Guidance for Safe Drinking Water in Canada: From Intake to Tap

Prepared by a working group of the
Federal-Provincial-Territorial Subcommittee on Drinking Water

of the

Federal-Provincial-Territorial Committee on Environmental
and Occupational Health

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Preface

This guidance document focuses on a multi-barrier approach as the most effective way to ensure Canada's drinking water supplies are clean, safe and reliable. It addresses water quality issues from intake to tap, including treatment, verification of drinking water quality, operation and maintenance of storage and distribution systems, and public awareness. The approach recognizes that while individual barriers may be inadequate in effectively removing or preventing contamination, and therefore in protecting public health, together they provide greater assurance that the water will be safe to drink over the long term. The guidance is designed specifically for the water industry (public and private), including managers and practitioners responsible for ensuring safe drinking water.

This guidance document is produced by a working group of the Federal-Provincial-Territorial Subcommittee on Drinking Water (DWS), which reports to the Federal-Provincial-Territorial Committee on Environmental and Occupational Health (CEOH). A separate document is being developed by the Canadian Council of Ministers of the Environment (CCME) Water Quality Task Group (WQTG) and looks at issues related to the safety of drinking water from source to intake, such as source water protection. These two pieces will be merged and then expanded in 2002 into a technical document for drinking water purveyors. The technical document will be developed by a consultant under the direction of the DWS and the WQTG.

1.0 Introduction

1.1 Background

In the past, many agencies in Canada and around the world have relied heavily on compliance monitoring as the mechanism for managing drinking water quality and therefore protecting public health. Compliance monitoring relies on sampling small amounts of water in a drinking water system and testing those samples for the presence of known and quantifiable organisms or substances. This approach has major limitations, including the shortcomings of sampling and monitoring techniques; inadequate consideration of the range of factors that affect drinking water quality; and failure to provide an effective response to microbiological pathogens and contaminants without a prescribed numerical guideline value or established method of analysis.

The multi-barrier approach recognizes that the key to ensuring clean, safe and reliable drinking water is to implement multiple barriers which control microbiological pathogens and contaminants that may enter the water supply system. Although the multi-barrier approach to safe drinking water is not a new concept, water purveyors around the world are beginning to shift their focus from compliance monitoring to the more holistic approach.

Implementing management and operation practices to ensure these barriers are in place and working is generally the job of regulatory agencies and owners/operators of drinking water systems. However, regulatory agencies and operators can only carry out these responsibilities if they are provided with required tools (e.g., human and financial resources, training and education). With the right tools, they are able to implement barriers, monitor their effectiveness, undertake required regulatory inspections and communicate information to the public in a timely and transparent manner.

1.2 Scope

Canada has about 9% of the world's renewable freshwater. However, more than half of this water drains northward into the Arctic Ocean and Hudson Bay, making it generally unavailable to the 90% of the Canadian population who live within 300 kilometres of the country's southern border. This fact, coupled with recent outbreaks of waterborne disease in Walkerton, Ontario, and North Battleford, Saskatchewan, has led Canadians to recognize they must treat freshwater sources as a precious resource, rather than an over-abundant commodity, in order to continue to access clean, safe and reliable drinking water.

To this end, the Federal-Provincial-Territorial Subcommittee on Drinking Water (DWS) – which represents government departments with interests in drinking water quality (usually health and environment) at the federal, provincial and territorial levels – has developed this guidance document for managing drinking water supplies in Canada.

This document considers the factors that affect drinking water quality from the intake to the tap, regardless of whether the supply is public or private, large or small, urban or rural. It identifies key elements in a comprehensive drinking water program and sets out best management practices for drinking water purveyors, with a broader goal of re-instilling public confidence in Canadian drinking water systems. This document will be expanded in 2002 into a larger, more technical document for use by drinking water authorities and others directly responsible for ensuring the safety of Canada's drinking water supplies, such as drinking water treatment plant operators. As bottled water is regulated under the Food and Drugs Act, neither this document nor the expanded technical document will address bottled water.

The DWS recognizes that source water protection is an essential component of the overall management scheme for ensuring the quality of drinking water. However, because source water protection is beyond the scope of this group's work, this report will not discuss source water protection in detail. Source water issues are the focus of the guidance document being produced by the CCME Water Quality Task Group and will be incorporated in a joint document in 2002.

2.0 Commitment to the Drinking Water Program

In order to be effective and to ensure drinking water supplies are clean, safe and reliable, drinking water programs rely on the commitment of a wide range of stakeholders. In order to build public confidence in the system, these stakeholders – including government departments, industry, private sector companies, non-governmental organizations and the public – must work cooperatively without losing sight of the ultimate goal: the protection of public health. Policies at all levels related to the quality of drinking water should support public health goals, such as ensuring the microbiological safety of supplies.

2.1 Legislation and regulation

In Canada, drinking water has historically been considered a natural resource. As such, the legislative responsibility for providing safe drinking water to the public has long been considered a provincial/territorial responsibility. Most provinces and territories have adopted enforceable regulations to protect their source waters and to establish requirements for providing drinking water, including the certification of operators.

2.2 Interjurisdictional responsibility

As mentioned, the responsibility for regulatory oversight of public drinking water quality generally lies with the provincial and territorial governments, with the obligation to provide potable water resting with the purveyor. Within each jurisdiction, the authority responsible for drinking water is normally either the ministry of health or the ministry of environment (or both). On First Nations' lands, the responsibility is divided between First Nation Band Councils, Health Canada, Indian and Northern Affairs Canada, provincial authorities and the community itself. Areas of exclusive federal jurisdiction include national parks and on-board common carriers such as airplanes, trains, buses and marine vessels.

Each of these authorities must find ways to competently manage the water supplies in its jurisdiction. Authorities should also ensure consumers have access to information about their drinking water supply which may affect their health.

2.3 Scientifically-sound and implementable drinking water quality guidelines

For the past thirty years, the provincial, territorial and federal governments have collaborated through the DWS to establish the *Guidelines for Canadian Drinking Water Quality.* Provincial and territorial authorities are responsible for the implementation of these guidelines within their jurisdictions. At the federal level, the guidelines provide a benchmark against which drinking water quality can be measured on federal lands, such as in national parks or at border crossings.

The *Guidelines for Canadian Drinking Water Quality* set out the basic parameters that every water system (public, semi-public and private) should strive to achieve in order to provide the cleanest, safest and most reliable drinking water supply possible.

Guidelines are developed for microorganisms or chemical substances which meet the following criteria:

- exposure to the microorganism or substance could lead to adverse health effects; and
- it is frequently detected in, or could be expected to be found in, a large number of Canadian drinking water supplies; or
- the level at which it is detected, or could be expected to be detected, is of health significance.

The most important drinking water guidelines deal with microbiological quality, to ensure that there is minimal risk of exposure to disease-causing organisms in drinking water. Turbidity is also considered a surrogate microbiological parameter because it is closely linked to the microbiological safety of drinking water.

Aesthetic and operational guidelines are also being developed. Aesthetic guidelines address those parameters which affect the consumer's acceptance of the water even though the substance in question is found at concentrations below which health effects may appear. These guidelines also address other characteristics of the water which may affect its taste, odour and colour.

All guideline values and supporting documentation are posted on Health Canada's water quality website (www.hc-sc.gc.ca/waterquality). Guidelines are re-assessed on an as needed basis.

2.4 Performance and design criteria

Authorities making decisions about treatment processes should select those that consistently provide potable and aesthetically-acceptable water to users. The microbiological safety of drinking water is a primary goal for public health. Therefore, barring system-specific exemptions, it is recommended that all drinking water supplies be disinfected. In addition, minimum treatment of all supplies derived from surface water sources and groundwater impacted by surface waters should include coagulation, sedimentation and filtration, or equivalent technologies.

It is also essential to develop comprehensive and scientifically defensible performance standards for those technologies that are economically affordable, effective, reliable and achievable. Treatment performance criteria are either narrative measures or numerical limits for a number of specific parameters which are required to meet a particular public health or environmental quality objective. At times, performance of available treatment technologies is limited, resulting in a less stringent drinking water quality guideline. Once new technology is available and is proven effective in achieving more stringent results, the guideline is modified.

Minimum criteria for design, construction (including materials) and operation should ensure public health protection and environmental quality objectives are met. Alternative approaches should only be used if it can be demonstrated these are better or equivalent ways of achieving the same objectives.

2.5 On-going infrastructure investment and maintenance programs

The costs of building, maintaining and operating infrastructure are very real. Assistance with funding for infrastructure projects is generally accessed through all three levels of government (municipal, provincial/territorial and federal), with each level contributing one third of the financial resources required to cover the cost of an approved project. On First Nation lands, Band Councils receive funding from Indian and Northern Affairs Canada.

It should be noted that a substantial portion of water supply infrastructure costs are borne by rate payers through normal water billing. While government "special funding" for water infrastructure is important, the user-pay model principle may better relate the true value of water to consumers.

That said, public health should be protected to the same degree regardless of the size of the community. For this reason, special consideration for additional funding support should be given to small systems in rural communities which have access to a much smaller municipal tax base than larger communities and which may not, therefore, be able to contribute their share of the capital cost of the project in question. For public health reasons, some small systems should be encouraged to amalgamate with municipal systems. Municipalities willing to take on ownership of these smaller systems should have access to financial assistance.

Faulty distribution systems are a significant cause of waterborne outbreaks. For example, a review of waterborne outbreaks in the United States from 1991 shows that 38.7% of outbreaks were caused by problems within the distribution system. For this reason, communities are strongly encouraged to have active cross-connection control programs in place, supported by municipal by-laws.

In addition, funding bodies should allocate resources along health lines: infrastructure projects that have the greatest positive health impact should be given funding priority over those that will have minimal health effects. For instance, funding for drinking water treatment plant maintenance and upgrades which will have a positive public health impact should be given priority over the construction and maintenance of other infrastructure projects.

A secondary, but no less important, cost related to infrastructure maintenance and upgrading is ensuring that installers and designers are properly qualified. In order to ensure that they are, training or certification programs may need to be put in place.

2.6 Compliance monitoring and laboratory accreditation

Compliance monitoring should be carried out using various methods to ensure test results are accurate and reported properly. Each jurisdiction should have approval processes in place for selecting laboratories, or quality assurance/quality control (QA/QC) programs, for routine testing of drinking water samples for all relevant substances, especially those which indicate the microbiological quality of drinking water. Approved microbiological tests must be those developed for drinking water; methodologies for environmental sample analysis are not appropriate in this situation. Laboratories should be accredited to perform the specific analyses required. It should be noted that laboratories are not always accredited to do all types of water analyses.

Recent events have demonstrated that guaranteeing the safety of drinking water involves more than compliance monitoring. It is equally important that water treatment plants have standards for treatment and plant operation and that mechanisms are in place to ensure these standards are followed.

It is imperative that clear lines of communication be established between the laboratory, the agency operating the treatment plant and the regulator, so test results which may affect public health can be dealt with in an open, timely and effective manner. Ideally, the local health officer in each jurisdiction, or his or her designated official, would be one of the first points of contact for the laboratories to report any unacceptable water quality results.

2.7 Education of drinking water program staff

It is critical for all members of a drinking water program – whether elected officials (including municipal), regulators, scientific staff, utility operators or others – to have access to continuing education in this field. Appropriate training ensures staff are able to make effective decisions and have knowledge and understanding of the impact of their activities and decisions on the quality of the water.

2.8 Research and development

Drinking water programs must respond to on-going research into emerging issues, with an emphasis on the microbiological quality of drinking water from source to tap. Jurisdictions should engage in local research to determine site specific health concerns and how research in other jurisdictions is applicable locally.

Water purveyors and public health officials play an important role in research by collecting data about their water systems and the health of the community; they should be encouraged to participate in research activities. Health effects can sometimes be monitored by comparing these data to local hospital admittance records, medical billing records or sales of over-the-counter pharmaceuticals. Data collected help identify whether the contaminants or pathogens in question are entering the system or are a concern in Canadian drinking water supplies. These data may form the basis of new or revised public health policies.

3.0 Assessment of the Drinking Water Supply

A comprehensive multi-barrier drinking water program includes:

- Source water protection
- Sanitary surveys of the source area and distribution system to identify and prioritize risks to health
- Watershed or well-head protection plans
- Expansion capacity for forecasted population growth
- For treated water, continuous optimal treatment
- Routine maintenance of the distribution system
- Treatment plant and distribution system classification, operator training and certification

The assessment of the drinking water supply forms the basis of all activities related to providing the cleanest, safest, most reliable drinking water to the public. Assessments identify the characteristics of the water source, potential hazards, how these hazards create risks and how these risks can best be managed. The drinking water supply includes everything from the collection of the raw water to the point where the water reaches the consumer.

3.1 Selecting source waters

The first step in implementing a drinking water program is to identify water to be used as the source of drinking water. At this stage, an assessment should be made of the potential risks associated with the source. Risks could include wildlife in a watershed, recreational activities such as boating in a reservoir, wastewater treatment plants nearby, agricultural or industrial activities, etc. The system should be designed to minimize the impact of the risks over time. The characteristics of the source water – including physical (such as aquifer characteristics for groundwater sources), microbiological and chemical parameters, and the types of natural and anthropogenic contaminants present – determine the type of treatment required in order to deliver the cleanest, safest, most reliable drinking water to the public. Wherever possible, the system chosen should also be capable of being adapted to deal with unforeseen contaminants.

3.2 Groundwater wells, intakes and raw water reservoirs

Some of the key characteristics in the design and the construction of groundwater wells, intakes and raw water reservoirs are the location, size and capacity, seasonal variations, retention times, design period, etc. In assessing these components, all potential hazards and their causes should be identified, and the level of risk associated with each of the hazards estimated, so priorities for risk management action can be established.

3.3 Treatment system

Treatment systems should be designed based on the site-specific raw water quality. Seasonal variations should be taken into account. Characteristics include treatment processes, treatment components, equipment design, chemicals used, treatment efficiency, monitoring procedures, etc. The treatment selected should address all potential hazards and the level of risk associated with those hazards.

3.4 Treated water reservoir, service connections and distribution system

Treated water reservoirs and distribution systems should be designed to take the following into account: access by wildlife and people, system capacity, emergency water storage, contact time required for disinfection, minimizing or eliminating dead ends, and cross-connection controls. They should also be designed and constructed in compliance with all local or provincial by-laws, best management practices and regulations.

Drinking water purveyors and consumers should be advised when purchasing materials that will come into contact with their drinking water (such as chemicals, plumbing materials or water filters) to buy only certified products which meet recognized health-based performance standards. This caution is particularly important for consumers purchasing off-the-shelf products which they will install themselves; licensed home builders and plumbers are required to install only certified products into homes in order to meet the requirements of plumbing codes. Nonetheless, proper operation and maintenance of these products by the consumer are equally important to reducing the risk of illness.

4.0 Drinking Water Quality Management

4.1 Regulatory control

Regulatory agencies set, and ensure compliance with, standards. Waterworks projects should be reviewed and, once approved, should have conditions to be met clearly outlined. Treatment plants should be inspected on an on-going basis to ensure quality benchmarks are being met. If these benchmarks are not being met, processes should be in place to remediate the situation. Compliance tools will vary from jurisdiction to jurisdiction.

4.2 Operational procedures

The proper maintenance and operation of water supply, treatment and distribution systems are essential parts of any effort to ensure the on-going production and delivery of the highest quality drinking water possible. Operational procedures vary between treatment plants and between jurisdictions, but, generally speaking, operational-related monitoring requirements should be in place and clear; plants should be supervised by trained and certified operators; operator training programs should be available; facilities should be inspected on a regular basis; and administrative support should be available.

4.3 Monitoring, reporting and record-keeping

Monitoring drinking water quality occurs on a number of levels. Protocols should be in place for all activities, including selection of laboratories, routine monitoring, sample analysis and public notification, and may vary from jurisdiction to jurisdiction. In general, monitoring requirements are specified by regulatory agencies.

Routine monitoring entails taking samples of raw water at the intake, water at the treatment plant or from wells, and treated water in the distribution system at predetermined intervals to verify the quality of the water. Monitoring results should be reported directly to the drinking water authority as well as be available to the public. As mentioned previously, it is imperative for a reporting system to be in place for notifying the public when test results show drinking water presents a potentially serious health risk, or to explain the significance of changes in aesthetic quality. It is particularly important to have protocols in place dealing with the microbiological quality of the drinking water.

Other types of monitoring include on-going assessment of the location of sampling sites. Because samples are taken from such a small fraction of the water in any given system, as much as possible should be done to ensure the water in the samples is representative of the quality of the water throughout the plant and distribution system. In order to quickly remediate situations where water flow appears to be restricted, it is imperative that up-to-date drawings of the distribution system be kept in an accessible location.

Treatment plants may opt to use computer technology to help monitor water quality and operational variables (such as water pressure) on an automated basis. In addition, in order to facilitate the exchange of information about the water supply, jurisdictions may wish to set up databases which can be accessed by multiple users. More and more, members of the public are expecting to be able to access information over the Internet about their water supply which may affect their health.

4.4 Certification and training

Because treatment plant and distribution system operators have a significant degree of control over the quality of a community's drinking water, and thus over public health, appropriate and up-to-date training is essential. This training must include basic education about the need for disinfection to ensure public health goals are met.

Drinking water supplies in Canada and the United States are classified into categories based on size and complexity of operation. These classifications are used as the basis for training and certification programs for treatment plant operators.

Operator certification programs should be available to ensure treatment plant operators have appropriate levels of education, experience and knowledge to allow them to competently operate the type of plant they are working in.

It is imperative that operators and other staff have on-going access to opportunities for maintaining and upgrading their skills and knowledge on a regular basis.

4.5 Incident and emergency plans

Every system must have a set of procedures to follow in the event of incidents and emergencies. These procedures should be in place well in advance of any event. Plans should cover off any number of incidents, such as loss of source water, major main breaks, vandalism, power failure and deliberate chemical or biological contamination of the distribution system or reservoirs. Emergency plans should include clear procedures for the remediation of the situation and communication with appropriate authorities.

4.6 Third-party evaluation and audit

Any system as large and important as delivering clean, safe and reliable drinking water requires evaluation to ensure services are being delivered as planned and expected. For Canadian drinking water programs, evaluations verify that the elements detailed in this framework have been implemented properly and are being carried out effectively. The results of the evaluation are used as the basis for making improvements in future years.

Formal auditing can be carried out in the following areas:

- Distribution system audits
- Construction audits
- Operational audits
- Regulatory compliance audits
- Treatment performance audits
- Administrative compliance audits
- Water quality data audits
- Design professional audits

5.0 Public Awareness and Involvement

The public has expectations of government transparency, especially about issues that affect its health. As noted earlier, public involvement in the drinking water program is key to its success. Involving the public at every stage means:

- Making monitoring results or summaries available and easily accessible, such as on the Internet
- Notifying the public about risks to their health and what the authority is doing to address the risks
- Issuing regular reports about drinking water systems, including improvements and areas which need further attention
- Educating the public on a number of issues, including: the benefits of disinfection over the risks of microbiological contamination and disease; how guidelines are developed and what the values mean; how to prevent deterioration of water quality in the home; and the true cost of providing safe drinking water
- Incorporating public consultations into decision-making processes which have an effect on public health, including the development process for new guidelines and regulations
- Education about water conservation issues

In the area of boil water advisories, members of the public must be informed when an advisory has been issued for their community, be given detailed information about the reason(s) for the advisory (whether it is precautionary or in response to an outbreak), and be told how long it is expected to be in place. Authorities should also consider visitors to their community when issuing an advisory – frequent advertising in highly visible areas may be prudent.

Private well owners need to be made aware that they are responsible for the quality of their own water, and that this should be tested regularly. This also applies to owners of private surface waters who use these as a source of drinking water. Owners need to know what to do should microbiological contamination occur or chemical contaminants be found in their drinking water, and how to properly abandon wells that are no longer safe or needed.