technical appendices are also attached where necessary.

2.0 Treatment Standard Components

The components of these treatment standards are based on the universally accepted multiple-barrier approach to drinking water management, namely:

- **Source Water Protection**: Minimum requirements are described in Part II.
- **Adequate Treatment and Distribution**: Minimum requirements are described in Part III.
- **Operations, Monitoring, Reporting and Management**: Minimum requirements are described in Part IV.

2.1 System Assessment Report

A system assessment report includes the following components to verify that the system meets current environmental standards for producing and distributing safe drinking water:

- a characterization of the water source;
- an evaluation of treatment processes, facilities and equipment;
- an evaluation of the distribution system;
- a review of operations, maintenance, monitoring and management of the municipal drinking water system.

Environmental standards are frequently updated and enhanced. A municipal drinking water system shall be assessed at least every ten years, or sooner if required, to:

- evaluate the capability of the system to consistently and reliably deliver an adequate quantity of safe drinking water;
- to verify compliance with regulatory requirements, as amended from time to time;
- present options and costs to address deficiencies.

A system assessment may be required sooner than every ten years if there are significant land use or environmental changes in the source water area or in response to a serious adverse water quality event.
The System Assessment Report shall be completed in accordance with Terms of Reference published by NSE, as amended from time to time. The System Assessment Report shall be acceptable to NSE.

2.2 **Protocol for Determining Groundwater Under the Direct Influence of Surface Water**

Municipal water utilities with groundwater supplies shall ensure that all wells in their system have been classified in accordance with the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* as outlined in Appendix A (GUDI Protocol). The completion of the GUDI Protocol and classification of wells, shall be acceptable to the NSE regional hydrogeologist. Classification is required for all wells that were not classified under the previous treatment standards. Re-classification of wells may be required if there are changes to the well construction or well setting that could cause significant changes to groundwater and surface water interaction. Well setting changes that would trigger the need for re-classification are those that involve surface water bodies, such as the installation of a new ditch or dugout within 60 metres of the well.

Wells that are classified “GUDI - High Risk” shall require engineered filtration and disinfection to meet Nova Scotia’s Treatment Standards.

Wells that are classified as “GUDI - Medium Risk” may be eligible to receive credit for natural in-situ attenuation provided the *Guidelines for the Determination of Natural Filtration Log Removal Credit for Protozoa* are followed as outlined in Appendix B and the NSE regional hydrogeologist accepts the determination in writing. In this case, natural attenuation plus UV disinfection may be utilized to address protozoan risks while chlorine is utilized to address viral risks as outlined in Part III. Minimum requirements for the use of UV disinfection are specified in Appendix C.

Municipal drinking water supplies with wells that have been classified as “GUDI - Medium Risk” shall also:

- continuously monitor turbidity at each individual GUDI wellhead at a point prior to disinfection;
- conduct Microscopic Particulate Analysis (MPA) testing every two years for each individual GUDI well, in spring following a rainfall. Any MPA testing shall be completed in accordance with Step 3 of the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* as outlined in Appendix A (e.g. if there is a 15 day time-of-travel, then the well shall be sampled 15 days after a surface water event).
If the classification of any medium risk GUDI well increases to high, NSE shall be immediately notified and the municipal water utility shall take any necessary corrective action.

If MPA results change from medium to low, the municipal water utility may request NSE reclassify the well. In evaluating this request, the NSE regional hydrogeologist will consider the site-specific hydrology, well construction and any changes that have occurred since the well was originally classified. The NSE regional hydrogeologist may require two or more additional MPA samples to confirm the new classification. Any MPA testing shall be completed in accordance with Step 3 of the Protocol for Determining Groundwater Under the Direct Influence of Surface Water as outlined in Appendix A.

Wells that are classified as low risk are deemed to be non-GUDI unless advised otherwise by the NSE regional hydrogeologist.

2.3 Compliance Timelines

2.3.1 Existing Municipal Drinking Water Systems

The timelines for meeting these treatment standards shall be as follows:

- On or before April 1, 2013 - the municipal water utility shall submit three copies of the completed System Assessment Report to the local office of NSE.

- On or before October 1, 2013 - the municipal water utility shall submit a corrective action plan to the local office of NSE to address deficiencies identified by the System Assessment Report.

The purpose of the System Assessment Report is to verify that municipal drinking water systems meet current environmental standards, including the minimum requirements set out by these treatment standards. The purpose of the corrective action plan is to outline the implementation schedule that will be followed to address all deficiencies identified by the System Assessment Report. The corrective action plan shall be acceptable to NSE.

It is the municipal water utility's responsibility to ensure that funding is in place to complete the System Assessment Report process and implement any required corrective action.

2.3.2 Drinking Water Systems Acquired by a Municipality

Drinking water systems transferred to, or purchased by, a municipality shall be given site-specific time frames to meet the treatment standards based on the complexity of the transferred/purchased system.
2.3.3. Newly Constructed Municipal Drinking Water Systems

All new municipal drinking water systems shall be designed and constructed to meet the minimum requirements set out by these treatment standards upon commissioning. NSE has also adopted the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems*. These treatment standards and the *Atlantic Canada Guidelines* establish the minimum requirements for all new municipal drinking water systems in Nova Scotia. If there is a discrepancy between the treatment standards and the *Atlantic Canada Guidelines*, the more stringent shall apply.

For new groundwater wells, a minimum of one raw water bacteria sample shall be collected to assess the water quality screening criteria in Step 1 of the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* (see Appendix A); the sample shall be collected at the end of the 72-hour pumping test, as specified in the Guide to Groundwater Withdrawal Approvals. If a new well will fail Step 1 because bacteria was detected in a single sample, additional sampling shall be carried out to confirm whether or not bacteria is regularly present. A minimum of four additional samples shall be collected, one per month, as outlined in Section A.2.1 of Appendix A. If any of these additional samples contain bacteria the well shall fail Step 1, unless subsequent corrective action and sampling demonstrate the well does not regularly contain bacteria.

For new groundwater wells that fail Step 1 of the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* as outlined in Appendix A, the following shall apply:

- The well may be connected to the distribution system to allow the completion of Steps 2 and 3 of the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* as outlined in Appendix A.

- Step 2 shall be completed under proposed “normal operating conditions” (e.g. proposed flow rate, well on/off cycling, etc.) for 52 weeks of operation in accordance with the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* as outlined in Appendix A.

- Step 3 shall be completed in accordance with the *Protocol for Determining Groundwater Under the Direct Influence of Surface Water* as outlined in Appendix A.

During the completion of the GUDI Protocol, the well shall be equipped with a disinfection system capable of achieving 4-log reduction for viruses with the provisions outlined in Section 4.5.2.
NSE may require twice weekly bacteria sampling and the maintenance of a 0.4 mg/L free chlorine residual during the completion of the GUDI Protocol. NSE may require the installation of UV disinfection during the completion of the GUDI Protocol.

Wells classified as GUDI shall be required to meet 3-log reduction for protozoa (e.g. Cryptosporidium oocysts and Giardia cysts) and a minimum of 4-log reduction for viruses as outlined in Section 4.1.1(b) of these treatment standards.

Wells classified as non-GUDI shall be required to meet a minimum of 4-log reduction for viruses as outlined in Section 4.1.1(c) of these treatment standards.
PART II - SOURCE WATER PROTECTION

3.0 Overview

Choosing the highest quality source, whether surface water or groundwater, is an important part of delivering a sustainable supply of high quality drinking water. Effective water treatment begins with source water protection to minimize the input of fecal contamination from human and animal sources, and chemical contamination from human activities. Source water protection is the first barrier in the multiple-barrier approach used in Nova Scotia.

3.1 Minimum Requirements

Municipal water utilities are responsible for taking reasonable steps to protect the source from contamination. Minimum requirements for source water protection include:

- A source water protection plan (SWPP) shall be developed by the municipal water utility responsible for the source. The SWPP should be developed using the five guidance documents published by NSE:
  - Step 1 - Form a Source Water Protection Advisory Committee
  - Step 2 - Delineation a Source Water Protection Area Boundary
  - Step 3 - Identify Potential Contaminants and Assess Risk
  - Step 4 - Develop a Source Water Protection Management Plan
  - Step 5 - Develop a Monitoring Program to Evaluate the Effectiveness of a Source Water Protection Plan

- The municipal water utility should complete the risk identification process depending on the source type as follows:
  - surface water - within the natural watershed boundary;
  - groundwater under the direct influence of surface water (GUDI) - within the natural watershed boundary's and the 25-year time-of-travel;
  - non-GUDI - within the 25-year time-of-travel.

Municipal water utilities with large natural watershed boundaries may focus their management strategies on high risk activities and activities close to the intake. They may also consider a graduated risk management approach based on distance from the intake. Examples of high risk activities include: wastewater discharges, agricultural uses, residential development, chemical plants, etc.
The municipal water utility shall submit the SWPP in written and electronic format to the local office of NSE. The SWPP shall be acceptable to NSE.

The municipal water utility shall develop a schedule to implement the SWPP. The schedule shall outline the tasks (short-, medium-, and long-term) for implementing the recommended risk management strategies and monitoring program. The implementation plan shall be acceptable to NSE.

The municipal water utility shall review the SWPP and implementation plan annually. The municipal water utility shall summarize the results of the annual review, using the checklist published by NSE, in the utility's annual report.

Municipal water utilities shall have regard for source-specific issues that may warrant additional review when evaluating risks. Additional monitoring may be required to make science-based decisions.
PART III - ADEQUATE TREATMENT AND DISTRIBUTION

4.0 Overview

The second barrier in the multiple barrier approach used in Nova Scotia involves making water safe by having adequate treatment in place to remove natural or man-made contaminants and maintaining a high-quality distribution system. This is achieved by determining what contaminants are present in the water supply and installing adequate treatment methods to remove the contaminants, including disinfection to inactivate microorganisms. A high-quality distribution system is reliable, providing a continuous supply of potable water at adequate pressure.

NSE has also adopted the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems*. These guidelines, and any additional technical details provided in Section 4.5 or Appendix C, shall be followed to standardize the design, approval, construction and operation of municipal drinking water systems in Nova Scotia. If there is a discrepancy between the treatment standards and the *Atlantic Canada Guidelines*, the more stringent shall apply.

4.1 Protection Against Pathogenic Organisms

Protozoa and viruses can be responsible for severe, and in some cases, fatal gastro-intestinal illnesses. The goal of treatment is to reduce the presence of disease-causing organisms and associated health risks to an acceptable or safe level (Health Canada, 2004).

Log reduction is a measure of the decrease of pathogenic organisms after treatment process. For example:

- 3-log reduction for protozoa means a 99.9% reduction in protozoa levels;
- 4-log reduction for viruses means a 99.99% reduction in virus levels.

Log reduction may comprise two components:

- “log removal” by physical treatment - well operated filtration technology is assigned a “removal credit” towards reducing protozoa and virus levels as described in Section 4.1.2;
- “log inactivation” by disinfection - protozoa and virus inactivation levels are calculated using the disinfection concepts described in Section 4.1.3.
4.1.1 Minimum Treatment Requirements

The municipal water utility shall ensure that the level of treatment provided to remove or inactivate pathogenic organisms is commensurate with the source type as outlined in the following sections.

a) Surface Water

For surface water sources, overall treatment requirements shall meet a minimum of 3-log reduction for protozoa (e.g. Cryptosporidium oocysts and Giardia cysts) and a minimum of 4-log reduction for viruses.

Surface water treatment requirements shall be met by a combination of engineered filtration and disinfection. Filtration shall be assigned treatment credits as described in Section 4.1.2. Disinfection shall provide a minimum of 0.5-log inactivation for Giardia. Where UV light is used for primary disinfection, chemical disinfection shall be required to meet log inactivation criteria for viruses as described in Section 4.1.3.

b) Groundwater Under the Direct Influence of Surface Water (GUDI)

For GUDI sources, as classified by the Protocol for Determining Groundwater Under the Direct Influence of Surface Water (see Appendix A) and accepted as such in writing by the NSE regional hydrogeologist, overall treatment requirements shall meet a minimum of 3-log reduction for protozoa (e.g. Cryptosporidium oocysts and Giardia cysts) and 4-log reduction for viruses.

High risk GUDI treatment requirements shall be met by a combination of engineered filtration and disinfection. Filtration shall be assigned treatment credits as described in Section 4.1.2. Disinfection shall provide a minimum 0.5-log inactivation for Giardia. Where UV light is used for primary disinfection, chemical disinfection shall be required to meet log inactivation criteria for viruses as described in Section 4.1.3.

Medium risk GUDI treatment requirements shall be met by a combination of filtration and disinfection. Filtration may be via natural in-situ attenuation if the Guidelines for the Determination of Natural Filtration Log Removal Credit for Protozoa are followed (see Appendix B) and the NSE regional hydrogeologist accepts the determination in writing. In this case, UV disinfection shall be required to meet the remaining log reduction requirements for protozoa and chemical disinfection shall be required to meet log inactivation criteria for viruses as described in Section 4.1.3.
c) Non-GUDI

For non-GUDI sources, as classified by the Protocol for Determining Groundwater Under the Direct Influence of Surface Water (see Appendix A) and accepted as such in writing by the NSE regional hydrogeologist, overall treatment requirements shall meet a minimum of 4-log reduction for viruses; treatment requirements shall be met by disinfection.

For water entering a distribution system from a non-GUDI source, or the combined flow, turbidity levels shall not exceed 1.0 NTU:

- In at least 95% of the measurements by grab sampling for each calendar month (minimum frequency of one per day or more frequently if stated in the facility Approval to Operate);

- In at least 95% of the measurements made or 95% of the time each calendar month if continuous monitoring is the method of turbidity measurement.

For systems experiencing elevated turbidity measurements related to well pump start-up, such as with air bubble formation, continuous monitoring recording may be delayed for up to 4 minutes, 59 seconds. However, it is recommended that all turbidity data be captured for trending purposes.

For groundwater supplies that exceed 1.0 NTU for water entering a distribution system, a maximum of 5.0 NTU may be permitted if the owner demonstrates that the turbidity is non-health related and that the disinfection process is not compromised by the use of this less stringent value.

4.1.2 Treatment Credits for Filtration (Log Removal)

Drinking water treatment technologies meeting the turbidity limits specified in Table 1 can apply the noted removal credits for Cryptosporidium, Giardia and viruses.

Facilities that believe they can achieve a higher log credit than is automatically given, can be granted a log removal credit based on a demonstration of performance. For example, facilities with conventional or direct filtration that achieve 0.15 NTU 95% of the time each calendar month in combined filter effluent are eligible to receive an additional 0.5-log removal credit for protozoa. Facilities with conventional or direct filtration that achieve 0.15 NTU 95% of the time each calendar month in individual filter effluent are eligible to receive an additional 1.0-log removal credit for protozoa.
<table>
<thead>
<tr>
<th>Treatment Technology</th>
<th>Protozoa Credit</th>
<th>Virus Credit</th>
<th>Individual Filter Turbidity Limit (unless noted otherwise)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cryptosporidium</td>
<td>Giardia</td>
<td></td>
</tr>
<tr>
<td>Conventional filtration - includes chemical mixing, coagulation, flocculation, clarification and rapid gravity filtration</td>
<td>3.0-log</td>
<td>3.0-log</td>
<td>2.0-log</td>
</tr>
<tr>
<td>Direct filtration - includes chemical mixing, coagulation, flocculation, and rapid gravity filtration</td>
<td>2.5-log</td>
<td>2.5-log</td>
<td>1.0-log</td>
</tr>
<tr>
<td>Slow sand filtration</td>
<td>3.0-log</td>
<td>3.0-log</td>
<td>2.0-log</td>
</tr>
<tr>
<td>Diatomaceous earth filtration</td>
<td>3.0-log</td>
<td>3.0-log</td>
<td>1.0-log</td>
</tr>
<tr>
<td>Micro-filtration</td>
<td>Demonstration and challenge testing</td>
<td>No credit</td>
<td></td>
</tr>
</tbody>
</table>

- **Shall be less than or equal to 0.2 NTU** in at least 95% of the measurements made or at least 95% of the time each calendar month.
- **Shall not exceed 1.0 NTU** at any time.
- **Filter-to-waste until below 0.2 NTU** - filters shall be capable of directing filtered water to waste immediately following a backwash for a period of time until the filtrate turbidity value is below 0.2 NTU.

- **Shall be less than or equal to 1.0 NTU** in at least 95% of the measurements made or at least 95% of the time each calendar month.
- **Shall not exceed 3.0 NTU** at any time.
- **Filter-to-waste** - a filter-to-waste feature shall be provided so that filtered water immediately after filter cleaning is directed into a waste stream.

- **Shall be less than or equal to 1.0 NTU** in at least 95% of the measurements made or at least 95% of the time each calendar month.
- **Shall not exceed 3.0 NTU** at any time.
- **Filter-to-waste** - a filter-to-waste feature shall be provided so that filtered water immediately after filter backwashing is directed into a waste stream.

- **Shall be less than or equal to 0.1 NTU** in at least 99% of the measurements made or at least 99% of the time each calendar month.
- **If turbidity exceeds 0.1 NTU for more than 15 minutes**, direct integrity testing shall be immediately conducted on the membrane treatment unit.
- **Shall not exceed 0.3 NTU** at any time.
- **Filter-to-waste** - a filter-to-waste feature shall be provided for operational flexibility.

Originating Division: Environmental Science and Program Management Division
Scope: Standard under the Environment Act
Nova Scotia Environment
<table>
<thead>
<tr>
<th>Treatment Technology</th>
<th>Protozoa Credit</th>
<th>Virus Credit</th>
<th>Individual Filter Turbidity Limit (unless noted otherwise)</th>
</tr>
</thead>
</table>
|                                           | Crypto-sporidium¹ | Giardia¹   | Removal efficiency demonstrated through challenge testing and verified by direct integrity testing | • Shall be less than or equal to 0.1 NTU in at least 99% of the measurements made or at least 99% of the time each calendar month.  
• If turbidity exceeds 0.1 NTU for more than 15 minutes, direct integrity testing shall be immediately conducted on the membrane treatment unit.  
• Shall not exceed 0.3 NTU at any time.  
• Filter-to-waste - a filter-to-waste feature shall be provided for operational flexibility. |
| Ultra-filtration⁴                         | Demonstration and challenge testing⁵ |                        |  |
| Reverse osmosis and nanofiltration        | No credit until direct integrity testing is available | No credit until direct integrity testing is available | • Shall be less than or equal to 0.1 NTU in at least 99% of the measurements made or at least 99% of the time each calendar month.  
• Shall not exceed 0.3 NTU at any time.  
• Filter-to-waste - a filter-to-waste feature shall be provided for operational flexibility. |
| Natural In-situ Attenuation for Medium Risk GUDI Sources | 1.0-log⁷ | No credit | • Shall be less than or equal to 1.0 NTU in at least 95% of the measurements made or at least 95% of the time each calendar month at each individual GUDI wellhead.  
• Continuous turbidity monitoring - required at each individual GUDI wellhead.  
• Microscopic Particulate Analysis - MPA testing is required every two years for each individual GUDI well, in spring following a rainfall.²⁸ |

Notes:
1. Disinfection shall provide a minimum 0.5-log inactivation for Giardia unless a higher log inactivation credit is required. Where disinfection is used to address any shortfall in the log reduction requirements for Cryptosporidium, an alternate disinfectant such as UV, chlorine dioxide or ozone shall be required.
2. Facilities with conventional or direct filtration that achieve 0.15 NTU 95% of the time each calendar month in combined or individual filter effluent are eligible to receive additional log removal credits for protozoa to meet minimum treatment requirements as follows: combined 0.5-log; individual 1.0-log.
3. Alternatives that demonstrate an equivalent benefit to filter-to-waste may be considered by NSE on a case-by-case basis for existing facilities. All new facilities shall include a filter-to-waste provision.
4. If membrane filtration is the sole treatment technology employed, disinfection shall follow the filtration process to meet virus inactivation requirements.
5. Membrane removal efficiency shall be demonstrated through challenge testing and verified by direct integrity testing. See Appendix C for additional information on membrane filtration.
6. If the unit passes direct integrity testing, it may continue to be used for water treatment, if not, the unit shall be taken out of service.
7. A natural in-situ attenuation log credit may be assigned if the Guidelines for the Determination of Natural Filtration Log Removal for Protozoa are followed (see Appendix B) and the NSE regional hydrogeologist accepts the determination in writing.
8. MPA testing shall be completed in accordance with Step 3 of the Protocol for Determining Groundwater Under the Direct Influence of Surface Water as outlined in Appendix A (e.g. if there is a 15 day time-of-travel, then the well shall be sampled 15 days after a surface water event).
For facilities that do not meet the individual filter effluent turbidity limits, the municipal water utility shall submit a corrective action plan outlining how they intend to meet the turbidity limits. The corrective plan shall be acceptable to NSE.

Filtration processes shall be approved and meet industry accepted standards. In particular, filtration processes for pathogen reduction are required to be continuously monitored, and have a shut off feature and alarm when turbidity criteria are not achieved. Other considerations are outlined in Section 4.5.1.

Wells classified as non-GUDI do not require treatment for protozoa because they are not under the direct influence of surface water; disinfection shall provide 4-log inactivation for viruses.

4.1.3 Disinfection Credits (Log Inactivation)

Disinfection is responsible for inactivating any microbial pathogens that pass through previous unit processes. Disinfection shall provide any remaining log reduction credits necessary to meet the minimum treatment requirements specified in Section 4.1.1. To determine the log inactivation portion that is necessary by disinfection involves a number of steps as follows:

- confirm the log reduction requirements (see Section 4.1.1);

- find the filtration log removal credits appropriate for the filtration system(s) employed (see Table 1 - for surface water and GUDI sources) and subtract this from the requirements specified in Section 4.1.1;

- determine if any additional filtration credits are available from enhanced performance (if applicable) and subtract this from the reminder above;

- the result is the log inactivation portion that shall be met by disinfection credits.

**Note:** For surface water and high risk GUDI sources with engineered filtration, a minimum of 0.5-log inactivation for *Giardia* is to be provided by disinfection credits.

Where disinfection is used to address any shortfall in the log reduction requirements for *Cryptosporidium*, an alternate disinfectant such as UV, chlorine dioxide or ozone shall be required. Where UV disinfection is used to inactivate protozoa, chemical disinfection shall be required to meet log inactivation requirements for viruses.
a)  **CT Concept for Chemical Disinfection**

Chemical disinfectants include free chlorine, chlorine dioxide and ozone. Due to the poor disinfecting capability of chloramines, they shall not be accepted as a primary disinfectant.

In order to demonstrate that required disinfection credits are achieved, these treatment standards use the concept of the disinfection concentration (C) multiplied by the time that 10 percent of the water is in contact with the disinfectant (T\textsubscript{10}). T\textsubscript{10} is calculated by multiplying the theoretical hydraulic detention time (e.g. tank volume divided by flow rate) by the baffling factor of the contact chamber. T\textsubscript{10} may also be established by trace studies.

This calculated value (i.e. CT\textsubscript{achieved}) is referenced to log inactivation tables for Cryptosporidium, Giardia and/or viruses first published by the US EPA (i.e. CT\textsubscript{required}). CT\textsubscript{required} can also be calculated from equation (for Giardia only) as outlined in Appendix D.

CT tables for free chlorine, chlorine dioxide, and ozone are included in Appendix D. The science-based impacts of pH and temperature on the effectiveness of some disinfectants have been taken into account where applicable.

To determine if a system meets the log inactivation requirements, the ratio of the calculated value (CT\textsubscript{achieved}) to the table value (CT\textsubscript{required}) must be equal to or greater than one. The CT calculation is based on the following equation:

**Formula:** \[ CT = \text{Concentration (mg/L)} \times \text{Time (minutes)} \times \text{Baffling Factor} \]

Baffling factors are provided in Table 2. Examples of baffling factors to use for sample contact chamber designs are included in Appendix E. The baffling factor shall be acceptable to NSE.

Typically, to ensure that different parameters and their effect on the disinfection process are addressed, design ranges are set for worst case scenarios that affect the primary disinfectant used for CT. For free chlorine, worst case design ranges typically include the following:

- Lowest temperature of the water to be disinfected.
- Highest pH value of the water to be disinfected with chlorine.
- Lowest chlorine residual found at the outlet of the designated chlorine contact volume.
- Minimum contact time (typically occurs under highest flow conditions).
For systems that include the volume in clearwell or on site storage tank for CT determination, the calculation shall be made based on the minimum operating level in the tank. The highest flow condition shall also be confirmed (e.g. inflow or outflow).

**Note:** Distribution system storage is not eligible for CT credits.

Sample CT calculations are provided in Appendix F for various sources and treatment technologies.

Where free chlorine is used, it is recommended that municipal water utilities minimize the formation of disinfection by-products. However, this should be done in consideration of operational requirements (e.g. water quality and quantity, distribution system residual, etc.) and without compromising the effectiveness of disinfection.

Disinfection processes shall be approved and meet industry accepted standards. In particular, disinfection processes are required to be continuously monitored, and have a shut off feature and alarm when the equipment malfunctions as outlined in Section 4.5.2. Other considerations are outlined in Section 4.5.2.

### Table 2 - Baffling Factors

<table>
<thead>
<tr>
<th>Baffling Condition</th>
<th>Baffling Factor</th>
<th>Baffling Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unbaffled (mixed flow)</td>
<td>0.1</td>
<td>• Agitated basin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Very low length-to-width ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High inlet and outlet flow velocities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High potential for stagnant zones and short-circuiting</td>
</tr>
<tr>
<td>Poor</td>
<td>0.3</td>
<td>• Single or multiple unbaffled inlets and outlets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No intra-basin baffles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Potential for stagnant zones or short-circuiting</td>
</tr>
<tr>
<td>Average</td>
<td>0.5</td>
<td>• Baffled inlet or outlet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Some intra-basin baffles</td>
</tr>
<tr>
<td>Superior</td>
<td>0.7</td>
<td>• Perforated inlet baffle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Serpentine or perforated intra-basin baffles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Outlet weir or perforated launders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Most of tank volume is utilized</td>
</tr>
<tr>
<td>Perfect (plug flow)</td>
<td>1</td>
<td>• Length to width ratio greater than or equal to 10:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Perforated inlet, outlet and intra-basin baffles</td>
</tr>
</tbody>
</table>
b) IT Concept for UV Disinfection

In order to demonstrate that required disinfection credits are achieved, these treatment standards use the concept of the UV intensity (I) multiplied by the exposure time (T).

The amount of UV light delivered to pathogens in a reactor is called “UV dose” and is measured in millijoules per square centimetre (mJ/cm²). The UV dose depends on:

- UV intensity, or magnitude of UV light, measured by UV intensity sensors in Watts/cm² or Watts/m².
- UV transmittance (UVT).
- Water flow rate and hydraulics in the reactor.

Formula: \[ \text{UV dose} = \text{UV intensity (Watts/cm}^2\text{)} \times \text{Time of exposure (seconds)} \]

These treatment standards require a minimum UV dose (IT) of 40 mJ/cm². The minimum required UV dose of 40 mJ/cm² achieves greater than 4-log reduction for protozoa but only 0.5-log reduction for viruses (assuming adenovirus).

Note: Where UV light is used for primary disinfection, chemical disinfection shall be required to meet log inactivation criteria for viruses.

UV performance is highly dependent on water quality, flow rate, electrical power quality and other operational parameters. To receive inactivation credit, a UV reactor must operate within the validated limits (e.g. intensity is greater than the minimum specified, flow is below the maximum specified, UVT is above the minimum specified).

UV systems are required to have a shut off feature and alarm when the equipment malfunctions, loses power or ceases to provide the appropriate level of disinfection as outlined in Section 4.5.2. Other considerations are outlined in Section 4.5.2.

4.2 Protection Against Chemical Contaminants

4.2.1 Disinfection By-Products

Water that meets the maximum acceptable concentrations for the disinfection by-products specified in Table 3 is considered safe for all domestic uses, including drinking, bathing, showering and food preparation.

Municipal water utilities shall balance effective disinfection for microbial protection (see Section 4.1) against the creation of disinfection by-products. Municipal water utilities shall make every effort to maintain concentrations of disinfection by-products as low as reasonably achievable without compromising the effectiveness of primary disinfection.
Municipal water utilities are responsible for routinely determining disinfection by-product levels. Trihalomethanes (THMs) and haloacetic acids (HAA5) shall be sampled on a quarterly basis at appropriate locations in the distribution system. It should be noted that sampling locations may differ for THMs and HAA5. This is because THMs continue to form from the chlorine injection point to the furthest location from the chlorine injection point; HAA5 on the other hand, may begin to decay at some point between the source and the furthest point from the source depending on the size of the distribution system.

Once a compliance value is determined after a minimum of four quarterly samples have been analyzed at each sample location (i.e. locational running annual average), non-GUDI groundwater supplies with THM and HAA5 concentrations less than 0.01 mg/L (10 µg/L) may request a reduction in sampling frequency to annual. Surface water and GUDI sources are not eligible for this reduction in sampling frequency; an increased sampling frequency may be required for facilities using surface water or GUDI sources during peak by-product formation periods.

Other disinfection by-products shall be analyzed as appropriate based on the considerations noted in Table 3.

Where results confirm that a maximum acceptable concentration has been exceeded, the municipal water utility shall notify NSE and develop a corrective action plan to remediate the situation. The corrective action plan shall be acceptable to NSE.

Any municipal water utility changing coagulants or disinfectants to control disinfection by-product concentrations shall undertake a study, complete with a monitoring program, to confirm that no unintended consequences (e.g. release of heavy metals such as lead, antimony, etc.) will occur due to the process change. The study and monitoring program design shall be acceptable to NSE. If unintended consequences are found to occur, the municipal water utility shall take appropriate corrective action to remediate the situation. The corrective action shall be acceptable to NSE.

4.2.2 Guidelines for Canadian Drinking Water Quality

Section 35 of the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations, made pursuant to the Environment Act, requires that municipal water utilities meet the health-related Guidelines for Canadian Drinking Water Quality (GCDWQ). In their guidance to authorities responsible for providing drinking water on federal lands, Health Canada recommends that the full suite of health-related parameters be tested once every five years. As NSE follows Health Canada recommendations, municipal water utilities shall test for the full suite of health-related parameters at a minimum of once every five years for:

- untreated raw water from each source; and
- treated water.
The sampling frequency shall be enhanced for parameters that have detectable levels in raw water. Sampling frequency shall be acceptable to NSE.

Where results confirm that a maximum acceptable concentration has been exceeded in treated water, the municipal water utility shall notify NSE and develop a corrective action plan to remediate the situation. The corrective action plan shall be acceptable to NSE.

An exceedance of an aesthetic objective or operational guideline may also require a corrective action plan if found to compromise disinfection or other critical treatment processes.

4.2.3 Guidelines for Monitoring Public Drinking Water Supplies

Section 33 of the *Water and Wastewater Facilities and Public Drinking Water Supplies Regulations*, made pursuant to the *Environment Act*, requires that municipal water utilities monitor water quality for the parameters listed in the *Guidelines for Monitoring Public Drinking Water Supplies* (GMPDWS). Surface water and GUDI supplies shall be monitored for these parameters once every year; non-GUDI supplies shall be monitored, at a minimum, once every two years. Sampling locations shall include:

- untreated raw water from each source; and
- treated water.

Where results confirm that a maximum acceptable concentration has been exceeded, the municipal water utility shall notify NSE and develop a corrective action plan to remediate the situation. The corrective action plan shall be acceptable to NSE.

An exceedance of an aesthetic objective or operational guideline may also require a corrective action plan if found to compromise disinfection or other critical treatment processes.
### Table 3 - Disinfection By-Products Requiring Monitoring by Municipal Water Utilities

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Maximum Acceptable Concentration (mg/L)</th>
<th>Considerations</th>
<th>Sampling Frequency</th>
<th>Sampling Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromate</td>
<td>0.01</td>
<td>• Forms when ozone reacts with naturally-occurring bromide</td>
<td>• Monthly monitoring required by municipal water systems using ozone</td>
<td>• In treated water entering the distribution system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Forms in sodium hypochlorite solutions that are not stored appropriately ¹</td>
<td>• Monitoring required by municipal water systems that store solutions for more than three months</td>
<td>• In treated water entering the distribution system</td>
</tr>
<tr>
<td>Chlorate</td>
<td>1.0</td>
<td>• By-product of chlorine dioxide</td>
<td>• A minimum of quarterly sampling is required by municipal water systems using chlorine dioxide as a disinfectant</td>
<td>• Mid-point and far-point ² in the distribution system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Forms in sodium hypochlorite solutions that are not stored appropriately ¹</td>
<td>• Monitoring required by municipal water systems that store solutions for more than three months</td>
<td>• In treated water entering the distribution system</td>
</tr>
<tr>
<td>Chlorite</td>
<td>1.0</td>
<td>• By-product of chlorine dioxide</td>
<td>• A minimum of quarterly sampling is required by municipal water systems using chlorine dioxide as a disinfectant</td>
<td>• Mid-point and far-point ² in the distribution system</td>
</tr>
<tr>
<td>Haloacetic Acids</td>
<td>0.08 (80 µg/L)</td>
<td>• By-product of chlorine addition</td>
<td>• Running locational annual average based on a minimum of four quarterly samples ⁴</td>
<td>• Where historical data show the highest HAA5 concentration ⁵</td>
</tr>
<tr>
<td>(HAA5)³</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Maximum Acceptable Concentration (mg/L)</td>
<td>Considerations</td>
<td>Sampling Frequency</td>
<td>Sampling Location</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>N-Nitrosodimethylamine (NDMA)</td>
<td>0.0000 04 (0.04 µg/L)</td>
<td>• By-product of chloramination • May be found in chlorinated systems with nitrogen or humic substances present in the source water</td>
<td>• A minimum of quarterly sampling is required by municipal water systems using chloramination</td>
<td>• In treated water entering the distribution system and far-point in the distribution system</td>
</tr>
<tr>
<td>Trihalomethanes (THMs)</td>
<td>0.1 (100 µg/L)</td>
<td>• By-product of chlorine addition</td>
<td>• Running locational annual average based on a minimum of four quarterly samples 4</td>
<td>• At the point in the distribution system with the highest potential THM levels 2</td>
</tr>
</tbody>
</table>

**Notes:**
1. Sodium hypochlorite solutions should be stored in a cool dry location away from sunlight where the temperature does not exceed 30°Celsius.
2. Areas in the distribution system with the longest disinfectant retention time (e.g. typically farthest from chlorine injection site(s)).
3. Non-GUDI supplies with THM and HAA5 concentrations less than 0.01 mg/L (10 µg/L) may request a reduction in sampling frequency to annual.
4. Increased frequency may be required for facilities using surface water or GUDI sources during peak by-product formation periods.
5. Where historical data are not available, HAA5 concentrations shall be monitored in the middle and extremities of the distribution system. Areas where disinfectant residuals are significantly lower than the system average because of long residence time (e.g. dead end, low flow areas) shall be targeted. In systems with booster chlorination stations and water tanks/reservoirs, HAA5 concentrations shall be monitored downstream of these components.
6. Quarterly monitoring may be reduced to an annual frequency if the monitoring program consistently does not show the presence of NDMA in the treated water entering the distribution system.
7. Current to February 2012; other disinfection by-products to be added per updates to the Guidelines for Canadian Drinking Water Quality.

**Originating Division:** Environmental Science and Program Management Division  
**Scope:** Standard under the *Environment Act*  
**Nova Scotia Environment**
4.3 Management of Waste Streams

Waste streams from all treatment facilities shall be properly managed. Drinking water treatment processes produce the following waste streams:

- filter backwash water;
- filter backwash solids;
- clarifier solids.

Membrane filtration technology produces other waste streams that shall be properly managed as outlined in Appendix C.

4.3.1 Filter Backwash Water

Filter backwash water shall be discharged to an approved location. Filter backwash water shall not be discharged to the raw water inlet pumps or intake structures. If water from the filter backwash treatment system is discharged to the raw water reservoir/intake, it shall be at a location which is downstream of the raw water intake. When an existing facility already has a discharge upstream, the municipal water utility shall demonstrate no impact on raw water quality. Otherwise the municipal water utility shall develop a corrective action plan to remediate the situation. The corrective action plan shall be acceptable to NSE.

a) Discharges into a Freshwater Watercourse

Where filter backwash water discharges to a freshwater watercourse, the following discharge criteria shall apply:

- Maximum concentration of suspended solids shall not exceed 5 mg/L over naturally-occurring clear flow background watercourse concentrations. The naturally-occurring background concentrations in the watercourse shall be calculated as the 90th percentile value from a minimum of 12 monthly clear flow samples.

- Chlorine residual shall not exceed 0.02 mg/L.

- pH shall be in the range of 6.5 to 9.0. If it is not possible to achieve this pH range, the municipal water utility shall complete a study to determine background values and recommend “end of pipe” discharge criteria for pH. The study shall be acceptable to NSE.

- Discharge shall be non-acutely lethal with acute toxicity determined using “Reference Method for Determining Acute Lethality to Rainbow Trout”.
For metals, the following options for setting discharge criteria limits may be considered by the municipal water utility (listed in order of preference):

i) Meet the limits set by the Canadian Council of Ministers of the Environment (CCME) *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.

ii) If naturally-occurring background concentrations of metals in the watercourse are higher than the values specified in the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*, NSE may allow discharge criteria limits to be set at the 90th percentile of the watercourse’s background concentrations. A minimum of 12 monthly samples from the watercourse shall be required to establish background concentrations.

iii) If it is not possible to achieve the 90th percentile of background concentrations, NSE may allow a 10 percent increase above the 90th percentile.

iv) If it is not possible to achieve the 90th percentile plus 10 percent, the municipal water utility shall complete a study to recommend “end of pipe” discharge criteria limits. The study shall be acceptable to NSE. Discharge criteria limits shall be specified by NSE once the study has been reviewed. Consultation may be required with NSE, Environment Canada, and the federal Department of Fisheries and Oceans (DFO).

Once discharge criteria limits have been set, the municipal water utility shall comply with the following:

- discharge criteria limits shall be met before discharging into the watercourse (i.e. end of pipe limits);

- discharge criteria shall be met in 95% of samples;

- sampling frequency shall be at least monthly or as required by NSE.

It should be noted that membrane processes may concentrate naturally-occurring compounds such as metals, solids and radionuclides in the waste streams to levels above the CCME *Water Quality Guidelines for the Protection of Aquatic Life*. It is important that municipal water utilities with membrane facilities establish discharge criteria, particularly where aluminum is naturally-occurring in the source water.
b) Discharges into a Municipal Wastewater System

Where backwash wastewater discharges into a municipal wastewater system, the municipal water utility shall:

- ensure capacity exists within the municipal wastewater system;
- contact NSE to determine if other requirements may apply.

c) Discharges into a Marine or Brackish Environment

Where backwash wastewater discharges into a marine or brackish environment, the municipal water utility shall contact NSE to determine what requirements shall apply.

d) Discharges into a Non-Aquatic Environment

Where backwash wastewater discharges into a non-aquatic environment, the municipal water utility shall contact NSE to determine what requirements shall apply.

4.3.2 Filter Backwash and Clarifier Solids

Solids generated by the filter backwash and clarification processes (e.g. sedimentation or dissolved air flotation) shall be disposed in accordance with a solids disposal plan that has been prepared by the municipal water utility. The solids disposal plan shall be acceptable to NSE.

4.4 Water Distribution Systems

The water distribution system is the final barrier before delivery to the consumer's tap. Even when the water leaving the treatment plant is of the highest quality, if precautions are not taken its quality can seriously deteriorate. In extreme cases, dangerous contamination can occur. A well-maintained distribution system is a critical component of a safe drinking water system. It is essential that municipal water utilities have adequate mechanisms in place so that their distribution systems can be properly maintained and renewed. Programs shall be in place to:

- monitor distribution system water quality (e.g. total coliforms and *E. coli* bacteria, chlorine residual, turbidity, pH, etc.);
- minimize corrosion and the release of lead;
- detect and deter cross-contamination from cross-connections, fire sprinkler systems, etc.
In addition, as part of the comprehensive distribution system program, municipal water utilities should have active programs to deal with threats to distribution system integrity, including but not limited to: pipe age, leaks, pressure transients, storage tanks, pumping stations.

4.5 Other Considerations

4.5.1 Engineered Filtration for Pathogen Reduction

In addition to the requirements outlined in Part III, the Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems and Appendix C, the following requirements apply in Nova Scotia:

- Engineered filtration for pathogen reduction is required for all surface water and high risk GUDI sources.

- A minimum of two filters (redundancy) is required. Where two filters are provided, each shall be capable of supplying the maximum day demand with the largest filter out of service. Where more than two filters are provided, the maximum day demand shall be met with the largest filter out of service.

- Conventional and direct filtration facilities shall filter-to-waste until turbidity is below 0.2 NTU. A filter-to-waste feature shall also be required for slow sand and diatomaceous earth filtration.

- Continuous on-line turbidity monitoring is required for individual filters with measurements taken at a minimum of once every five minutes.

- Filtration shall meet the turbidity limits set in Table 1 to receive the log removal credits noted in Table 1. Alarms shall be in place to alert staff when turbidity limits are not met.

- For membrane filtration, if turbidity exceeds 0.1 NTU for more than 15 minutes, direct integrity testing shall be immediately conducted on the membrane treatment unit. If the unit passes direct integrity testing, it may continue to be used for water treatment; if not, the unit shall be taken out of service.

- Standard operational procedures shall be developed for the filtration process.
4.5.2 Primary Disinfection for Pathogen Reduction

In addition to the requirements outlined in Part III, the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems* and Appendix C, the following requirements apply in Nova Scotia:

- A minimum of two primary disinfection units (redundancy) is required at each treatment facility to ensure that inadequately disinfected water is not distributed. Where two disinfection units are provided, each shall be capable of meeting the maximum day demand flow. Where more than two disinfection units are provided, the maximum day demand flow shall be met with the largest unit out of service.

- Groundwater supplies with multiple wells may apply for system-wide redundancy. System wide redundancy means the disinfection unit at one well can act as the redundant unit for another well provided there is adequate system capacity to meet maximum day demand with the largest well out of service.

- Continuous on-line monitoring of the disinfection process is required at each treatment facility with measurements taken at a minimum of once every five minutes to ensure that inadequately disinfected water is not distributed.

- Disinfection equipment shall be operated in such a manner as to prevent inadequately disinfected water from being distributed.

- Water systems shall be equipped with alarm capabilities to notify operations staff if the disinfection process fails to operate properly.

- Acceptable primary disinfectants include: free chlorine, chlorine dioxide, ozone and UV. Chloramines shall not be accepted as a primary disinfectant.

- If sodium hypochlorite is used for primary disinfection, bromate and chlorate shall be monitored when solutions are stored for more than three months.

- If chlorine dioxide is used for primary disinfection, the process shall operate in such a manner as to ensure that the maximum chlorine dioxide dose is 1.2 mg/L. Chlorate and chlorite shall be monitored as disinfection by-products.

- If ozone is used for primary disinfection, bromate shall be monitored as a disinfection by-product.
• If UV is used for primary disinfection, units shall provide a minimum dose of 40 mJ/cm²; UV disinfection shall be followed by chemical disinfection to achieve log inactivation criteria for viruses. Additional requirements are described in Appendix C.

• Standard operational procedures shall be developed for the primary disinfection process.

• Municipal water utilities shall immediately notify NSE when operational conditions are outside the design ranges for the primary disinfection process. Municipal water utilities shall investigate the cause and take necessary corrective action. CT/IT shall be calculated during every such event.

4.5.3 Secondary Disinfection

In addition to the requirements outlined in Part III, the *Atlantic Canada Guidelines for the Supply, Treatment, Storage, Distribution and Operation of Drinking Water Supply Systems* and Appendix C, the following requirements apply in Nova Scotia:

• Continuous on-line chlorine residual monitoring, with measurements taken at a minimal of once every five minutes, is required for the water entering the distribution system from the facility and leaving any water storage structure within the water distribution system.

• Grab sample monitoring of the distribution system chlorine residual is required on a weekly basis.

• Utilities shall use secondary disinfection to maintain an effective residual in the distribution system. Acceptable secondary disinfectants include free chlorine and chloramines.

• If free chlorine is used for secondary disinfection, the process shall be operated in such a manner as to ensure that a 0.20 mg/L minimum free chlorine residual is achieved throughout the water distribution system; the maximum free chlorine residual of water delivered to consumers is 4.0 mg/L.

• If chloramines are used for disinfection, the process shall be operated in such a manner as to ensure that a minimum of 1.0 mg/L combined chlorine residual is achieved throughout the water distribution system; the maximum combined chlorine residual of water delivered to consumers is 3.0 mg/L.
• If chloramines are used for disinfection, free ammonia and nitrates/nitrites shall be monitored weekly. Municipal water utilities shall take necessary corrective action to address nitrification events. Corrective action shall be acceptable to NSE.

• If chloramines are used for disinfection, NDMA shall be monitored as a disinfection by-product.

• THMs and HAA5 shall be monitored as disinfection by-products.

• Any municipal water utility switching from free chlorine to chloramines to stabilize chlorine residual levels shall undertake a study, complete with a monitoring program, to confirm no unintended consequences will occur due to the switch in secondary disinfectant. The study and monitoring program design shall be acceptable to NSE. If unintended consequences are found to occur, the municipal water utility shall take appropriate corrective action to remediate the situation. The corrective action shall be acceptable to NSE.

• Municipal water utilities shall notify NSE whenever the distribution system chlorine residual is lower than the stipulated level and take corrective action as necessary to restore the chlorine residual to required levels. Corrective action shall be acceptable to NSE.
PART IV - OPERATIONS, MONITORING, REPORTING AND MANAGEMENT

5.0 Overview

The final stage in the multi-barrier approach is proving that the drinking water is safe through effective operations, monitoring, reporting and management. All municipal water utilities are encouraged to publicly report their water quality results to their consumers.

5.1 Operations Manual

Municipal water utilities shall prepare a comprehensive operations manual that includes:

• Standard Operational Procedures;
• Emergency Notification Procedures;
• Contingency Plans.

The municipal water utility shall review and update the contingency plans and emergency notification procedures annually and ensure that the operations manual is kept up to date. A copy of the operations manual is to be kept on site at all times and is to be available for review immediately upon request by NSE. All employees shall be apprised of the operations manual.

Municipal water utilities should refer to the guidance document published by NSE on developing a comprehensive operations manual for minimum requirements.

5.2 Monitoring and Recording

Methods for monitoring and recording are to be carried out as per the requirements of the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations, made pursuant to the Environment Act, and the Guidelines for Monitoring Public Drinking Water Supplies.

Municipal water utilities shall monitor and sample in accordance with their annual monitoring program to demonstrate that Section 35 of the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations is being met. The annual monitoring program shall include:

• compliance monitoring, including QA/QC requirements;
• process monitoring;
• response monitoring;
• special process characterization and optimization monitoring (if applicable);
• source water characterization monitoring.
The monitoring program shall be acceptable to NSE.

Municipal water utilities should refer to the guidance document published by NSE on developing an annual sampling plan for minimum requirements.

5.3 Reporting Requirements

Municipal water utilities are responsible for complying with all terms and conditions of their operating approval. This includes immediate, annual and ad hoc reporting functions as outlined in Appendix G. There are also requirements to provide information upon request or for inspection/review as outlined in Appendix G.

5.4 Management

Classified water treatment and water distributions facilities shall be operated by certified operators in accordance with the Water and Wastewater Facilities and Public Drinking Water Supplies Regulations, made pursuant to the Environment Act.

Municipal water utilities are responsible for meeting the terms and conditions of their Approval to Operate. A thorough, well-thought-out due diligence program for managing water-related risks and meeting public expectations can help meet these responsibilities. Municipal water utilities should refer to the guidance document entitled “Safe Drinking Water Systems: A Diligent Approach”, as published by NSE for more information.
PART V - GLOSSARY AND REFERENCES

6.0 Glossary

*Average day demand* means the average amount of water necessary in a 24-hour timeframe to meet all needs of all customers. It is determined by dividing annual usage by the total number of days in the year.

*Contact time* denoted as $T_{10}$ is an effective contact time for disinfection in minutes and represents the time when 10 percent of the water passes the contact unit; that is 90 percent of the water remains in the unit and will be exposed to longer disinfection within the unit. $T_{10}$ can be established by tracer studies or calculated using theoretical hydraulic detention times multiplied by an appropriate baffling factor.

*Conventional filtration* means a treatment process that includes chemical mixing, coagulation, flocculation, clarification (sedimentation or dissolved air flotation) and rapid gravity filtration. All filters should be designed so that the filtered water immediately after filter backwashing is directed into a waste stream (“filter-to-waste” provision).

*Cryptosporidium* means a widespread intestinal coccidian protozoan parasite about 3.5 micrometres in diameter, causing diarrhea and capable of infecting humans, birds, fish and snakes. It is responsible for waterborne disease outbreaks.

*Diatomaceous earth* means the microscopic remains of the discarded outer surface of diatoms.

*Diatomaceous earth filtration* means a filtration method on which diatomaceous earth is used as the filtering medium.

*Direct filtration* means a treatment process that includes chemical mixing, coagulation, flocculation and rapid gravity filtration (e.g. no clarification process). All filters should be designed so that the filtered water immediately after filter backwashing is directed into a waste stream (“filter-to-waste” provision).

*Disinfectant* means an agent that destroys or inactivates harmful microorganisms.

*Disinfection* means the process of destroying or inactivating pathogenic organisms by either chemical or physical means.

*Disinfection by-products* means the chemical by-products that are formed when a disinfectant reacts with organic matter in the water.
Filtrate means the liquid that has passed through a filter.

Filtration means the removal of suspended materials in a fluid stream by passage of the fluid through a filter medium.

Filter-to-waste means a practice of discharging filtered water directly to disposal immediately following backwashing until the filtered water is of acceptable quality.

Giardia means the genus name for a group of single-celled, flagellated, pathogenic protozoans found in a variety of vertebrates, including mammals, birds and reptiles. These organisms exist either as trophozoites or as cysts, depending on the stage of the life cycle.

Giardia lamblia means the species of Giardia that is a common cause of human diarrheal disease.

Log reduction means a negative of the base 10 logarithm of the fraction of pathogens remaining after the treatment process.

Maximum day demand means the highest daily use rate during the year.

Membrane filtration means a filtration process that uses pressure-driven semi-permeable membranes to reject particles and produce a filtrate. The most appropriate type of membrane depends on a number of factors including targeted material to be removed, source water quality characteristics, treated water quality requirements, membrane pore size, molecular weight cut-off, membrane material and system configuration. A “filter-to-waste” feature should be provided for initial start-up and commissioning of the membrane system and for emergency diversions in the event of a membrane integrity breach.

Municipal drinking water system means a public drinking water supply that holds a municipal water works approval issued under the Activities Designation Regulations, made pursuant to the Environment Act, for the collection, production, treatment, storage, supply or distribution of potable piped water to the public.

Municipal wastewater system means a municipality owned or operated facility for the collection, treatment and release of wastewater.

Municipal water utility means a utility owned, operated or managed by a municipality, village or service commission either directly or through a board or commission, for the purpose of producing, transmitting, delivering or furnishing water directly or indirectly to or for the public.

Natural attenuation means the attenuation of particles through in-situ soil, filtration or adsorption prior to a location from which the water is withdrawn (e.g. through a well).
Natural watershed boundary means the area drained by or contributing to a stream, lake or other body of water. It is the area that topographically appears to contribute all the water that passes through a given cross-section of a stream. Topography is the change in height of land relative to sea level.

Peak hourly demand means the highest hourly use rate during the year; it is typically two to four times the average day flow and is generally supplied from storage tanks.

Redundancy means a minimum of two process units shall be provided (e.g. two filters, two primary disinfection units, two pumps, etc.). Where only two process units are provided, each shall be capable of meeting the maximum day demand at the unit’s rated capacity. Where more than two process units are provided, the process shall be capable of meeting maximum day demand with the largest unit out of service.

Slow sand filtration means filtration that depends on the formation of schmutzdecke, which is a layer of bacteria, algae and other microorganisms on a biopopulation within the sand bed. Raw water passes through the sand bed where physical, chemical and biological mechanisms remove contaminants. The most important removal mechanism has been attributed to the biological process. No chemicals are added nor is there a need to backwash. The filter is cleaned by scrapping off the clogged sand and eventually replacing the sand. A filter-to-waste feature should be provided so that the filtered waste immediately after filter cleaning is directed into a waste stream.

Time-of-travel means the determination, usually by modeling, of the time in years for groundwater recharge to travel from a certain field point to the wellhead. In Nova Scotia, three time-of-travel zones are recommended, including a 2-year zone, 5-year zone, and 25-year zone. The 2-year zone is the smallest zone. This zone is used to protect against microbial contaminants such as bacteria and viruses. The 5-year zone is used to protect against chemical contaminants such as petroleum contaminants and persistent mobile contaminations. The 25-year zone is the largest zone. This zone is used to protect against chemical contaminants such as chlorinated solvents, nitrate and road salt. The three zones are also used to define the source water protection area. The outer boundary of the 25-year zone - the largest zone - sets the boundary for the source water protection planning process.
7.0 References


--------. 2011. *Guideline for Canadian Drinking Water Quality - Turbidity in Drinking Water (Document for Public Comment)*. Ottawa, ON.


