

Total Quality Approach to Drinking Water
International Conference on Water and Health
September 23-25, 2002

CONFERENCE DISCUSSION DOCUMENT

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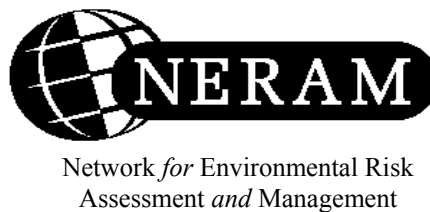


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Conference Objective

In addition to dissemination and discussion of drinking water quality research findings, the conference goal is to produce a document that presents expert opinions on how, over the next 5 years, significant advances can be made in drinking water safety to prevent a recurrence of the Walkerton tragedy. What are the most pressing needs, issues and actions?

The expected outcome is a set of priorities for implementation in the next 5 to 10 years. These will become candidates for adoption by governments, operators, laboratories etc. and for each priority it will then be necessary to develop guidelines, standards, best practices, or procedures.

This document provides a structured basis and a starting point for the break-out session discussions and the recording of expert opinions on the most pressing issues to be faced to ensure safe drinking water in Canada. Recommendations for practices and policies are drawn largely from Ontario through the report of Walkerton Inquiry (O'Connor, 2002b) as Justice O'Connor's report reflects extensive review of literature, input from leading water quality experts on best practice in water management and regulation around the world and the latest in science and technology. The discussion of priorities for effective risk management should not be limited to drinking water safety needs in Ontario nor to the issues and recommendations identified in this document.

The priority setting exercise is not trivial and there is no "right" answer. This conference is just one step towards reaching consensus on priority actions to ensure safe drinking water in Canada. Priorities are necessary because of the following constraints:

- i) Time and resources are required to improve the drinking water system. For example, in Ontario not all 93 recommendations of the Walkerton Inquiry are possible to implement in a 5 year period.
- ii) Methods of risk assessment, application of the precautionary principle, risk communication with system users, and other methods for implementing the recommendations are not well developed nor readily available.
- iii) Numerical data to assess the "safety" of the drinking water system and guide priority setting are limited.

Priorities to Improve Drinking Water Safety

The Reports of the Walkerton Inquiry (O'Connor, 2002a, 2002b) provide a starting point for a Canadian strategy for safe drinking water. Justice O'Connor's 93 recommendations address various dimensions of the water system including source protection, standards and technology for treatment and monitoring, quality management of operating agencies, and strengthening provincial oversight of water delivery systems. A review of waterborne outbreaks in Walkerton and the developed world over the past 30 years identified failures in more than one of the following main elements of the multiple barrier water system: source, treatment, distribution, monitoring, and response and a pervasive culture of complacency among key players in the drinking water system (Hrudey, 2002). The review notes the discouraging observation that the highly publicized Walkerton tragedy in May 2000 was insufficient to lead to improvements to prevent the spring 2001 waterborne disease outbreak in North Battleford Saskatchewan and

suggests the need to ensure a wider understanding of what is necessary to assure safety drinking water.

The following excerpts from the Walkerton Inquiry reports illustrate the objectives and challenges in achieving drinking water safety.

THE OVERARCHING GOAL: SAFE DRINKING WATER

- Safe means that the risk associated with drinking water is so minimal that a reasonable and informed person would feel safe drinking the water (O'Connor, 2002b, p. 74).

LACK OF COMPLIANCE WITH CURRENT POLICIES AND PROCEDURES

- It is clear that the technology for treating and monitoring water quality to a high standard is well established. Failures in Walkerton, and elsewhere, appear to arise because of poor management or the inadequate implementation of good practices (Hrudey 2002).¹ The outbreak would have been prevented by the use of continuous chlorine residual and turbidity monitors at Well 5. Well 5 was supplied by a groundwater source that was under the direct influence of surface water. For such sources the Ontario Drinking Water Objectives (ODWO) was amended in 1994 to require continuous monitoring of chlorine residuals and turbidity. The failure to use continuous monitors at Well 5 resulted from shortcomings in the approvals and inspections programs of the Ministry of the Environment (MOE). (O'Connor, 2002a, p. 25).
- Of the 659 plants inspected by MOE in 2000, more than half were identified with one more deficiencies in the following areas: inadequate sampling programs (267), inadequate disinfection procedures (111); failure to meet minimum treatment standards (76) or improperly certify operators (63) (O'Connor, 2002b, p. 442) (Justice O'Connor noted that the deficiencies may be overstated).

CRITERIA FOR DECISIONS

- Major institutional changes are recommended only if necessary and only if clear benefits outweigh the inevitable substantial costs (O'Connor, 2002b, p. 401).

DECISION ANALYSIS

- The government should conduct a risk assessment for decisions to fund drinking water safety programs in which the risks that might result from the decision are identified and assessed. The approach to risk assessment should be precautionary in always erring on the side of caution (O'Connor, 2002b, p. 465).

¹ Hrudey, et al. (2002) provide a short list of key principles for drinking water safety including: maintaining effective treatment and disinfection of pathogens; enhanced vigilance during sudden or extreme changes in water quality, flow or environment conditions; robust and resilient multiple barriers; effective response by system operators to adverse monitoring signals; a sense of personal dedication among those responsible for providing safe drinking water.

PRACTICAL CHANGES

- In relation to physical and technical capabilities of the municipal water system it is important that the MOE approve systems and any significant modifications to systems in order to ensure that each system is capable of meeting minimum requirements and that it does not wildly exceed what would reasonably be required (O'Connor, 2002b, p. 423).

COMPLEXITY – E.G. TRAINING REQUIREMENTS

- These courses (for technical staff) should emphasize science and technology, including all matters that could present a risk to public health and safety; emergency pathogen risks; existing, new and emerging treatment technologies; the limits of particular technologies; and the proper interpretation and application of government regulations, guidelines, and policies (O'Connor, 2002b, p. 467).

Break-out Group Priority Setting Process

Seven major topics for Total Quality Management of Drinking Water Safety will be discussed in two break-out group sessions to be held on Day Two and Day Three of the conference. The topics are proposed to structure the debate to be sure that it is comprehensive and that existing recommendations and options for improving drinking water safety are considered. The topics are designed to capture the broad scope of recommendations on governance, oversight, technology, total quality management, and a variety of threats to and risks associated with drinking water as set out in the Part Two report of the Walkerton Inquiry (O'Connor, 2002) and the North Battleford Saskatchewan Inquiry (Laing, 2002). Membership of the three break out groups will be preselected according to the areas of expertise required for informed discussion of the topics assigned to each break out group. The topics for discussion and group assignments are as follows:

Group 1 <i>Drawing Room</i>	Group 2 <i>Quebec Suite</i>	Group 3 <i>Renaissance Room Tuesday MacDonald Room Wednesday</i>
Governance and Oversight – Governance, auditing, monitoring, etc. to ensure low risk, continuous improvement, and adequate resources. This includes the requirement to be transparent and to communicate with the users and public.	Water Sources – Risks to drinking water safety posed by the adequacy and quality of sources of drinking water.	Best Practice – Best practice for design and operation of drinking water systems recognizing the diversity in: sources of water, size of system, available technology, and local user characteristics.
Quality Control and Assurance – Quality control and assurance to public on the quality of their drinking water, including; laboratory testing, performance measures, and third party validation.	Emerging Threats – What threats and new risks will drinking water systems have to cope with? How can these risk issues best be managed?	Research and Innovation – Dramatic improvements in safety are usually linked to new technology, new processes or other new ideas. Where should we look for innovative new approaches and how can it be encouraged?
Human Resources – Training needs, accreditation, licensing and so forth.		

Break out Session I: Tuesday September 24 15:00 – 17:30 pm

15:00 – 17:00 pm Break out groups will convene to consider the assigned topics and identify priority recommendations for drinking water safety improvement. As a starting point for discussion, existing recommendations from recent Canadian drinking water inquiries are provided in this document for each topic (refer to table of contents). A suggested approach is to use the following prompting questions, however other approaches to identify priorities may be used by the group.

- Is present performance satisfactory – if not, what are the outstanding problems? What are the opportunities and or options?
- Are current standards, procedures, methods acceptable and can they be expressed in terms of risk (or safety)?
- What is the most important issue/solution that needs research, development, or improvement? Is it cost effective?
- Are there any special issues related to transparency (risk communications) and analysis of uncertainty (risk analysis)?

17:00 – 17:30 pm Delegates will select up to three priority recommendations for action for each topic. A Post-it note exercise may be used to indicate priorities.

Review and discussion of outcome. Clarification of group position for reporting in opening plenary session at 8:30 am on Wednesday September 25. Each group will have 10 minutes to present a summary of discussion and priorities for action. Rapporteurs are asked to submit a brief report to the conference organizers by 19:00 pm on Tuesday September 24 so that a summary of results can be distributed to delegates the following morning.

Break out Session II: September 25 10:30 – 11:45 am

A summary of priority recommendations for each topic resulting from break out Session 1 discussions will be distributed to delegates. The purpose of this session is to identify priorities for total water quality management from the complete list of recommendations from all 7 topic areas. Each recommendation will be ranked as a low, medium or high priority according to the expert judgment of the group. Key benefits and barriers related to each issue and/or implementation of the recommendation selected as a priority will be discussed. The results should be summarized for presentation and discussion in the concluding plenary session.

TOPIC 1: GOVERNANCE AND OVERSIGHT

Background

In Ontario, for example, The Ministry of the Environment (MOE) is the provincial government ministry with primary responsibility for regulating and enforcing legislation, regulations, and policies that apply to the construction and operation of municipal water systems. The MOE sets the standards according to which municipal systems are built and operated. It also approves the construction of new water facilities, certifies water plant operators, and oversees the treatment, distribution, and monitoring practices of municipal water facilities. The overall goal is to ensure that water systems are built and operated in a way that produces safe water and does not threaten public health. The Part One report of the Walkerton Inquiry concluded that a number of MOE programs or policies involved in the regulation and oversight of Walkerton's water system were deficient. A number of significant issues were raised in both parts of the Inquiry including the contents of the Certificates of Approval, the frequency of inspections, the desirability of unannounced inspections, the need for more direction on the scope of inspections, the need for more attention to follow-up on identified deficiencies, the need to improve the training and qualifications of MOE staff, the preference for voluntary rather than mandatory abatement and the need for a strict enforcement policy. Other inadequacies were related to the MOE's management of information and the use of guidelines (ODWO and the Chlorination Bulletin) rather than legally binding regulations to set out the requirements for chlorination and monitoring. Following the Walkerton incident the MOE developed a new Drinking Water Protection Regulation, Ontario Regulation 459/00. The revised ODWO and the Chlorination Bulletin are referred to in the new regulation. The regulation requires increased testing and treatment of water, mandatory water sampling by all waterworks and testing by accredited labs; stricter reporting procedures, more frequent inspections, upgrading of existing water treatment systems; the issuance of quarterly reports by large waterworks, public access to sample results, approvals and orders. In 2001, the provincial government passed Regulation 505/01 requiring small water systems to meet certain treatment requirements.

The Gibbons report entitled [*Managing the Environment: A Review of Best Practices*](#) was commissioned by the Ontario Government to provide an independent review of best practice in environmental regulation and oversight in other jurisdictions and make recommendations for environmental management in Ontario. Justice O'Connor noted that the Gibbons report describes a number of shortcomings that were also identified in submissions to the Walkerton Inquiry, including the absence of a top-down strategic approach, the need for more resources and for a better allocation of resources, the need to rebuild or obtain access to sufficient expertise, and the need to better integrate existing data and information to support policy development.

In Saskatchewan, Justice Robert Laing's investigation into the April 2001 Cryptosporidium outbreak at North Battleford Saskatchewan identified a number of shortcomings with respect to the governance and oversight role played by the provincial regulator, Saskatchewan Environment and Resource Ministry (SERM) in the management of drinking water safety (Laing, 2002). SERM had abandoned its inspection program of surface water treatment plants in 1993 and adopted a "risk-based" model, based on bacteriological monitoring only of those municipalities who chose to submit bacteriological samples. The risk-based model used by SERM since 1996 was criticized as being based primarily on economics and having nothing to do with how best to safeguard health. The lack of inspection by SERM of the North Battleford surface water treatment plant for ten years prior to 2001 was identified as having a direct bearing on the events of April 2001. SERM had no timely information on how the operations in any particular plant were being conducted, or the quality of the

persons conducting them. SERM had no program for regular and ongoing inspection of all water treatment facilities for the purpose of determining compliance with permit requirements and to assess the quality of the infrastructure and operations procedures. Beyond the legislated standard for chlorine residuals, SERM did not establish mandatory standards with respect to water treatment and were reluctant to enforce compliance on those municipalities who did not meet operating requirements. City of North Battleford officials did not fully appreciate the health aspects of drinking water and the municipality's statutory responsibility to produce safe drinking water. The Water Management Framework produced by SERM illustrated that the government and SERM were well aware of the requirements for safe drinking water, however the framework lacked an implementation strategy. Justice Laing was critical of the total lack of transparency in decisions made to cut budgets and minimize SERM's supervisory role to the point that SERM was prepared to withdraw from active regulation except for bacteriological follow-up.

Initial Recommendations to Improve Governance and Oversight (G)

G1 Need for a coherent and comprehensive drinking water strategy by the responsible government Ministry.

- The provincial government should develop a comprehensive "source to tap" drinking water policy covering all elements of the provision of drinking water, from source protection to standards development, treatment, distribution, and emergency response. (O'Connor, 2002b, Recommendation 65 p. 399)
- That the City of North Battleford prepare a written safe drinking water policy that commits to the principle of quality of water over quantity of water, that commits to maintaining best industry practices in its water treatment plants, and that encourages the manager of the water treatment plant to report directly to city council whenever he has concerns that affect the safety of drinking water which are not being addressed by city administration officials. (Laing, 2002, Recommendation 5 p. 109)

G2 The strategy of the responsible Ministry should be expressed through co-ordinated legislative arrangements.

- The provincial government should enact a Safe Drinking Water Act to deal with matters related to the treatment and distribution of drinking water. (O'Connor, 2002b, Recommendation 67 p. 405)
- The provincial government should amend the Environmental Protection Act to implement the recommendations regarding source protection. (O'Connor, 2002b, Recommendation 68 p. 410)
- The Ministry of the Environment should take the lead role in regulating the potential impacts of farm activities on drinking water sources. The Ministry of Agriculture, Food and Rural Affairs should provide technical support to the Ministry of the Environment and should continue to advise farmers about the protection of drinking water sources. (O'Connor, 2002b, Recommendation 11 p. 130)
- That the Environmental Management and Protection Act be amended to provide that within the drinking water quality unit in SERM there exist a separate compliance section (Laing, 2002, Recommendation 26, p. 290)
- That the Water Pollution Control and Waterworks Amendment Regulations be amended: a) to provide that in the event of persistent non-compliance by a municipality, the regulator may order the replacement of the existing management or operators and may temporarily hire replacements as required at the municipality's expense; and b) to make it an offence to knowingly operate a water treatment facility in contravention of the operational requirements set out in the operating permit (Laing, 2002, Recommendation 28, p. 290)

G3 Need for transparency and prominence of drinking water safety within the responsible government Ministry.

- The provincial government should create a Drinking Water Branch within the Ministry of the Environment to be responsible for overseeing the drinking water treatment and distribution system. (O'Connor, 2002b, Recommendation 69, p. 414)
- That Environmental Management and Protection Act (EMPA) be amended to establish a separate drinking water quality unit in SERM whether it is called a branch, a directorate, or a section, with its own "director" (Laing, 2002, Recommendation 26, p. 290)
- The provincial government should create an office of Chief Inspector – Drinking Water Systems (O'Connor 2002b, Recommendation 72, p. 431)
- The provincial government should create a Watershed Management Branch within the Ministry of the Environment to be responsible for oversight of watershed-based source protection plans and, if implemented, watershed management plans. (O'Connor, 2002b, Recommendation 70, p. 416)
- The Ministry of the Environment should initiate a process whereby the public can require the Investigations and Enforcement Branch to investigate alleged violations of drinking water provisions (O'Connor, 2002b, Recommendation 76, p. 453)
- I suggest that the federal-provincial process for proposing drinking water quality guidelines be refined to provide for greater transparency and public participation (O'Connor, 2002b, Recommendation 21, p. 151)

G4 Need for an integrated database maintained by the responsible government Ministry.

- The Ministry of the Environment should create an Integrated Divisional System (IDS) which provides central electronic access to information:
 - relevant to source protection;
 - relevant to each drinking water system in Ontario (including a description of the system, trend analyses, water quality, and systems data);
 - required by the Drinking Water Branch (including for approvals and inspections); and
 - required by local Boards of Health. (O'Connor, 2002b, Recommendation 79 p. 468)
- That the Government of Saskatchewan approve SERM'S request to fund an integrated provincial water quality database in the fiscal year 2002-2003. (Laing, 2002, Recommendation 12, p. 183)

G5 Need for annual performance evaluations and reporting to public.

- The Drinking Water Branch should prepare an annual "State of Ontario's Drinking Water Report", which should be tabled in the Legislature (O'Connor, 2002b, Recommendation 80, p. 470)
- That the subcommittee of council prepare a report annually for the city council on the state of drinking water in the city, which report shall be part of the public record (Laing, 2002, Recommendation 8, p. 108)
- That EMPA be amended to provide that the drinking water quality unit in SERM provide that the unit produce an annual report to the legislature on the state of drinking water quality in the province (Laing, 2002, Recommendation 26, p. 290)
- That the public health officers for the health districts be briefed annually by a SERM representative for the purpose of learning the state of water treatment systems in the district, and what the potential may be for problems that might lead to disease (Laing, 2002, Recommendation 21, p. 195)

G6 Need for consultation between stakeholders, especially those with direct responsibility and roles in the provision of drinking water

- The role of the Ontario Clean Water Agency in offering operational services to municipalities should be maintained. The provincial government should clarify the Ontario Clean Water Agency's status and mandate. In particular, OCWA should be:
 - an arm's-length agency with an independent, qualified board
 - responsible for choosing the chief executive; and
 - available to provide standby emergency capabilities (O'Connor, 2002b, Recommendation 50 p. 331)
- The Ministry of the Environment should work with the Ministry of Agriculture, Food and Rural Affairs, agricultural groups, conservation authorities, municipalities, and other interested groups to create a provincial framework for developing individual farm water protection plans. (O'Connor, 2002b, Recommendation 15 p. 141)

G7 Responsible authorities to increase commitment to mandatory abatement and enforcement to ensure compliance with all safety policies.

- The Ministry of the Environment should increase its commitment to the use of mandatory abatement (O'Connor, 2002b, Recommendation 74, p. 443)
- The Ministry of the Environment should increase its commitment to strict enforcement of all regulations and provisions related to the safety of drinking water. (O'Connor, 2002b, Recommendation 75, p. 451)
- That the regulator pursue a comprehensive inspection policy of water treatment facilities and apply a rigorous abatement-enforcement compliance policy on all water treatment facilities (Laing, 2002, Recommendation 27 p. 290)
- To better ensure that surface water treatment plants remain capable in both infrastructure and operations year after year, that they be inspected by the regulator at least biannually by a person knowledgeable in surface water treatment best industry practices. This inspection should include: a record review to determine the level of compliance with the parameters for performance and sampling requirements set out in the permit; a review of the plant's processes and their operational effectiveness; an interview with the manager; and an interview with at least one operator a) that a detailed inspection report be produced that records any non-compliance with permit requirements, recommends any improvements to be made and a timetable for the same, and offers an overall grading of where the plant fits in the spectrum of quality for surface water treatment plants. b) that a copy of the inspection report be delivered to the manager of the plant, to the city commissioner or his or her equivalent, and to the medical health officer for the health district. (Laing, 2002, Recommendation 11, p. 171)
- That the regulator pursue a comprehensive inspection policy of water treatment facilities and apply a rigorous abatement-enforcement compliance policy on all water treatment facilities. (Laing, 2002, Recommendation 27, p. 290)
- That the new data system incorporate the permit requirements for each licensee with a flagging system to identify communities that have not submitted the required samples and produce a printout on a weekly basis of all such non-compliances. a) that all non-compliances be followed up, within 7 days, with the chief municipal administrator or his or her designate b) that with respect to a missed bacteriological sample, the municipality be advised to submit one within seven days. In the event the municipality fails to do so a precautionary drinking water advisory (PDWA) be issued. (Laing, 2002, Recommendation 14, p. 183)

That in the event of persistent non-compliance by a municipality with respect to bacteriological sampling requirements, the regulator should appoint new management, or should rescind the permit to operate the facility. (Laing, 2002, Recommendation 15, p. 184)

G8 Responsible authorities to ensure level of safety for small systems (also farms and first nations)

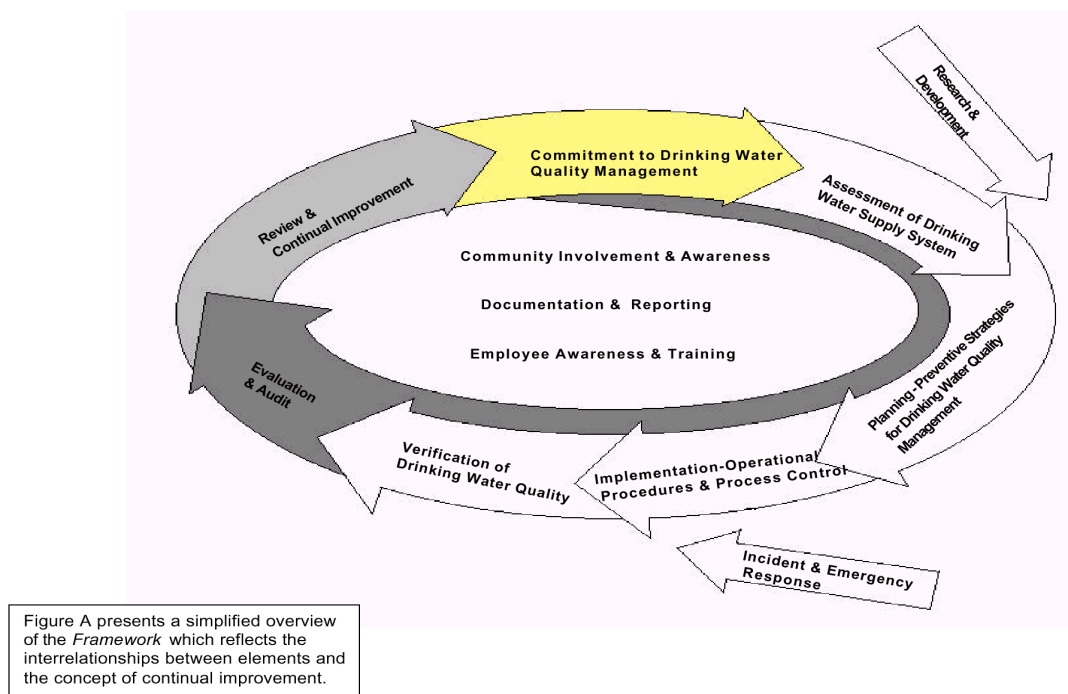
- The Ministry of the Environment should establish a procedure under which owners of communal water systems may apply for a variance from provincial regulations only if a risk analysis and management plan demonstrate that safe drinking water can be provided by means other than those laid down in regulations. (O'Connor, 2002b, Recommendation 82, p. 474)
- As a matter of principle, the provincial government should make technical assistance, drinking water testing, inspection, and enforcement available to First Nations communities on a cost-recovery basis, if requested. (O'Connor, 2002b, Recommendation 93, p. 497)
- The provincial government should require the Ontario Clean Water Agency (OCWA) to offer its services to First Nations band councils for operating on-reserve water systems on a normal commercial basis. (O'Connor, 2002b, Recommendation 91, p. 496)

TOPIC 2. QUALITY CONTROL AND ASSURANCE

Background

Justice O'Connor concluded that the failures in Walkerton, and elsewhere, appear to arise because of poor management or the inadequate implementation of good practices (O'Connor, 2002b, Hrudey et al. 2002). To prevent future water quality failures, Justice O'Connor recommended that municipal water providers adopt a "quality management" approach consisting of the following key principles: the adoption of best practices and continuous improvement; "real time" process control (e.g. the continuous monitoring of turbidity, chlorine residual, and disinfectant contact time) wherever feasible; the effective operation robust multiple barriers to protect public health; preventive rather than strictly reactive strategies to identify and manage risks to public health; and effective leadership (O'Connor, 2002b, p. 336). The quality management approach extends beyond compliance monitoring, requiring commitment from managers and staff at all levels to continuous improvement of the water system. The Australian Framework for Management of Drinking Water Quality, The New Zealand Guidelines for Drinking Water Quality Management and the programs of the American Water Works Association were described in Justice O'Connor's report as examples for the MOE to consider in developing a drinking water quality standard for Ontario. The Australian Framework includes 12 interrelated elements considered good practice for system management of drinking water safety as illustrated in Figure 1 (NHMRC/ARMCANZ, 2001).

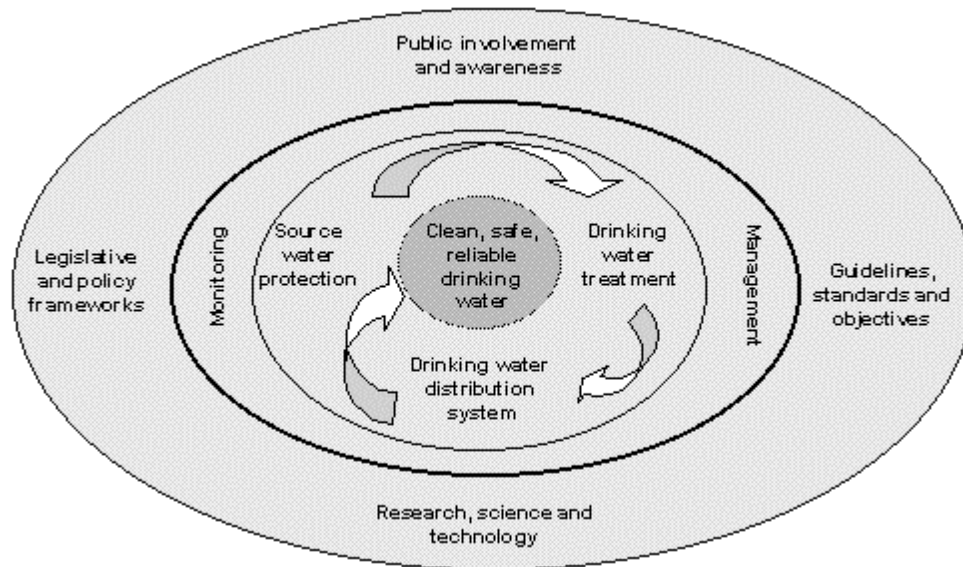
Figure 1: Australian Framework for Management of Drinking Water Quality



The Framework is providing the primary basis for the 2002 revision of the Australian Drinking Water Guidelines.

The Canadian Federal-Provincial-Territorial Committee on Drinking Water and the Canadian Council of Ministers of Environment's Water Quality Task Group recently released a position paper outlining a Source to Tap multi-barrier approach to drinking water protection (CEOH/CCME, 2002). The multi-barrier approach is defined as *"an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water from source to tap in order to reduce risks to public health"*. The approach consists of three major elements - source water protection, drinking water treatment, and the drinking water distribution system. These elements of the multi-barrier approach are addressed in an integrated manner by using a system of water quality monitoring and management of water supplies from source to tap; legislative and policy frameworks, public involvement and awareness; guidelines, standards and objectives, research and the development of science and technology solutions. The elements of the Multi-Barrier Approach are depicted in Figure 2 below:

Figure 2: The Canadian Multi-Barrier Approach



A comprehensive technical supporting document is under development to provide guidance to authorities in implementing the Source to Tap approach in communities across Canada. For a description of how these two frameworks are linked to the NERAM benchmark risk management framework, an evolving framework for systematic risk management, see Appendix A.

Initial Recommendations for Quality Control and Assurance (Q)

Q1 Need for municipalities to have approved management and operating plan including risk analysis and assessment of all risks to drinking water.

- The provincial government should require all owners of municipal water systems, as condition of their license (see Recommendation 71), to have an accredited operating agency, whether internal or external to the municipality. (O'Connor, 2002b, Recommendation 51, p. 346)
- Accreditation should be based on an independent audit and a periodic review by a certified accrediting body. (O'Connor, 2002b, Recommendation 52, p. 347)
- Operational plans should be approved and reviewed as part of the Ministry of the Environment approvals and inspections programs. (O'Connor, 2002b, Recommendation 57, p. 359)
- The Ministry of the Environment should require the owners of municipal water systems to obtain an owner's license for the operation of their waterworks. In order to obtain a license, an owner should have:
 - a Certificate of Approval for the facility;
 - a Permit to Take Water;
 - approved operational plans;
 - an approved financial plan; and
 - an accredited operating agency. (O'Connor, 2002b, Recommendation 71, p. 422)
- Each permit to operate a surface water treatment plant should require as a condition to operate that there exist a quality control/quality assurance written policy in place that is acceptable to the regulator. (Laing, 2002, Recommendation 3 p. 75).

- That in the future the performance requirements expected of a surface water treatment plant be itemized in its permit to operate, and include not only the parameters to be met, but also the quality assurance and quality control procedures that are to be in place. (Laing, 2002, Recommendation 10 p. 171).
- Municipalities should review the management and operating structure for their water system to ensure that it is capable of providing safe drinking water on a reliable basis. (O'Connor, 2002b, Recommendation 44 p. 281).
- That the City of North Battleford in the next six months: a) install a supervisory control and data acquisition system (SCADA) in the surface water treatment plant; b) retain a management consultant to assess the adequacy of the management component and the operator component of the plants department and to report within a further two months..and c) commission an engineering study to determine if the city's resource capacity is adequate (Laing, 2002, Recommendation 12 p. 180).
- Given that the safety of drinking water is essential for public health, those who discharge the oversight responsibilities of the municipality should be held to a statutory standard of care (O'Connor, 2002b, Recommendation 45, p. 296)

Q2 Responsible authorities to develop drinking quality management standard including information management, regular reporting, audits, performance analysis, peer review and assessments of options for restructuring.

- The Ministry of the Environment should initiate the development of a drinking water quality management standard for Ontario. Municipalities, the water industry, and other relevant stakeholders should be actively recruited to take part in the development of the standard. The water industry is recognized as an essential participant in this initiative. (O'Connor, 2002b, Recommendation 53, p. 348)
- The drinking water quality management standard should come into force by a date to be fixed by the provincial government. All municipalities should be required under the *Safe Drinking Water Act* (see Recommendation 67) to have an operating agency for their water system accredited within a specified time. (O'Connor, 2002b, Recommendation 55, p. 353)
- I encourage First Nations and the federal government to consider moving to a quality management standard over time, even if the consequence is that several communities, perhaps both reserve and non-reserve, might collaborate on a regional basis, or that First Nation communities might choose to contract with others to manage their water supply systems. (O'Connor, 2002b, Recommendation 90, p. 495)
- That the criteria for surface water treatment plants reporting to SERM be standardized for the province, and not differ between EcoRegions (Laing, 2002, Recommendation 1 p. 33).

Q3 Drinking water testing laboratories should be accredited, licensed and periodically inspected by the responsible provincial authorities.

- The provincial government should phase in the mandatory accreditation of laboratories for all testing parameters, and all drinking water testing should be performed only by accredited facilities (O'Connor, 2002, Recommendation 41, p. 268).
- The Ministry of the Environment should license and periodically inspect, as required, environmental laboratories that offer drinking water testing; as with water treatment operations, continuing accreditation should be a condition of license (O'Connor 2002, Recommendation 42, p. 268).

Q4 Responsible Ministry to specify decision criteria in approach to setting standards.

- Standards setting should be based on a precautionary approach, particularly with respect to contaminants whose effects on human health are unknown. (O'Connor, 2002b Recommendation 19, p. 150)

Q5 Responsible authorities to update drinking water guidelines based on best available science.

- I suggest that the Federal-Provincial Subcommittee on Drinking Water focus on drinking water quality guidelines. I encourage Health Canada to commit the required scientific support to the federal-provincial process for proposing drinking water quality guidelines. (O'Connor, 2002b; Recommendation 22, p. 154)

Q6 Existing most stringent standards should be the starting point for standards

- I encourage the federal government to adopt standards that are as stringent as, or more stringent than, Ontario Regulation 459/00 for all federal facilities, Indian reserves, national parks, military installations, and other lands under federal jurisdiction in Ontario. (O'Connor, 2002b, Recommendation 23, p. 155)

Q7 Responsible authorities in collaboration with water industry stakeholders to develop an emergency response plan for municipal water providers.

- The Ministry of the Environment should work with Emergency Measures Ontario and water industry associations to develop a generic emergency response plan for municipal water providers. A viable and current emergency response plan, and procedures for training and periodic testing of the plan, should be an essential element of mandatory accreditation and operational planning. (O'Connor, 2002b, Recommendation 58, p. 366)
- That a provincial protocol for water-borne disease investigation be prepared, distributed, and adopted by all health districts in the province. (Laing, 2002, Recommendation 16 p. 187)
- That the provincial Department of Health prepare for distribution to all health districts guidelines, including sample documents where appropriate, for all action to be taken by a health district once a PDWA or a boil water order is issued. (Laing, 2002, Recommendation 193 p. 306)
- A steering group should be established within each public health unit area in the province, comprised of representatives of affected local hospitals, municipalities, local Ministry of the Environment offices and local boards of health, for the purpose of developing in a coordinated fashion emergency response plans for the control of, or the response to, infectious diseases and public health hazard outbreaks. (O'Connor, 2002b, Recommendation 77, p. 461)

TOPIC 3. HUMAN RESOURCES

Background

Both the Walkerton and the North Battleford Saskatchewan inquiries revealed that water system operators lacked the training and expertise required to understand the need for proper treatment and monitoring practices and to fully appreciate the serious health consequences that could result from contaminated drinking water. While mandatory certification of water operators was introduced in 1993 in Ontario, certification of the Walkerton operators was obtaining through a

grandparenting scheme in which experienced operators were certified without examination. The training they did take did not adequately address drinking water safety. The Walkerton inquiry noted that at present it is not necessary for a prospective operator to complete a training course that has a specific curriculum and that it is possible to pass the certification exam with no knowledge of, or experience on one or more specific subjects. Owners of facilities are required to ensure that each operator receives a minimum of 40 hours of training each year. However there is currently no requirement that training focus on technical issues involving water treatment or public health issues. The Walkerton inquiry noted that an insufficient number of quality courses are available to operators in Ontario.

The Inquiry also determined that several MOE officers did not appreciate that E. coli was potentially lethal. Justice Laing noted that operators and management at North Battleford were still unaware in 2001 that cryptosporidium oocysts posed a health risk in surface water supplies; that the North Saskatchewan River was a major source of these oocysts; that chlorine was ineffective in disinfecting cryptosporidium oocysts, that allowing treated water turbidity levels to exceed 0.3 NTU could allow cryptosporidium into treated water (Laing, 2002). The North Battleford inquiry noted as cause for concern the shortage of qualified public health inspectors, as evidenced by the inability of the health district to hire two replacement public health inspectors.

The Ministry announced in May 2002 that it would hire an additional 26 municipal water system inspectors, bringing the total number of inspectors to 51. The Ministry also announced the development of tailored training programs to give its environmental officers the additional technical skills and knowledge to conduct these more thorough and effective inspections as well as comprehensive mandatory training programs for municipal water system operators. The government is also exploring potential models for the certification and re-certification of all municipal water system operators in the province.

Five provinces have established or are establishing mandatory operator certification requirements. Many U.S states have established mandatory certification for waterworks operators (O'Connor, 2002b).

Initial Recommendations to Improve Human Resources (HR)

HR1 Responsible Ministry to require mandatory certification of water system operators.

- The Ministry of the Environment should continue to require the mandatory certification of persons who perform operational work in water treatment and distribution facilities. Education, examination, and experience are essential components of ensuring competence. (O'Connor, 2002b, Recommendation 59, p. 378)
- The Ministry of the Environment should require water system operators who currently hold certificates obtained through the grandparenting process to become certified through examination within two years, and it should require operators to be recertified periodically. (O'Connor, 2002b, Recommendation 60 p. 382)
- That the government amend the operator certification regulations to provide that, after the first renewal, each operator must take a certain number of continuing education credits to qualify for the second renewal and each renewal thereafter. (Laing, 2002, Recommendation 24 p. 308)

HR2 Responsible Ministry to offer a comprehensive training curriculum for water system operators.

- The Ministry of the Environment should develop a comprehensive training curriculum for operators and should consolidate the current annual training requirement in Ontario Regulation 435/93 and the proposed requirement of ministry-approved training into a single, integrated program approved by the Ministry of the Environment. (O'Connor, 2002b, Recommendation 62, p. 386)
- That the provincial government take steps to ensure a better supply of public health inspectors in the province of Saskatchewan. These steps should include either greater educational opportunity for persons wishing to become public health inspectors to be educated in the province, or financial assistance for those persons who must leave the province to obtain the appropriate education. (Laing, 2002, Recommendation 22, p. 201)
- The Ministry of the Environment should require all applicants for an operator's license at the entry level to complete a training course that has a specific curriculum to ensure a basic minimum knowledge of principles in relevant subject areas. (O'Connor, 2002b, Recommendation 61, p. 385)
- The Ministry of the Environment should take measures to ensure that training courses are accessible to operators in small and remote communities and that the courses are tailored to meet the needs of the operators of these water systems. (O'Connor, 2002, Recommendation 63, p. 388)
- The provincial government should actively offer, on a cost-recovery basis, its training facilities and curriculum to First Nations water system operators. (O'Connor, 2002, Recommendation 92, p. 496)
- The Ministry of the Environment should meet with stakeholders to evaluate existing training courses and to determine the long-term training requirements of the waterworks industry. The ministry should play an active role in ensuring the availability of an array of courses on the subjects required to train operators. (O'Connor, 2002b, Recommendation 64, p. 389)
- That the government ensure there are sufficient continuing education courses available to meet the needs of operator continuing education (Laing, 2002, Recommendation 25 p. 275)

HR3 Responsible Ministry to ensure that inspectors are adequately trained and qualified.

- Inspectors should be required to have the same or higher qualifications as the operators of the systems they inspect and should receive special training in inspections. (O'Connor, 2002, Recommendation 73, p. 432)

TOPIC 4. SOURCE PROTECTION

Background

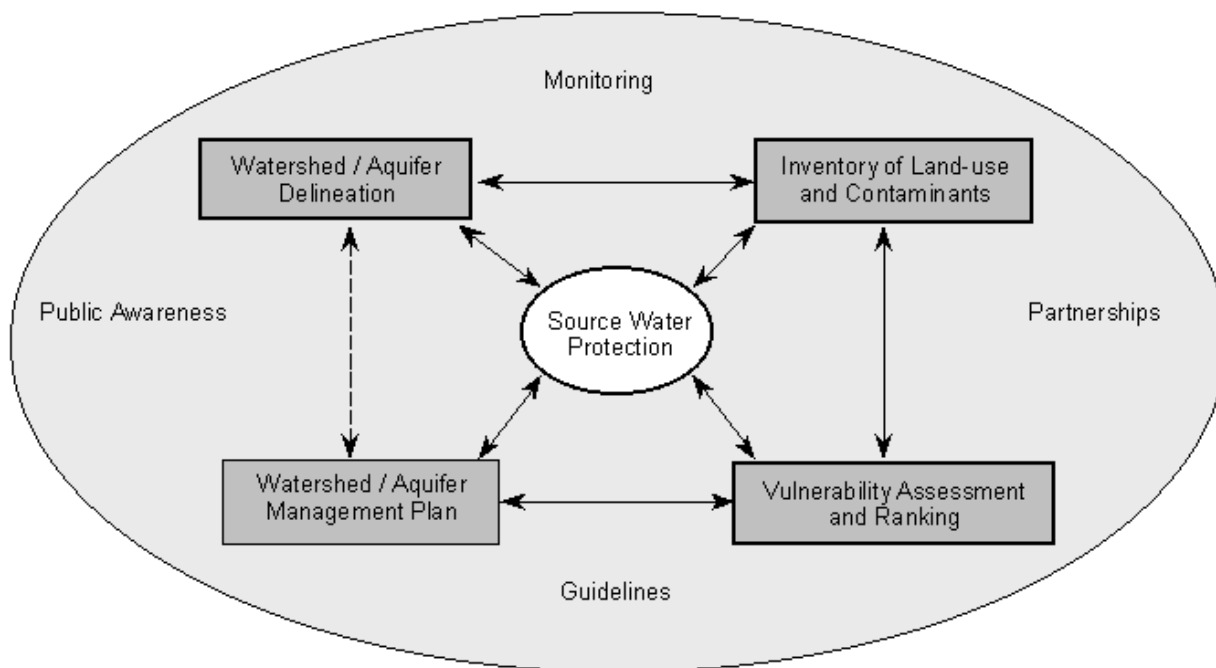
Source water protection has been recognized as the first and most cost-effective component of a multi-barrier approach for drinking water safety (O'Connor, 2002b, Krewski 2002). An analysis of waterborne outbreaks in developed countries noted several common themes related to the drinking water source: contamination arising following heavy rainfall or runoff after snowmelt, raw water sources in locations that were vulnerable to obvious sources of contamination, and geology of groundwater sources that were highly vulnerable to rapid contamination from surface sources (Hrudey et al. 2002).

According to the Canadian Federal-Provincial Source to Tap safe drinking water document, source water protection (see Figure 3) is part of watershed management approach involving a coordinated approach among stakeholders to develop short- and long-term plans to prevent,

minimize, or control potential sources of pollution or enhance water quality where necessary (CEOH/CCME, 2002). Source water includes surface waters, aquifers or groundwater recharge areas.

Watershed-based management planning has been adopted in Europe and Australia and is already being used in a few Ontario watersheds (O'Connor, 2002b). The US Environmental Protection Agency (EPA) and individual states and tribes have increasingly adopted watershed management approaches rather than separately addressing individual water bodies or dischargers to protect aquatic and human health. The approach is based on multi-stakeholder partnerships, geographic focus and management based on scientific data. The EPA notes the many environmental, financial and social benefits of the partnership process including the ability to identify and prioritize the most critical problems within each watershed; cost savings through leveraging and less duplication of efforts; strengthened teamwork between the public and private sectors and enhanced sense of community through joint commitment to actions (EPA, 1996). The Federal-Provincial Source to Tap document identifies health benefits associated with reducing the degree of drinking water treatment required, the quantity of chemicals used during treatment, and the creation of treatment by-products.

Figure 3: Components of source water protection



Justice O'Connor's recommendations for drinking Source Protection heavily emphasize planning at the local watershed level, co-ordinated by conservation authorities wherever possible. The MOE would establish the framework for developing the watershed-based source water protection plans, would help to fund and participate in their development and would approve the completed plans. A number of recommendations relating to various potential sources of contamination, including sewage treatment plants, septage and biosolids, septic tanks, agricultural and industrial activity are proposed with the goal of ensuring that no discharges into drinking water sources are

permitted unless they are consistent with watershed –based source protection plans (O’Connor, 2002b).

Initial Recommendations for Source Protection (S)

S1 Responsible authorities to develop source protection plan for surface and subsurface water sources.

- Drinking water sources should be protected by developing watershed-based source protection plans. Source protection plans should be required for all watersheds in Ontario. (O’Connor, 2002b, Recommendation 1, p. 92)
- Draft source protection plans should be reviewed by the Ministry of the Environment and subject to ministry approval. (O’Connor, 2002b, Recommendation 3, p. 110)
- The Ministry of the Environment should ensure that draft source protection plans are prepared through an inclusive process of local consultation. Where appropriate, this process should be managed by conservation authorities. (O’Connor, 2002b, Recommendation 2 p. 98)
- Ontario First Nations should be invited to join in the watershed planning process outlined in Chapter 4 of this report. (O’Connor, 2002b, Recommendation 88, p. 494)

S2 Need for public education on the requirements and importance of drinking water source protection.

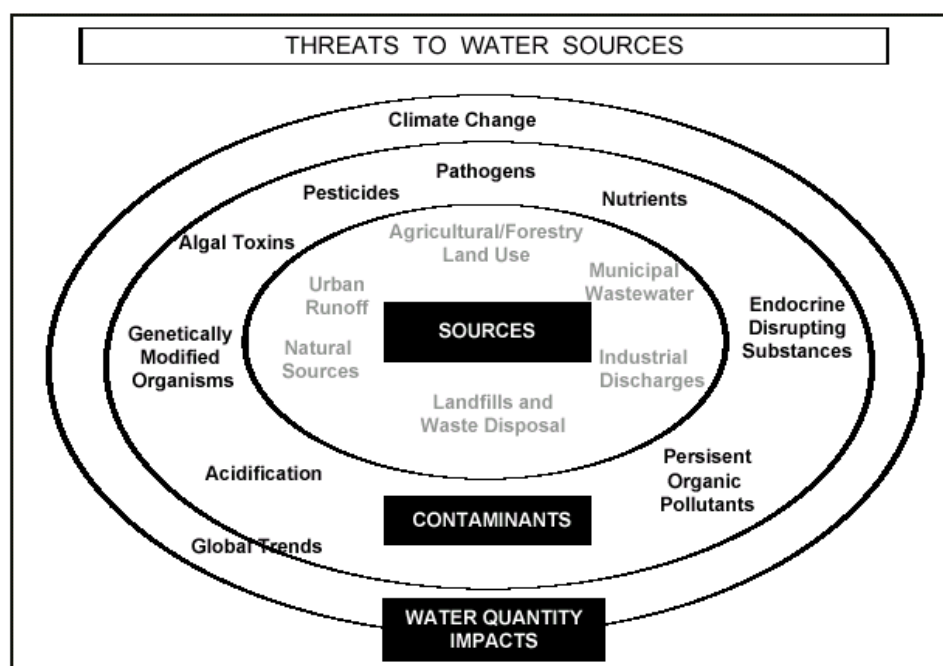
- Conservation authorities (or, in their absence, the Ministry of the Environment) should be responsible for implementing local initiatives to educate landowners, industry, and the public about the requirements and importance of drinking water source protection. (O’Connor, 2002b, Recommendation 8, p. 119)

TOPIC 5. EMERGING THREATS

Background

Scientists and managers at the National Water Research Institute of Environment Canada recently identified the following 13 water quality related threats to sources of drinking water and aquatic ecosystem health (see Figure 4): waterborne pathogens, algal toxins and taste and odour, pesticides, persistent organic pollutants and mercury, endocrine disrupting substances, nutrients – nitrogen and phosphorus, aquatic acidification, ecosystem effects of genetically modified organisms, municipal wastewater effluents, industrial point source discharges, urban runoff, landfills and waste disposal, agricultural and forestry land use impacts, natural sources of trace element contaminants, and impacts of dams/diversions and climate change (Environment Canada, 2001).

Figure 4: Threats to Water Sources (Environment Canada, 2001)



Krewski et al. (2002) note that despite significant advances in drinking water treatment and protection since the 1950s, emerging pathogens are now recognized as causing significant water-borne disease outbreaks. The incidence of gastrointestinal disease from *Cryptosporidium* and *Giardia* is a public health concern because there is no practical way of detecting these organisms, or of determining their infectivity if detected, in a reasonable period of time (O'Connor, 2002b). False positives and false negatives are prevalent in current testing methods. *Cryptosporidium* is resistant to chlorine disinfection and *Giardia* demand more than minimal chlorine disinfection. Management of outbreak risks from these pathogens requires an effective filtration treatment barrier. Several outbreaks have occurred because of inadequate filtration performance, including Milwaukee and North Battleford (Hrudey, 2002). *E. coli* 0157:H7 has only recently acquired new virulence factors through DNA transfer (O'Connor, 2002b).

The reporting of water-borne diseases and the determination of disease etiology are critical to managing health risks associated with drinking water. Krewski et al. (2002) report the lack of a coordinated, sustained reporting program within Canada and Ontario. Recent developments in surveillance methodology and the steps taken to establish a National Health Surveillance System in Canada may provide an opportunity to strengthen surveillance of enteric diseases and enable risk managers to better anticipate and prevent water-borne disease outbreaks (Krewski et al., 2002).

Initial Recommendations to manage emerging threats (T)

T1 Responsible Ministry to establish process for identifying and managing emerging threats including new pathogens and chemicals.

- The Advisory Council on Standards should have the authority to recommend that the provincial government adopt standards for contaminants that are not on the current federal-provincial agenda (O'Connor, 2002b, Recommendation 26, p. 22)

- The Advisory Council on Standards should review Ontario's standards for disinfection by-products to take account of the risks that may be posed by the by-products of all chemical and radiation-based disinfectants. (O'Connor, 2002b, Recommendation 31, p. 198)

T2 Responsible Ministry to establish protocol for water-borne disease investigation.

- That a provincial protocol for water-borne disease investigation be prepared, distributed, and adopted by all health districts in the province (Laing, 2002, Recommendation 16, 187)
- That each health district establish sentinel pharmacies to report any increase in anti-diarrheal medications. This is recommended by the Centers for Disease Control and Prevention in Atlanta, Georgia and seems necessary when so many patients experiencing enteric disease self-medicate. This alert can also result in a request to physicians to increase stool sampling (Laing, 2002, Recommendation 17, p. 188)

TOPIC 6. BEST PRACTICE

Background

Justice O'Connor prefaced his recommendations for improvements to Ontario's water delivery system with the comment that the existing system does not need radical reform. The technology for treating and monitoring water quality to a high standard is well established. The challenge is one of ensuring that the best practices are implemented across the Province (O'Connor, 2002b). Justice O'Connor notes, *"In protecting public health, the first step is to ensure that adequate technology is in place. This technology in turn should be operated by trained and conscientious people as part of a well-managed organization. Together with effective oversight and regulation, these are the elements necessary to ensure a very high level of drinking water safety"* (O'Connor, 2002b, p. 79). Failures in Walkerton, and elsewhere appear to arise because of poor management or the inadequate implementation of good practices. The quality management approach aims to protect public health by ensuring that industry best practices in managing and operating water systems are being employed to produce water of the highest quality (O'Connor, 2002b, p. 336). The key features of this approach include "the adoption of best practices and continuous improvement; "real time " process control (e.g. continuous monitoring of turbidity, chlorine residual, and disinfectant contact time) wherever feasible; the effective operation of multiple barriers and preventive strategies to identify and manage risks to public health and effective leadership (O'Connor, 2002b, p. 336).

Initial Recommendations for Best Practice (P)

P1 Responsible authorities to implement best practice for management of parasites.

- No formal maximum contaminant level for protozoa should be established until real-time tests are available. The objective, as with bacterial and viral pathogens, should be zero, and the regulations should so state; but the standard should be a treatment standard, specified in terms of log removal dependent on source water quality. (O'Connor, 2002b, Recommendation 28, p. 164)

P2 Responsible authorities to implement best practice for turbidity limits.

- The provincial government should seek the advice of the Advisory Council on Standards regarding the desirability of a turbidity limit that is lower than the limit specified in the federal-provincial Guidelines. (O'Connor, 2002b, Recommendation 29, p. 172)

P3 Responsible authorities to implement best practice for designing treatment systems based on risk assessment.

- All raw water intended for drinking water should be subject to a characterization of each parameter that could indicate a public health risk. The results, regardless of the type of source, should be taken into account in designing and approving any treatment system. (O'Connor, 2002b, Recommendation 30, p. 185)

P4 Responsible authorities to implement best practice for design of treatment system materials.

- The provincial government should encourage the federal government, working with the Standards Council of Canada and with advice from municipalities, the water industry, and other stakeholders, to develop standards for materials, including piping, valves, storage tanks, and bulk chemicals, that come into contact with drinking water. (O'Connor, 2002b, Recommendation 34, p. 237)

P5 Responsible authorities to implement best practice for design of distribution materials.

- As part of an asset management program, lead service lines should be located and replaced over time with safer materials. (O'Connor, 2002b, Recommendation 35, p. 238)

P6 Responsible authorities to implement best practice for basic monitoring of drinking water systems.

- All municipal water providers in Ontario should have, as a minimum, continuous in-line monitoring of turbidity, disinfectant residual, and pressure at the treatment plant, together with alarms that signal immediately when any regulatory parameters are exceeded. The disinfectant residual should be continuously or frequently measured in the distribution system. Where needed, alarms should be accompanied by automatic shut-off mechanisms. (O'Connor, 2002b, Recommendation 36, p. 250)

P7 Need to tailor the measurement and the reporting data to requirements of the responsible ministry and also to annual performance indicators.

- Every municipal water provider should be responsible for developing an adequate sampling and continuous measurement plan as part of its operational plan. (O'Connor, 2002b, Recommendation 37, p. 254)

TOPIC 7: RESEARCH AND INNOVATION

Background

A number of key areas for further research to guide safe drinking water strategies have been identified (O'Connor, 2002b, Environment Canada, 2001). Enhanced surveillance and research will be required to understand and control the sources of pathogens entering aquatic ecosystems as well as the epidemiological factors associated with infectious disease outbreaks. The identification and control of threats posed by waterborne pathogens will require effective pathogen detection techniques. The value and limitations of traditional pathogen indicators like coliform counts must be evaluated since such indicators are unable to accurately assess the presence of certain protozoan and viral pathogens (Environment Canada, 2001). The following chemicals should be investigated for possible regulatory action including, water soluble

pesticides and herbicides, certain industrial chemicals, nitrates, and the large family of chemicals, including human and veterinary antibiotics and other pharmaceuticals, that may disrupt endocrine systems in humans and other animals (O'Connor, 2002b).

Initial Recommendations for Research and Innovation (R)

R1 Responsible authorities should implement changes in practices and policies, wherever feasible and practical, in response to scientific advances in detection and monitoring.

- The Advisory Council on Standards should consider whether to replace the total coliform test with an *E. coli* test (O'Connor, 2002b; Recommendation 27 p. 162)

R2 Provincial government should support research on removal of chemical contaminants from wastewater.

- The provincial government should support major wastewater plant operators in collaborative studies aimed at identifying practical methods of reducing or removing heavy metals and priority organics (such as endocrine disruptors) that are not removed by conventional treatment. (O'Connor, 2002b, Recommendation 32, p. 210)

R3 Provincial government should review alternative delivery practices for small communities

- The provincial government should review the current practices for the delivery of drinking water in bulk and the need for a regulatory framework in this area. (O'Connor, 2002b, Recommendation 87, p. 483)

R4 Responsible authorities to conduct health risk assessment research to support standard setting.

- Regarding drinking water quality research, I encourage Health Canada and other agencies to adopt as a priority the development of sufficiently detailed definitions of the susceptibility of vulnerable population groups to drinking water contaminant exposures to allow appropriate adjustments in drinking water quality guidelines. (O'Connor, 2002b; Recommendation 20, 150)

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APPENDIX A

Risk Management Frameworks

Introduction

Risk Management frameworks provide a structure for managing risks or improving safety. They are similar to frameworks for quality control and quality assurance except that risk - low probability high consequence events - requires some special attention since people do not interpret and calculate probabilities very well. Frameworks work as evidenced by the high quality results obtained by Disneyland, McDonalds, UPS, car manufactures, and so forth. Risk management frameworks are a part of the regular line management function.

This year, ISO/EIC published Guide 73, which gives for the first time a consistent set of definitions for risk and risk management. NERAM has incorporated these definitions (and the underlying risk management framework inherent in the definitions) into a general risk management “benchmark” framework. The NERAM framework is consistent with the Canadian CSA Q850 (1997) risk management framework.

Figure 5 gives the highest level of the NERAM framework and Table 1 gives a cross reference to the Australian and Canadian drinking water frameworks. For example, in Figure 5, stakeholders are “engaged” by the decision making function and the concerns of stakeholders are documented and input into the decision making process. In the Australian framework there is “community involvement and awareness”, and in the Canadian drinking water framework there is “public involvement and awareness”. For stakeholders the correspondence between the frameworks is almost exact at the general level.

NERAM Risk Management Framework

Returning to Figure 5 and the NERAM benchmark framework, there are three major groupings of functions, 1) Decision Making, 2) Operations, and 3) Risk Assessment and Treatment Options.

Decision-making includes the governance structure of the system; the monitoring of safety levels; consideration of stakeholder concerns; allocations to research, capacity building, criteria and standards, design and review of treatment options, and operations. Decision-making links to the other two major functional groups through engagement of stakeholders, provision of the “context” to the planning and design function (Risk Assessment and Treatment), and decisions on implementation and operation of the system to provide drinking water. Decision-making receives as inputs to the decision process, proposed risk control options (a control is a treatment that is implemented according to ISO), stakeholder concerns and monitoring of performance of the operations.

Operations are the day to day running of the system and the only place in the framework where risk is increased or reduced, depending on the programs and procedures in place.

Risk Assessment and Treatment Options is the traditional “planning and design” familiar to engineers, designers, managers, and others charged with suggesting improvements to the system. A key component of this function is Risk Analysis – the construction of risk estimation models

and the application of risk criteria to come up with good designs and provide decision-makers with information on the expected improvements to be expected from implementation of specific treatment/control options. Risk analysis is critical since people do not process and calculate probabilities very well or very consistently.

Figure 6 gives the expanded framework for “Risk Assessment and Treatment Options” of the NERAM framework. It will not be described in detail other than to note that there is a preliminary (or once over lightly on the back of an envelope) analysis and a comprehensive time consuming, resource intensive assessment and option development. It is also noted that there are middle level of detail frameworks for each of the three major functional groupings and also a lower level of detail for each of the middle level functional tasks of risk estimation, risk evaluation, generation of treatment options, etc. For example, at this third level of detail is the research and development functions for water treatment and distribution.

The NERAM framework has specific general good management requirements for all functions. These include,

1. Risk Communication and Consultation
2. Documentation
3. Best “practical” Practice
4. Partners
5. Staff and Human Resources functions.

In Table 1 it is noted that in the Australian framework the employee awareness and training function, the documentation and reporting function, and the community involvement and awareness function are also shown “off-line” as general requirements of the overall management system.

Application of Risk Management Frameworks

Frameworks provide a common language to help people understand how their activity helps produce safety in the system, as well as to produce other dimensions of quality such as reliable service, cost-effective service, response to special cases, and so forth. But frameworks need to be implemented in a typical management application so the system “works” and customers and employees are satisfied. So the framework is necessary but not sufficient.

Frameworks define the elements of a particular system and the organization of the common elements of the NERAM framework must be arranged to suit the tasks at hand. These will differ from ongoing continuous improvement, or for emergency response, or for review of the system after a major incident. Fortunately, the common language of risk and risk management helps to make these applications more transparent and the linkages between them (the so-called integrated risk management or the enterprise wide risk management) clearer.

Common difficulties with the implementation of risk management frameworks include:

- Confusion between levels – misunderstandings due to one person speaking at the level of a detailed operational activity and others thinking in terms of general safety
- Inability to process and evaluate probabilities – many “improvements” to the system have little or no impact on safety and may even reduce safety if resources are drawn away from more effective control activities. Checking proposed changes with risk assessment methods is an imperative

- Inadequate staff, experience, and training – implementation of grand schemes falter because the people/capacity are not there to make it happen and the result is a muddle. This is the “practical” in the NERAM “best ‘practical’ practice”
- Lack of monitoring, audits, performance measurement, and other tasks to ensure the system is working as planned and to provide safety information for stakeholders (so they trust the system)

Frameworks are in one sense a tool to create a shared vision of what the system is supposed to do and how the system is continuously improved. If frameworks use common terminology and elements, they can also provide the means to learn from and to take useful ideas and procedures from other areas and activities. For example, the NERAM framework is based in part on work done in risk management for chemical plants, and blood systems.

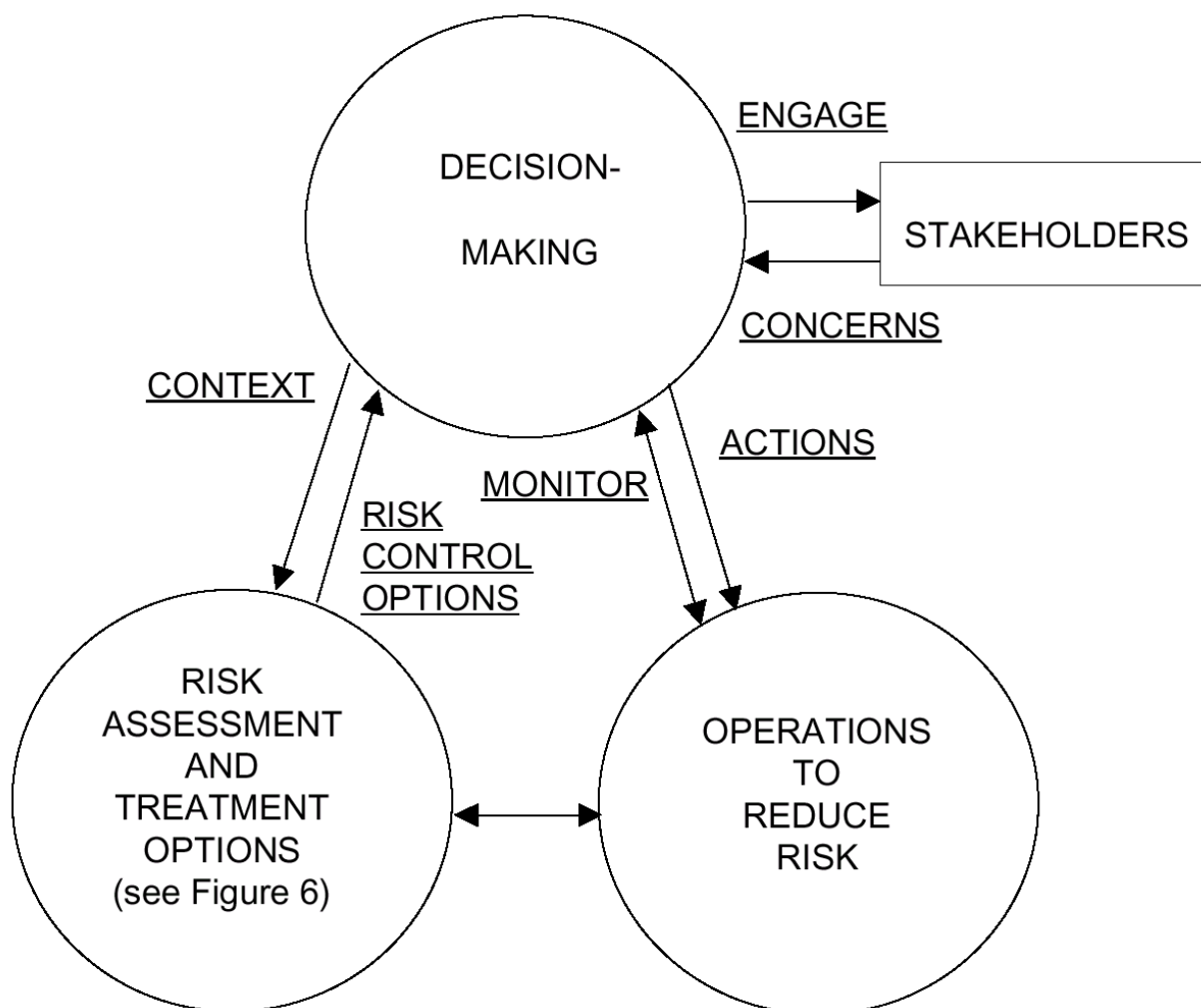


Figure 5: NERAM Benchmark Risk Management Framework

Table 1: Comparison of Risk Management Framework Elements

NERAM BENCHMARK FRAMEWORK ELEMENTS	AUSTRALIAN FRAMEWORK ELEMENTS	CANADIAN SOURCE TO TAP FRAMEWORK ELEMENTS
Decision-Making	Verification of Drinking Water Quality Commitment to Drinking Water Quality Management Evaluation and Audit Review and Continual Improvement	Legislative and policy frameworks Monitoring Management Guidelines, standards and objectives
Risk Assessment and Treatment Options	Assessment of the Drinking Water Supply System Planning: Preventive Strategies for Drinking Water Quality Management Research and Development	Research, science and technology
Operations to Reduce Risk	Implementation: Operational Procedures and Process Control Incident and Emergency Response Employee Awareness and Training Documentation and Reporting Review and Continual Improvement	Drinking water treatment Drinking water distribution system Source water protection
Stakeholders	Community Involvement and Awareness	Public involvement and awareness

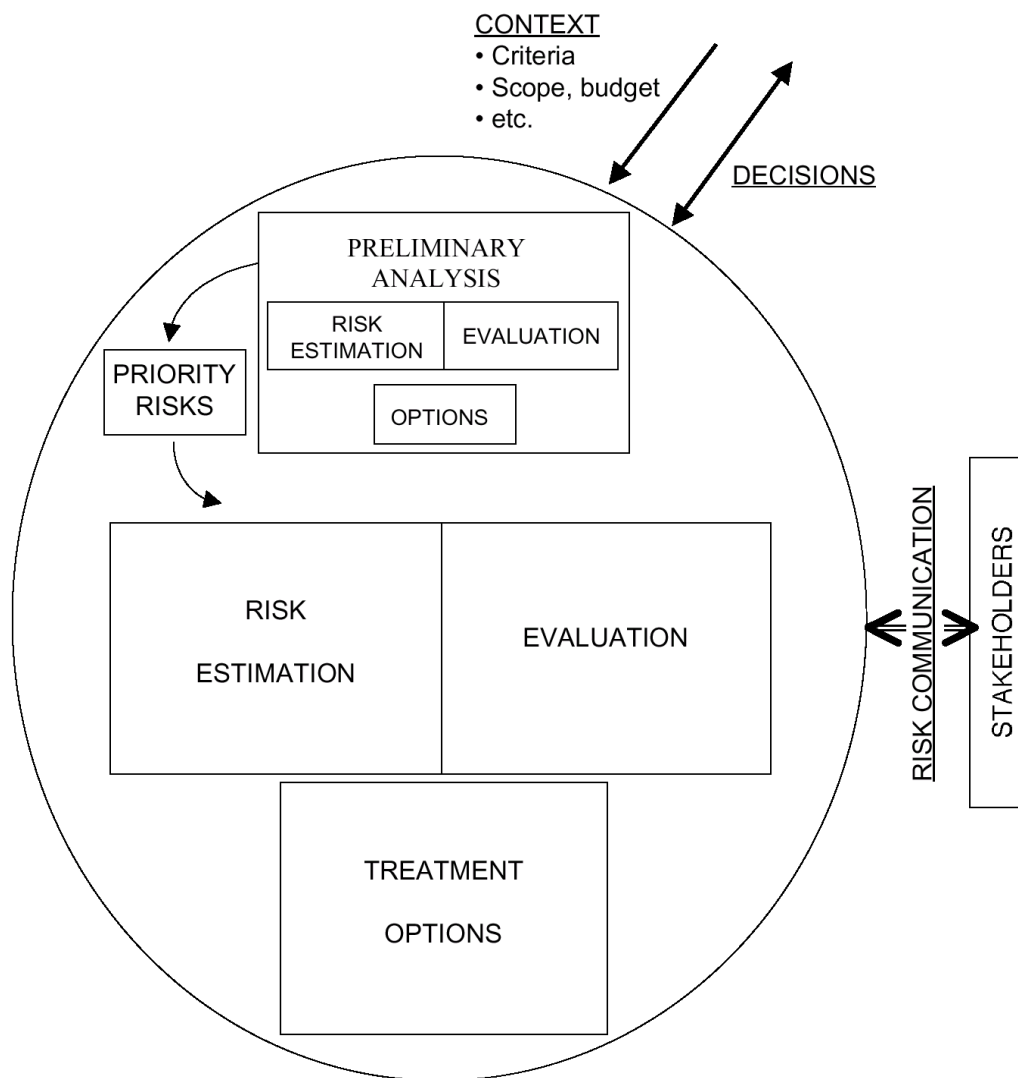


Figure 6: Expanded NERAM Framework for Risk Assessment and Risk Treatment Options (details of Figure 5)