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# Guidance on the Use of the Microbiological Drinking Water Quality Guidelines



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# **Guidance on the Use of the Microbiological Drinking Water Quality Guidelines**

**Prepared by the  
Federal-Provincial-Territorial Committee on  
Drinking Water  
of the  
Federal-Provincial-Territorial Committee on  
Health and the Environment**

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# Guidance on the Use of the Microbiological Drinking Water Quality Guidelines

## 1.0 Introduction

The provision of reliable, safe drinking water requires drinking water purveyors to take a holistic approach to the management of drinking water supplies. A holistic approach considers risks from all potential contaminants (microbiological, chemical and radiological) in a supply and allows the development of management strategies that prioritize risks and minimize potential impacts on human health. There are many examples of holistic approaches for drinking water management, including the multi-barrier source-to-tap approach used in the *Guidelines for Canadian Drinking Water Quality* (GCDWQ) and the water safety plan approach developed by the World Health Organization. These approaches can be, and have been, applied to both municipal and residential scale systems. It is widely recognized that microbiological risks are considered a top priority in drinking water management and that the microbiological quality of drinking water should never be compromised. This document provides an overview of microbiological considerations to ensure drinking water quality. It integrates the relevant information found in the various documents developed as part of the GCDWQ in order to illustrate their use as part of a multi-barrier source-to-tap approach.

The guideline technical documents and guidance documents should be consulted for detailed information on using these parameters to understand the water quality in each component of the drinking water system including the source water, during the treatment processes, and in the treated and distributed drinking water. The list of documents developed as part of the GCDWQ that should be consulted for further information can be found in section 5.0.

## 2.0 GCDWQ: Guideline technical documents and guidance documents

The guideline technical documents and guidance documents developed under the GCDWQ that focus on microbiological risks address parameters that are used to assess water quality or safety. They include *Escherichia coli* (*E. coli*), total coliforms, turbidity, and heterotrophic plate counts (HPC). In addition, disinfectant residuals are discussed in several documents (e.g. chlorine, chloramine). Documents also address the removal and inactivation of specific groups of human pathogens including enteric protozoa, enteric viruses, and waterborne bacterial pathogens. All of these documents are briefly discussed below.

*E. coli* and total coliforms are bacterial indicators that are used to verify water safety and changes in water quality, respectively. Monitoring for these indicators is one of the measures used to determine groundwater vulnerability, surface water quality, and to verify that water has been adequately treated and safely distributed.

The guideline technical documents on enteric protozoa and enteric viruses set health-based treatment goals that are the recommended minimum requirements in a drinking water system. The health-based treatment goal for *Giardia* and *Cryptosporidium* (oo)cysts is a minimum 3 log removal and/or inactivation in any system that has been identified as requiring treatment for protozoa (surface and groundwater under the direct influence of surface water [GUDI] water sources). The health-based treatment goal for enteric viruses is a minimum 4-log

reduction for all water sources, including groundwater sources. A jurisdiction may allow a groundwater source to have less than the recommended minimum 4-log reduction if the assessment of the drinking water system has confirmed that the risk of enteric virus presence is minimal. A quantitative microbial risk assessment (QMRA) process was used to support these minimum requirements. QMRA uses mathematical modelling and relevant information on source water quality data, treatment barrier information and pathogen-specific characteristics to estimate the risk from pathogenic microorganisms in a drinking water source. Using Canadian data, this process shows that the health-based treatment goals for enteric protozoa and enteric viruses are the minimum reductions necessary to meet the acceptable level of risk of  $10^{-6}$  Disability-Adjusted Life Years (DALYs) per person per year. In many source waters, a greater level of reduction may be required. The benefit of using a QMRA approach is that assessments can include site-specific information to investigate how changes in the source water quality or the addition or optimization of treatment barriers can impact the microbiological quality of the drinking water being produced.

Turbidity measurements have different implications and limits depending on the nature of the particle and whether they are being monitored in the source water, during treatment processes or in the distribution system. High turbidity measurements or measurement fluctuations can indicate inadequate water treatment, changes in source water quality, or disturbances in the distribution system.

For systems that use chlorine or chloramine for disinfection, chlorine residual measurements are used to assess the adequacy of disinfection and to indicate deterioration in distribution system water quality.

HPC is an analytical method that is a useful operational tool for monitoring general bacteriological water quality throughout the treatment process and within the distribution system.

The guidance document on waterborne bacterial pathogens discusses the risks from numerous other bacterial pathogens which may be found in drinking water sources, and how these risks can be minimized through the application of a multi-barrier source to tap approach.

### **3.0 Multi-barrier source to tap approach for microbial risks**

Monitoring water for all pathogens that could be present in a drinking water system is not technically or economically feasible. Instead, a multi-barrier source-to-tap approach is used to remove or inactivate microbiological contaminants and thereby reduce the risk of illness from pathogenic microorganisms to an acceptable level.

A multi-barrier source-to-tap approach for the management of drinking water includes the protection of source water, the use of appropriate and consistently effective treatment, a well-maintained distribution system, qualified personnel, routine verification of drinking water quality, and communication and public education. Numerous publications are available that discuss this approach in detail, including “From source to tap: guidance on the multi-barrier approach to safe drinking water” (CCME, 2004). The purpose of this overview document is not to provide a comprehensive list of activities and measures that should be implemented as part of a multi-barrier approach but to summarize how the *Guidelines for Canadian Drinking Water Quality* guideline technical documents and guidance documents should be used throughout the source to tap process.

### 3.1 Source water quality

Source water protection and management is an important first step in a multi-barrier approach to providing safe and reliable drinking water. To adequately understand a water source, it is important to carry out a source water assessment. Source water assessments should be included as part of a routine sanitary survey. Sanitary surveys are used to assess the adequacy of the water supply system to produce and distribute safe drinking water. Although outside the scope of this current document, further information on sanitary surveys can be found in CCME (2004).

Source water assessments include the identification of current and potential faecal contamination sources in the watershed/aquifer, potential pathways by which the microbial pathogens can make their way into the source water, and some source water monitoring. For groundwater sources, a comprehensive classification assessment should also be conducted to identify the source as either GUDI or groundwater considered to be less vulnerable to faecal contamination (i.e., those not under the direct influence of surface water). Groundwater considered to be less vulnerable to faecal contamination will henceforth be referred to only as groundwater. This comprehensive assessment should include, at a minimum, a hydrogeological assessment, an evaluation of well integrity, and a survey of activities and physical features in the area. Groundwater should also be periodically reassessed.

#### 3.1.1 Sources and transport of enteric pathogens

In Canadian drinking water sources, the pathogens of greatest concern to human health are those that result from faecal contamination. Sources of human faecal matter, such as sewage treatment plant effluents, sewage lagoon discharges, combined sewer overflows, and improperly maintained septic systems have the potential to be significant sources of enteric protozoa, particularly *Giardia* and *Cryptosporidium* species, enteric viruses, and many bacterial pathogens. Faecal matter from animals is also considered an important source of enteric protozoa and bacterial pathogens, but is not a significant source of human pathogenic enteric viruses. Pathogens can be transported overland or through the subsurface to impact surface and groundwater sources. The extent of transport can be impacted by numerous factors such as land use, type of overlying soil and subsurface materials, and climatic factors such as drought, rainfall, and snowmelt.

#### 3.1.2 Source water monitoring

Surface water and GUDI sources may be contaminated with any or all categories of enteric pathogens (protozoa, viruses, or bacteria). Source water monitoring in these types of sources should include *E. coli*, *Giardia*, *Cryptosporidium* and turbidity. Where source water sampling and analysis for *Giardia* and *Cryptosporidium* are not feasible (e.g., small supplies), (oo)cyst concentrations can be estimated by taking into account information obtained from the source water assessment along with other water quality parameters that can provide information on the risk and/or level of faecal contamination in the source water.

In surface water and GUDI sources, *E. coli* and turbidity data are used to identify changing source water conditions, such as a decline in source water quality, higher loadings of pathogens and increased challenges to filtration and disinfection. Turbidity data are also essential to appropriately design and operate a treatment plant. *Cryptosporidium* and *Giardia* monitoring data are used to help determine the types and level of treatment that should be in place to produce water that meets an acceptable level of risk from these pathogens. In systems where the estimates of *Cryptosporidium* and *Giardia* concentrations are not based on monitoring data,

additional factors of safety should be used during engineering and design or upgrade of the treatment plant to ensure production of drinking water of an acceptable microbiological quality.

Groundwater that has been properly classified and that has a protection and management plan in place should not have protozoa or enteric bacteria present. However, even groundwater sources that are less vulnerable to faecal contamination will have a degree of vulnerability and may be contaminated with enteric viruses. Therefore groundwater should be routinely monitored for faecal indicators, such as *E. coli*, along with total coliforms and turbidity. In some instances, other microbial indicators may also be used. Groundwater does not need to be monitored for *Cryptosporidium* or *Giardia*.

In groundwater systems, *E. coli*, total coliform, and turbidity data are used to help identify any changes occurring in the water that may indicate it is being influenced by surface water. These data, along with the data from the comprehensive classification assessment and the sanitary survey, can help the responsible authority determine if the groundwater source can be exempted from the minimum health-based treatment goal for enteric viruses. Turbidity should generally be below 1.0 NTU to ensure that it does not interfere with the disinfection of the water supply.

In source waters, bacteriological indicators and turbidity should be measured at a greater frequency than *Cryptosporidium* and *Giardia* since these are relatively inexpensive tests that provide valuable information on source water quality, whereas the methods currently available for *Cryptosporidium* and *Giardia* monitoring are not practical for use on a frequent basis. *E. coli*, total coliforms and turbidity are typically measured on an on-going basis (e.g., daily to weekly), whereas *Giardia* and *Cryptosporidium* monitoring is carried out less frequently (monthly, or during peak events). Source water monitoring should reflect both normal pathogen loads in the water source and peak events. The conditions that are likely to lead to peak events can be identified using information about sources of faecal contamination from a sanitary survey, together with historical data on rainfall, snowmelt, river flow and turbidity measurements as well as any available data on the occurrence of enteric viruses.

### 3.1.3 Source water protection and management

Where source waters are well characterized, it may be possible to implement barriers/risk management measures to help reduce the levels of pathogens in the water source. For example, in surface water sources this may include protection measures such as ensuring wastewater discharges are treated, or reducing or eliminating combined sewer overflows. A detailed discussion on source water protection measures is outside the scope of this document but further information on source water protection can be found elsewhere (e.g., CCME, 2004). Utilities may also be able to implement some management strategies to address changes in their source water quality. For example, surface waters and GUDI sources may be able to limit capture of raw water during high-risk events, selectively operate an additional barrier during high-risk events, or use alternative sources or blending of varying sources (groundwater and surface water) to lower the level of pathogens in the water they are treating. For groundwater sources, protection measures may include ensuring the well is appropriately sited and constructed and that activities such as on-going well maintenance are being carried out to protect groundwater quality and maintain system integrity.

As a follow-up to any measures implemented, the responsible authorities should conduct an assessment to determine the impact that the measures have had on the quality of the water entering the treatment process.

### 3.2 Drinking water treatment

Drinking water treatment is an important barrier in the multi-barrier approach for producing microbiologically safe, reliable drinking water. For drinking water treatment processes to be effective, they need to be appropriately designed, operated, and optimized for the quality of the source water. Process control measures also need to be in place to ensure that the treatment processes are working, and verification monitoring should be conducted to confirm that the system is operating as expected.

#### 3.2.1 Selection and optimization of treatment barriers

Generally, minimum treatment of supplies derived from surface water sources or GUDI sources should include adequate filtration (or technologies providing an equivalent log reduction credit) and disinfection. The technologies in place should meet the minimum health-based treatment goals for both enteric protozoa and enteric viruses, and in many surface water sources, may need greater log reductions than the minimums to produce drinking water of an acceptable quality. For groundwater sources, adequate treatment should be in place to meet the minimum health-based treatment goal for enteric viruses, unless exempted by the responsible authority. Some water systems will have multiple redundant barriers, so that even if a given barrier fails, the water will continue to be adequately treated. In other cases, all barriers must be working well to provide the required level of treatment. For these systems, failure of a single treatment barrier could lead to an increased risk of a waterborne disease outbreak.

There are numerous types and combinations of treatment processes that can be used to reduce the concentration of pathogens in the treated water to an acceptable level. The treatment barrier(s) selected may be relatively simple, consisting of only disinfection, or complex, using combinations of pre-treatments, filtration, and disinfection. The choice of treatment processes will depend on numerous factors, including:

- the type and concentration of pathogens in the source water (including short-term water quality degradation);
- the type of source water;
- the physical and chemical qualities of the source water;
- the variability of the raw water quality, which may require seasonal adjustments of the treatment process to ensure optimal treatment performance at all times; and
- other practical or operational considerations.

Where possible, systems should evaluate the performance of existing and proposed treatment barriers/processes. Exact pathogen removal efficiencies will depend on the particulars of the water to be treated (e.g., the source water quality) and the treatment processes, including optimization. Specific log reduction rates can be established on the basis of demonstrated performance or pilot studies. Demonstration and challenge testing using pilot plant trials, or challenge trials with microbial surrogates (such as *E. coli*, HPC, total coliforms, MS-2 coliphage and microspheres) provide site-specific information on treatment plant performance and aid in optimization of the system. This can also help assess treatment barrier removal or inactivation performance under a variety of operating conditions. In addition to challenge testing, water systems can use tools such as QMRA to assess how variations in treatment performance contribute to the overall risks in their water system.

Table 1 provides a summary of filtration technologies that are used for pathogen removal and the average pathogen log removal credits when these technologies are meeting the treatment limits for turbidity. As shown in the table, filtration can be a very effective method for removing

protozoan pathogens. It is, however, less effective at removing enteric viruses. Although not included in the table, waterborne bacterial pathogens can also be effectively removed using filtration technologies. Further information is available in the guidance document on waterborne bacterial pathogens.

**Table 1:** Treatment limits for turbidity and average log removal credits for various treatment barriers as specified in the *Guidelines for Canadian Drinking Water Quality*.

Treatment barrier	Treatment limits for turbidity	<i>Cryptosporidium</i> removal credit (average)	<i>Giardia</i> removal credit (average)	Virus removal credit (average)
Conventional filtration	≤ 0.3 NTU <sup>a</sup> Never exceed 1.0 NTU	3.0 log	3.0 log	2.0 log
Direct filtration	≤ 0.3 NTU <sup>a</sup> Never exceed 1.0 NTU	2.5 log	2.5 log	1.0 log
Slow sand filtration	≤ 1.0 NTU <sup>a</sup> Never exceed 3.0 NTU	3.0 log	3.0 log	2.0 log
Diatomaceous earth filtration	≤ 1.0 NTU <sup>a</sup> Never exceed 3.0 NTU	3.0 log	3.0 log	1.0 log
Microfiltration	≤ 0.1 NTU <sup>b</sup>	Demonstration and challenge testing; verified by direct integrity testing	Demonstration and challenge testing; verified by direct integrity testing	No credit
Ultrafiltration	≤ 0.1 NTU <sup>b</sup>	Demonstration and challenge testing; verified by direct integrity testing	Demonstration and challenge testing; verified by direct integrity testing	Demonstration and challenge testing; verified by direct integrity testing
Nanofiltration and reverse osmosis	≤ 0.1 NTU <sup>b</sup>	Demonstration and challenge testing; verified by integrity testing	Demonstration and challenge testing; verified by integrity testing	Demonstration and challenge testing; verified by integrity testing

<sup>a</sup> Must meet this value in 95% of measurements per filter cycle or per month.

<sup>b</sup> Must meet this value in 99% of measurements per operational filter period or per month. If measurement exceeds 0.1 NTU for more than 15 minutes, membrane integrity should be investigated.

Disinfection is used for two different objectives. The goal of primary disinfection is to inactivate microorganisms before the water enters the distribution system. The effectiveness of primary disinfection is dependent on the physical characteristics of the water, such as temperature, pH and turbidity, and on the pathogen and the type of disinfectant. For example, chlorine is highly effective at inactivating enteric viruses and waterborne bacterial pathogens, and may be used as a primary disinfectant to meet the treatment goals for these groups of pathogens. On the other hand, it is not effective for *Cryptosporidium* inactivation in a drinking water system and other disinfectants, such as ozone and ultraviolet light (UV), are better choices than chlorine for meeting the health-based treatment goals for this organism. The efficacy of chemical disinfectants is commonly described using the CT concept. CT is the product of “C” (the residual concentration of disinfectant, measured in mg/L) and “T” (the disinfectant contact

time for a specified proportion of the water, measured in minutes) for specific disinfectants at pH values and temperatures encountered during water treatment. Disinfectants commonly used for primary disinfection include chlorine, ozone, chlorine dioxide and UV. Chloramine is not used for primary disinfection, as it requires very high CT values. UV, which is not a chemical disinfectant, is measured as UV dose as opposed to CT. The guideline technical documents for enteric viruses and enteric protozoa, as well as the guidance document on waterborne bacterial pathogens, should be consulted for further information.

Secondary disinfection is practiced to provide a disinfectant residual throughout the distribution system. This has two main benefits: (1) maintaining a disinfectant residual helps limit the growth of biofilms within the distribution system; and (2) a rapid drop in disinfectant residual can indicate a treatment plant malfunction or a break in the integrity of the distribution system. Similarly to primary disinfection, the effectiveness of secondary disinfection depends on the physical characteristics of the water, including pH, temperature and turbidity. The only disinfectants that provide a disinfectant residual are chlorine based, namely chlorine and chloramine.

It is important to note that many treatment processes are interdependent and rely on optimal conditions (e.g., temperature, pH) upstream in the treatment process for efficient operation of subsequent treatment steps. For example, coagulation and flocculation should be optimized to effectively remove particles by filtration. Optimization may also include adjustments for seasonal variations.

### 3.2.2 *Assessing water treatment processes*

As part of a robust treatment system that reliably produces microbiologically safe drinking water, process control measures need to be in place. Both chlorine residual and turbidity measurements are used as part of these control measures.

Turbidity monitoring of the treated water is used for assessing the removal credits for the various filtration technologies. To achieve the average pathogen log removals for these various filtration technologies, turbidity measurements must, as a minimum, meet the treatment limits as recommended in the guideline technical document for turbidity. Systems already meeting the applicable treatment limits should strive to meet a treated water turbidity target of less than 0.1 NTU to ensure production of the highest water quality possible. Systems that are using filtration for reasons other than pathogen removal do not need to meet the treatment limits. However, they should still monitor turbidity and try to limit turbidity to less than 1.0 NTU as the water enters the distribution system to ensure that disinfection is not hindered. Systems may be allowed to have greater than 1.0 NTU based on their site specific risk characterization.

Control and optimization of disinfection processes are essential to ensure that the pathogens of concern are being inactivated to the level necessary while reducing the formation of disinfection by-products as much as possible. The health risks from consuming water that has not been adequately treated for pathogens is much higher than any health risk associated with DBPs. Thus, disinfection must never be compromised by efforts to minimize DPBs. For primary disinfection, the equipment should be operated in such a manner as to prevent the distribution of inadequately disinfected water and to alert staff when the disinfection process is not operating properly. It is essential that the reduction in pathogen levels is achieved before drinking water reaches the first consumer in the distribution system. For secondary disinfection, it is recommended that chlorine be monitored using a continuous analyser at the point of entry and throughout the distribution system or that grab samples be frequently tested for disinfectant residuals (e.g., free or total chlorine). Disinfection effectiveness will be impacted by factors such

as pH, temperature, and turbidity of the water. It is therefore important to monitor these parameters regularly so that adjustments can be made to the treatment process if necessary.

### 3.2.3 *Verification monitoring*

An important component of a multi-barrier, source-to-tap approach to producing safe, reliable drinking water is verification monitoring. Verification monitoring involves routinely monitoring the treated drinking water for an indicator organism that provides assurance that the treatment system is operating as expected.

*E. coli* and total coliforms are used as indicator organisms. They are routinely monitored as a confirmation that the treatment process control measures are working and that the water has been adequately treated and is, therefore, of an acceptable microbiological quality. Because *E. coli* and total coliforms are more susceptible to many of the disinfectants commonly used in drinking water than some pathogens, analysis for these indicators needs to be used in conjunction with other indicators and process controls to reliably produce drinking water of an acceptable quality. When used as part of a multi-barrier, source-to-tap approach, the presence of either of these indicators in the water as it leaves the treatment plant indicates a serious breach in the treatment process and corrective actions should be carried out immediately and the cause of the breach investigated. The guideline technical documents on *E. coli* and total coliforms provide further information on the actions that should be taken.

### 3.2.4 *Qualified personnel*

The successful operation of any drinking water supply system—from private wells to large complex treatment plants—depends on the skills, abilities, and knowledge of the responsible owners and operators. Individuals need to understand the impact their activities and decisions can have on the quality and safety of the water being produced. It is therefore important that these individuals have the appropriate type and level of training for their systems. Training can include studies at post-secondary institutions, water association training courses, in-house training and mentoring programs, on-the-job experience in consultation with other trained operators or government specialists, workshops, seminars, courses, and conferences (CCME, 2004). Training should be an on-going process to ensure owners and operators maintain and update their skills and are kept informed of new regulatory requirements. It is recommended that jurisdictions have in place programs that ensure responsible individuals are properly trained and certified.

## 3.3 **Distribution system integrity**

Properly managed distribution systems are important for maintaining the water quality as it is delivered to consumers. A distribution system management plan may include: identification of a system's vulnerabilities and the corresponding risk management plan for preventing and handling contamination events; required maintenance activities; frequencies and locations for monitoring water quality parameters; and documentation requirements for adverse events and corrective actions. Although distribution system management is important for maintaining water quality, detailed activities are outside the scope of this overview document.

### 3.3.1 *Distribution system monitoring*

The parameters that are routinely monitored in distribution systems for determining the microbiological quality of the water are *E. coli*, total coliforms, turbidity, and chlorine residual. These parameters can be supplemented with HPC tests to provide additional data on the

microbial quality of the water. Monitoring for these parameters should be carried out throughout the entire distribution system particularly in areas with long retention times (e.g., dead-ends) or that have demonstrated deteriorating water quality. The frequency of monitoring should be based on system-specific characteristics such as the type and size of the system and the vulnerability of the system to changes in water quality. Changes in the trend of distribution system parameters should trigger more frequent monitoring.

Utilities that chloramine, as well as utilities with ammonia in the source water, should also monitor for free ammonia, nitrite, nitrate and HPC at key locations in the distribution system, as part of a nitrification monitoring program. When nitrite concentrations increase within the distribution system due to nitrification, the primary concern is that the nitrite consumes available chlorine and decomposes chloramine (i.e., reduction of disinfectant residuals). This can result in an increase in microbial counts, including a potential increase in the presence of coliform bacteria in the distribution system. Further information can be found in the guideline technical documents on nitrate and nitrite, and ammonia.

### 3.3.2 *Distribution system operation and management*

#### Bacteriological indicators

The confirmation of *E. coli* or total coliform bacteria in the distribution system indicates deterioration in the water quality. Since *E. coli* is not considered a major colonizer of distribution system biofilms, its presence in the distribution system but not in water tested immediately post-treatment, suggests that post-treatment contamination with faecal material has occurred. The confirmed presence of *E. coli* at any point in treated water indicates there is a potential health risk from consuming the water. Corrective actions, including the issuance of a boil water advisory, should be implemented. A guidance document on issuing and rescinding boil water advisories is available as part of the GCDWQ. Although the presence of *E. coli* is a good indicator of recent faecal contamination, such contamination is often intermittent and may not be revealed by the examination of a single sample. Therefore, as part of a multi-barrier source to tap approach, if the assessment of the water supply system shows that an untreated supply is subject to faecal contamination, or that treated water is subject to faecal contamination during storage or distribution or is inadequately treated, the water should be considered unsafe, irrespective of the results of *E. coli* analysis. Further information can be found in the guideline technical document on *E. coli*.

Monitoring total coliforms, along with turbidity, chlorine residuals and HPC, detects changing conditions, intrusion of contaminants, or areas of declining water quality. If total coliforms (in the absence of *E. coli*) are detected in more than 10% of samples in a given sampling period, or from consecutive samples from the same site, the cause should be investigated and appropriate corrective actions taken. Further information on the appropriate actions that should be taken can be found in the guideline technical document on total coliforms.

#### Disinfectant residuals

Maintenance of a disinfectant residual throughout the distribution system provides two main benefits: it can limit the growth of biofilm within the distribution system and its associated taste and odour problems; and a rapid drop in disinfectant residual may provide an immediate indication of treatment process malfunction or a break in the integrity of the distribution system. It is recognized that maintaining a residual may be difficult in low-flow areas such as dead-ends or extreme parts of the distribution system without producing high levels of disinfection by-products and that the implementation of other more appropriate control strategies could be

required in these locations. As mentioned earlier, certain systems may also need to include strategies to control nitrification in order to maintain their chlorine residuals. This may include: controlling water quality parameters (pH, free ammonia entering the distribution system, organic matter) and operating parameters (chlorine to ammonia weight ratio and chloramine residual); implementing corrosion control programs; flushing distribution system pipes; establishing booster chlorination or chloramination stations; and adding temporary/seasonal free chlorination (breakpoint chlorination). Other activities, such as sediment flushing in the pipe network and reservoir turnover and cleaning will help maintain water quality in the distribution system as well as prevent or delay the onset of nitrification

### Turbidity

To ensure effectiveness of disinfection and for good operation of the distribution system, it is recommended that water entering the distribution system have turbidity levels of 1.0 NTU or less. For systems that are not required to filter by the appropriate authority, a higher turbidity level may be considered acceptable, provided that a multi-barrier approach is in place.

Increases in turbidity can provide an indication of potential contamination or stagnation of water in the distribution system. Although some variation in turbidity is normal, it is good practice to minimize turbidity fluctuations. Turbidity increases can have different origins which vary considerably in the threat they can pose to water quality and public health. It is therefore not possible to establish an across-the-board maximum value for turbidity in the distribution system to be used to make public health decisions and to expect it to be protective for all situations. If an unusual, rapid, or unexpected increase in turbidity levels does occur, the system should be inspected and the cause determined. The responsible authority may choose to allow turbidity increases for individual systems, in light of a risk assessment that takes into account local knowledge of the system's capabilities and performance history.

### **3.4 Communication and public education**

An important component of the source-to-tap approach is helping consumers understand the quality of their drinking water and the role they play in maintaining this quality. Although it is generally outside the scope of drinking water purveyors, premise plumbing is included in the overall source-to-tap approach. It is important that the quality of the water delivered to consumers not lead to premise plumbing issues, such as leaching of lead, and that activities within a consumer location not adversely affect the distribution system, such as contamination through cross-connections. The key to managing many premise plumbing concerns is consumer education. This becomes particularly important as premise plumbing becomes more complex with dual plumbing and water reuse systems.

### **4.0 References**

CCME (2004). From source to tap: Guidance on the multi-barrier approach to safe drinking water. Produced jointly by the Federal-Provincial-Territorial Committee on Drinking Water and the Canadian Council of the Ministers of the Environment Water Quality Task Group. Available at: [www.ccme.ca/assets/pdf/mba\\_guidance\\_doc\\_e.pdf](http://www.ccme.ca/assets/pdf/mba_guidance_doc_e.pdf)

## 5.0 Further reading

Guideline Technical Documents (GTD) and Guidance Documents (GD) on:

- Chloramines (GTD – 1995)
- Bromate (GTD – 1998)
- Trihalomethanes (GTD – 2006)
- Chloral hydrate (GD – 2008)
- Chlorite and chlorate (GTD – 2008)
- Haloacetic acids (GTD – 2008)
- Chlorine (GTD – 2009)
- Issuing and rescinding boil water advisories (GD – 2009)
- Enteric viruses (GTD – 2011)
- *N*-Nitrosodimethylamine (GTD – 2011)
- Heterotrophic plate counts (GD – 2012)
- Enteric protozoa: *Giardia* and *Cryptosporidium* (GTD – 2012)
- *Escherichia coli* (GTD – 2012)
- Total coliforms (GTD – 2012)
- Turbidity (GTD – 2012)
- Waterborne bacterial pathogens (GD – 2013)
- Ammonia (GTD – 2013)
- Nitrate and nitrite (GTD – 2013)

All these documents are available from the Health Canada website at:  
[www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php)