THE WALKERTON INQUIRY

**Commissioned Paper 19**

# A TOTAL QUALITY WATER MANAGEMENT SYSTEM FOR ONTARIO: THE MODEL WATER UTILITY

By
**Darren E. Romain, Ken Mains, and Peter G. Nicol,**
**CH2M HILL Canada Limited,**
**and Bill Fields and Wendy M. Joyce,**
**Diamond Management Institute**

**Toronto**

**2002**

Published by Ontario Ministry of the Attorney General

This paper and other Walkerton Inquiry Commissioned Papers are available on the Walkerton Inquiry CD-ROM and at <www.walkertoninquiry.com> with the complete final report.

General editor, Commissioned Papers: Sheila Protti
Editor and proofreader: Doug Linzey
Design: Madeline Koch, Wordcraft Services; Brian Grebow, BG Communications

## Abstract

Ontario is blessed with abundant supplies of fresh water and produces more drinking water per capita than nearly anywhere on earth. Costs for water rank near the lowest in the world. However, the public's confidence in the safety of drinking water is in crisis.

Certain water utilities in the province and elsewhere have risen far above minimal expectations by adopting an approach of continuous quality improvement and establishing water quality goals that far exceed those of the provincial regulator. They maintain ties to other quality-driven drinking water organizations to keep current. They monitor and retrofit buried infrastructure continuously, and they measure water quality routinely at the customer's tap, not just at the treatment plant discharge. Their customers are informed. These utilities do not rely on grant funding, yet their water rates are competitive and reasonable. Their secret: leadership, culture, and the right people.

This paper examines these superior practices and suggests a model water utility structure that will encourage a return of public confidence and support. Through review of other jurisdictions and best practices, it is clear that many elements of this model are in place. No one jurisdiction, however, has pulled it all together in the comprehensive approach proposed here.

Part 1, The Model Water Utility, addresses the issue of public confidence by establishing a regime of transparency underlying a culture that relentlessly pursues excellence and continuous improvement. Its technological infrastructure is current and sustainable. It has competent operators – trained, examined, and certified. Its leadership and management expertise is self-evident. It has established management systems, policies, and practices, including a fully functioning Total Quality Water Management System. It practices full cost recovery. Its governance structure is exemplary and accountable. Industry and professional associations create new partnership arrangements.

Part 2, Transitional Issues and Strategies, identifies and analyzes the barriers and issues that must be overcome to move from the current situation. Appendix 1 refers to the Australian framework, in which the authors see significant merit. Appendix 2 provides templates for the annual report of the model water utility and the annual report for the Total Quality Water Management System. Appendix 3 is a summary of the literature review. Appendix 4 is a commentary of the multiple layers and varied roles on government in general and the Ontario Ministry of the Environment in particular.

## About the Authors

CH2M HILL Canada Limited (formerly known as CH2M Gore & Storrie Limited) is a Canadian-controlled employee-owned engineering company with more than 75 years experience in water treatment and distribution systems. The company employs more than 350 professionals across the country and a team of 10,000 worldwide through the CH2M HILL Inc. family of companies.

Diamond Management Institute provides customized management consulting and training services to both the private and public sectors. The Diamond Management team comprises dedicated and accomplished professional consultants and instructors who are seasoned industry and subject-matter experts. They bring a diversity of experience and insight to every situation.

## Acknowledgements

The authors would like to acknowledge the comments provided by James W. MacLaren and Kent Edwards.

James MacLaren has been involved in policy studies for the World Bank, Ontario Ministry of the Environment, CIDA, and Environment Canada, and he has served as a member of the Federal Water Inquiry and as chairman of the MISA Advisory Committee to the Ontario Minister of the Environment. Mr. MacLaren is a past president of the Association of Consulting Engineers of Canada.

Kent Edwards is president and CEO of Windsor Canada Utilities Inc. and general manager of Windsor Utilities Commission (ISO 9001 registered). He is a past chair of the Ontario Water Works Association, a past president of the Municipal Electric Association, and a founding partner for the NSERC Water Research Chair at the University of Waterloo. Mr. Edwards is a member of the Electricity Transition Committee as an advisor to the Minister of Energy for deregulation of Ontario's electricity markets.

# Contents

## PART 1: THE MODEL WATER UTILITY

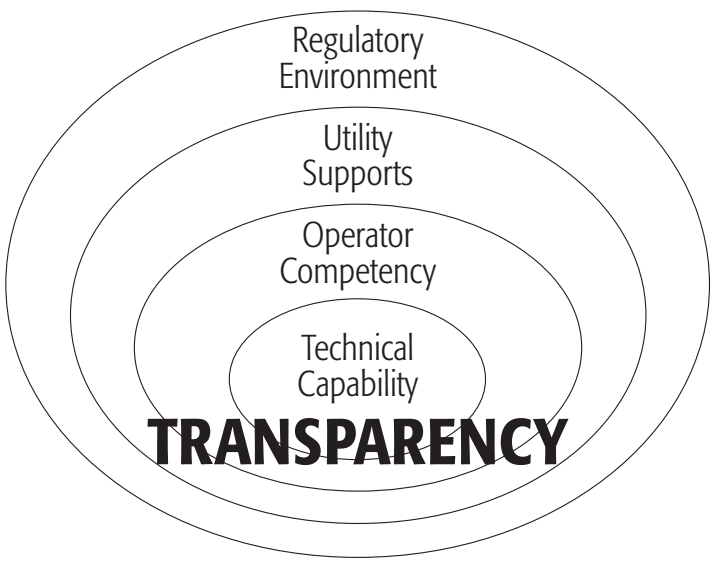
## Tables, Figures and Boxes

# PART 1
# THE MODEL WATER UTILITY

## 1 Model Summary

The goal of this paper is to examine superior practices, in Ontario and elsewhere, and to suggest a model water utility structure that will encourage a return of public confidence and support. The suggested drinking water utility model is shown pictorially in figure 1-1, where the correctly applied process has resulted in a system that is capable of providing the required level of protection to the public (technical capability). The process is being operated, controlled, and monitored by operators with the appropriate skills (operator competency). An intricate set of supports for the operators (utility supports) is in place to facilitate the desired operation of the process. Finally, the system must operate within the laws, regulations, and rules of the province (regulatory environment). The common element of transparency is a requirement of all components of the system.

**Figure 1-1 Model Water Utility Environment**




This paper has been prepared for discussion purposes only and does not represent the findings or recommendations of the Commissioner.

## 1.1 Transparency (see section 3)

Transparency is required for accountability and trust. The public must be able to trust that its drinking water is safe, but its trust has been eroded by recent events. The model incorporates transparency elements on every level, from the water utility to the regulator. This transparency will ensure that the roles and responsibilities of each stakeholder are well understood by all other stakeholders.

For the water utilities, transparency manifests itself through public reporting and customer advisory council participation and consultation. The regulator must have a transparent assessment practice that ensures that the water utilities are aware of the processes used to evaluate them. The standards-setting body is also required to have a transparent process in implementing new standards.

## 1.2 Technology (see section 4)

At the heart of a water utility is the technology and the equipment used to treat and transport the water provided to the customer. The right technology must be used to provide the required level of treatment. Proper engineering must be applied to ensure that the treated water is supplied safely and consistently to the customer at all times. The feasibility of alternatives must be investigated to ensure that value is provided to the customer.

To reduce the risk as much as possible of a contaminant reaching a customer, a multiple barrier approach is employed. The barriers are selected to achieve redundancies and also to improve the efficiency of treatment in an area where another barrier is deficient.

This paper does not prescribe a single technology or approach to determining the correct technology for water treatment. Rather, application of the correct technology, with insightful and creative engineering, will come as a natural result of applying the various elements of the model. Identifying a problem in the existing process will result from the Hazard Analysis Critical Control Points (HACCP) program. A specific process for the improving the utility will be selected following a research and development project. Identification of the need for pipe replacement will be the result of monitoring and the asset management plan.

## 1.3 Technical Competence (see section 5)

Competent operators following the Triple-E process (experience, education, and examination) will be trained to ensure that the integrated systems are operating at the desired performance level. The operators will be certified, under Ontario's *Apprenticeship and Certification Act,* to operate the equipment, and they will be empowered to apply continuous improvement techniques to the water utility's operation. The employees of the utility are key to its success.

Operators have a lot of responsibility. With that responsibility must come education about technical issues, quality management, standards, and customer needs. Operators are asked to perform increasingly difficult tasks that will challenge them and keep them interested. Within the Total Quality Water Management System (TQWMS) proposed in this paper, the employees will be authorized and required to alter the operation of the water utility to ensure that all water reaching the customers meets the utility's objectives – objectives that may be more stringent than government regulated standards.

## 1.4 Utility Management (see section 6)

Participation in the TQWMS will be a requirement of each and every employee of the water utility. At the forefront of the TQWMS is the concept of continuous improvement. A water utility is subject to many external forces (public pressure, legislative changes, environmental changes, etc.) and, to continue to thrive and grow, it must have the ability to adapt.

A leader must provide the direction and vision to inspire the employees to meet these new challenges. Leadership, and the leader's impact on an organization, is well understood. It is the obligation of the water industry to attract leaders and develop the leadership skills of people within the industry. Leadership is particularly important in the time of transition to the TQWMS. The leader will empower all levels of the organization to meet, and strive to improve upon, the new objectives. The leader will make success and achievement systemic.

Managers will be required to have the training to meet the demands of the TQWMS. Managers will be expected to have financial, technical, personnel, risk, and quality management skills at their disposal. They will be certified to ensure that they are familiar with these skills. Employee performance will be

reviewed regularly to ensure that employees have the appropriate skills and training to perform their prescribed duties.

A comprehensive quality management program by way of HACCP and the standard operating procedures (SOPs) developed for each facility will provide the methodology required to achieve and improve upon the performance objectives. HACCP will ensure that the infrastructure is optimized with regard to risk reduction. Analysis will result in a prioritized list that identifies the highest risk and highest hazards within the utility. The SOPs will make certain that the proper methodology is in place to operate, monitor, and verify the performance of the water utility. SOPs will provide the operators and managers with the ability to improve the performance and efficiency of the system in which they work. SOPs will be a living entity that will change and be continually updated as new challenges, ideas, and technologies are introduced to the water utility. To ensure that a water utility is achieving its best results, benchmarking with other water utilities and other organizations will be used to compare performance.

TQWMS does not eliminate risk. Risk management incorporates both of the aforementioned programs, but it must account for the possibility of an emergency or a contamination incident that has the possibility of affecting the customers. Risk management will include emergency response protocols that notify the public and public agencies, communication programs that actively engage customers in the issues that affect the water utility, and public education programs that provide information to the public. The communication program is a key element of the transparency concept that is fundamental to the accountability of water utilities.

The other elements of accountability to the customer and public perception of the water utility are external reports that detail the monitoring and verification programs and TQWMS updates detailing operational improvements, financial performance, standards compliance, and the water utility's performance against objectives. Annual reports will be audited to ensure that the TQWMS is being followed and that the financial accounts are consistent with accepted practice.

A financial model will be followed to ensure the long-term stability of the water utility. The regulator will include an assessment of the water utility's business plan in its review of licensure. The business plan will include costs for training of employees, the TQWMS plan, and a sustainable asset management plan. The regulator will review the costs and the rates of the water utility to ensure that the public receives water at a fair price.

Finally, the water utility must be governed by a board of directors whose members have appropriate skills and experiences, and have been provided the training to ensure that they are aware of the responsibilities and issues associated with a water utility.

## 1.5 Utility Regulation (see section 7)

The regulator will, at minimum, ensure compliance with drinking water standards.

Standards will be set by a government agency employing the latest in analytical and epidemiological techniques. Health Canada will continue to set maximum acceptable concentration (MAC) levels on parameters by way of its Canadian drinking water guidelines. The province will set Ontario Drinking Water Standards, using the guidelines as a base, with the ability to make individual standards more stringent. All new standards will be discussed with the industry to ensure that the water utilities have sufficient time to comply using a practical approach. The regulator will enforce the standards.

The regulator will be responsible for licensure of all water utilities in the province. The regulator is responsible for reviewing all aspects of a water utility, including its TQWMS (HACCP, SOPs, etc.), financial plan, governance, personnel management, reporting and communication programs, and standards compliance. For the water utility to receive an operating licence, the regulator must approve all of the above components.

The regulator must operate in a transparent manner to ensure accountability to the water utilities and the public, as well as to ensure the accountability of the water utilities to the public.

As a further support system for individual water utilities, professional and industry associations can be used as a vehicle to exchange information, conduct peer review assessments, benchmark performance, coordinate research and development efforts, and promote best practices. Associations also can be used to coordinate lobbying efforts and education programs. In short, associations can be used to share resources that ordinarily are not available to any one water utility.

## 2 Introduction

After a review of the drafts of commissioned papers from the Walkerton Inquiry and the authors' own literature search (see appendix 3), a concept of a model water utility evolved. The structure of the model Ontario water utility is based largely on *Australian Framework for Management of Drinking Water Quality* (the Australian Framework). That document presents a very strong foundation on which – with additional information and concepts where (in the authors' opinions) the Framework could be strengthened – to build a model for Ontario. Appendix 1 of this paper contains relevant sections from the draft Australian Framework modified where applicable to reflect the Ontario context. The final version of the Australian Framework has been completed and is available on line.[1]

The relative virtues of private and public ownership are not discussed in this document. The structure of the model water utility allows for either private or public ownership, in-house or contract employees, and a union or non-union environment. The model promotes the highest level of water quality for the public, and this paper focuses on the organizational behaviour of model water utilities.[2] This should be the main goal of either a publicly or privately owned or operated water utility. The operator could be a private company, while the owner remains public.[3]

Water utilities in Ontario will deliver their product (water) to consumers in a manner that is safe and perceived to be reliable and assured. For a water utility to achieve this performance, processes, and people must be in alignment and of the highest quality. The values of quality and accountability are embedded in the operating principles for governing the water utility. All employees must be competent in performing their jobs and committed to excellence and continuous improvement. What would such an organization look like?

---

[1] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, *Framework for Management of Drinking Water Quality: A Preventive Strategy from Catchment to Consumer* [online], (public consultation) [cited December 2001], <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.
[2] See also Roger L. Martin, Mary Ann Archer, and Loretta Brill, 2002, *Why do People and Organizations Produce the Opposite of What They Intend?* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 20, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.
[3] Nicholas d'Ombrain, 2002, *Machinery of Government for Safe Drinking Water in Ontario* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 4, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.

The culture of an organization can be understood as the collective behaviour of the employees. It can be lethargic, unfocused, unaccountable, unresponsive, and of poor quality. Or it can be the reverse.

A previous regulatory regime in Ontario endeavoured to achieve quality through enforcement. Enforcement will continue to be an important element of the new system, but it will not be sufficient to ensure that the water utilities achieve excellence. As has been observed in many other sectors, when industries or organizations choose to pursue a model of operation that relentlessly demands continuous improvement, the quality outputs exceed expectations. The model water utility will embrace this operating philosophy and will reflect it through seamless and open transparency to the regulator and the public.

The new water utilities in Ontario will develop cultures that are high energy, professional, quality-oriented, collaborative, consumed with conversation (internally and externally), and dedicated to problem identification and solving and to continuous improvement. These cultures will be accountable and transparent.

Organizations don't just run themselves. Although at times it may appear that an organization seems to have a life of its own, it is in fact being led, either actively or tacitly, by its leader. The leader stamps the organization with his or her DNA, in the process creating apathy or enthusiasm, mediocrity or excellence, shallow performance or high performance, uncertainty or confidence. The leader shapes direction and establishes the culture of the organization.

In shaping the direction of the water utility, the leader will establish the strategic imperatives – those critical features that determine success. Managers, conversely, need to be trained properly to be managers. Operators need formulized training under Ontario's apprenticeship program, with re-testing and re-certification every three years.

The water utilities will have to develop systems and processes to manage drinking-water-associated risks in a judicious manner. The public needs to be educated about the risks and how their water utility is managing those risks.

Proper finances and budgets will reflect the true cost of water, the actual operating requirements of the water utility, and a sound plan for sustainable asset management.

The water utilities will need to be accountable and transparent. In order to achieve this type of drinking water utility, issues of scale will need to be considered. A governance structure, overarching the above, strategically will drive the process.

Many aspects of this description are to be found in the Australian model, and that is why it is referenced extensively.

To help understand the interrelationships of the stakeholders, see the model utility stakeholder relationship chart in figure 2-1.

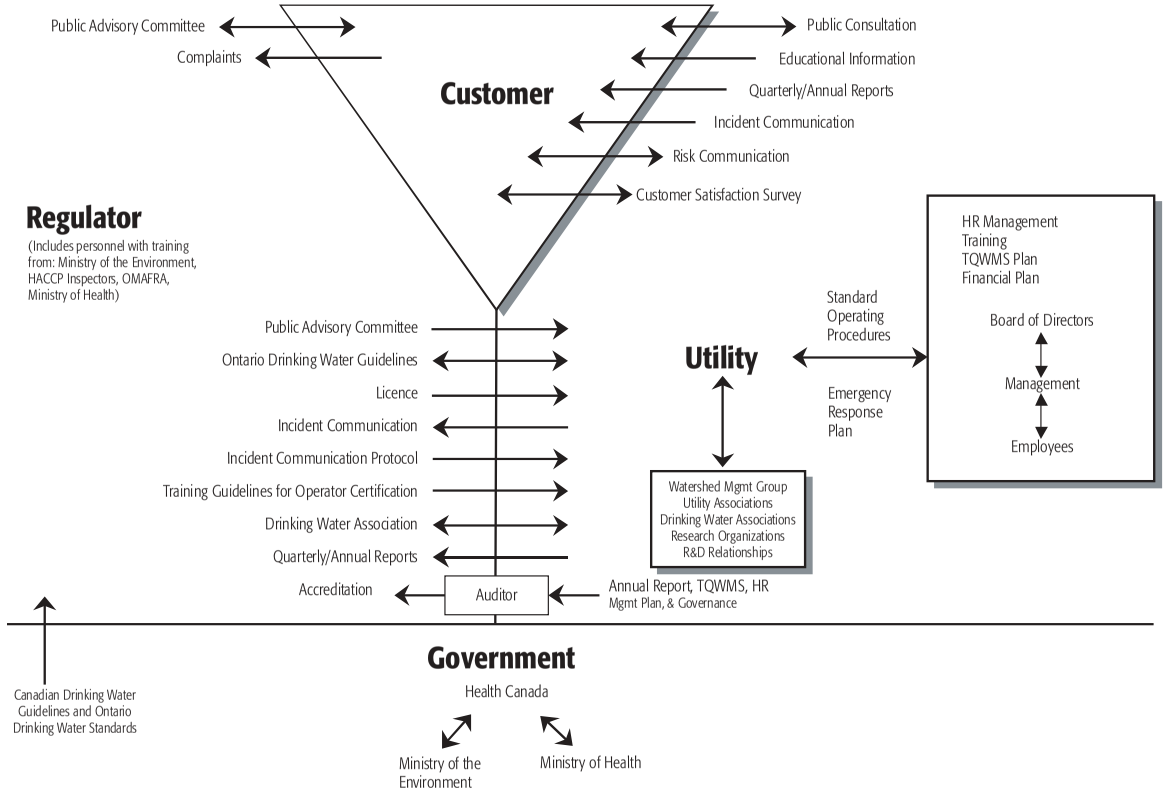
## 3 Transparency

As members of the public become more aware and educated on the issues that affect their health, the level of accountability and transparency expected of the utilities that serve them also increases. Transparency is a fairly recent concept in the water community. Many jurisdictions including the United States, the United Kingdom, Singapore, and Ontario have implemented elements of transparency. Transparency in the context of this discussion refers to the ability of all stakeholders to understand easily the elements of the Total Quality Water Management System described in this paper. Examples of the execution of transparency in other jurisdictions follow.

The U.S. Environmental Protection Agency (EPA) mandated in 1998 that utilities publish an annual Customer Confidence Report (CCR), which provides information to the public about water quality, water quality standards and objectives, and health effects of drinking water contaminants. The EPA also has a Public Notification Rule, promulgated in 2000, to provide a framework for water utilities on the procedures to be undertaken in the event of occurrences of non-compliance with water quality standards. Both items were mandated as part of the consumer right-to-know provisions in the 1996 *Safe Drinking Water Act* (*SDWA*) amendments.

In England and Wales, compliance reports must be made available to the public by water utilities. Benchmarking results of key parameters from the water utilities are made available to the public by way of the Office of Water Services (Ofwat), the financial regulator of the water industry. Water rates are tracked and reported by Ofwat for review by the general public. Finally, Ofwat organizes two councils that are made up of members from the general public – at the national level by

## Figure 2-1 Model Utility Stakeholder Relationship Chart




**Source:** Developed by authors.

the Ofwat National Customer Council (ONCC) and at regional level by the ten Ofwat Customer Service Committees (CSCs). These councils provide a common voice for customers and ensure that the water suppliers are maintaining good customer relationship practices. These public information measures have been in place since the mid 1990s.

As can be seen from the examples of other jurisdictions, transparency and accountability are requirements of utilities that supply drinking water to the public. As a fundamental tenet of any model water utility, regular reporting – readily available to the public – must be instituted.[4] Regular reporting will form the foundation of the utility's accountability to the customer. The individual elements of the customer involvement program are described in detail in Section 8 – The Customer. Water utility requirements are summarized below to highlight the transparency elements integral to the operation of the proposed model water utility.

A fully accountable water utility is one that demonstrates, in a transparent manner, that public expectations are being met, water quality can be assured, and good risk management and operational practices are in place. The water utility will need to report to the regulator on compliance with preventive measures and any non-conformance. In addition, the water utility will report to the customer on the quality management of the water supply.

There will be a clear definition of roles and responsibilities for the regulator and the utility.

There will be a clear designation of powers and regulatory reporting requirements outlined in legislation and regulation.

The mission statement for the individual water utility, including customer needs and expectations, will be available publicly. It will capture how the water utility goes about implementing and operating a Total Quality Water Management System (TQWMS).

The water utility will report on the progress of meeting the annual business and operational plan for the utility. Such an annual report will provide the full range of information to describe the effective operation of the water utility, including

---

[4] d'Ombrain, 2002; Pollution Probe, 2001, *The Management and Financing of Drinking Water Systems: Sustainable Asset Management,* submission to the Walkerton Inquiry (Toronto: Pollution Probe).

financial statements, progress measured against the plan, investments and improvements in the year, training undertaken as compared to planned training, sustainable asset management, and technical compliance with standards.

Regular reporting can take a variety of forms, but will address the basic performance criteria for the TQWMS. Ongoing monitoring of water quality will be available on a regular basis. Results of continuous improvement initiatives will be communicated to the customers and other stakeholders.

The progress reporting will provide customers with a "consumer confidence report," so that any technical information on standards and implementation will be communicated effectively to the public.

The water utility, working with industry associations, will work to develop performance benchmarks for the TQWMS. The regulator will establish standard procedures and forms for reporting that are clear and concise and that will facilitate benchmarking. Over time, these benchmarks will be reported to the public as an indication of how the water utility is managing improvements and change. In addition, these benchmarks will offer system-wide indicators to the regulator on performance, quality, and effectiveness.

## 4 Technology – Utility Infrastructure

The core of any industrial production process must include the proper application of technology to provide an appropriate solution for a specific problem. This holds true for the water industry. Preventing contamination and managing risks at the source using technology and technical expertise provide the assurance of safe drinking water. In protecting public health, prevention is more effective than end-of-pipe compliance monitoring.

Prevention is a ubiquitous concept in the quality management field. The intent of implementing a quality management system is to prevent negative events by systematically reducing the risk of hazards. Risk analysis is fully described in section 6.2.3 on Hazard Analysis Critical Control Points (HACCP). A general procedure for evaluating prevention strategies is discussed in the Australian Framework.[5] The Framework proposes a rational decision-making approach that encourages the use of a remediation measure proportional to the level of risk of the hazard.

---

[5] See appendix 1, section A1.2.4, for a discussion of prevention strategies.

Furthermore, prevention strategies are actively encouraged by many organizations, including the American Water Works Association and the Water Environment Federation through their QualServe program and the EPA through its Partnership for Safe Water program. These organizations focus on evaluations (both self-assessment and peer review) of the water treatment facility. With the goal of providing the highest possible quality of water to the customer, these evaluations are intended to lead the utility to optimize performance by modifying existing procedures and practices. At the foundation of optimization is the concept of prevention.

A standard prevention strategy in the drinking water community is the application of the multiple barrier approach, which is outlined in the *SDWA.* The European Union includes source-water protection and disinfection requirements in its Drinking Water Directive, thereby having an implied multiple barrier strategy to water treatment.

A multiple barrier approach is encouraged in meeting the 2000 Ontario Drinking Water Standards, which use the CT concept to evaluate disinfection effectiveness and set requirements for CT levels.[6] The CT concept was modelled on the EPA CT requirements. Credit is provided to a treatment facility in meeting the CT requirements by the addition of a disinfectant for a prescribed time and concentration. A facility can earn substantial CT credits if it practises effective physical removal of particulates through filtration. This method of determining disinfection effectiveness encourages utilities to adopt a multiple barrier approach for water treatment.

## 4.1 Multiple Barrier Approach to Water Treatment

The multiple barrier approach employs several barriers in series to reduce the risk of pathogen transmission. If one barrier is performing less than optimally (or has failed), another is in place to compensate for the suboptimal performance, resulting in a complete system that still provides the desired level of treatment. Furthermore, optimized barriers in series will reduce dependency on, and improve results from, each barrier, thereby providing superior water quality to

---

[6] Ontario, Ministry of the Environment, 2000a, *Ontario Drinking Water Standards* [online], PIBS 4065e (revised January 2001) [cited July 2001], <www.ene.gov.on.ca/envision/WaterReg/Pibs4065.pdf>. CT is the product of disinfectant concentration C and the contact time T. See *Standards,* procedure B13-3, sec 3.0, for a discussion of the concept.

the customer. Examples of barriers in water treatment include the watershed catchment area, settling tank, filter, disinfection, and the water distribution system.[7]

### 4.2 Sustainable Asset Management

The heart of the water utility is its assets. It is critical that they be completely accounted for and judiciously managed and that a comprehensive computerized plan for preventive maintenance and renewal is developed and maintained (see section 6.3.4 for further discussion).

## 5 Technical Competence – Utility Operations

The technical skills of the operators – those who have control of the switches, conduct the tests, monitor daily flows – are the key for assurance of water quality. Operators must be able to demonstrate their competence through certification. Operator certification is required in the United States under the 1996 *SDWA* amendments and in Ontario by Ontario Regulation 435/93 and its amendments.[8] Others, including Doyle and the Australian Framework, have reinforced that proper training of operators is required to ensure the reliable provision of safe water to the customer.[9] Employees must be committed to continuous improvement, from the perspectives of both their own skills and the overall operation of the water utility. The ability to assure the public of the technical competence of operators is integral to building consumer confidence.

The knowledge, skills, motivation and commitment of employees and contractors ultimately determine its ability to successfully operate a water supply system. This element ensures that the level of awareness, understanding and commitment to performance optimisation and continuous improvement is developed and maintained within the organization.

---

[7] See appendix 1, section A1.2.4.1, for information on how each barrier can be used and managed in a drinking water treatment system to manage risk effectively.

[8] Ontario legislation and regulations can be found on the e-Laws Web site <www.e-laws.gov.on.ca/home_E.asp>.

[9] E. Doyle et al., 2002, *Production and Distribution of Drinking Water* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 8, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>, sec. 3.4; and Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 7.

## 5.1 Employee Awareness

Increasing awareness and understanding of drinking water quality management are essential elements in empowering and motivating employees to make effective decisions. All employees should be aware of the organisation's drinking water quality policy, the characteristics of the water supply system, what preventive strategies are in place throughout the system, regulatory and legislative requirements, roles and responsibilities of employees and departments, and how their actions can impact on water quality and public health.[10]

A water utility will increase employee awareness of the commitment to drinking water quality management throughout its organization. An awareness program will include

- the education element of the public information program,
- newsletters,
- participation in maintenance of operations manual,
- notice boards,
- seminars and videos, and
- briefings and meetings.

Employees will also be encouraged to participate in community meetings to get first-hand knowledge of customer concerns.

An employee rewards program will be developed to encourage suggestions to reduce operating cost or improve quality.

## 5.2 Operator Certification

The commitment and training of employees in issues relating to drinking water quality are essential to the provision of a safe and reliable drinking water supply. Because their actions have a major impact on drinking water quality, employees and contractors must be appropriately skilled and properly trained in the management and operation of water supply systems.

A water supplier should identify employees' training needs and ensure that employees performing tasks that have a significant impact on drinking water

[10] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 7.

quality are competent to perform those tasks. Employees assigned responsibilities for managing drinking water quality are required to be certified drinking water treatment plant operators.

The following excerpt is from an Ontario Ministry of the Environment (MOE) Fact Sheet dated December 6, 2000:

> Anyone who operates a drinking water facility in Ontario must hold a valid operator's licence. Ontario's operator certification standards are consistent with the Association of Boards of Certification whose standards are followed by most U.S. states and Canadian provinces.

Licensing requirements are set out in Ontario Regulation 435/93 under the Ontario Water Resources Act. There are four classes of licence based on facility complexity. Licences are renewable every three years. All plant operators are required to undergo 40 hours of training each year in courses such as new or revised operating procedures, refresher courses in existing procedures, safety training and other related courses that improve operator knowledge and skills. It is the responsibility of facility owners to ensure training requirements are met.

On August 8, the Minister of the Environment announced the intention to require all operators to undergo an additional 36 hours of ministry approved training over three years to ensure they have the most current knowledge, skills and experience needed to sample water quality. In addition, a new licence will be created for water quality analysts. This licence will be required to perform a range of tests for operational parameters.[11]

Currently, the MOE establishes the training standards for operators and maintains the related certification system. This system does not appear to have the rigour and infrastructure support necessary to ensure that occupational standards are defined clearly and that the training is achieving those standards. Another ministry has the prime responsibility for organizing skills training in Ontario.

The Ministry of Training, Colleges and Universities (MTCU), under the *Apprenticeship and Certification Act* (*ACA*), has a workplace-based model to support all skills training. The model combines formalized classroom instruction, with performance-based on-the-job curricula. For many occupations, there also are

---

[11] Ontario, Department of the Environment, 2000b, *Training Requirements for Sampling Drinking Water* [online] (fact sheet), [cited October 2001], <www.ene.gov.on.ca/envision/news/factdec6.htm>.

formal examinations. This system incorporates the testing of knowledge and the demonstration of the on-the-job skills (competency or performance). It also has the potential to provide flexibility – in terms of defining and mapping competencies in a rationalized system – in relation to the diversity and variation of water treatment facilities in the province.

The MOE's role in setting occupational standards, attempting to manage an infrastructure for training, and maintaining a registration and certification system is a throw-back to the 1970s, when ministries tended to compete with one another. Such competition among ministries results in duplication of effort, additional infrastructure costs, inconsistencies, fragmented outcomes, and confusion for the public. It makes eminent sense, therefore, to transfer the training and certification of operators to the ministry best suited to manage these activities.

The MTCU has the experience, expertise, infrastructure, systems, certification, and visibility in this domain. Re-testing and re-certification also can be accommodated by MTCU. This model could create a hybrid that includes both apprenticeship and post-secondary education as requirements for operator certification. The program can also offer cross-Canada recognition under the Inter-Provincial Red Seal Program, thereby promoting harmonization of occupational standards and labour mobility.

The Ministry of Training, Colleges and Universities should work with the industry to determine the adequacy of the current operator-training program and implement any necessary adjustments. In particular, under most apprenticeship programs, the formalized classroom instruction requires 720 hours over a three-year period. The MTCU also arranges with training-delivery agents (colleges and other approved agencies) to develop and deliver the classroom instruction. Current arrangements by the MOE are piecemeal and inadequate. Furthermore, through the Canada-Ontario Contribution Agreement, federal Employment Insurance funds may also be used to support the classroom instruction of qualified apprentices under the *ACA*.

Re-testing and re-certification, as in a number of other professions, would be required every three years to maintain a drinking water treatment plant operator licence. Grandfathering, the concept of exempting some current water plant operators based only on the number of years of experience, must of necessity be discontinued to ensure that the operators are sufficiently qualified to ensure

public safety. 'Education' must be further defined to be in the format of formalized classroom instruction with a certified education unit (CEU) being provided at the completion of the training. Industry and professional associations, with the assistance of the MTCU, will determine which training programs meet this requirement. "Training programs should encourage employees to communicate and think critically about the operational aspects of their work."[12]

Certification will include components of the following elements:

- water and its effect on public health
- safe operation of equipment
- regulations and standards
- planned emergency response
- customer awareness (sensitivity training)
- implementation of TQWMS

Certification records of all employees who have received CEUs are to be maintained by the water utility and the MTCU, as part of the TQWMS.

"Training is an ongoing process and employee training requirements should be regularly reviewed. It should be ensured that employees maintain the appropriate experience and qualifications."[13]

## 6 Support – Utility Management

People believe that their own industries and organizations are unique. Each person believes that he or she is unique. Each of these beliefs is true, yet the patterns of accomplishment or shortfall for each are very similar. When patterns are examined at an organizational level, the elements of leadership, management, and culture can be seen to determine the overall performance. In technical environments, technical solutions tend to be sought out. Although it may seem somewhat counter-intuitive, it is through the social side of the work environment (i.e., achieving collaboration) that the discovery of the technical solutions will evolve.

---

[12] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 7.2.
[13] Ibid.

This section discusses the elements – critical to shaping the organization – that will create a work environment that helps employees achieve excellence in their performance. The presentation might appear generic because the authors see nothing dramatically different that sets apart the drinking water supply industry. Like any other industry, there are processes, people, and product. Here, we discuss people.[14]

Management systems demonstrate a commitment to quality, strong leadership, competent management, and a comprehensive approach to performance management. The Total Quality Water Management System (TQWMS) has the processes and procedures that form a foundation for effective drinking water quality management.

Ongoing investment and strong accountability support technology and technical competence. Investment in people and quality are integral to achieving the TQWMS. The responsible management and financing of the product (quality water) and the asset (the utility) are necessary for a sustainable strategy of quality. Accountability to the public begins with effective oversight of the direction and management of the water utility through good governance.

## 6.1 Personnel Management

### 6.1.1 Culture of Quality

Quality was the mantra of the late 20th century and is now the mantra early 21st century. Quality has been driven by customer expectations of improved durability, longer life, and improved safety. In response to, or driven by, this requirement for quality there have arisen many institutions to support and further the quality endeavour. The most prevalent are the International Organization for Standardization (ISO), the American National Standards Institute (ANSI), and in Canada the Quality Management Institute (QMI). All standards institutions have as a core value the concept of improving quality through standardization.

Quality methodologies developed for specific industries include Hazard Analysis Critical Control Points (HACCP) in the food industry and Six Sigma in the

[14] For further reading on the subjects of this section, a number of papers by contributing author Bill Fields are listed in the reference section. Most of the material in this section, including tables, figures, and lists, are derived from those papers.

manufacturing industry. Six Sigma is mostly applicable to the manufacturing environment and focuses on reducing the number of defective units produced in a given lot. This type of mentality and the steps to achieve Six Sigma standards are not applicable to a water utility environment.

Conversely, HACCP has the effect of being a quality management tool by way of its assessment and corrective action protocols. Although in its strictest sense it is a risk management tool, it reduces risk to the lowest reasonable level. In the case of drinking water, low risk means high quality. Risk in the case of drinking water is quantified by way of pathogen contamination and trace metal and chemical concentrations. HACCP identifies points where risk can be managed by improving processes that are under the control of the water utility personnel. For example, in a water treatment facility, adjustments to coagulant dosage (a process – coagulation) could be used to remove pathogens (a risk).

In the water industry, associations such as the AWWA (through its QualServe program) and regulators such as the EPA (Partnership for Safe Water) promote the use of best practices to improve treated water quality delivered to the customer. Other associations such as the American Productivity and Quality Center (APQC) and the Association for Quality and Participation (AQP) offer support for quality programs.[15] In the UK water industry, a culture of continuous improvement is integral to the operation of the utilities because of the massive investment in infrastructure to make the water systems comply with European Union standards.

The Australian Framework emphasizes commitment to quality across all levels of the water utility. The concepts of communication and continuous improvement are also established in the framework of the drinking water quality policy. Although the Australian Framework is not proven and will most likely require some modifications upon implementation, it is the most comprehensive quality system for the drinking water industry. The Australian Framework includes elements of HACCP and of ISO 9000 and 14000 quality standards, which are recognized internationally. The standards have been adapted and applied in a drinking water treatment context, allowing for a straightforward implementation by other drinking water organizations.

A sample generic statement of policy can be adopted and adapted by any water utility (see appendix 1, section A1.1). Of critical importance is that each

[15] APQC worked in conjunction with AWWA and WEF to develop the QualServe program.

employee should know how the utility's mission statement applies specifically to the performance of his or her job. Each employee must understand that he or she is responsible for the quality of the water that a utility produces. The culture of quality must be instituted in an organization by educating all employees about the benefits of a quality system.

Quality is about much more than just a system, forms, and methodology. Quality is about attitude – and attitude resides in the gut. The system, forms, and methodology will be established to support the attitude of continuous improvement. Water utilities will inculcate in all employees the belief and commitment to aspire to excellence and continuous improvement. There will be an obvious passion for quality. How will this passion be developed? It starts with the leader.

### 6.1.2 Leadership

Strong leadership is a requirement for implementation and maintenance of the TQWMS. A large body of knowledge is available on developing leaders in organizations. The authors are attempting only to summarize and provide some general principles of leadership in the modern business environment.

There is both a technical side and a social side to managing. The social side is addressed in this section, the technical issues in the next.

It is through leadership that an idea, such as the Drinking Water Quality Policy, is implemented at a practical operational level. It is about getting people to do things in a certain way. Leading is not about telling, but rather about influencing the way in which employees interact and perform.

There are definitive attributes and strategies that culminate in effective leadership. A leader stands apart and above others through vision, commitment, and communication:

- *Vision* interprets how the strategic business priorities will become transformational. It is a clear understanding and internalization of how business will come to be conducted.

- *Commitment* is an unrelenting, consistent behaviour that advances the vision. It is demonstrated in everything that the leader does.

- *Communication* is the process of explaining, influencing, engaging, supporting, and coaching employees in achieving their contribution to the vision.

Leaders believe that they can make a difference regardless of the prevailing environment, and they will strive for excellence. Leadership is directional. It is the leader, therefore, who will establish and maintain the culture of excellence and continuous improvement in the water utility.

Leaders motivate others to achieve high performance. They are high-impact players who can help organizations become better-aligned and less imperfect. In fact, a leader can inspire not only an entire organization, but suppliers and customers as well.

The leader can take the challenges of moving from the current system to the model water utility and create opportunities to effect improvement and achieve successes. The leader is the prime instrument in establishing and maintaining the organization's culture, and creates within the staff the concept of challenge in job performance.[16]

### 6.1.3 Management

Managers face unlimited choices and make a variety of decisions every day. Each decision carries certain elements of risk. Fundamentally, the decisions are about how managers will choose to participate in changing the world around them.

From setting goals through to execution, all organizations are challenged to perform to their maximum potential. A myriad of factors can constrain performance, including

- conflicting priorities,
- organizational misalignment,
- underlying contradictions,
- inconsistent culture,
- inadequate leadership,
- inappropriate skill sets,

---

[16] See also Doyle et al., 2002; and Martin, Archer, and Brill, 2002.

- constrained resources,
- personality conflicts, and
- insufficient time.

Given these organizational dynamics, what is it that managers must do to achieve effective performance? The management process is illustrated in figure 6-1.

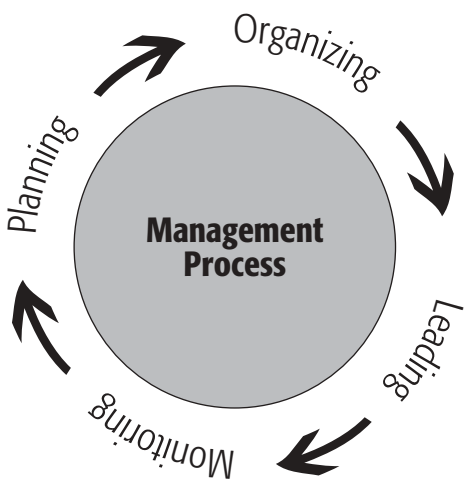
Planning, organizing, and monitoring essentially are technical activities, along with methodologies, processes, and measurements. The TQWMS (see section 6.2) expands on these elements. Leadership is an important element of management. It was dealt with in a previous section. The other elements in the management process are discussed in the following subsections.

### *Delegation*

Successful management requires delegation. The water utility manager must be confident that jobs delegated to operators will get done properly.

Delegation can be defined as commissioning a person as a representative with power to act for another. Thus, delegation implies both responsibility and authority. Omitted from this definition, however, are the competencies required to carry out the action effectively.

**Figure 6-1 Management Process**



If an employee has the required competencies, the manager can

- clearly define the assignment,
- make available the necessary resources,
- assign authority,
- specify deliverables and timelines,
- establish accountabilities and consequences,

and let the employee carry out the assignment.

*At the task level: a four-step process* If a manager is to delegate with confidence, the employee must first be coached in how to perform a particular task. This coaching represents the on-the-job component of the operator apprenticeship program. The complexity of the task will determine how in-depth the coaching will have to be. For tasks of a less complex nature, a four-step process is used:

- *Describe* In detail, the manager will describe the task in its entirety. The use of written procedures, work instructions, videos, and checklists is highly recommended. The manager will provide relevant related information, so that the operator can understand the task in relation to other activities. For example, if the task relates to the measurement of a water quality parameter, relevant information would include the testing equipment required to perform the test, calibration procedures (if required), the chemicals for the test, the forms and recording procedures, and sample locations.

- *Demonstrate* The manager will show the operator how to perform the task. The operator observes each step of the process. Critical actions and potential problems and their solutions are identified.

- *Observe* The manger will observe the operator performing the task.

- *Debrief* The manager will provide immediate feedback to the operator, critiquing the performance. The manager will ensure that the operator has sufficient opportunity to ask questions and to confirm performance standards and operating procedures.

Because operators achieve competency through training and experience, the cycle must be conducted several times. Periodic performance reviews are also appropriate.

*Complex functions and assignments* More complex functions and assignments have a number of additional features. Description of an assignment will be more detailed and comprehensive. In fact, for some assignments or projects, all the details might not be known at the outset, but are discovered through the process itself. The manager will have to be available for regular reviews and coaching sessions.

At the outset, the manager must determine the skills and knowledge required to perform the function. If the employee has skill gaps, formal training might be appropriate. For instance, if the assignment is to lead a project team on continuous improvement related to a particular function of the water utility, a training program in project management and team leadership could be extremely beneficial.

Critical paths, timelines, deliverables, resource requirements, and strategies for overcoming constraints have to be identified. Potential problems must be highlighted and contingency planning conducted. Regular reviews during the life of the assignment must be scheduled. In complex assignments, the manager should expect to spend significant time with the employee, coaching for higher performance.

*Job functions* Job functions are even more complex. Detailed job descriptions are established for jobs, but major responsibilities may be recast as competency groupings. Practical exposure, testing, and analysis will determine which training interventions are necessary and appropriate. Employees will progressively mature in their positions through regular training, upgrading, and coaching.

In situations that require judgment, wisdom often comes from reflecting on previous mistakes. Therefore, the manager must create circumstances that allow the employee to take risks, with the implied recognition that there will be some failures. It is the manager's responsibility to manage this process in a way that minimizes the water utility's exposure while maximizing the employee's growth potential.

Through a consistent and persistent system of coaching, employees will develop and demonstrate the required competencies to perform a task, project, or job. Managers must have the commitment to invest the time to share their knowledge and experience.

### *Motivation of Employees*

Every employer wants to know how to motivate employees. The following is a very simple and practical three-step approach for turbocharging the workforce.

*Mutual respect* This is the fundamental premise for all positive human interactions. A culture characterized by weakened mutual respect will breed unhappiness, contempt, lethargy, and conflict. Respect is that condition whereby diversity of character, individuality, and thought are acknowledged. In a culture built on respect, consideration is extended to each person in an equitable manner. This contributes to a happier, more dynamic environment, in which employees feel wanted and valued. In turn, they will want to achieve higher levels of performance, quality, and service.

*Open communication* High-performance environments have trusting, two-way communication. Information is shared openly and discussion replaces 'telling.' The norm is to solicit employees' opinions and insights. As employees become more involved, real collaboration begins to develop and there is increased conversation regarding how best to contribute to the organization's success.

*Active engagement* Participation must be integrated with the entire process. It is critical that processes be structured to engage all employees actively in

- identifying issues, problems, and opportunities;
- conducting analysis;
- solving problems;
- developing alternatives; and
- implementing solutions.

Asking employees to buy in at the implementation stage just does not work. Quality solutions best come from those directly doing a particular job, and they need to participate in designing answers to their problems. Having been actively engaged in developing the solutions, employees are highly motivated to deliver success with pride of ownership.

The manager is responsible for creating and maintaining an environment that cultivates mutual respect, promotes open communication, and actively engages the workforce in developing solutions. This is how water utilities will achieve the goals of the TQWMS.

### 6.1.4 Human Resources Management

The authors believe that a sound human resources management system applies equally to publicly or privately operated organizations, and to union or non-union environments.

To support productivity and employee satisfaction and to become the employers of choice in a fiercely competitive labour market, water utilities have to establish and maintain effective human resources management systems. They must deal with legal requirements (including pay equity), health and safety, the Workplace Safety and Insurance Board (WSIB), employment equity, the *Labour Relations Act,* the Human Rights Code, and the *Employment Standards Act.*

Water utilities must embed a new level of management sophistication by establishing a number of elements. The utilities will have to

- set up a progressive corporate human resources function;
- audit and adjust current human resources practices;
- establish and maintain corporate compliance with legislative requirements;
- analyze staffing requirements and demographics to develop a succession plan;
- analyze job functions and develop job specifications, competencies, job descriptions, and standard operating procedures;
- institute a process to deal with human resource issues at a strategic level;
- develop an in-house resource by which staff can communicate – to increase employee satisfaction;
- create an employee handbook that consolidates the water utility's policies, procedures, values, corporate mission, and a summary of significant working conditions and benefits;
- develop an employee performance management system linked to the utility's strategic plan;

- identify corporate training needs and develop a training strategy, including a management leadership development program and an operator apprenticeship program;

- handle grievances; and

- identify external resources required to assist in the foregoing actions.

Table 6-1 identifies the elements of an established human resources management system, and the benefits derived from it.

### 6.1.5 Performance Management

Formal job descriptions and employee performance interviews are required. The job description is not intended to limit the employee, but to give for management a tool for identifying current gaps and needs within the organization. Management needs an integrated system to provide the context for human resource functions and activities.

When business operations and systems are not properly coordinated or are functioning at cross purposes in an organization, performance and morale suffer. This has a profound negative effect on the bottom line. It therefore makes eminent good business sense for an organization to take the time and effort to develop and implement a performance management system.

#### *The Performance Management System*

A performance management system is an intrinsic element of the business systems of every organization. It is driven by an organization's strategic business priorities, and it functions at the critical juncture where strategy becomes translated into performance. This is the system that manages the people part of a business, and it must be aligned with the other systems that support the water utility.

A performance management system is not overly complex, but it does require a certain level of attention and precision to manage it effectively. Organizations that establish and maintain good performance management systems function better and attract and retain high-performing employees. Because it affects

## Table 6-1 Elements of a Human Resources Management System

| | Human resources activity | Deliverables | Benefits |
|---|---|---|---|
| A | Strategic planning | • facilitate a planning process to identify goals, objectives, and business priorities<br>• document and communicate the results | • identifies business goals to focus activity<br>• increases the alignment of resources<br>• clarifies strengths and areas for development |
| B | Orientation | • create an orientation process to be followed for new staff<br>• create an orientation document for guidance on the process, addressing organizational issues, employment benefits, introductions, and establishment of job duties<br>• review the process with relevant staff | • provides a professional welcome for new staff and sets the right tone<br>• reduces errors and saves time<br>• develops clear organizational and job expectations<br>• supports rapid achievement of acceptable performance levels for new employees<br>• increases organizational stability |
| C | Training | • review employee training database<br>• conduct training needs analysis<br>• profile training needs by position<br>• develop a training calendar coordinate and facilitate training events<br>• follow up evaluations on course effectiveness and application of skills by employee | • ensures employees are all moving toward the ideal competency for their position<br>• database provides valuable information on human resource strengths and weaknesses<br>• provides data for organizational planning and development |
| D | Policies and procedures | • review existing policies and procedures<br>• revise or create all relevant human resources policies to meet statutory requirements and good business practices | • establishes company structure, culture, and norms<br>• informs employees, assists in decision making<br>• provides a basis for corrective and disciplinary action<br>• demonstrates compliance with legislative requirements<br>• (hiring, working conditions, termination, etc.) |
| E | Peformance management | • develop format for performance evaluation<br>• document procedures and definition of terms<br>• provide complete training of management staff<br>• conduct staff information session on objectives and process<br>• provide support for implementation | • provides feedback for supervisors and employees<br>• provides basis for compensation adjustments, training activities, internal staffing, succession planning, job design review<br>• focuses future activity of employee |

## Table 6-1 Elements of a Human Resources Management System, cont'd

| | Human resources activity | Deliverables | Benefits |
|---|---|---|---|
| F | Staffing<br>• internal<br>• external | • formalize a general process for internal and external selection that meets provincial employment standards<br>• design an application form approved by the Human Rights Commission<br>• establish communication pieces for stages of process<br>• establish evaluation grid for selection<br>• develop reference-checking format<br>• train the appropriate managers | • provides a professional approach for staff and external candidates<br>• expedites selection by providing a process<br>• demonstrates company adherence to good business practices and statutory compliance |
| G | Team building | • identify employee work preferences<br>• identify team members<br>• identify profiles of key positions<br>• workshop to develop more effective team management skills | • ensures that people can perform more effectively by working in the right jobs<br>• increases understanding and respect of skills and contributions of team members |
| H | Job analysis – Organizational development | • examine the work of the organization<br>• identify competencies required by position<br>• write job profiles | • provides profile of the work of the organization<br>• ensures that grouping of work is effective<br>• provides data for growth and development of company and staff |
| I | Job evaluation | • rank positions based on pay-equity principals of skill, effort, working conditions, and responsibility | • provides an objective process with which to value the work of a position and removes subjective assessment of worth that can lead to fairness and human rights concerns |
| J | Compensation Policy | • review current industry salary surveys<br>• review merit pay and bonus practice<br>• recommend compensation plan | • improves company ability to attract and retain the staff required for success of the operation<br>• ensures compensation practices are in line with business direction |
| K | Employee benefits package | • examine current health care benefits for employees<br>• assess the package for cost effectiveness and their families<br>• examine use and suitability<br>• ensure coverage is communicated in orientation, policy manual and employee handout, recruiting material | • ensures that coverage meets needs of employees<br>• provides clear communication to employees about benefits coverage<br>• ensures cost effectiveness of benefits premium costs |

**Table 6-1 Elements of a Human Resources Management System, cont'd**

| | Human resources activity | Deliverables | Benefits |
|---|---|---|---|
| L | Health and safety, WSIB, WHMIS | • review existing policy and procedures<br>• establish health and safety committee and practices | • assures company and staff of safe work practices<br>• demonstrates compliance with legislative requirements |
| M | Reward and recognition program | • assess existing program, industry standards, employee interest<br>• formalize a basic program | • formalize a basic program<br>• motivates for performance<br>• acknowledges good performance<br>• establishes role models for all staff<br>• increases company loyalty |
| N | Employee relations – Communication | • establish a mechanism for workplace communication and problem solving | • improves moral and productivity through information exchange, better understanding of the utility's strategies<br>• provides an opportunity to resolve problems at an early stage<br>• involves employees in activity of the company |

and involves every employee, it also provides early warnings of other systems being out of alignment.

The flow-chart in figure 6-2 illustrates the overall context of the performance management system. Note how it links the strategic business priorities to each employee.

### *How It Works*

Job functions are driven by a utility's strategies and priorities. As conditions change, it is important to review the job functions to ensure that they continue to be relevant and in alignment with the strategies and priorities.

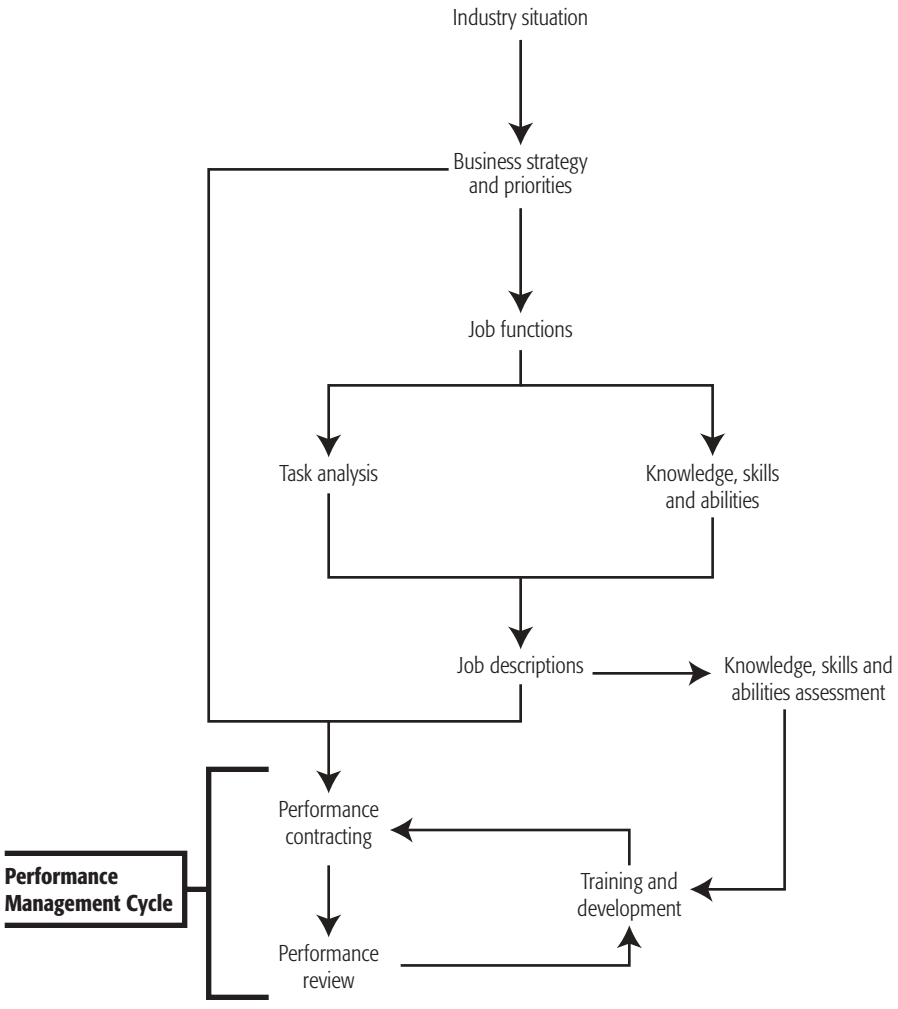
Once a job function has been defined, the tasks to be performed and the related knowledge, skills, and abilities can be identified. These, in turn, lead to the development of a job description. The job description should include both the technical and behavioural (performance) attributes required in the job.

Assessing the knowledge, skills, and abilities (both technical and behavioural) of incumbents or job prospects against the job description will facilitate better recruitment practices and identify training and development needs.

Performance contracting – the process of establishing an employee's individual goals –should be a negotiated process between employee and supervisor. It is critical that these goals, which should include technical, behavioural, and business objectives, be developed in a manner that makes them measurable, impartial, relevant, and attainable. Training managers how to conduct performance contracting sessions is part of the leadership development program discussed later.

Performance reviews (both formal and informal) should be conducted regularly to assess the employee's progress and to determine training and development

**Figure 6-2 Performance Management System**



needs. These reviews should be a negotiated process between employee and supervisor, taking into account the employee's goals and any support or intervention required to meet performance standards.

Employees, with their supervisors, should develop priority-ranked training and development plans, which can then be incorporated in a utility-wide training plan. Training can thus be organized and delivered in a planned and rational manner, always in support of business priorities and individual employees' needs.

This is a full performance management system. It should be applied to the entire organization and to employees at all levels. Implementing such a system will bring cohesion, order, and direction to the human resources activities of an the water utility, in support of its strategic business priorities.

### 6.1.6 Training Managers and Developing Leaders

The drinking water industry, like most other industries, promotes technically adept workers into management positions. Unfortunately, many of those managers have never had any management training.

To support and ensure excellence and quality, a water utility must commit to a comprehensive leadership development program for all employees in management positions. The utility's annual report should contain a report on the successful completion of this program by its managers. An abbreviated version of the training should also be considered for other employees. Training managers how to conduct performance contracting sessions is part of the leadership development program discussed below.

The following list identifies elements of a leadership development program. The program would extend over some period of time – each element would require a day of formal training. This training should be supplemented by participation in activities organized by the various professional and industry associations.

***Topics Required for Leadership Development Program:***

- vision
- roles of the manager, supervisor, and employee

- communication
- understanding behaviour
- managing difficult employees
- delegating and following-up
- coaching for performance
- handling conflict
- human resources forum
- labour relations
- employment standards, diversity
- health and safety
- time management
- problem solving and decision making
- project management
- leadership
- teamwork
- investigating, evaluating, and documenting incidents
- performance management
- interviewing and recruiting
- setting goals and priorities
- grievance handling and collective agreement administration
- workplace harassment, attendance management
- ethics
- business writing
- report writing
- managing with a customer focus
- strategy
- finance for non-financial managers
- developing and managing budgets
- effective meetings

The three programs described in this section – a human resources management system, a performance management system, and a leadership development program – may seem somewhat unexciting. Taken together, however, they form an essential cornerstone in establishing and maintaining the model water utility. To their own detriment, organizations often overlook or truncate these processes and activities. Though not particularly glamorous, they are fundamental to the success of an organization and must therefore be supported by the model water utility.

## 6.2 Total Quality Water Management System

### 6.2.1 Continuous Improvement

Continuous improvement is an element of the ISO 9000 and 14000 standards. This ongoing endeavour ensures that an entity changes with the environment in which it operates and takes advantage of its collective minds to define methodologies to improve efficiency and quality. Much of the concept of continuous improvement is based in quality management (see section 6.1.1). For the same reasons that the Australian Framework was selected as the standard to be employed for quality management, it is again selected as the model to form the foundation of the proposed continuous improvement element of the of the Total Quality Water Management System (TQWMS). See appendix 1, section A1.2.1, for a discussion of continuous improvement.

Continuous improvement requires commitment from senior management in the water utility to strive for optimal performance and to track changes within the industry that could affect operations. The TQWMS plan ensures that the management system is being reviewed and regularly updated with innovations and improvements. The requirement for short-term (1-year), intermediate-term (5-year), and long-term (20-year) reviews of the TQWMS plan is outlined by the regulator.

Research and development are important components of continuous improvement in the drinking water sector. A utility could have staff dedicated to ongoing R&D projects for plant optimization. Or projects might be better suited for contracting to outside agencies such as universities, or for collaboration with universities, researchers, consultants, associations, or other utilities.

### 6.2.2 Benchmarking

Benchmarking is the process of comparing in-house performance with that of other water treatment plants. Benchmarking is encouraged in the United States and Canada by programs such as QualServe, in Australia by way of its Framework for Management of Drinking Water Quality, and in the United Kingdom. Performance parameters can be compared by utilities with similar capacities and source waters. Many water utilities in Ontario already have subscribed to the QualServe program.

Benchmarking has also been used by public advocacy groups such as Clean Water Action's Measuring Up II, which rates all consumer confidence reports provided by California's water utilities.[17] The public can use the power of benchmarking to rank the performance of water utilities and to identify the quality and efficiency that can be expected from a utility.

Benchmarking is a quick way for water utility managers to evaluate their treatment plant performance, and it should lead to discussion and exchange of information between managers and operators on best practices. If one utility has higher performance on a specific parameter, other utilities will want to emulate its practices.

Several parameters can be used as a basis for benchmarking (see table 6-2). Other parameters can be added as necessary or desired.

### 6.2.3 Hazard Analysis Critical Control Points

Hazard Analysis Critical Control Points (HACCP) was developed in the 1960s and has been adopted as the preferred quality control tool in the food industry since the early 1990s, much as ISO 9000 (and its variations) is the standard of quality control in manufacturing and other industries. HACCP is internationally recognized as assurance that a food product has been packaged with proper quality control.

**Table 6-2 Benchmarking Parameters**

| Parameter | Unit |
|---|---|
| Turbidity | NTU |
| Colour | TCU |
| Leakage | % of total |
| Energy | kWh/$m^3$ |
| Cost of water production and supply | \$/$m^3$ |
| Price of supplied water | \$/$m^3$ |

[17] Clean Water Action, Clean Water Fund, and California Public Interest Research Group Charitable Trust, 2001, *Measuring Up II – An Evaluation of Water Quality Information Provided to Consumers in California* (San Francisco: CWA).

HACCP is currently being used extensively in the Canadian food industry. In brief, the program consists of seven basic principles:

1. identification of hazards that may be present from harvest through ultimate consumption and preventative measures for controlling them
2. determination of critical control points (CCP) required to control the identified hazards
3. establishment of critical limits that must be met at each critical control point
4. appropriate monitoring procedures for CCP
5. establishment of deviation procedures at critical control points
6. procedures for verification that a HACCP plan is working
7. documentation records concerning all procedures and records appropriate to principles (1) through (6)[18]

Adaptation of HACCP to water treatment and implementation by utilities would be relatively inexpensive. Not only are there many similarities between packaging food products and treating and distributing water, the expertise required to implement the program is resident in our geographical area, and the government already has the infrastructure to implement and regulate HACCP.

Inspectors from the Canadian Food Inspection Agency (CFIA) could be used to provide inspection services for water utilities. Inspectors would require some additional training and education, but their core values and skills are common with those in the water industry – concern with health and safety, appreciation for microbial contamination, and dedication to the protection of the public. Separate divisions for food and water would be required to ensure that specialized inspectors would be used in the water sector.

Finally, HACCP was included in the Australian Framework, with rough protocols worked out on typical water treatment. Some of the groundwork for HACCP implementation in drinking water, therefore, has already been started.

---

[18] The full implementation manual for HACCP in the food industry can be found at the Canadian Food Inspection Agency Web site [cited December 2001], <www.cfia-acia.agr.ca/english/ppc/psps/haccp/haccpe.shtml>.

### *Hazard Identification and Risk Assessment*

A hazard is an agent or a situation with the potential for causing harm (e.g., *Cryptosporidium* is a water quality hazard, a potential danger to public health). Risk is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences (e.g., the likelihood that *Cryptosporidium* oocysts will breach water management system barriers in sufficient numbers to cause illness is a risk).[19]

The Australian Framework details how hazard identification and risk assessment are applied in the drinking water treatment system.[20] Potentially hazardous or contamination events are identified for the different stages of the water system, from the catchment to the distribution system.[21] Following the quantification of the risks, a prioritized list can be developed to identify the order in which to tackle them.

### *Critical Control Points*

"A critical control point (CCP) is defined as a point, step, or procedure at which control can be applied and is *essential* to prevent or eliminate a hazard or reduce it to an acceptable level (Codex Alimentarius)."[22] In the drinking water system, the process can be most controlled at the treatment plant. Other CCPs include the watershed and the drinking water distribution system. Each of these general processes of the drinking water system can be subdivided into smaller processes to analyze specific strategies of control. Some characteristics of an ideal CCP are identified in appendix 1, section A1.2.3.

Individual unit processes within a drinking water treatment plant are identified as CCPs. Strategies for managing the risk at each point are developed in appendix 1, section A1.2.3. These strategies are general in nature and would require further development for implementation at a specific water treatment plant.

---

[19] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 2.3.

[20] See appendix 1, sec. A1.2.2, for a thorough discussion of hazard identification and risk assessment as per the Australian Framework. It includes a methodology for qualitative computation of risk (identifying high- and low-risk hazards).

[21] See appendix 1, table A1-1.

[22] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 3.2.

A CCP not listed in appendix 1 is membrane technology. The use of membranes has been gaining wider acceptance in small plants, and now – with costs decreasing as a result of economies of scale and improvements in membrane manufacturing technologies – in large plants (up to 150 ML/d). Membranes physically remove pathogens, particulates, and some dissolved compounds.

### 6.2.4 Risk Management

Risk management is a continuous and iterative process. It is a combination of reducing technical risk to reasonable levels and having open and frank discussions with the public about risk and its implications. Although risk cannot be eliminated in drinking water, it can be mitigated to levels that provide adequate protection. A properly executed risk management program will result in higher quality and safer water.

The HACCP program is in essence a procedure for minimizing technological risk. It will

- identify chronic and acute risk within the treatment system,
- mitigate chronic risk by the development of operational procedures to ensure the desired water quality is achieved on a consistent basis, and
- identify acute risks that need to be addressed with the development of procedures.

Acute risks and the occurrence of an out-of-range parameter are the focus of the final two parts of this section. See appendix 1, section A1.2.5, for a discussion of risk management.

#### *Risk Communication*

The concept of risk minimization has to be conveyed to the public. The public must be aware that there is always an element of risk when any food or beverage – including tap water and bottled water – is ingested. The objective of the treatment system is to reduce the risk to a reasonable level. When an incident occurs where standards are contravened, the public then will be able to put the warning into

context: a specific parameter has exceeded a prescribed risk level. The warning is not necessarily to tell people that they will get sick if they drink the water (although that could be the case). Rather, it is to let them know that the maximum risk level, as determined through epidemiological studies, has been exceeded.

Powell provides seven rules of risk communication:

- Accept and involve the public as a legitimate partner.
- Plan carefully and evaluate performance.
- Listen to your audience.
- Be honest, frank, and open.
- Coordinate and collaborate with other credible sources.
- Meet the needs of the media.
- Speak clearly and with compassion.[23]

Powell also summarizes detailed guidelines for risk communication. The basic principle of risk communication is to protect the public. A strong emphasis, however, is placed on maintaining public trust in the water being supplied. This public trust is best maintained by following rules of communication like the ones in the foregoing list. Effective risk communication will assure members of the public that they have not been deceived, so that at the end of the event, when the risk has been reduced to reasonable levels, they will be comfortable with and have trust in their drinking water.

Dobell extends risk assessment and characterization to include the public. Dobell characterizes the drift toward an "audit society"; we are increasingly moving toward quality systems and the resultant checking that is required. This puts increased pressure and expectations on public servants to have transparent processes understandable by others, including the public. Dobell has put together a recipe for making decisions on behalf of individuals, but in the public interest:

- It must be principled – there is a core layer of individual human rights (requirements of natural justice) to be respected.
- It must meet social tests of procedure.
- Within these constraints, it must be substantively justifiable.

---

[23] Douglas A. Powell et al., 2002, *Water Warnings: Communication in Drinking Water–Related Public Health Emergencies* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 12, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.

- In a situation where there appear to be fundamental conflicts among these precepts, it must meet a final test of personal responsibility.
- It must be clear and understandable.[24]

The second step – meeting social tests or procedure – is in a state of flux. The public is demanding increasing access to information. Public servants should understand that eventually, at some stage, the public will attain knowledge of a project. It is therefore in the best interest of any decision maker to include the public at an early stage. It is better to know about strong resistance to the project early in its life cycle, when expectations and planning can be modified. A change late in a project costs more than an early change. Because meeting the social tests requires more and more participation, a frank discussion with stakeholders on the project's risks and risk assessment procedure is a requirement of modern utilities. Because of the complexity of the issues surrounding this type of discussion with the public, it is recommended that experts be used for the communication program.

### *Incident and Emergency Response Protocols*

A standard protocol must be established for reacting to an emergency situation. The protocol includes characterization of the problem, correction of the problem, and communication with the required authorities. Of key importance are established protocols that have been effectively communicated across the organization before an emergency situation arises. After the emergency has been brought under control, an evaluation process is required to analyze the cause(s) of the emergency, review the response to the emergency, and modify the emergency protocol if required.[25]

### *Emergency Planning*

Uncontrollable events with irregular cycles can have an impact on the operation of the drinking water treatment system. Examples include natural disasters

---

[24] Rod Dobell, 2002, *Social Risk, Political Rationality, and Official Responsibility: Risk Management in Context* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 13, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.

[25] See appendix 1, sec A1.2.5.1, for a discussion of incident and emergency response protocols. An example water incident communication and notification protocol is included (box A1-7).

such as the ice storm of 1998. Maintaining a consistent water supply is critical during such periods to ensure that potable water is available to people in crisis and to ensure adequate flow for firefighting if the events result in fires. A good resource for emergency planning is AWWA Manual M19 – *Emergency Planning for Water Utility Management.*[26]

### 6.2.5 Standard Operating Procedures

The development of standard operating procedures (SOPs) is a valuable process. It results in the collection of information that forms the foundation of many TQWMS components, including continuous improvement, identification of CCPs, and the SOPs themselves. Optimization programs such as QualServe and Partnership for Safe Water would benefit by the use of SOPs to define current operating practices as a basis for modifications to improve the performance of a drinking water facility.

> The effectiveness of preventive management strategies is highly dependent upon the design and implementation of associated process control programs. To consistently achieve a high quality water supply it is essential to have effective control over the processes and activities that govern drinking water quality and safety. This is particularly important for those activities that have been defined as Critical Control Points.
>
> Operations must be optimized and controlled on a continuous basis as even short periods of suboptimal performance can represent a serious risk to public health. Therefore, ensuring that barriers are functional at all times is a critical requirement for the provision of a safe drinking water supply.
>
> A process control program supports the preventive strategies by detailing the specific operational factors that will ensure that all processes and activities are carried out effectively and efficiently. This includes a description of all preventive strategies and their functions together with

---

[26] American Water Works Association, 1994, *Emergency Planning for Water Utility Management,* 3rd ed., manual M19 (Denver: AWWA).

- documentation of effective operational procedures including identification of responsibilities and authorities,
- use and maintenance of suitable equipment,
- use of approved materials and chemicals in contact with drinking water,
- establishment of a monitoring protocol for operational performance including selection of operational parameters and criteria and the routine review of data, and
- establishment of preventive and corrective actions to control excursions in operational parameters.

Additional requirements for effective process control are the skills and training of operations staff and the documentation of the process control program.[27]

For details of the methodology for developing SOPs, see appendix 1, section A1.2.6. The process will by necessity involve many or all of the water utility staff. This will give the staff a sense of ownership of the SOPs that will ultimately lead to greater participation in the ongoing TQWMS.

### 6.2.6 Verification of Drinking Water Quality

Verification involves monitoring the quality of drinking water supplied to consumers to determine compliance with established criteria and requirements. Monitoring of drinking water parameters is necessary to ensure compliance with regulated standards and for benchmarking performance. At a minimum, the standards are to be followed to ensure that a minimum number of samples are taken over a given period. Tables in *Ontario Drinking Water Standards* include a comprehensive list of parameters to be monitored, frequency of monitoring, and the required reporting schedule:

- Table 5 – Sampling
- Table A – Microbiological organisms
- Table B – Volatile organics
- Table C – Inorganics
- Table D – Pesticides and PCBs[28]

---

[27] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 4.
[28] Ontario, Ministry of the Environment, 2000a.

As important as verification is in TQWMS, meeting standards is not always sufficient to protect public health. Jack Hoffbuhr, executive director of the American Water Works Association, stated:

> I hope we can all agree that a table of numbers – whether they are guidelines or strict standards – does not protect public health in and of itself. Meeting the numbers is just part of an effective program. More important to me is whether utilities have continuous quality improvement systems to verify that the entire process of delivering safe drinking water is working as it should.[29]

See appendix 1, section A1.2.7, for a discussion on verification of drinking water quality.

### 6.2.7 Documentation and Reporting

Documentation procedures and the forms used to standardize internal utility reports will form the foundation of the SOPs (discussed in section 6.2.5). Once the forms are filled out, the information will have to be processed and analyzed with the objective of identifying trends and modifying procedures to improve water quality. Periodically (every three months in Ontario), some of the pertinent information will be summarized and presented to the public in a quarterly report.

Ontario Regulation 459/00 requires quarterly reports, which must be available within 30 days after the end of each quarter. Parameters that are required to be sampled at intervals greater than three months should have the value of the last sample, along with its date. Criteria by which a public notice must be issued are clearly specified in Section 8 of the regulation – Notice to Medical Officer of Health and to Ministry. As an additional requirement of the TQWMS, annual reports will also be produced for audit and public reporting purposes.

Appendix 1, section A1.2.8, provides details about the types of activities that require documentation. The documentation system should be kept as simple as possible to ensure that information or data can be readily retrieved when needed. A system of updating forms and documents should be in place to reflect the changes that occur within the organization.

---

[29] Jack W. Hoffbuhr, 2001, "The regulatory paradox," *Journal of the American Water Works Association*, vol. 93, no. 5.

See appendix 1, section A1.2.8, for a discussion of documentation and reporting.

### 6.2.8 Evaluation and Audit

To ensure that staff adhere to the TQWMS, regular evaluations and audits are required. A system of internal evaluation and audit will identify areas relating to the organization, staff, and equipment that could be improved. External evaluation and audit can provide analysis of specific issues. Regular audits will be conducted by third parties who are recognized registrars (see section 7.1.3 for a description of the audit function). See appendix 1, section A1.2.9, for a discussion of evaluation and audit.

## 6.3 Financing

### 6.3.1 Value

Sometimes when purchasing external services there is a tendency to make the selection solely on the basis of lowest cost. Water utilities must recognize that there is a *value proposition* – a certain correlation between cost and value. The inclination to purchase services at the lowest cost reduces other values to the lowest common denominator, that being cost. Making purchases on this basis ignores the intrinsic values being sought in the services and renders the purchaser with something less than the desired outcome.

For every contemplated purchase, a utility must develop a filter – a set of screening criteria, with related standards and weighting. By applying this filter to every proposal that is submitted, the utility can make a transparent decision based on interrelated factors. This approach will help ensure an appropriate balance between expenditures and deliverables. Such a balance brings true value to the purchases of the water utility.

Water utilities also have to explore innovative common purchasing arrangements that might reduce costs or bring greater value to purchases. For example, forging links with other water utilities or other public sector organizations in the community (schools, hospitals, colleges, universities, other municipal departments), can achieve economies of scale in purchasing power. This will have the effect of reducing costs or improving services. Innovative purchasing

approaches will serve as another example of best practices that should be promoted by the industry and professional associations.

### 6.3.2 Investing in People

The model water utility being described in this paper is anchored in a culture that strives for excellence and continuous improvement. To achieve this end, and to create the sound human resources management systems described in section 6.1, the utility must make ongoing investments in its employees.

In determining the related costs, the following considerations are critical:

- the need for external resources to help build the human resources management system and performance management system
- determining appropriate pay bands and making provision for these costs
- the need for external resources to conduct a skills inventory and gap analysis
- appropriate resources to support technical training of operators through a formalized apprenticeship program
- appropriate resources to support leadership development training of all managers
- adequate provision to participate in industry and professional associations

Developing and implementing a human resources management system and a performance management system are intensive activities. The ministerial task force, which is to be set up by the minister to get the process of forming a TQWMS underway, might enable some collaboration in the high-level development of these systems.[30] Each water utility, however, has to budget sufficient time and resources to implement the systems effectively. To help fast-track the initiatives, a combination of external and internal resources will probably be necessary.

We expect that the labour market that will continue to constrict over the next several decades. Attracting and retaining quality employees will be a challenge for all industries and organizations. Compensation will be one important consideration, and establishing appropriate pay bands will be an immediate

[30] The ministerial task force referred to here and in sec. 6.3.3 is fully explained in sec. 10.2.

requirement. Furthermore, as water utilities move to shared services, consolidation, or cross-boundary configurations, they will have to take into account such factors as harmonization of wages.

Employees of the new water utilities will have a significant range of existing knowledge, skills, and competencies. Not everyone will need all the training detailed in previous sections. To determine training requirements, utilities will therefore have to understand each employee's existing skills. External resources can facilitate this process.

Training of operators in an apprenticeship program and of managers in a leadership development program is key to developing the competencies and culture embedded in the model water utility. Training expenditures must be viewed as investments, not as costs.

The utility will have to establish a multi-year plan, with supporting budget, as part of its human resources management system.

As the sector matures, industry and professional associations will take a stronger leadership role in promoting best practices and lessons learned. Employees must be able to participate in these activities.

### 6.3.3 Investing in Quality

The model water utility is committed to developing and maintaining a TQWMS. Although we have identified some approaches whereby system-wide efficiencies could be realized, individual utilities need to budget for their quality initiatives, taking into account

- the need for external resources to help establish the TQWMS,
- the need for external resources to help customize SOPs, as required and appropriate,
- the need for external resources to train all staff on the TQWMS and related documentation, and
- adequate provision to support a third-party audit by a recognized registrar.

The ministerial task force will review existing systems and approaches to quality management (ISO, HACCP, QualServe, etc.) and develop the framework for a

total quality management system customized to the needs of water suppliers in Ontario. Each water utility then will have to implement that TQWMS framework in its organization. External resources will help fast-track this initiative.

The ministerial task force will strike a working group to develop standard operating procedures for similar-type water facilities. Individual utilities might require some customization, and provision should be made for external resources to assist in this process.

All staff will require training in the TQWMS, its purpose and benefits, protocols, documentation, and appropriate levels of responsibility, authority, and accountability. Employees will need to be trained for the audit. Again, external resources will assist in this process.

The ministerial task force will share the TQWMS with the audit community of registrars, who are recognized by the Standards Council of Canada. Each water utility will have to contract for audit services with a registrar.

### 6.3.4 Sustainable Asset Management

Water utilities should address all financial considerations strategically, with life-cycle considerations embedded in all elements of financial development and budgeting. Some items that previously might have been viewed as costs should, in fact, be understood as investments. Financing must be developed using the *matching principle*, so that long-term capital activities (e.g., infrastructure renewal) have long-term debt financing. Full cost recovery also must form the cornerstone of the new water utilities.

Strategically, budgets must include ongoing commitments to expenditures that will enable staff and facilities to minimize risk and to deliver water that consistently meets the required quality standards. Significant investments, particularly during the transitional phase, will be required for technical and managerial training. A multi-year training plan and supporting budget will have to be developed and implemented.

We need to re-fix the price of water not only to reflect its true cost and value, but also to cultivate the types of behaviours we desire, such as less waste and maintenance and renewal of infrastructure.

According to Pollution Probe,

> Canadians are charged, on average, significantly less for their municipal water supply and water services than other developed countries. Water prices in Germany and Denmark, for example, are about four times greater than Canada's prices – and this is after Canada posted a 100% increase from 1987 to 1999.[31]

The principle of full-cost accounting was one of six principles of sustainable development endorsed by the Ontario Round Table on Environment and Economy.[32] Full-cost accounting demands that the natural assets be fully valued to ensure proper use and allocation and to make certain that the beneficiary of the activity pays the full price, including the cost of any environmental damage and resource use. Application of this principle should lead to better use of existing water management infrastructure and provide a basis for rational assessment and informed decision-making about the need for new or expanded infrastructure.

This view is echoed by the Ontario Sewer and Watermain Construction Association (OSCWA):

> The main reason why Ontario's water rates are low is because municipalities are not billing consumers for the full cost of water treatment and supply. As well, water use is not universally metered, and where water charges are based on a "flat rate," the rate may not cover the full cost of the service.
>
> Full cost accounting is a method by which all monetary costs of resources used, committed, or required in the future, for water treatment and supply and sewage collection, treatment and disposal are taken into consideration.
>
> At a minimum we would propose that full cost means adopting a method such as the following:
>
> - Determine total cash expenditures by adding together all direct and indirect overhead costs and operating costs of the works;

---

[31] Pollution Probe, 2001.

[32] These principles came out of the Round Table's 1992 report *Restructuring for Sustainability.* The Round Table disbanded in 1995.

- determine total debt repayment costs reasonably attributable to the works;

- determine a total sustainability allowance for the works by adding together a reasonable total allowance for renewal and replacement and a reasonable total allowance for improvement; and

- determine the total annual sustaining costs by adding together total cash expenditures, total debt repayment costs, and the total sustainability allowance, each as determined above.[33]

If the model water utility is viewed as totally independent, stand-alone operation that is a financially discrete and viable entity accountable to its board, some further factors must be considered in determining full cost recovery. Obviously, operating costs and sustainable asset management are the starting point; cash reserves are another element. Provision for fire services forms part of the municipal tax base, and some portion of that will have to be transferred back to the water utility. Support for ongoing industry research and for maintaining the regulatory regime might also be relevant costs. In this way, consumers will be supporting the true and full costs of their water supply system.[34]

Sporadic funding for infrastructure by the federal and provincial governments has created a number of distortions in the system.

> [T]he politically inspired up and down provision of infrastructure funding from both federal and provincial governments during the past two decades has added to the difficulties of long-term financial planning by municipalities and to the uncertainty of funding availability for all competing municipal service sectors, including water services.[35]

The current confusion of cross-subsidization of drinking water, compounded by the inconsistent and unplanned federal and provincial infrastructure funding,

---

[33] Ontario Sewer and Watermain Construction Association, 2001, *A Nine Step CPR Plan For Ontario's Water and Sewage Systems* (Mississauga: OSWCA), p. 3. Find also on the OSWCA Web site: <www.oswca.org/files/information/CPRNineSteps.pdf>.

[34] See also Strategic Alternatives, in association with Michael Fortin, Enid Slack Consulting Inc., and Mike Louden, 2002, *Financing Water Infrastructure* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 16, Walkerton Inquiry CD-ROM, <www. walkertoninquiry.com>.

[35] Ontario Sewer and Watermain Construction Association, 2001.

has resulted in water utilities behaving in unintended ways. The water utilities routinely do not manage their assets in a renewable manner, because they hold out the expectation that infrastructure funds will flow to them in a just-in-time manner. Inadvertently, government effectively is rewarding bad behaviour and inadequate management, while actually penalizing those water utilities that manage their assets properly. The model water utility will plan for asset renewal and will budget accordingly. If the federal and provincial governments wish to continue funding infrastructure, such funding should depend on an analysis of the soundness of a utility's sustainable asset management plan. This will eradicate the current distortions.

Pollution Probe discusses sustainable asset management:

> The provision of safe drinking water is an essential service that must be put on a steady, sustainable, long-term funding basis. Based on the principle of full-cost accounting, a Sustainable Asset Management model is proposed for the financing of drinking water systems in Ontario. This conceptual model provides a more systematic, long-term, anticipative and transparent approach to planning and decision-making.
>
> …
>
> The Sustainable Infrastructure Investment Program walks through the evaluation of the full life-cycle of a water system by asking six basic questions:
>
> - What do we have (an inventory of infrastructure assets, including the water)?
> - What is it worth (total asset value – valuation and replacement value)?
> - What condition is it in (relationship of asset condition to age)?
> - What do we need to do to it (maintenance/rehabilitation/replacement)?
> - When do we need to do it (life expectancies of system assets)?
> - How much will it cost (sustainable funding levels)?[36]

This view is shared by the OSWCA:

---

[36] Pollution Probe, 2001, p. 9.

> Prudent water and sewage system management begins with an inventory of assets and an assessment of the condition of each.
>
> …
>
> An inventory provides municipalities with details (such as size) about individual water and sewage system components and where the components are located. Condition assessment takes the inventory one step further, providing municipalities with information about the integrity of each component, including its anticipated service life and expected replacement value. Information obtained during inventory development and condition assessment can provide a "snapshot" of strengths and weaknesses within water and sewage systems. Appropriate management strategies can then be adopted.[37]

## 6.4 Governance

> "Governance refers to the process and structure for overseeing the direction and management of a corporation so that it carries out its mandate and objectives effectively."[38]

Over the past decade, in Canada and around the world, there has been a review and discussion of governance. Moving beyond issues of control and financial accountability, observing good corporate governance principles and practices is a way to ensure that potential problems can be discovered quickly and that risks can be reduced and managed. For the model water utility, principles of good governance and effective practices become integral to assuring quality drinking water.

In Canada the Joint Committee on Corporate Governance, building on the 1995 Dey report, recommended governance principles that focus on how boards should perform to ensure that Canadian corporate governance is among the best in the world.[39] The Auditor General of Canada's review of crown corporations provided recommendations to improve accountability and board effectiveness.[40]

---

[37] Ontario Sewer and Watermain Construction Association, 2001, p. 9.
[38] Canada, Office of the Auditor General, 2000, *Governance of Crown Corporations* [online], [cited October 2001], <www.oag-bvg.gc.ca/domino/reports.nsf/html/0018ce.html>, p. 18-8.
[39] Toronto Stock exchange, Joint Committee on Corporate Governance, 2001, *Beyond Compliance: Building a Governance Culture* (Toronto: TSE). The report is also available on line [cited January 2002], <www.jointcomgov.com/cica/cicawebsite.nsf/public/JCCG/$file/Governance_Eng_Final.pdf>.
[40] Canada, Office of the Auditor General, 2000.

In Ontario a review of best practices conducted by the Haldimand-Norfolk Transition Board identified the terms of reference for a local board as a template for good governance and accountability (see section 13.1.5). With the introduction of the *Public Sector Accountability Act,* there will be new accountability requirements on public organizations.

Reviews and studies in Australia, the United Kingdom, and Europe affirm the principles of good governance, and all offer suggestions and guidance on effective practices. In New South Wales, an audit of governance practices concluded that it was necessary to enhance these practices to ensure efficient and effective management of organizations. In the United Kingdom, the Chartered Institute of Public Finance and Accountancy (CIPFA) developed a framework for public service bodies by combining the foundation principles of good governance defined by Cadbury in 1992 with the responsibilities of public office.[41] This framework was adapted for use by European countries by the Fédération des Experts Comptables Européens.[42] Recent work by CIPFA and senior executives in local government provides guidance on how this framework can be used by local government.[43]

These reviews and studies conclude that there is no single structure for boards or a single prescriptive model for governance. Rather, the focus is on adopting demonstrated principles of good governance and effective best practices. Whether public or private, large or small, the model water utility can apply those principles and best practices of governance to ensure the responsible direction and management of the organization. Adherence to these principles is essential for quality performance.

The basic principles of good governance are openness in decision-making and actions, integrity based on honesty and objectivity, and accountability for stewardship and performance. There are fundamental elements for action to translate these principles into practice:

---

[41] Chartered Institute of Public Finance and Accountancy, 1995, *Corporate Governance: A Framework for Public Service Bodies* ([London]: CIPFA).

[42] Fédération des Experts Comptables Européens, 2001, *Approaches to Corporate Governance in the Public Sector* (Brussels: Fédération des Experts Comptables Européens).

[43] Chartered Institute of Public Finance and Accountancy and Society of Local Authority Chief Executives and Senior Managers, 2001, *Corporate Governance in Local Government: A Keystone for Community Governance – Framework and Guidance Notes* ([London]: CIPFA and SOLACE).

- clear understanding of roles and responsibilities
- effective practices in place
- capacity to govern assured
- accountability and transparency

Currently in Ontario, the responsibility for governance of a water utility can rest with different bodies, such as the municipal council, a public utility commission, the board of a public body (e.g., the Ontario Clean Water Agency (see section 7.3)), or the board of a private utility. In the following description of the principles and their enabling elements, "the board" refers to that group of people with responsibility for overseeing the direction and management of a water utility.

### 6.4.1 Clear Understanding of Roles and Responsibilities

The role of the board is to provide stewardship to the organization. Specific roles and responsibilities will be set out and shared with stakeholders in a statement that represents a code of corporate governance. The statement will address the board's responsibility for

- strategic planning,
- budget approval,
- internal controls and management information systems,
- risk management systems,
- recruitment of, setting compensation for, and performance review of the chief executive officer,
- human resources strategy,
- sustainable asset management strategy,
- open communications with all stakeholders,
- systematic nomination of new members,
- assessing board effectiveness,
- orientation of new members, and
- public reporting.

The members of the board agree to commit the time and resources necessary to carry out their responsibilities effectively.

### 6.4.2 Effective Practices

#### *Strategic Planning*

The board will establish the mission statement for the utility. The regulator may establish a general mission statement that describes basic expectations and purpose for the water utility. This general statement can be modified for use by each water utility. Working with management, the board will develop a strategic plan in support of that mission statement. The responsibility for implementation of the plan rests with management; the board, however, will ensure that there are mechanisms in place to monitor performance against the plan. The board will also be required to review, amend, and approve the annual budget that supports the plan.

#### *Internal Control and Management Information Systems*

The board will ensure that control and management information systems are in place to determine whether the water utility is being properly managed and whether objectives are being met. These systems will flag issues that have an impact on the business and that are required for reporting on compliance. The board will ensure that necessary audit systems are in place (through the use of internal and external auditors).

#### *Risk Management*

The board will ensure the implementation of appropriate systems to identify and manage risk. The risk management system will be based on the Hazards Analysis Critical Control Points (HACCP) approach. The Australian Framework offers a modification of this approach for use with drinking water systems.

#### *Executive Recruitment and Compensation*

There will be established processes for recruitment, performance review, and compensation of the senior utility manager or chief executive officer.

### *Human Resources Strategy*

The board will review and approve human resources plans and compensation strategies and will ensure that performance management approaches are aligned with the achievement of the strategic plan. The senior executive is responsible for developing and implementing the human resources strategy.

### *Sustainable Asset Management*

The board will ensure that there is an inventory of assets and an assessment of their condition. As a key part of its stewardship role, the board will ensure that appropriate management strategies for the physical assets are implemented.

### *Communications*

The board will ensure that there are ongoing and effective communications with the customer, public stakeholders, and regulator, and it will establish a comment and feedback loop of communication with customers.

## 6.4.3 Assurance of Capacity to Govern

### *Board Profiles*

Board members (directors) must possess the required skills, knowledge, and experience to carry out its responsibilities effectively. Some members will have knowledge and expertise in areas such as operations, public health, and financial management. These skills will be described in profiles that reflect the requirements of the position of the board member, rather than the individual. All board members will demonstrate integrity and accountability in their decisions, informed and knowledgeable judgment based on experience in the water industry, a commitment to the public trust that they hold, and the ability to work as part of a team.

### *Recruitment of Directors*

Recruiting new directors is based on the board profiles. Vacancies will be filled by a person who brings the necessary skills to the boardroom table. To maintain continuity and experience for the board overall, best practice suggests that appointment terms for individual members be staggered.[44] The appointment term should be of sufficient length that members can exercise their responsibilities with knowledge and experience. The ability to reappoint members ensures a foundation of knowledge and experience on the board. Such reappointments, coupled with the appointment of new members, will ensure the required knowledge and skill sets around the table at all times.

### *Orientation and Training of Directors*

The board profile and the statement of responsibilities will set out the expectations for new members. An orientation program will include a briefing on the nature of the business and challenges, the legal framework governing directors' obligations, and the contribution expected from the new member. Ongoing training of directors will be done in conjunction with professional and industry associations.

### *Board Assessment*

The board will have a formal and ongoing process to evaluate its own effectiveness.

## 6.4.4 Accountability and Transparency

The board ensures that regular reports are made – on the operational and financial situation of the water utility, on the progress of meeting the strategic plan and objectives, on performance measures, and on performance against industry benchmarks.

The board will document the mechanisms it has adopted for citizen engagement and report on the activity and involvement of citizens.

---

[44] Canada, Office of the Auditor General, 2000.

In some cases the board will be required to adhere to the provisions of the *Public Sector Accountability Act.*

## 6.5 Partnership Agencies

Several aspects of drinking water quality management require commitment and involvement with other agencies. For example, where catchments and water sources are beyond the utility's jurisdiction, it must collaborate with the relevant agency. It must also consult with the regulator to establish many of the elements of drinking water quality management (such as monitoring and reporting requirements, emergency response plans, and communication strategies). See the Western Australia example in box 6-12.

The range of agencies involved in individual water supply systems will vary depending on local organizational and institutional arrangements. Agencies that could be involved in drinking water quality management include provincial ministries (e.g., Health, Municipal Affairs, Natural Resources, the Environment, and Agriculture, Food and Rural Affairs), other relevant provincial and local authorities, catchment boards or groups, local government, non-government organizations and community-based groups, and industry associations.

An integrated management approach with collaboration from all relevant agencies is essential for effective drinking water quality management. As lead agency in the management of drinking water quality, the water supplier should regularly identify all major stakeholders who could affect, or be affected by, decisions or activities of the water supplier.

Stakeholder commitment and involvement requires mechanisms and documentation, such as working groups, committees, task forces with appropriate representatives, and signed memoranda of understanding. The various agencies involved should define what they can do to support the water supplier and, where appropriate, coordinate their planning and management activities.

Professional and industry associations play a key role in continuous improvement of water suppliers. More than just providing information and access to expertise, the associations are a catalyst for change and improvement. To help their members establish TQWMS, they will lead research, promote best practices (including benchmarking), build the capacity of the sector, and speak on behalf of the sector.

**Box 6-1 Partnership Example for Source Protection**

In Western Australia, principal agencies involved in drinking water quality management include the Water Corporation of Western Australia (WCWA), the Water and Rivers Commission (WRC), the Health Department, and the Office of Water Regulation.

Under licence by the Office of Water Regulation, WCWA is the major utility supplier of drinking water for the entire state and is responsible for the collection, treatment, and distribution of drinking water to consumers. Legislative responsibility for catchment protection rests with the WRC. The WRC has specific responsibilities of administering catchment protection legislation and for ensuring appropriate catchment management programs are in place to protect the quality of a drinking water source.

Under this legislation, the WRC has delegated certain catchment management functions to WCWA. Delegated functions include catchment surveillance, bylaw enforcement, permitting land use activities, emergency response, and catchment management planning for certain catchments.

Recognizing that a co-ordinated approach is essential to effectively protecting drinking water sources from contamination, a Source Protection Operational Partnership exists between the WRC and WCWA, which defines and clarifies respective roles and responsibilities. The partnership agreement establishes the basis for a cooperative and effective collaboration between WRC and WCWA and assists each organization in the achievement of its objectives.

Regular meetings between key groups in both agencies ensure that agreed arrangements are implemented effectively. There is a process for regular review of the agreement and it is recognized that roles and responsibilities may be modified over time.

The Health Department provides specialist advice to both agencies.

**Source:** Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec 1.3, box 1.2.

### 6.5.1 Leading Research

Leveraging financial support for ongoing research and development is critical. The association can provide a focal point or be the contracting entity for research and development funding from the government. This research, of benefit to water suppliers across the province, might concentrate on overall best practices and process improvements. As well, it might focus on the specific challenges faced by a few suppliers. Such research would have the potential to be shared and showcased around the world.

The American Water Works Association Research Foundation (AwwaRF) has conducted leading research in collaboration with water utilities, academics, and other stakeholders. This research has generated innovative solutions to both unique and common issues.

The Canadian Natural Sciences and Engineering Research Council (NSERC) Chair in Water Treatment is located at the University of Waterloo. Members contributing to this research program include municipalities, the Ontario Clean Water Agency, water suppliers, and the universities. The NSERC chair also trains students in drinking water issues, allowing a continuous stream of expertise to be developed and promoted in the industry.

### 6.5.2 Promoting Best Practice

Developing and documenting best practices in a TQWMS requires knowing about them in the first place. The opportunity for knowing about and implementing best practices involves the utilities working together with industry and government. Sharing information among the various parties can take many forms, such as Web-based information, publications, workshops, roundtables, and conferences.

Promotion of best practices involves a cascade of activity, for which the association can act as the coordinating organization for the sector overall. One of the crucial best practices is disseminating relevant information and introducing best practices throughout the organizations of the water suppliers. Another crucial best practice is effectively engaging the customer in planning and decision making.

Peer review has an important function in the TQWMS as a method of providing third-party review and auditing of activities including operations, water quality sampling practices, optimization programs, and research and development programs. The peer reviewer can provide valuable information regarding techniques. The formal peer review process also provides a platform for information exchange.

The combination of research and best practices will enable the sector to develop benchmarks for effective operations that can be adopted by individual water utilities.

### 6.5.3 Building the Capacity of the Sector

Using resources from across the industry, the industry association can provide a locus for learning, training, and development activities. This lead role could involve working with general management and business experts on developing and delivering programs for leadership development and management training in the water utility sector. In promoting the Triple-E approach to certification (experience, education, and examination), the association can play a role in both the education and evaluation of operators.

### 6.5.4 Watershed Management

Watershed management has long been recognized as an effective method for preventing pathogens from entering the drinking water treatment process. Sources of contamination in water supplies are discussed in other Walkerton commissioned papers.[45] Watershed management is recognized in the Australian Framework, the U.S. *Safe Drinking Water Act,* and the Ontario Drinking Water Standards as an effective barrier for pathogen transmission prevention.

---

[45] See Michael J. Goss et al., 2002, *The Management of Manure in Ontario with Respect to Water Quality* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 6, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>; Carolyn Johns, *Policy Instruments to Manage Non-Point-Source Water Pollution: Comparing the United States and Ontario* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 11, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>; and Len Ritter et al., 2002, *Sources, Pathways, and Relative Risks of Contaminants* (Toronto: Ministry of the Attorney General), Walkerton Inquiry Commissioned Paper 10, Walkerton Inquiry CD-ROM, <www.walkertoninquiry.com>.

Increased emphasis on watershed protection has been gaining support in the United States through the total maximum daily load (TMDL) program. A TMDL is "a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources."[46] Current provincial regulations regulate only the maximum concentration of a pollutant that can be discharged from a point source. Non-point pollutant sources such as farms, and other sources such as septic beds, are not currently regulated in Ontario. A more holistic approach, such as the TMDL, should be applied in Ontario, if our water resource is to be maintained for current and future needs.

The regulator and water utilities must coordinate with watershed management groups, such as the Conservation Authority, to ensure that watersheds are protected as much as possible:

- The watershed management group will regulate the volume, mass, and density of discharges from all sources in the watershed. Entities that would fall under the umbrella of the watershed management groups include farms, factory farms, wastewater treatment plants (WWTPs), stormwater outfalls, industrial discharges directly to the environment or through a WWTP, residential and commercial septic beds, and any other types of point and non-point discharges to the watershed that could have an impact on the raw-water quality for a downstream water treatment plant (WTP). The watershed management groups could use a program similar to the TMDL approach developed by the EPA.

- The watershed management group will review and summarize raw water reports from water utilities. The data will be analyzed with the objective of identifying trends in parameters and also one time occurrences of increased contaminant levels.

- The watershed management group will coordinate with the regulator on issues that have an impact on the watershed, such as residuals discharge from a WTP and Permits to Take Water.

---

[46] United States, Environmental Protection Agency, Office of Water, 2000, *Total Maximum Daily Load (TMDL) Program* [online], [cited October 2001], <www.epa.gov/owow/tmdl/>.

- The watershed management group will facilitate active watershed management stakeholder associations to encourage discussion and cooperation among the stakeholders.

- The watershed management group should be given the power to enforce laws regarding emission violations in the watershed. Emphasis should be given to effluents that have pollutants detrimental to humans and expensive to remove at the WTP.

Utilities in the same watershed will have a reporting mechanism to alert downstream utilities about sudden changes in raw water, such as increased turbidity. This will give the downstream utility an opportunity to anticipate a raw-water change, instead of reacting after event characteristics have already been identified in the downstream WTP. The process could follow the early warning flood program already established in most watersheds.

# 7 Control – Utility Regulation

Moving beyond the water utility, external players also have roles in providing safe drinking water. The government sets the policy, legislative, and regulatory environment within which water utilities operate. The professional and industry associations play a role in leading research, promoting best practices, and building the capacity of the sector. The customer plays a role in ensuring the transparency of the production of drinking water – in terms of both cost and quality.

## 7.1 Policy Environment

The government has responsibility for setting the policy framework for safe drinking water in Ontario. This policy framework will affirm the standards-based approach demonstrated in the Total Quality Water Management System (TQWMS) and set out expectations for water utilities. The standards setter, the regulator, and the auditor are separated and independent of each other.

Clear, research-based water quality standards will demonstrate the priorities of health protection and risk prevention. The regulator enforces the water quality standards, grants licences, and reviews applications for rates. As previously discussed (see section 6.2.8), internal evaluation is a key component of the TQWMS and external parties will conduct audits on the successful implementation of the TQWMS. There are

clearly stated roles and responsibilities for the water quality standards setter, the regulator, and the auditor (see sections 7.1.1, 7.1.2, and 7.1.3, respectively), and the utility (previously discussed in sections 3–6).

### 7.1.1 Water Quality Standards

Health Canada develops both health and aesthetic limits for drinking water. The individual parameter limit values are the result of fundamental research, review of existing data in the scientific community, epidemiological studies, and consultation with the provinces. The guideline numbers are the best estimate that the drinking water community has to determine acceptable levels of contamination and risk to the population. Under the TQWMS, the provincial government will work with national standards, which have been developed in an open manner with a scientific base, and prescribe water quality standards through regulation for Ontario water utilities. The Canadian drinking water guidelines should be the minimum standard that the Ontario standards must meet.[47] There is some latitude for compromise on adoption of the limits, if the province can argue on a scientific or social basis for the relaxation of a specific parameter in the federal guidelines. The relaxation of limits cannot be made simply on a financial basis (i.e., where the regulated limit on a parameter would require a capital expenditure by utilities).

Health Canada is best suited to set water quality standards. It has the resources, the properly trained staff, and the infrastructure to continue with this work. Transparency of the water quality standards-setting process is required for cooperative effort in the water community; the process should be well understood by all involved parties. Once a new water quality standard is identified and scheduled for adoption in *Guidelines for Canadian Drinking Water Quality,* the utilities should be given sufficient time to comply with the standard. The utilities will use the time to conduct engineering studies, test alternative operating procedures and equipment, implement procedural changes and or procure, and install new equipment as necessary.

Advance notice of pending regulations by the standards-setting body is critical to maintaining a cooperative environment. For the most part, the standards will be prescriptive. The advance notice is the most powerful tool that the

---

[47] Canada, Health Canada, 1996, *Guidelines for Canadian Drinking Water Quality,* 6th ed. (Ottawa: Supply & Services Canada).

standards body can use to encourage participation by the utilities in setting new standards. The standards body should publish draft statements with respect to adding new parameters or changing existing MACs and invite comments from all interested parties.

The standards-setting body for Ontario will be part of the provincial government, but not directly associated with the regulator. The regulator (see section 7.1.2) will be required to perform inspections and enforce the water quality standards.

The provincial standards-setting body is responsible for providing information to the customer and utilities about the procedures generally used in developing standards. If a new parameter is added to the list, the reasons for the addition will be explained, as well as a justification for the level at which the parameter value was set. This information – intended to increase the knowledge of how the values are set and increase appreciation of the concept of risk – should therefore be provided in a format appropriate for the intended audience.

The standards setter should focus on microbial risks, as they are acute in nature compared with chemical contamination, which poses generally more of a long-term risk. The EPA has initiated a process that would see adoption of *Cryptosporidium* as the basis for micro-organism-related disinfection standards. This move is the result of monitoring programs that have identified *Cryptosporidium* in many surface waters, as well as its resistance to conventional disinfectants such as chlorine and chloramine. In Ontario, utilities are required to monitor for only total coliforms, *E. coli,* and other bacteria. Requirements for microbial disinfection are represented only in the form of a theoretical disinfection calculation for *Giardia,* but no monitoring or verification of *Giardia* disinfection is required. It is because *Cryptosporidium* is far more resistant to disinfection than *Giardia* that the EPA has moved toward using it as the basis for setting disinfection standards. Current regulations do not provide the public with adequate protection from microbial risk.

### 7.1.2 Regulation

At the provincial government level, there will be a single window on the regulation of water quality. It is not up to individual water utilities to coordinate the efforts and programs of various ministries of the provincial government. The regulator will perform functions currently performed by the Ministry of the Environment (granting certificates of approval, enforcing the Ontario

Drinking Water Protection Regulation through the Ontario Drinking Water Standards, operator certification, etc.), the Canadian Food Inspection Agency (HACCP inspections), the Ministry of Health, and any other agency that has a role to play in drinking water. The regulator will also perform new functions, including assessment of the financial and TQWMS plans of utilities. The regulator can be set up with personnel responsible only to the regulator, or it can be established as an entity with some core staff and the ability to draw staff with the necessary expertise from existing agencies. The provincial government will have to establish necessary coordinating mechanisms for internal operations to be able to work with water utilities from a single point of service.

This paper does not make a recommendation on whether this single point of service is a regulatory arm's-length crown agency or a provincial ministry. D'Ombrain makes the argument for this regulatory role to remain in government and that it be taken on by a renewed Ministry of the Environment.[48] The assumption here is that the regulator is an arm of government in some way – it is *not* a kind of self-regulating industry body.

For the purposes of this paper this single window in the provincial government will be referred to as the 'regulator.' The regulator will regulate drinking water utilities in Ontario. It will be established in statute with a clear legislative mandate.

The regulator

- will provide the focal point for a safe drinking water policy framework in Ontario.

- will not set technical or environmental standards, but will work closely with the provincial water quality standards setting body and will oversee the development of requirements for accreditation and licensing.

- will adopt a policy of facilitating communication with the water utilities and the standards setter on expected changes to the water quality standards. Water utilities will be given sufficient lead time for the introduction of, or modifications to, certain standards.

- will establish the licensing process and oversee its application to the water utilities. A water utility would receive a licence to operate when it demonstrates

[48] d'Ombrain, 2002.

that it is capable of satisfying the requirements for the TQWMS. This licence would be reviewed and renewed on a five-year basis.

- will grant a renewable license to a water utility for extracting surface water or groundwater or both.

- will ensure that expertise and operational services can be provided in case of an emergency.[49]

- will establish regulations that provide for a system of public reporting, evaluation, and audit on all aspects of the drinking water policy, including the performance of the regulator, the water utilities, and testing laboratories.[50]

- will maintain the system of public reporting and receives quarterly reports as per the ODWS and annual reports as per the TQWMS requirements.

All reports to the regulator will be publicly available on the regulator's Web site.

The regulator will set out in regulation the requirements for licensure to operate a facility. They include

- accreditation from an auditor, who is a recognized registrar,
- compliance with monitoring and reporting as per the ODWS,
- compliance with required components of the HACCP risk analysis program,
- employment of appropriately classified operators for the facility,
- a financial plan, including sustainable asset management, and
- an emergency response plan.

There will be a fair process for review of any appeals to licensing decisions. This will be important, particularly where the water utility might not be big enough to meet the obligations for licensing and will need to explore ways of meeting the obligation of service to its community.

When reviewing an application for licence to operate a facility, the regulator will make a range of decisions:

---

[49] Ibid.
[50] Ibid.

- Approve the application.

- Approve the application, with conditions as per the requirements. Compliance with these conditions can be reviewed at the next inspection, audit, or licence renewal

- If the applicant is not able to comply with the licensing requirements, the regulator can
  - direct and facilitate discussions of water utilities to ensure that communities continue to be served with quality drinking water. These discussions can include exploration of shared services, promoting the establishment of "hubs" and "nodes" as demonstrated by OCWA, and examining alternatives to respond to capacity issues associated with scale.
  - assign a technical or financial review of the utility to determine whether the requirements for licensing can be met.
  - direct the water utilities to implement a solution, which could include mergers or amalgamations, adoption of a service delivery alternative that meets the needs of the community, or more appropriate financing plans.

The regulator must have the skills, resources and capacity to do the job expected. The regulator will be expected to be highly accountable. The regulator will demonstrate, through reporting, its adherence to the general principles of a good regulator:

- transparency of actions and decisions
- accountability
- targeting
- consistency
- proportionality
- a clear legislative mandate
- efficiency
- expertise
- reproducibility
- non-prejudicial
- non-retrospection
- timeliness
- flexibility

In addition to reviewing applications for licences to operate a facility, the regulator will conduct inspections of water utilities. Inspections will concentrate

on utilities with issues of higher risk. Inspection will be carried out in a manner consistent with the HACCP system, with an emphasis on prevention. Inspection will be done effectively with resources directed at high-risk situations, depending on the product type, plant complexity, and how well the utility complies with standards. Inspection will include a review of the internal evaluations conducted by the utility, third-party audits, and any other conditions that may be part of the approved licence. The regulator will develop a code of enforcement that encompasses the kind of standards set out by the UK government's Drinking Water Inspectorate. Non-compliance discovered through inspection will be reported publicly, and there will be the potential for fines and penalties. For cases in which non-compliance indicates that the utility does have the capacity to meet the requirements of TQWMS, the regulator will not be bound by the licensing cycle and can conduct the required reviews and make decisions as necessary.

The regulator will establish public advisory councils made up of members from the general public and other stakeholders. They will provide a common voice for the customers and ensure that water utilities are maintaining good customer relationships across the province.

### 7.1.3 Audit Function

The evaluation and audit of drinking water quality management is required to ensure that prevention strategies are accurate, effective, and implemented appropriately. A review of the monitoring data, reports, and management processes will provide assurance that quality and safety are achieved. This kind of evaluation is a key element of planning for improvement.[51]

The need for internal processes for evaluation and audit is described in section 6.2. There will also be formal external audits. Combined, the internal and external audits demonstrate a utility's commitment to achieving the highest standards possible and maintaining customer confidence.

The method and procedures for such audits will be developed in collaboration between the water industry, the audit community, and the regulator (including other provincial ministries as considered necessary). Audits will cover all aspects

[51] Australia, NHMRC/ARMCANZ Co-ordinating Group, 2001, sec. 11.

of the TQWMS: technical operations, management systems, compliance with testing and monitoring, performance audits, and effectiveness of emergency response. The frequency and schedule of audits will be defined.

The external evaluation and audit will be conducted by approved independent third parties recognized as "registrars" by the Standards Council of Canada.

Items required to be evaluated by the auditor for utility accreditation include

- the TQWMS plan, including implementation of HACCP risk analysis tools, continuous improvement programs, and ISO 9000-like standards;
- the human resources management plan; and
- governance structure and statement on stewardship responsibilities.

## 8 The Customer

The customer is the most critical element of the water industry. The customer needs opportunities to be involved in the utility at several points:

- planning (both engineering and financial)
- operation of the water system, including performance reports
- risk management
- regulation and enforcement

The water utility operation must be transparent to the public. The customer can be involved by way of various communication mechanisms:

- consultation
- educational information
- public advisory committees
- publishing of operations reports

The Australian Framework lists the following items that could make up a comprehensive *consultation strategy*:

- public hearings for major and controversial initiatives
- briefings that target groups with specific interests or responsibilities
- workshops or seminars on key issues, or for special groups

- focus groups and market research and surveys to determine community views, knowledge, and attitudes[52]

*Education* on water treatment principles is critical to developing in the public an understanding whereby people can put published information into context. Information must be formatted in a way that lay people can understand. Information can be communicated by way of

- informative media programs targeting print, radio, and television,
- including information flyers with water bills,
- community education and information exchange programs,
- school programs,
- technical issues papers, and
- newspaper advertising of activities and available papers.

The *public advisory committee* will ensure a continuum of public involvement in the drinking water process and provide the public a constant voice in the operation of the water utility. The committee will report through the regulatory regime. Utility involvement in the committee will provide timely response to the concerns of the public. The public advisory committee reports directly to the regulator to ensure that the public voice is heard and that it has bite. Such committees have precedence in the Ofwat National Customer Council (ONCC) and Ofwat customer service committees (CSCs) in England and Wales, and in the National Drinking Water Advisory Council in the United States.

Finally, *publishing* of operations reports is necessary to maintain public confidence in the drinking water system. The performance of the system, by the numbers, will be there for all to see. Reports will typically include the regulatory limits, operational objectives, average values, lowest values, and highest values during the reporting period. If the operational objectives are not met for a specific parameter, the conditions surrounding the non-compliance should be explained with the report. It also would be beneficial to include revised protocols that have been enacted by the water utility to ensure that the non-compliance of that parameter is mitigated or eliminated in the future.

If a full explanation and solution for non-compliance events cannot be included in the report (depending on the complexity of the problem, the effort required to develop a strategy to deal with the problem may not allow for resolution

[52] Ibid., sec. 8.1.

within the 30-day publishing period), a subsequent news release will be required. Information is to be published in the local newspaper and an Internet site and sent out with the water bill. Originals will be available at the utility office for a small reproduction fee. Also included in this report will be the long-term infrastructure renewal requirements and corresponding expenditures. By the end of the transition period, these reports will include survey results and benchmarking results on many different parameters.

The goal of the public involvement program is to achieve transparency of the drinking water process. Public involvement will increase confidence in the safety of water – people will know that when they are notified not to drink the water owing to a higher than acceptable risk assessment of one or more water quality parameters, the water is unsafe. The public will also know that in the absence of any such notice, the water is safe for consumption. The transparency will reduce or eliminate the stigmatization of drinking water by the public after such an emergency or incident.

*The five-step approach to customer involvement:*

1. Public consultation at conceptual and design stages of a project will include allowance for public input to modify plans.

2. A Public Advisory Committee will report aesthetic or health concerns to the regulator. It meets on a regular schedule to discuss local and provincial concerns that members would like the regulator and utilities to addressed.

3. Public education will include leaflets of basic information and water conservation ideas mailed with the water bill, school education programs, and public service announcements in the various media. Information for the public will include such topics as risk, water resources and conservation, drinking water treatment processes, regulations and standards, and water quality parameters.

4. Regular quarterly and annual reports as per Ontario Regulation 459/00 will be made available as described in the legislation.

5. Customer surveys will be implemented and will include analysis, with the objective of determining customer satisfaction and customer needs.

# PART 2
# TRANSITIONAL ISSUES AND STRATEGIES

## 9 Transition to the Total Quality Water Management System

The Total Quality Water Management System (TQWMS) is an ideal model for assurance of safe water for our communities. The following action plan, together with the accompanying transition plan, provides the pathway to achieve the TQWMS model. This is not an imposition of a new and untried ideal; rather, the model can be built on existing good practices and strengthened practices. It is also possible to address some of the more difficult and challenging issues within the context of the TQWMS.

With a careful and planned transition, all the necessary decisions can be made, planning done, and financial arrangements established in the first year. Implementation of all TQWMS elements will be well underway at the start of year two. Before the end of five years, the TQWMS will be fully operational. A review of the legislation will be conducted at the end of five years to determine if any changes have to be made in the policy, legislative, and regulatory provisions.

### 9.1 The Action Plan

The action plan is an 11-point sequencing of the major activities to be undertaken (see table 9-1). Actions 1–7 are sequential and are part of establishing the new responsibility infrastructure. Actions 8–10 are the implementation of the TQWMS. Action 11 provides for reporting on results. Actions 8–11 will be carried out concurrently.

The issues considered for the transition plan are the same as the major elements of the TQWMS. For the purpose of illustrating the timing and relationship of elements, the issues are organized according to the general sequencing of events.

In order to provide a focal point for the launch and initial implementation of the TQWMS, the minister will establish a ministerial task force, which will enable the minister to develop the implementation plan and conduct research and consultation in a focused, direct, and open manner. We anticipate that the Ministry of the Environment will be undergoing restructuring as a result of

the adoption of a new mission – "to make the environment a broad responsibility across all ministries and beyond, to involve community groups, businesses, academics and the public, all within a climate of continuous improvement" – and a new framework for policy development and enforcement.[53] The establishment of a new Cabinet Environment Policy Committee and a new senior executive position within the ministry will direct the new framework. The task force, as proposed here, will allow the minister to accomplish significant reforms in as efficient and effective a manner as possible.

This ministerial task force will be made up of stakeholders and will be responsible for developing the implementation plan and setting into action many of the core elements of the TQWMS. It is anticipated that the task force will be necessary for the first six to twelve months and will be superseded by the advisory body to the regulator.

### Table 9-1 TQWMS Action Plan

| Activity |
|---|
| *Building the responsibility infrastructure* |
| 1. Create the ministerial task force, with a mandate and budget to carry out its responsibilities. |
| 2. Establish the legislative and regulatory framework (regulator, standards setter, and auditor). |
| 3. Convene regional information sessions, with round table discussions. |
| 4. Develop scorecard on current water utility management and operations. |
| 5. Regionally, examine the issue of scale and determine appropriate configurations. |
| 6. Establish the governance structure, recruit board members, and deliver the required training to the new boards. |
| 7. Recruit the leaders of the new water utilities. |
| *Implementing the Total Quality Water Management System* |
| 8. Establish and implement the TQWMS. |
| 9. Deliver the operator training and certification program. |
| 10. Deliver the leadership development program. |
| *Reporting on results* |
| 11. Establish and implement the financial and other reporting systems that support the transparency. |

[53] Statement to the Ontario Legislature by the Honourable Elizabeth Witmer, Minister of the Environment (Toronto, May 2, 2001).

## 9.2 The Transition Plan

The first track of activities ensures the development of clear roles and responsibilities for those who have oversight for water quality and that they have the understanding and capability to act on their responsibilities. It begins with an assessment of the current situation (building on the work in the engineers' reports), and from that the scope of implementation will be determined. In addition, the question of scale will be considered early on in order to plan for alternative arrangements and continue service to the community. Change in an organization creates a distraction for the day-to-day work as operators, employees, and the public consider what is in store. A focus on business continuity is critical.

The second track is the implementation of the management processes and requirements for the TQWMS, including the training and development of operating staff.

The third track relates to the financing and reporting on the TQWMS. Financial information will be produced for common understanding – in such a way as to enable common benchmarks of financial sustainability. It is at this stage that the public reporting will be matched to the expectations and results of the TQWMS. This final track will also include assessment of the TQWMS implementation. Are there any gaps, has anything been overlooked, and what issues still need resolution? This final year review will provide the action plan for maintaining TQWMS.

Figure 9-1 illustrates the relationship of the three tracks over the planned transition period.

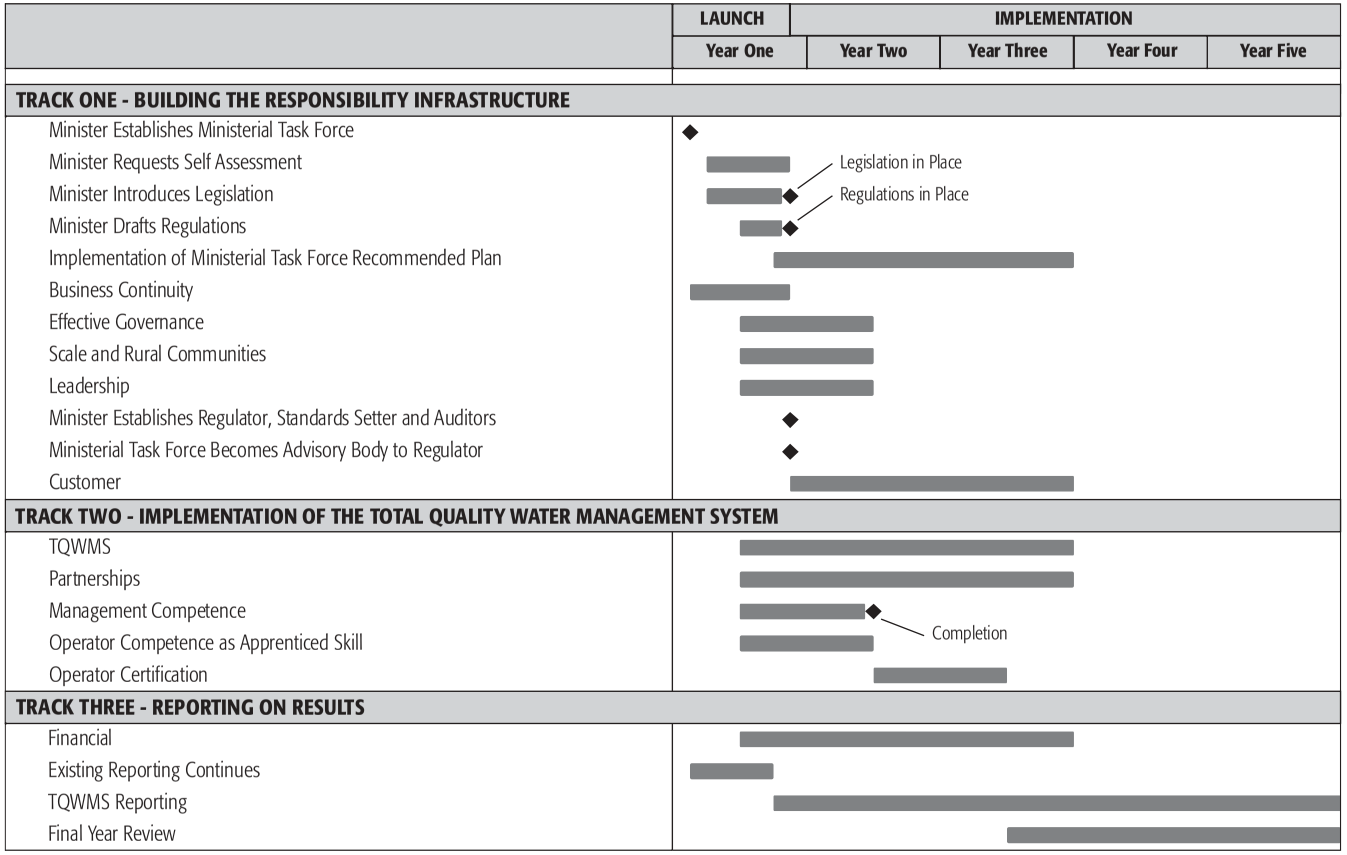
# 10 Track One – Building the Responsibility Infrastructure

## 10.1 The Legislative and Regulatory Framework

### 10.1.1 Goal

To create the policy, legislative, and regulatory framework that establishes the TQWMS and sets out the roles and responsibilities for the government, the regulator, and the water utility.

## Figure 9–1 Tracks for Transition



### 10.1.2 Issues and Barriers

Development, introduction, and passage of the legislation and regulations will be done expeditiously.

There will be activity by the ministerial task force during the period from the introduction of the legislation to its passage. Developing the implementation plan, research, and consultation will occur in this period.

### 10.1.3 Transition Strategies

- The minister will appoint the ministerial task force immediately (see following item).

- The ministerial task force will work with the minister in drafting the legislation and regulations.

- The ministerial task force will advise the minister on the information necessary for the self-assessment scorecard to be completed by all water utilities. This information will build on the work already done in the engineers' reports and will provide input to the details and scope of the model to be developed by the ministerial task force.

### 10.1.4 Sustainable Strategies

- The minister of the environment will introduce legislation that clearly sets out the role of the government, the regulator, and the water utility.

- The minister has responsibility for setting the policy framework for safe drinking water in Ontario. This policy framework will affirm the standards-based approach as demonstrated in the TQWMS, provide for the powers and responsibilities of the regulator, and set out expectations for water utilities, including technical competence, the principles of good governance and accountability, the elements of transparent reporting, and the role of the advisory body and the consumer advisory councils.

- The regulator will have the responsibility to grant licences to water utilities (including determination of appropriate scale), to require testing and monitoring, to require annual reporting, to hear applications for rates, and to intervene when public health may be at risk. An advisory body of stakeholders will work with the regulator on an ongoing basis. Consumer advisory councils will offer advice and input to the continuing implementation of the TWQMS.

- The water utility will have the responsibility to fulfill the obligations of the TQWMS.

- The minister of the environment will introduce regulations that offer specific requirements in key areas: standards for water quality; requirements for testing, monitoring, and reporting test results; requirements for obtaining a licence as a water utility; training and certification requirements for operators; requirements for reporting in a common format; and requirements for conducting audits and third party reviews.

- The legislation establishing the TWQMS framework will include a provision for a review at the end of five years on the effectiveness of the framework and consideration of modifications. This review will include an initial assessment of the implementation and any corrections and modifications necessary, as well as the provision for another review five years after the assessment.

## 10.2 Ministerial Task Force

### 10.2.1 Goal

To establish water utilities that will achieve the desired attributes of the model.

### 10.2.2 Issues and Barriers

Municipalities might experience resistance and inertia in moving to the new model. Power, politics, 'ownership,' and subterfuge may inhibit collaboration with adjacent municipalities in creating the scale of operations underpinning the new model.

### 10.2.3 Transitional Strategies

- The minister will establish a task force of stakeholders, which will be responsible for kick-starting the process.

- The ministerial task force will comprise 8–10 members representing stakeholders. Primary composition will be water utility managers, but could include NGOs, professional or industry associations, and experts.

- The ministerial task force will maintain a close working relationship with the deputy minister of the environment.

- The ministerial task force will be in place for 6–12 months and will be superseded by the advisory body to the regulator.

- The ministerial task force will work in an open and collaborative manner to ensure the successful development of elements of the plan.

- The minister will be responsible for implementation of the plan.

- The ministerial task force will develop the plan for implementing the model water utility – including the development of common elements of the model, conducting education and consultation, providing advice and expertise to the minister, and facilitating expert resources for municipalities.

Common elements of the model:

- The ministerial task force will develop the customized framework for the TQWMS in Ontario and share it with the audit community.

- The ministerial task force will strike working groups to develop common high-level supports, such as standard operating procedures (SOPs), human resources management systems, performance management systems, etc.

- The ministerial task force will develop a self-assessment scorecard for use by water utilities to determine areas of strength and weakness against the TWQMS. This self-assessment can build on the work already done in

the engineers' reports. The minister will request that all water utilities complete this scorecard within the first six months.

- The results of this self-assessment will offer greater clarity to the implementation priorities, scope of work ahead, and challenges. It will also provide an early report to the public on the overall state of water quality management in the province. This self-assessment will provide the basis for plans in individual water utilities.

Education and consultation:

- The ministerial task force will convene a round table of international experts with experience in implementing parts of the TQWMS approach in other jurisdictions. The results of this round table discussion will inform and guide the implementation plan.

- The ministerial task force will convene information sessions through AMO, OMWA, and OWWA to discuss related issues. The information sessions will include round table discussions, grouped geographically, that will be facilitated by external experts. The information sessions also will include lessons learned from electrical deregulation and other relevant undertakings and jurisdictions.

Advice and expertise:

- Expert external facilitation will also be available to municipalities to help them negotiate new utilities or shared services with neighbouring municipalities.

### 10.2.4 Sustainable Strategies

- Once new water utilities or shared services are established, they will be maintained through the governance structure and the annual reporting requirements, as described in Part 1 of this paper.

- The advisory body to the regulator will offer expert advice to the regulator and provide oversight of the regulatory function.

## 10.3 Business Continuity

### 10.3.1 Goal

To ensure the safe supply of drinking water to the public during the transition to the TQWMS.

### 10.3.2 Issues and Barriers

The move to a TQWMS is to ensure the safe supply of drinking water to the people of Ontario. It may be perceived incorrectly as a power struggle between levels of government or between the public and private sectors.

During a time of change, employees can be distracted from their work, as they worry about the future organization and their roles in it.

There will be new roles and responsibilities, and all the players need time to learn and develop the necessary skills.

### 10.3.3 Transitional Strategies

- The ministerial task force will play a strong leadership role in communicating the purpose and intent of the TQWMS:
  - The purpose of the transition is to meet public expectations for safe supply of drinking water, not to test new technical standards.
  - There is no single solution for how water utilities are organized, but there are expectations for how they perform.

- Those responsible for governance play a critical role in affirming the purpose and intent of the TQWMS. They do this through
  - ongoing and effective communication with the public,
  - clear expectations for the leadership of the water utility,
  - ensuring that the operational capacity meets the requirements of the TQWMS, and
  - taking responsibility for plans to ensure that they can fulfill their responsibility for the supply of safe water to their community.

- Expert resources will be available to the governance board and the leadership of each water utility to ensure that it can move to become a TQWMS entity effectively and quickly.

- Because TQWMS is about assurance for safe supply of drinking water, training and development of existing staff will be a first priority for each water utility.

- The implementation of the TQWMS will require each water utility to develop a preparedness plan in the event of any emergency.

- Financial resources will be available to the professional and industry associations to take on the leadership and coordinating role during the development of the processes, standards, and best practices.

### 10.3.4 Sustainable Strategies

- Once water utilities address the issue of scale and begin consolidation, any concerns about business continuity will be overcome by the new utility.

## 10.4 Effective Governance

### 10.4.1 Goal

To ensure that the mandate and the objectives of the water utility are carried out effectively, through having effective process, structure, and management in place.

### 10.4.2 Issues and Barriers

The TWQMS provides for a water utility that is a distinct organization with financial and management responsibilities. Accordingly, there will be a governing body with specific responsibility for overseeing the direction and management of the water utility.

Bodies already in place have responsibility for governance of the water utilities. The framework does not propose one single structure for these bodies, but ensures their effectiveness in practice.

Where the governing structure for the water utility is the local council, there is potential for an entire change of members of the board at the time of a municipal election. This possibility is a challenge for long-term planning.

Among the governing bodies that exist, the understanding of roles and responsibilities varies. The skills, knowledge, and capability to carry out the roles and responsibilities are mixed and in some cases insufficient. Effective practices in ongoing governance must be sustained.

### 10.4.3 Transitional Strategies

- Sessions through AMO, OMWA, and OWWA will provide a general orientation to boards of water utilities on their roles and responsibilities, and the legal framework within which they operate.

- The self-assessment tool will include a checklist for boards to determine how well they meet the principles of good governance.
  - Based on this self-assessment, boards will develop plans for improvement.
  - Expert resources will be available to boards throughout the transition process from self-assessment to developing a plan for continuing improvement to implementing that plan.

- The ministerial task force will conduct a comprehensive review of best practices in governance generally, and in water utilities specifically. These practices will be shared with all water utilities.
  - Best practices will be developed to meet the obligations and responsibilities that come with the provision of a life necessity such as quality drinking water.
  - Best practices will include areas of public engagement and participation, internal control and management information systems, senior executive recruitment and compensation, human resource strategies, recruitment and appointment of members, and board assessment methods.
  - Best practices for the board's role in risk management will be developed specifically for the TQWMS.

- On a case-by-case basis, expert resources will be available to advise on the appropriate governance structures for new utilities or shared services.

### 10.4.4 Sustainable Strategies

- Each water utilities board will include in its annual report a report on board effectiveness and its plans for continuing improvement.

## 10.5 Leadership

### 10.5.1 Goal

To recruit and retain high quality leaders to establish the organization and culture desired in the new water utilities.

### 10.5.2 Issues and Barriers

There is a general scarcity of leadership in organizations, especially in the water industry. It will be a challenge to identify sufficient numbers of leaders in the industry or to attract such talent from other industries. The required compensation level could be problematic.

### 10.5.3 Transitional Strategies

- The board of each water utility will be responsible for identifying the competencies and attributes of the leader.
- The board of each water utility will determine the appropriate compensation level.
- The board of each water utility will be responsible for executive recruitment and may need to consider innovative approaches to fill these positions.
- Compensation levels will probably exceed current rates, but there is likely to be a significant offset through consolidations or shared services.
- The ministerial task force will commission a sector-wide compensation review that will be available to all water utilities.

### 10.5.4 Sustainable Strategies

- The executive's performance will be reviewed annually by the board of the water utility.

- The professional and industry associations can continue to update the compensation review periodically.

## 10.6 Scale

### 10.6.1 Goal

To ensure that each water utility has sufficient capacity – human resources, financial, and future investments – to be licensed by the regulator in compliance with the TQWMS.

### 10.6.2 Issues and Barriers

Scale is determined by the balance among three key factors: the desired quality of the drinking water, the quality of the source water, and the density of population being served. Size alone is not a determinant of scale.

Some water utilities will not be able to qualify for licensing because of limits on their capacity (human resources, financial, and future investment).

Partnerships across political boundaries are challenging.

The ability to make collaborative and partnering arrangements depends on the ability of leadership. The scarcity of leaders limits successful collaboration.

In the past, financial subsidy and grants from governments masked the real challenge communities faced in infrastructure management.

There has not been a sustainable way for ensuring that the human resources (skills, knowledge, and expertise) were up to the job. Some utilities face a challenge in attracting the leadership needed for TQWMS.

The local services realignment initiative in Ontario and the *Water and Sewage Services Improvement Act, 1997* transferred ownership of all provincially owned facilities to municipalities, but did not address the capacity issues – human resources, financial and future investments.

### 10.6.3 Transitional Strategies

- The ministerial task force will take a leadership role in developing strategies for the capacity issue. Alternatives will include
  - a single utility owned by one municipality that offers its services to other communities,
  - shared services among neighbouring communities where the existing resources are applied to ensure that the TQWMS can be implemented for each community,
  - operational co-ventures among water utilities,
  - a single utility owned by several municipalities,
  - a combined electrical, water, and wastewater utility corporation as the local management group, and
  - introduction of point-of-use systems.

- The ministerial task force will involve those with responsibility for the Rural Economic Development Strategy to ensure that alternative strategies for providing safe drinking water are consistent and supported by economic development plans. Access to expert resources can be obtained under the Rural Economic Development Strategy.

- The ministerial task force will consult with the stakeholders in developing the licensing process so that when a utility cannot meet certain abilities and functions, a discussion of strategies to deal with the capacity issues will occur. The results of the initial self-assessment scorecards will be used in this consultation.

- The ministerial task force will conduct a consultation with the insurance industry to examine the implications – for insurance coverage and rates – of scale, accreditation, and compliance with the TQWMS.

### 10.6.4 Sustainable Strategies

- The available strategies for addressing capacity issues are documented, including costs and benefits, and communicated to all water utilities.

- The licensing process includes a step for considering these strategies.

- The public reporting will indicate how well the utility is doing in realizing the benefits of scale. The regulator may put a utility 'on watch' based on its report, if the indicators demonstrate that the utility is disadvantaged because of scale.

## 10.7 Rural Communities

### 10.7.1 Goal

To maintain the quality attributes of the TQWMS in water utilities regardless of location in the province.

### 10.7.2 Issues and Barriers

Rural communities in Ontario have small populations and are often separated by large distances. It is difficult for them to realize the benefits of scale that other communities will achieve. In the south, this can be accommodated through consolidation or shared services.

In the north, distances pose a challenge to shared services and infrastructure. Although there are technological solutions, the water utility itself may not have sufficient capacity – human resources, financial and future investments – to fully implement the TWQMS.

The circumstances of size and distance may require alternative technology and alternative operational and management solutions. However, the need to manage risk and provide assurance of water quality to the public still exists.

### 10.7.3 Transitional Strategies

- The ministerial task force will establish a working group to develop technological, operational, and management approaches appropriate for Northern Ontario.

- Technological solutions can include alternatives such as
  – point-of-use,
  – drip feed systems, and
  – truck delivery.

- Operational alternatives will include the use of information technology and automation to enable control hubs or shared services over wide geographic areas. In addition, the assurance of water quality in certain systems will require a different kind of monitoring, testing, and reporting (especially for in-home systems).

- Management solutions to achieve the quality attributes of TWQMS will have to be structured to the technical and operational design of the water supplier.

- A comprehensive education program will have to be developed and delivered to the public.

- The ministerial task force will also develop the methodology and approach that can be used by rural communities to assess risk against cost.

### 10.7.4 Sustainable Strategies

- All water utilities will still have to report to the public on performance, test results, and incidence rates. Ongoing education will be required.

## 10.8 Regulator

### 10.8.1 Goal

To ensure that the regulator demonstrates adherence to the principles of good regulation (as outlined in section 7.1.2).

### 10.8.2 Issues and Barriers

There is still uncertainty about the structure of the regulator (provincial ministries, single window for provincial ministries, or arm's-length agency) and the organization and behaviour of the regulator (sufficient expert staff and adequate resources to carry out the role effectively).[54]

The regulator will have to be unencumbered and able to command the skills, resources, and capacity necessary to carry out its responsibility. It also must be seen to be fair, reasonable, and free from conflict.

The water utilities, as regulated organizations, do not have a joint mechanism for interacting with the regulator, communicating issues, and participating in ongoing development of regulatory practices and protocols.

There are questions over the nature of interventions and penalties for failure to comply.

Once the regulator is established and operational, the ministerial task force becomes the first advisory body to the regulator.

### 10.8.3 Transitional Strategies

- The general principles of a good regulator will be reviewed and endorsed by the sector. The regulator will work with the water utilities in developing licensing requirements, the public reporting system, and the role and functioning of the advisory board and consumer advisory councils.

- The regulator will work with the advisory body (the former ministerial task force) on developing intervention mechanisms for non-compliance. As with the TQWMS, these mechanisms will be matched to the risk presented by the non-compliance event.

- The regulator will work with the advisory body to determine what information should be reported to indicate the performance of the

[54] Although the structure of the regulator is not discussed in this paper, the authors maintain that a self-regulated industry body would not be appropriate in an area of such significant health and public safety. The regulator is a representative of the provincial government, and there is potential for government policy and direction, as it affects water utilities, to change from time to time.

regulator. Indicators will relate to how closely matched the performance of the regulator is to the principles of a good regulator.

- The regulator will work with the advisory body to determine the processes for nominating members to the consumer advisory councils and for the flow of information to and from these councils.

### 10.8.4 Sustainable Strategies

- The regulator will affirm the existing provincial government policy that any public financial support for community infrastructure will be given on a priority basis. Water, sewage, and road developments take precedent over community buildings or recreation facilities.

- The regulator will affirm the policy that financial assistance, if available, is directed only to TWQMS-licensed utilities that have demonstrated their efficiency and effectiveness.

- Fair process will be used for reviewing decisions of the regulator.

- The regulator will provide an annual report of its performance in implementing and ensuring the ongoing effective operation of TQWMS. If the regulator is a public body, such as a crown agency, it will be subject to the *Public Sector Accountability Act.* If the regulator is part of the government, it will be required to prepare business plans and report on performance, as do all other ministries and agencies.

- The environmental commissioner will report on the effectiveness of the regulator on the basis of how performance matches the principles of a good regulator.

## 10.9 Water Quality Standard Setter

### 10.9.1 Goal

To establish a clear set of water quality standards that are research based and that demonstrate the adoption of health protection and risk prevention.

### 10.9.2 Issues and Barriers

Parameter limits in the current guidelines are sometimes "relaxed" on the basis of financial considerations rather than health protection.

The current guidelines have been developed and reviewed, with little transparency, by committees of bureaucrats at the provincial and federal levels of governments. The processes for researching, developing, and introducing new standards is slow and not necessarily in pace with international standards and trends.

Traditional methods to remove or inactivate pathogens such as chlorine-resistant parasitic strains might not be effective. Traditional tests to ensure that treated drinking water is safe take time and money. Thus, the focus of drinking water treatment has shifted toward risk reduction in treatment and protection of source water.

Ontario has no treatment requirements for *Cryptosporidium* or requirements to analyze source water for *Cryptosporidium* or *Giardia.*

Standards have tended to be defined by what the available technology can measure in a timely and cost effective manner, rather than by risks that pose a threat to public health.

Changes in regulations have been introduced without notice and without lead time for compliance.

The standards adopted must be defensible based on evidence and research.

### 10.9.3 Transitional Strategies

- The existing Ontario drinking water standards will continue to apply as a minimum for all water utilities in the province.

- The water quality standards expressed in the Canadian drinking water guidelines should be the minimum required by Ontario standards.[55] There is some latitude for compromise on adoption of the limits if the province can argue on a scientific or social basis for the relaxation of a specific parameter in the Canadian guidelines. Relaxation of parameters cannot

[55] Canada, Health Canada, 1996.

be done simply on a financial basis (i.e., when the regulated limit on a parameter would require a capital expenditure by utilities).

### 10.9.4 Sustainable Strategies

- As the TQWMS is phased in, any new water quality standard will be developed through Health Canada and adopted by the provincial standards-setting body as the minimum standard for all water utilities across the province. Any relaxation will be done on a scientific or social basis.

- The provincial standards-setting body will provide for notice and sufficient time for compliance when new standards are identified and scheduled for adoption.

## 10.10 Audit

### 10.10.1 Goal

To ensure that regular evaluations and audits are completed by the water utilities in order to plan for continuous improvement and public reporting.

### 10.10.2 Issues and Barriers

The few water utilities that have received quality management certification (ISO, TQM) have internal evaluation and external audit processes in place. Very few water utilities, however, have received such certification.

The TQWMS will require processes for internal evaluation and external verification and audit. A water utility's internal resources and expertise will not be sufficient to implement the TQWMS. External expertise will be required during the implementation stage.

The engineers' reports recently completed by all water utilities provide initial evidence of the current operational and technical capacity of utilities.

The regulator or ministry will oversee the development of management standards and methodology for use in the TQWMS.

### 10.10.3 Transitional Strategies

- The water utilities will need external expertise to help establish the TQWMS.

- Training at the water utility will address the requirements for internal expertise for on-going management and evaluation of the TQWMS.

- The ministerial task force will develop the TQWMS framework, which will be shared with the audit community. The external evaluation and audit will be conducted by credible third parties that are registrars recognized by the Standards Council of Canada.

### 10.10.4 Sustainable Strategies

- A standard methodology for audit with defined audit standards will be developed.

- Third parties to conduct such audits will be recognized registrars.

- The regulator or ministry will provide – by regulation – for the methodology and the third-party evaluation and audit.

## 10.11 Customer

### 10.11.1 Goal

To achieve transparency of the drinking water process to the public and to engage the public effectively in the TQWMS.

### 10.11.2 Issues and Barriers

There is not a strong record of involvement of the public in the planning, operation, and regulation of water utilities.

The involvement of customers and the public has been largely ad hoc, each individual water utility developing its own means and ways of communicating and engaging its customers.

The Operation Clean Water Program establishes regular reporting to the public on the treatment of water and how the quality compares to provincial standards.

### 10.11.3 Transitional Strategies

- The ministerial task force will create a working group of stakeholders who will develop the five-step approach for customer involvement (see section 8).
- This five-step approach will be available to utilities to adopt, modify, and use as appropriate for their communities.
- The ministerial task force will develop a public education and communication program as part of its mandate.
- Reporting and communication of information to the community must be implemented.
- Customer advisory councils must be instituted.

### 10.11.4 Sustainable Strategies

- The regulator will establish customer advisory councils.
- Each water utility will communicate with its community through public reports.
- Public education and communications are elements of the TQWMS.
- All reports of the water utilities will be posted to the Web site of the regulator.

# 11 Track Two – Implementing the Total Quality Water Management System

## 11.1 Total Quality Water Management System

### 11.1.1 Goal

To establish and maintain a Total Quality Water Management System (TQWMS) that includes risk management, accountability, and education.

### 11.1.2 Issues and Barriers

A comprehensive and consistent system that will assure the public that risks are being managed in a deliberate and thoughtful manner does not exist. There is no effective means of communicating to the public the nature of risk management.

### 11.1.3 Transitional Strategies

- The Canadian drinking water guidelines set by Health Canada will be the baseline reference for all standards regulated in Ontario.
- The ministerial task force will develop the TQWMS framework, which will be a customized made-in-Ontario version based on the ISO methodology, with enhancements from HACCP, QualServe, EPA Partnership, etc. The TQWMS will be shared with the audit community.
- A working group of operators will develop standard operating procedures for various types of facilities.
- The functions of regulator, standards setter and auditor will be separated, and roles and responsibilities will be defined clearly.
- Water utility staff will need training in the TQWMS.

### 11.1.4 Sustainable Strategies

- Achievements and non-conformances of the TQWMS will be reported in the annual report.

- Ongoing training requirements will be identified in the performance management system (see section 3.6 – Model Water Utility). The professional and industry associations will provide expertise and information about training requirements on an ongoing basis.

## 11.2 Partnerships

### 11.2.1 Goal

To build the capacity of the Ontario water supply system through effective partnerships and leadership of professional and industry associations.

### 11.2.2 Issues and Barriers

Many agencies are currently involved in water supply management. There is no integrated approach, and collaboration has been limited. Protection of source waters will require a watershed management group.

The industry and professional associations have a record of leadership in supporting the sector and advancing knowledge and information. There may be resistance, however, from some water utilities to using other utilities as a resource. A utility might believe that it will look as if it can't do its job if it acknowledges that there is a problem,.

### 11.2.3 Transitional Strategies

- Integrated watershed management is essential. The ministerial task force will develop a model approach for water utilities and agencies in working together to ensure the safe supply of drinking water.

- The associations play a key role in promoting best practices.
  - The ministerial task force, with a working group of industry and professional associations, will identify the priority areas for determining best practices and which group can best take a lead.
  - The ministerial task force will provide funding for the initial research and development of information on best practices, building on existing resources wherever possible.

- The associations play a key role in the triple-E approach to certification (see section 6.5.3).
  - The learning, training, and development activities of the associations will be enhanced and aligned with the TQWMS.
  - Initial funding will be provided for this start-up activity. Fees will support ongoing costs.

### 11.2.4 Sustainable Strategies

- The TQWMS approach for integrated watershed management will be adopted by water utilities and the regulator.

- There will be a province-wide clearinghouse for research and sharing information on best practice.

- Associations will have a role – recognized by the regulator – in learning, training, and development.

## 11.3 Management Competence

### 11.3.1 Goal

To install in the new water utilities managers who demonstrate exemplary competence.

### 11.3.2 Issues and Barriers

As with most other industries, the water industry has not provided sufficient training to its managers; consequently, the existing competence level might not meet the requirements of the model.

The requirements and demands on managers as envisioned under the TQWMS are new and different from past expectations.

### 11.3.3 Transitional Strategies

- The ministerial task force will develop a comprehensive leadership development program, with the assistance of an external expert and in consultation with industry and professional associations.
- Water utilities will commit to support the leadership development program.
- Financial resources will be budgeted for the leadership development program.

### 11.3.4 Sustainable Strategies

- Performance assessments and ongoing training requirements are incorporated in the performance management system.
- Deliverables, progress, and expenditures will be detailed in the annual report.
- Industry and professional associations will provide ongoing leadership in defining and refining the leadership development program.

## 11.4 Operator Competence

### 11.4.1 Goal

To develop and maintain a workforce whose members are competent in performing their jobs and committed to high quality and continuous improvement.

### 11.4.2 Issues and Barriers

Training standards have been developed for the operators. When implemented in the 1990s, however, all existing operators who had sufficient work experience were grandfathered and certified.

There could be encumbrances in collective agreements, such as access to training and compensation levels, that will have to be sorted out. Any issues covered under a collective agreement will be dealt with between employer and employee.

### 11.4.3 Transitional Strategies

- The training standards for operators should become a formalized apprenticeship program, with restricted skill sets, under the *Apprenticeship and Certification Act.* All operators, including those who are grandfathered, will have to be re-examined and re-certified every three years.

- The ministerial task force will establish a working group that will consult with the Ministry of Training, Colleges and Universities to review and revise the operator training program to make it consistent with the provincial apprenticeship program and to ensure that it fully meets current occupational requirements for an operator.

- Water utilities (perhaps using external expertise) will have to conduct a gap analysis on all operators to determine what training is required and for whom.

- Water utilities will commit to support the apprenticeship program.

- Financial resources will be budgeted for the apprenticeship program.

### 11.4.4 Sustainable Strategies

- Performance assessments and ongoing training requirements are incorporated in the performance management system.

- Deliverables, progress, and expenditures will be detailed in the annual report.

- Operators will be re-tested for re-certification every three years.

# 12 Track Three – Transparency

## 12.1 Financing

### 12.1.1 Goal

To develop and manage budgets that reflect the true costs of the operations of water utilities and that support the attributes of the new model.

### 12.1.2 Issues and Barriers

This model is based on a move to full cost recovery. Currently, most customers in Ontario are not paying the true cost for their water.

Operational budgets do not match the true costs. They do not accommodate sustainable asset management. They do not accommodate future investment and deferred maintenance. The contributions of water utilities to fire services are not reimbursed to the utilities. Support for research and the regulatory regime is not part of the current cost of water. There has been a reliance on special government-sponsored infrastructure programs for major works. In other instances, water revenues may be in excess of costs and are applied to other purposes within the community.

The current grants structure, which does not encourage fiscal responsibility for water utilities, is inconsistent with the move to full cost recovery.

### 12.1.3 Transitional Strategies

- Each water utility must develop a metered user-pay system, with a phased-in implementation plan.

- The ministerial task force will develop a common financial accounting system for use by each water utility.

- Budgets must be developed to support fully the requirements of the new water utilities, including operations, sustainable asset management, conducting a gap analysis, providing training, establishing and maintaining the TQWMS, and establishing and maintaining a human resources management system.

- Each utility will have to implement a sustainable asset management system, including an inventory of all assets, evaluation of their life cycles, a prioritized replacement plan, and a corresponding budget allocation.

- The federal and provincial governments should either withdraw from funding water infrastructure or set forth a multi-year commitment to enable proper budgeting.

### 12.1.4 Sustainable Strategies

- The regulator will be responsible for rate reviews of all water utilities.

- All financial aspects of actual expenditures and achievements against plan (including asset management) will be in the annual report. This transparency will keep a positive, healthy tension and accountability in the system.

- The common accounting system will facilitate comparison and benchmarking.

## 12.2 Accountability

### 12.2.1 Goal

To establish an open and transparent accountability system for water utilities.

### 12.2.2 Issues and Barriers

Organizational change in the provincial government and the implementation of local services realignment initiative in municipalities have occurred at such a pace that a clear definition of roles and responsibilities of each level of government has not been made.

Public reporting required by a TQWMS builds on the water quality reporting introduced under the Operation Clean Water program. It is also consistent with the requirements under the *Public Sector Accountability Act.*

The development of a reasonable and relevant reporting regime will require an investment of time, effort, and resources.

### 12.2.3 Transitional Strategies

- The ministerial task force will develop a template for the mission statement that provides direction for implementing the TQWMS.

- The ministerial task force, with a working group of stakeholders, will develop the information required as a basis for the annual report.
  - This information will build on commonly used practices for annual reporting, including financial statements and progress against plans and future developments.
  - There will be additional information relating specifically to the implementation and continuing improvement of the TQWMS.
  - These annual reports will provide, at a minimum, the information required under the *Public Sector Accountability Act* or by publicly traded companies.

- The ministerial task force, with a working group of stakeholders, will develop requirements for regular reporting as a result of the ongoing monitoring of standards and performance.

- The ministerial task force will identify the kinds of information and the means most appropriate for communicating with the public.

- Existing reporting will continue and will be enhanced over time to reflect the implementation of TQWMS.

### 12.2.4 Sustainable Strategies

- The ministerial task force will establish a mechanism for the water utilities, working with industry and professional associations, to identify best practices in reporting and communication with the public. See appendix 3 for an annual report template.

- Water utilities owned by municipalities (as commissions, corporations with share capital held by the municipality, or part of the municipalities) will be required to report under the *Public Sector Accountability Act.*

- The Ontario Government will develop system-wide indicators (for reporting performance, quality, and effectiveness) to be assessed by the auditors and regulator as appropriate.

## 12.3 Five-Year Assessment of the Legislation

### 12.3.1 Goal

To assess the implementation of the TQWMS as provided for by legislation.

### 12.3.2 Issues and Barriers

It is difficult for the ministerial task force and regulator to assess their own work.

An assessment will identify necessary corrections and adjustments to the TQWMS.

An assessment will determine whether the purpose and objectives of the legislation have been met, whether the regulatory requirements are sufficient or reduplicative, and whether the minister has to make changes to the policy framework.

### 12.3.3 Transition Strategies

- A third party will lead an assessment, with the involvement of the regulator and the advisory body to the regulator.
- The report of this assessment is available to the public and decision-makers – the water utilities, the regulator, and the government.

### 12.3.4 Sustainable Strategies

- The TQWMS will be modified and improved based on the findings of the assessment.
- Improvements will be done according to priority.
- Any policy changes, legislative amendments, or regulatory changes will reflect the results of the assessment.

# 13 Financing the Transition

There will be costs associated with the transition to the new model for water management in Ontario. Over and above the demands of ongoing operations and needed investments, the transition will have to be financed.

The transition costs, at a general level, include

- the work of the ministerial task force,
- development of communications,
- regional information sessions,
- provision of expert resources,
- introduction of new training and development for utility staff, including operators and managers,
- priority-based research to establish best practices,
- development and implementation of the elements of the TQWMS,
- development work for the standard operating procedures, indicators, methodology on assessment of risk, and protocols for integrated management,
- launching any new service delivery arrangements, and
- introduction of new reporting information.

There will be change as a result of the Walkerton Inquiry. The Minister of the Environment has committed to a plan to "refocus" the ministry and, through both regulatory and non-regulatory initiatives, adopt an approach of continuous improvement. In particular, the minister has committed to a multidisciplinary approach to water management. There are commitments to rural economic development, infrastructure development, and improvements to processes. The government has introduced the *Public Sector Accountability Act*. These changes have been anticipated and announced, and they are being planned. The TQWMS complements these initiatives. All that is needed is the commitment to ensure that existing resources and related new resources are directed at achieving the goal of quality water management.

Many municipalities are currently having trouble meeting the new standards for drinking water quality. Failure to comply with the standards is not an option. The province cannot allow systems to fail and health to be threatened. There are demands for new investment and skills now. The transition plan provides a focal point for that investment. Rather than expect each individual water utility to try to develop the core elements of the TQWMS on its own, the common

information and commonly used practices can be developed once through the work of the ministerial task force. Such information and practices include the standard operating procedures, performance indicators, compensation review, methodology for risk assessment, financial accounting, training, and audit standards.

# Appendix 1 The Australian Framework as Foundation for an Ontario Model Water Utility Structure

The structure of the model Ontario water utility is based largely on *Australian Framework for Management of Drinking Water Quality* (the Australian Framework). That document presents a very strong foundation on which – with additional information and concepts where (in the authors' opinions) the Framework could be strengthened – to build an Ontario model. This appendix contains relevant sections from the draft Australian Framework. The final version of the Framework has been completed and is available on line.[56]

The elements of this appendix are not meant to be accurate transcriptions of the Australian Framework text. First, the appendix was prepared using a draft version of the Framework. Second, the authors chose to adapt some of the text to the Ontario context. For example, the phrase "Ontario Drinking Water Standards" has been substituted for "Australian Drinking Water Guidelines," where applicable. Likewise, the term TQWMS (total quality water management system) has been substituted for the Australian DWQMS (drinking water quality management system). Third, the standard conventions of spelling and punctuation for this paper have been applied.

For the convenience of readers wishing to refer to the Framework, each section of this appendix gives the section reference to the Framework from which the text was adapted.

## A1.1 Commitment to Drinking Water Quality Management (Framework, Section 1)

Commitment to continually improve performance is the foundation to effective management of drinking water quality. This commitment should be based on the awareness and understanding of the importance of drinking water quality management and how decisions affect the protection of public health.

Leadership from a drinking water supplier's senior management is essential to the development of a management philosophy within the organization that fosters commitment to continuous improvement and cultivates employee responsibility and motivation. The ongoing and active involvement of senior

[56] Australia. NHMRC/ARMCANZ Co-ordinating Group, 2001.

management is a key factor in maintaining and reinforcing the importance of drinking water quality management to all employees, as well as to those outside the organization.

Senior management should ensure that its actions and policies support the effective management of drinking water quality (e.g., appropriate staffing, training of employees, provision of adequate financial resources, active participation, reporting to the board or chief executive). Establishment of a water quality policy, review of requirements, and involvement of relevant agencies demonstrate a water supplier's commitment to drinking water quality management and provide a means for communication of this commitment throughout the organization and to the public.

### A1.1.1 Drinking Water Quality Policy

Development of an organizational drinking water quality policy is an important step in increasing focus on water quality management throughout the organization and in formalizing the level of service to which the water supplier is committed. The drinking water quality policy should define the commitments and priorities of a water supplier relating to drinking water quality and provide the basis for which all subsequent actions can be judged.

The drinking water quality policy is intended to provide a framework from which more detailed policies and implementation strategies can be developed. As such, it should be clear, succinct, and address broad issues and requirements of drinking water quality management. The policy may consider, for example,

- commitment to drinking water quality management,
- the level of service provided,
- involvement of employees,
- compliance with relevant regulations and other criteria,
- liaison with relevant agencies,
- communication with employees and the public,
- intention to adopt best practice management and multiple barriers, and
- continual improvement in the management of drinking water quality.

In developing the drinking water quality policy, the opinions and requirements of employees, consumers, and other stakeholders should be considered.

It is the responsibility of all employees to maintain this commitment. Employees must be assured that senior management is committed to achieving the goals of the drinking water quality policy, particularly given the pace of change within the industry in recent years. Management should ensure that this policy is highly visible and continually communicated and understood at all levels of the organization. Each employee should know how the mission statement applies specifically to the performance of his or her job.

An example of a generic drinking water quality policy is provided in box A1-1.

## A1.2 Total Quality Water Management System

### A1.2.1 Continuous Improvement (Framework, Section 12)

Senior management support, commitment, and ongoing involvement are essential to the continual improvement of the organization's activities relating to drinking water quality. Management regularly should review its approach to drinking water quality management, develop action plans, and commit the resources necessary to improve its operational processes and overall drinking water quality performance. This review will be a part of the annual report.

#### A1.2.1.1 *Senior Management Review (Framework, Section 12.1)*

In order to ensure continual improvement, senior management should assess the extent to which the drinking water quality management system remains suitable and effective. This provides the necessary mechanism to ensure that the drinking water quality management system is maintained and reviewed on an ongoing basis.

Senior management should take the opportunity to critically assess the effectiveness of drinking water quality management activities and evaluate the need for any changes to be made. The scope of the review should be comprehensive, though not all elements of the drinking water quality management system need to be reviewed at once. A systematic review schedule is a requirement of the Total Quality Water Management System (TQWMS) Plan.

The process will include review of audit results and drinking water quality performance, evaluation of any previous management reviews, any concerns of

**Box A1-1 Generic Drinking Water Quality Policy**

The organization is committed to managing its water supply effectively to provide a safe, high quality drinking water that consistently meets or exceeds the Ontario Drinking Water Standards, customer and other regulatory requirements.

To achieve this, in partnerships with stakeholders and relevant agencies, the organization will

- manage water quality at all points along the delivery chain from source water to the consumer.
- integrate the needs and expectations of our customers, stakeholders, regulators and employees into our planning.
- establish regular monitoring of the quality of drinking water and effective reporting mechanisms to provide relevant and timely information and promote confidence in the water supply and its management.
- develop appropriate contingency planning and incident response capability.
- participate in appropriate research and development activities to ensure continued understanding of drinking water quality issues and performance.
- continually improve our practices by assessing performance against corporate commitments and stakeholder expectations.

Consistent with the Ontario Drinking Water Standards approach, detailed plans that support the management of drinking water quality will

- utilize a risk-based approach in which potential risks associated with water quality are identified and balanced, and
- provide the most economical community solutions to maintain an acceptable cost of supply.

The organization will establish a good working relationship with public health agencies to ensure it contributes to the debate on setting industry regulations and guidelines and other standards relevant to public health and the water cycle.

The organization will implement and maintain a Total Quality Water Management System consistent with the Ontario Drinking Water Standards to adequately manage the risks to drinking water quality.

All managers and employees involved in the supply of drinking water are responsible for understanding, implementing, maintaining, and continuously improving the Total Quality Water Management System.

(*Dated and signed by responsible officer*)

consumers, regulators and other stakeholders, plus an evaluation of the suitability of the drinking water quality policy, objectives, and preventive strategies in relation to changing internal and external conditions such as changing legislation, changing expectations and requirements, changes in the activities of the organization, advances in science and technology, outcomes of drinking water quality incidents and emergencies, and reporting and communication.

Observations, conclusions, and recommendations from the senior management review should be documented.

### A1.2.1.2 *Total Quality Water Management System Plan (Framework, Section 12.2)*

A Total Quality Water Management System (TQWMS) plan is required to address the recommendations for improvements defined by the management review. Improvement plans should include short-term (1 yr.), intermediate-term (5 yr.), and long-term (20 yr.) programs that address the resolution of any existing or potential drinking water quality problems.

Examples of actions that could be included in improvement plans include long-term capital works projects such as the covering of water storages and the introduction of filtration, or short-term operational improvements such as the development of pesticide programs, increasing staffing, and the development of community awareness programs.

Implementation of TQWMS plans will often have significant budgetary implications and may require detailed cost-benefit analysis and careful prioritization.

TQWMS plans will include the objectives, actions to be taken, accountability, timelines, and reporting. A water supplier should ensure that the improvement plan is communicated throughout the organization and to the community, regulators, and other stakeholders by the prescribed methods. Implementation of improvements should be monitored to confirm they have been made and are effective.

#### A1.2.1.3 *Research and Development (Framework, Section 9)*

Applied research and development should be directed toward increasing the understanding of a water supply system and potential impacts and investigating improvements and new processes. Investigations will necessarily include validation of operational effectiveness of new products and processes such as coagulation and filtration.

A corporate commitment to conduct and participate in research and development activities aimed at advancing knowledge of drinking water quality issues is important to ensure continual improvement and to support the ongoing capability to meet drinking water quality requirements.

Ongoing research at a local level increases understanding of the specific characteristics of individual water supply systems. Local research could include examination of specific characteristics of individual water systems and detailed analysis of temporal and spatial variations in source water quality parameters. Research and development activities also should investigate mechanisms to improve or optimize plant performance, evaluation of treatment processes including the validation of critical limits and targets, and the design of new equipment. These activities should be carried out under controlled conditions by qualified staff and all protocols and results should be documented and recorded.

Additionally, participation in research and development activities through partnerships and industry-wide cooperation can be a cost-effective approach for addressing the broader issues associated with water quality and treatment including the development and evaluation of new technologies. A water supplier should identify opportunities for collaboration and seek to initiate joint research and development projects.

### A1.2.2 Hazard Identification and Risk Assessment (Framework, Section 2.3)

Adoption of a risk-based approach that enables the identification of hazards from catchment to consumer and the assessment of their potential impact on water quality is essential to efficient system management. Hazard identification and risk assessment are valuable tools for understanding the vulnerability of a drinking water supply and planning effective risk management strategies to assure drinking water quality and safety.

A hazard is an agent or a situation with the potential for causing harm (e.g., *Cryptosporidium* is a water quality hazard, a potential danger to public health). Risk is the likelihood of identified hazards causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or the consequences (e.g., the likelihood that *Cryptosporidium* oocysts will breach water management system barriers with sufficient numbers to cause illness in consumers would constitute a risk).

A structured approach to identify areas of greatest risk is important in ensuring that significant issues are not overlooked. A water supplier first may choose to carry out a screening level risk assessment to identify broad issues and then determine where to focus efforts on a more detailed risk assessment. An example of a hazard identification and risk assessment methodology is provided in box A1-2.

Realistic expectations for hazard identification and risk assessment are important. Hazard identification and risk assessment are predictive activities that will inevitably be based on less evidence than is desirable for definitive calculation. These inherent limitations must be recognized by viewing the predictions as no more than reasonable and practical judgments and not as scientifically derived determinations of the 'real' risk. Such perspectives are necessary to maintain flexibility to read events as they unfold and respond effectively when events differ from predictions. Likewise, when dealing with the public, a realistic perspective on the limitations of the predictions is essential so that dialogue can focus on improving the evidence rather than engaging in unproductive debate about real versus perceived risk.

#### A1.2.2.1 *Hazard Identification*

A hazard is an agent or situation with the potential for causing harm

The 2000 ODWS provides a comprehensive list of potential hazardous agents in drinking water. These include physical, microbiological, chemical, and radiological agents. Events, scenarios, and causes that might give rise to exposure to these hazards and affect drinking water quality (what can happen and how) should be identified and documented for each water supply system component and their risk assessed so that appropriate strategies can be planned for their prevention.

All potential hazards and hazardous events should be included regardless of whether or not they are under the direct control of the water supplier. This

**Box A1-2 Hazard Identification and Risk Assessment**

A structured approach to identify areas of greatest risk is important in ensuring that significant issues are not overlooked. While there can be wrong ways to conduct the analysis (i.e., if erroneous characterizations are relied upon), there is no single right way to perform these activities. The process must evolve from a comprehensive and rigorous evaluation of the system under study. Steps involved in the process should logically include

Structure and Scope of Analysis

- Define the structure of the analysis by dividing the system and the assessment into logical elements, e.g. catchment, treatment plant, distribution system, consumers, etc.
- Define the approaches and methodology used to identify hazards and hazardous events (tools and techniques, appropriate representatives).
- Define the scope of analysis, i.e. the range of conditions that correspond to unacceptable water quality (hazards and events) and the nature of the risks being considered (e.g. impacts on human health, aesthetics, public relations and company image, legal liability).

Hazard Identification

- Identify and document all potential hazards from catchment to consumer regardless of whether or not they are under the control of the drinking water supplier.
- Identify and document the hazardous events, causes and scenarios that might affect the drinking water quality (what can happen and how).
- The initial hazard identification process should not be constrained by practical considerations that might stifle the creativity of the assessors in foreseeing obscure hazards. After acquiring a full list of hazards, those that are judged to be too improbable to warrant an assessment of risk may be simply listed without any required follow-up action.

Risk Assessment

- Estimate the level of risk for each hazard/scenario (a function of likelihood and severity of the consequences). This will be at best a semi-quantitative exercise that must rely on an agreed scoring system that is transparent to scrutiny.
- Establish and document priorities for risk management action based on assessment of risk. The sensitivity of the risk ranking to the scoring system used must be open to scrutiny. This system must be viewed as distinguishing very big risks from very small risks and will not be likely to achieve on strictly objective grounds any fine distinctions among a number of moderate risks.

**Source:** Adapted from AS/NZS 4360:1999 *Risk Management.*

includes identification of point sources of pollution such as human and industrial waste discharge as well as diffuse sources of pollution such as those arising from agricultural and animal husbandry activities, etc. Potential continuous, intermittent or seasonal pollution patterns also should be considered as well as extreme and infrequent events such as droughts or floods.

The information provided by the Water Supply System Analysis and Review of Water Quality Data should be used to ensure that hazards and hazardous events are not overlooked. It is important that the hazard identification and risk assessment be reviewed and updated on a periodic basis. This is essential to ensure that staff is involved in and familiar with the judgments that are inherent in the hazard identification and risk assessment. Likewise, changing conditions may introduce important new hazards or modify risks associated with identified hazards.

Table A1-1 includes examples of some typical hazardous events and causes. Box A1-3 provides an example of various pollution sources and the potential hazards they produce.

#### A1.2.2.2 *Risk Assessment*

Risk is the likelihood of a hazard causing harm in exposed populations in a specified time frame, including the magnitude of that harm and/or consequences

Once potential hazards and their causes have been identified, the level of risk associated with each hazard/scenario must be estimated so that priorities for risk management action can be established and documented. It is important to recognize that there are countless contaminants that can compromise drinking water quality but that not every potential hazard may require the same degree of attention. The distinction between hazard and risk needs to be made so that attention and resources can be directed to actions based primarily on the degree of the risk rather than just the existence of a hazard.

The level of risk for each hazard or scenario can be estimated by identifying the likelihood of occurrence (e.g., certain, possible, rare) and evaluating the severity of consequences if the hazard occurred (e.g., insignificant, major, catastrophic). Rarely will enough knowledge be available to complete a detailed quantitative risk assessment, and in most cases it will be more appropriate to adopt qualitative or semi-quantitative approaches that are transparent and fully understood by involved parties.

**Box A1-3 Examples of Sources and Potential Hazards**

Human and animal waste represent the largest sources of potential hazards in drinking water. Both can include high numbers of enteric pathogens and large amounts of nutrients. Due to the scale of primary production in Australia, the total amount of livestock waste would greatly exceed the amount of human waste.

- Septic tanks – pathogens*, nitrates/nitrites
- Sewage treatment plants – pathogens, nutrients
- Animal husbandry – pathogens, nutrients, turbidity, colour
- Horticulture – pesticides, fertilizer nutrients, turbidity, colour
- Rural stormwater – pathogens, high turbidity, colour
- Forestry – pesticides
- Industry – heavy metals, organic chemicals including halogenated organics (specific industries can be associated with specific types of contaminants such as arsenic and copper associated with wood preserving, cadmium and chromium with electroplating, chromium with leather tanning, etc.)
- Mining – acid mine wastes from pyrites tailings can release and transport metals such as aluminium, iron and manganese, other naturally occurring metals such as cadmium and copper can also be leached, arsenic can be associated with old goldfield areas
- Urban stormwater – lead and zinc from roads, colour, turbidity, micro-organisms from pets (lower range of pathogens than from humans or livestock waste)
- Stormwater/sewer overflows – pathogens, high colour, turbidity

* The potential range of pathogens present will vary according to the type of waste involved. Many enteric pathogens and in particular viruses and protozoa exhibit species specificity. In general, human enteric viruses are only carried and excreted by humans. Human infectious *Cryptosporidium parvum* can be carried by humans and livestock, but the species of *Cryptosporidium* that infect birds do not infect humans.

# Table A1-1 Examples of Potential Hazardous/Contamination Events

| Catchments and Groundwater Systems | Storage Reservoirs and Intake | Treatment System | Service Reservoir and Distribution System | Service Reservoir and Distribution System (cont' d) |
|---|---|---|---|---|
| • Rapid variations in raw water quality<br>• Sewage discharges/septic systems<br>• Industrial discharges<br>• Chemical use in catchment areas (e.g., use of fertilisers and agricultural pesticides)<br>• Major spills/accidental spillage<br>• Public roads<br>• Human access (recreational activity)<br>• Wildlife (native and feral)<br>• Unrestricted livestock<br>• Inadequate buffer zones<br>• Surrounding land use (e.g., animal husbandry, agriculture, forestry, industrial area, waste disposal, mining)<br>• Changes in surrounding land use<br>• Poorly vegetated riparian zones and failure of sediment traps/soil erosion<br>• Stormwater flows and discharges<br>• Existing or historical waste-disposal or mining sites/contaminated sites/hazardous wastes<br>• Unconfined and shallow aquifer<br>• Groundwater under direct influence of surface water<br>• Inadequate well-head protection and unhygienic practices<br>• Uncased or inadequately cased bores<br>• Saline intrusion of coastal aquifers<br>• Contaminated aquifer<br>• Climatic and seasonal variations (e.g., heavy rainfalls, droughts)<br>• Bush fires, natural disasters, sabotage | • Open reservoirs and aqueducts/ uncovered storages<br>• Human access/absence of exclusion areas around shorelines<br>• Animal access including birds and vermin<br>• Short-circuiting of reservoir<br>• Depletion of reservoir storage<br>• No selective withdrawal<br>• No alternative water sources<br>• Unsuitable intake location<br>• Algal blooms<br>• Stratification<br>• Soil erosion<br>• Inadequate buffer zones and vegetation<br>• Climatic and seasonal variations (e.g., heavy rainfalls, droughts)<br>• Public roads/accidental spillage<br>• Failure of alarms and monitoring equipment<br>• Bush fires and natural disasters<br>• Sabotage | • Significant flow variations through water treatment system<br>• Incapable equipment/ unit processes<br>• Inadequate backup<br>• Inappropriate treatment processes<br>• Process control incapability/operational flexibility<br>• Use of unapproved or contaminated water treatment chemicals and materials<br>• Chemical dosing failures<br>• Inadequate mixing<br>• Failure of dosing equipment<br>• Inadequate filter operation and backwash recycling<br>• Ineffective disinfection<br>• Equipment malfunctions<br>• Poor reliability of processes<br>• Failure of alarms and monitoring equipment<br>• Power failures<br>• Sabotage and natural disasters | • Open reservoirs and aqueducts/ uncovered storages and unprotected pipe system<br>• Human access/absence of exclusion areas around shorelines<br>• Animal, bird and vermin access<br>• Short-circuiting of reservoir/stagnation zones<br>• Build up of sediments and slimes<br>• Inappropriate materials and coatings or material failure<br>• Aged pipes, infrastructure<br>• Corrosion of reservoirs and pipe system<br>• Mixing of different source waters<br>• Infiltration and ingress of contamination from cross connections, backflow (soil and groundwater)<br>• Biofilms, sloughing and resuspension/regrowth<br>• Pipe bursts/leaks<br>• Inadequate repair and maintenance/inadequate system flushing and reservoir cleaning | • Commissioning new mains<br>• Inadequate disinfection after construction, repairs<br>• Flow variability/inadequate pressures<br>• Treatment dosing failure<br>• Inadequate maintenance of chlorine residual<br>• Formation of disinfection byproducts<br>• Failure of alarms and monitoring equipment<br>• Sabotage and natural disasters<br><br>**Consumers**<br><br>• Potential consumer misuse<br>• Inappropriate plumbing and construction materials<br>• Leaching of metals |

**Note:** This list provides examples of some typical hazardous events and scenarios. It is not intended to be exhaustive. Inadequate staffing and training, inadequate operating procedures, poor communication, lack of community involvement, etc. should also be considered as potential hazardous scenarios. These issues are discussed in subsequent elements

Examples of risk definition and classification for estimating the level of risk of each hazard are provided in tables A1–2, A1–3 and A1–4 (as adapted from AS/NZS 4360:1999 *Risk Management*). These tables can be adapted to meet the needs of an individual organization.

## Table A1-2 Qualitative Measures of Likelihood

| Level | Descriptor | Example description |
|---|---|---|
| A | Almost certain | is expected to occur in most circumstances |
| B | Likely | will probably occur in most circumstances |
| C | Possible | might occur at some time/the event should occur at some time |
| D | Unlikely | could occur at some time |
| E | Rare | may occur only in exceptional circumstances |

## Table A1-3 Qualitative Measures of Consequence or Impact

| Level | Descriptor | Example description |
|---|---|---|
| 1 | Insignificant | insignificant impact, little disruption to normal operation, low increase in normal operation costs |
| 2 | Minor | minor impact for small population, some manageable operation disruption, some increase in operating costs |
| 3 | Moderate | minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring |
| 4 | Major | major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required |
| 5 | Catastrophic | major impact for large population, complete failure of systems |

## Table A1-4 Qualitative Risk Analysis Matrix – Level of Risk

| | Consequences | | | | |
|---|---|---|---|---|---|
| Likelihood | 1 Insignificant | 2 Minor | 3 Moderate | 4 Major | 5 Catastrophic |
| A (almost certain) | moderate | high | very high | very high | very high |
| B (likely) | moderate | high | high | very high | very high |
| C (moderate) | low | moderate | high | very high | very high |
| D (unlikely) | low | low | moderate | high | very high |
| E (rare) | low | low | moderate | high | high |

Using these tables to guide a risk assessment exercise will quickly reveal the need to reach a consensus on the level of detail and format to be used for specifying events that will be listed in the assessment. The approach to designating events determine how they will be ranked because events may arise along a continuum from commonly recurring events of minor consequence to rarer manifestations of the same event with more serious consequences. Take, for example, the failure to maintain specified disinfectant residual in the reticulation (distribution) system. Whereas slight deficiencies may be common with limited consequences, a total disinfection failure should be rare and could raise potentially severe consequences. There is no absolute set of rules to be followed in using these tables; rather, they are offered as a general guide for the development of a consistent approach that will make sense for the water system under study.

The foregoing risk assessment process is different in scope and purpose from other environmental health risk assessments that may be used to develop environmental quality guidelines (including health-based drinking water quality guideline levels) or to assess specific developments or activities. The latter usually involve a wide range of detailed environmental, toxicological and epidemiological information about individual contaminants or mixtures. Typically, after formulating the problem to be assessed in its full context, the process will involve a hazard assessment, dose-response assessment, exposure assessment, and a risk characterization.[57]

Risk assessment as described in the Framework is designed to be part of a management process which establishes priorities and evaluates the effectiveness of preventive strategies in minimizing risk. Risk can be assessed at two levels: maximum risk in the absence of preventive strategies; and residual risk assuming that existing preventive strategies are operating effectively (see section A1.2.4 – Prevention Strategies)

Assessing maximum risk is useful in preparing for emergencies, while residual risk provides an indication of the need for additional preventive strategies. Determining each provides valuable information on both high priority risks and the preventive strategies that are critical for ensuring the delivery of safe drinking water (see section A1.2.3 – Critical Control Points).

---

[57] See Australia, EnHealth Council, 2000, *Environmental Health Risk Perception in Australia* [online], (public consultation) [cited January 2002], <www.health.gov.au/pubhlth/publicat/document/metadata/envrisk.htm>.

#### A1.2.2.3 *Rare Events*

When systems are operated well, problems will be rare, making them more challenging to anticipate and possibly to respond to creating a more difficult response. This reality highlights the need for collaboration with other water suppliers within the country and internationally to maximize opportunities to learn constructive lessons from the difficult experiences of others. There are a number of notable examples where rare events have had severe consequences.[58]

#### A1.2.2.4 *Uncertainty*

The predictive nature of hazard identification and risk assessment dictates that there will always be substantial uncertainty associated with these activities. An appreciation of the types of uncertainty can be helpful in dealing with it. Uncertainty can be classified broadly into two types: variability and knowledge uncertainty.

*Variability* represents the true differences that can exist in the specific values of parameters that contribute to a risk such as contaminant concentrations over time and space, flows, number of people exposed, etc.

These characteristics contribute to uncertainty because they vary, and we usually cannot describe them completely because we have incomplete monitoring data and there is no single correct answer that will cover all circumstances. For example, what is the correct representation of water temperature over some time period? The mean temperature will not represent the high and low extremes, which may be more important depending on what we are seeking to know. Because there is variability in temperature, we must decide which value is correct to use among the data we have, and this choice will carry with it some uncertainty.

*Knowledge uncertainty,* however, represents our inadequate state of knowledge that exists in the values of parameters measured. Knowledge uncertainty may be reflected in a lack of assurance that methods are accurately measuring what we intend them to or in a lack of understanding of how a process works. For example,

---

[58] Box 4.1 in the Australian Framework outlines the Walkerton (2000) and Milwaukee (1993) outbreaks.

in using methods to count *Cryptosporidium* oocysts, there may be a degree of uncertainty that the particles being counted are truly *Cryptosporidium* oocysts. Alternatively, while there may be confidence that the method for counting oocysts is accurate, further uncertainty exists about what the measurement means because it is not known if the oocysts are viable and infective.

There is value in being able to distinguish the relative impacts of variability and knowledge uncertainty. Variability cannot be reduced by measuring it more accurately. However, by better characterizing variability, the nature of a hazard and thereby, the dimensions of the risk, can be better understood. Understanding the role of variability in contributing to uncertainty may lead to actions to change a system to reduce its variability (e.g., increase reservoir storage times to minimize fluctuations in water quality).

In contrast, knowledge uncertainty can be reduced by additional measurement and research. The increased understanding from reducing knowledge uncertainty can provide greater assurance that the preventive measures being considered will achieve their intended purpose. This requirement supports the need for a research capability within the water industry (see section A1.2.1.3 – Research and Development).

Hazard identification and risk assessment have to explicitly consider the sources and types of uncertainty. By documenting the major sources of variability and knowledge uncertainty that arise for all risks, insights can be gained into the appropriate actions for reducing the role of uncertainty.

#### A1.2.2.5 *Risk Prioritization*

Based on the assessment of risks, priorities for risk management and application of preventive strategies can be established and documented. Generally, risk assessment will be at best semi-quantitative and will often include subjective judgments. The aim should be to at least distinguish between very high risks and low risks. Very high risks require implementation of preventive strategies, whereas low risks might be tolerated.

Investigative studies and research monitoring can be used to provide further information to input into the risk assessment and priority setting process.

### A1.2.3 Critical Control Points (Framework, Section 3.2)

In addition to the placing of multiple barriers (discussed in section A1.2.4 – Prevention Strategies) that reduce exposure to hazards, a crucial requirement is the selection/identification of the critical activities and processes essential for the control of water quality (i.e., critical control points) and establishing the mechanisms to control these processes, including methods that will verify effective performance and trigger immediate corrective actions to operational processes where required.

A critical control point (CCP) is defined as a point, step, or procedure at which control can be applied and is essential to prevent or eliminate a hazard or reduce it to an acceptable level (Codex Alimentarius). In determining whether a step or process should be considered a CCP, a practical explanation is whether loss of control at that point will lead to an unacceptable health risk. If an activity or step can not be adequately controlled, it is more difficult to use it as a critical control point.

An ideal CCP has several characteristics (Tompkin 1992):

- Operational parameters and criteria are specific, quantifiable, and provide a yes/no response.
- Operational parameters and criteria are validated through research and technical literature.
- The technology for controlling the CCP is readily available at reasonable cost.
- Monitoring of criteria is continuous and real time and the operation can be automatically adjusted to maintain control.
- There is a favourable history of control.
- The potential hazard is prevented or eliminated.

It is recognized, however, that ideal CCPs are often not achievable, and measurable parameters and clearly defined criteria may not be available. Thus, parameters and criteria are sometimes more subjective, based on judgment and operational experience (e.g., compliance with procedures, inspection, auditing). Also, in many cases it may not be possible to prevent a hazard but rather minimize it to an acceptable level.[59]

---

[59] R.B. Tompkin, 1992, "Corrective action procedures for deviations from the critical control point critical limits," in *HACCP – Principles and Applications*, eds. M.D. Pierson and D.A. Corlett, Jr. (n.p.: Chapman & Hall), pp. 72–82.

Major efforts in process control for a water supply system will be directed toward the activities selected as critical control points. The appropriate selection of CCPs is an important consideration, as too many CCPs may make the system unwieldy, and too few may not provide adequate assurance of drinking water quality and safety.

The selection of CCPs will be different for each water supply system depending on the nature of the system, the range of hazards, the number of barriers, and the treatment processes used. Examples of potential CCPs that can be controlled effectively and that can prevent, eliminate, or reduce a hazard to acceptable levels are listed in box A1-4 and are briefly described below.

CCPs are not limited solely to the following examples, and alternate treatment methods can make effective CCPs, provided that appropriate operational criteria are developed.[60] Additional CCPs and criteria may need to be defined as water systems adopt advanced technologies such as dissolved air flotation, activated carbon, membrane systems, and alternative disinfection and treatment processes.

Operational parameters and criteria for CCPs; a monitoring system including corrective actions; and verification procedures, record-keeping, and documentation are discussed in subsequent steps of the Framework.

**Box A1-4 Potential Critical Control Points**

CCPs will be different for each water supply system depending on the levels of barriers and the treatment processes used. Some common examples of potential critical control points that can be used include

- groundwater/wellhead protection,
- selective use of water sources,
- (alternate sources/source water type),
- selective withdrawal/reservoir drawoff,
- coagulation, flocculation and/or sedimentation,
- filtration,
- disinfection, and
- protection of distribution system.

[60] See Framework, sec. 9.2 – Validation of Processes.

#### A1.2.3.1 *Groundwater/Wellhead Protection*

In a groundwater supply, location, design, construction and maintenance of bores, and protection from localized contamination, undesirable surface water or shallow groundwater could be considered a CCP. The essential requirements are protection of the wellhead, including sealing and casing of bores and the local aquifer infiltration area from agricultural, industrial, and septic discharges.

Monitoring can include regular inspections of protection areas and integrity of bore casings and seals and by testing groundwater for the ingress of fecal micro-organisms.

#### A1.2.3.2 *Selective Use of Water Sources (Alternate Sources/Source-Water Type)*

Where available and feasible, a potential CCP for surface water sources could be in the selection of source water. When water quality parameters vary (e.g., seasonal variations, after heavy rainfall, algal blooms), an effective approach may involve changing the source of raw water.

Avoiding poor water quality by employing alternative sources (e.g., groundwater, alternate surface water, or available storage) can minimize the number of contaminants entering the treatment system.

Continuous monitoring of raw water quality parameters such as turbidity, pH, stream flow, and climatic conditions could be used to indicate periods of poor raw water quality and trigger control by the selection of alternative source water.

#### A1.2.3.3 *Selective Withdrawal/Reservoir Drawoff*

Reservoir drawoff can serve as an effective CCP for a water supply system. Understanding water quality profiles and utilizing multiple take-off points can assist in selecting good quality drinking water.

Specific operational criteria based on temperature, pH, turbidity, and depth profiles of algal numbers can be developed but may rely more on operational experience and understanding of the reservoir and which parameter is likely to be unique to the specific reservoir.

### A1.2.3.4 *Coagulation/Flocculation and/or Sedimentation*

Coagulation/flocculation and sedimentation (where used) are key activities in a water treatment plant. These processes are well established and provide an effective means for the removal of particles, including micro-organisms. It is important that operations are optimized and controlled so that the subsequent barriers of filtration and disinfection are not overloaded and can achieve consistent and reliable performance.

Optimizing coagulation and coagulant dose is dependent on a number of raw water conditions such as colour, alkalinity, pH, and the size, surface charge, shape, and composition of particles. The use of streaming current detectors is increasingly being used for optimizing coagulant dosage. Effective flocculation depends on the temperature, mixing conditions, and the rate of treatment. Key parameters in sedimentation are the surface loading rate and regular maintenance and cleaning of sedimentation basins. High effluent turbidities in water after sedimentation are usually indicative of poor performance.

Using turbidity or particle counts as indicators for the effectiveness of these steps can provide the desired control over these processes and provide an early indication of limitations in the system. Monitoring turbidity can be continuous, and real time and operational criteria have been studied extensively and are well established in the scientific and technical literature.

### A1.2.3.5 *Filtration*

Filtration is becoming an increasingly important barrier for removal of contaminants, particularly for viruses and pathogens that are more resistant to disinfection. Extensive research has been conducted on the effectiveness of filtration in eliminating or reducing potential hazards to an acceptable level. Filtration is conducive as a CCP because specific operational criteria have been developed and online continuous monitoring is possible to provide rapid response to poor performance.

For optimal performance of media-based filtration, particular attention should be given to monitoring turbidity from each filter, appropriate handling of backwash water to avoid recycling pathogens, minimizing turbidity increases during filter start ups, and operation of filters to avoid sudden flow surges.

Filtration should be monitored continuously, and treated water of a constant quality should be produced irrespective of the quality of the raw water. The most established indicator of filtration performance is turbidity monitoring, with operational criteria limits placed on upper levels and acceptable variations. Particle counters after each individual filter could also serve as an effective indicator, providing that the appropriate operational criteria are developed. Another key characteristic to be monitored is head loss on filters.

#### A1.2.3.6 *Disinfection*

Disinfection of surface water supplies to prevent waterborne disease is an essential activity in the treatment process. Disinfection is capable of inactivating bacterial and viral pathogens and may have some effect against protozoa. The most common methods of disinfection are chlorination, ozonation, UV irradiation, chlorine dioxide addition, and chloramination.

Disinfection lends itself very effectively as a CCP. It is supported by extensive research and technical literature on effectiveness of various methods to eliminate potentially harmful micro-organisms. In addition, the technology for process control, including online continuous monitoring, feedback on dose control, alarm systems, and automatic backup systems, is readily available.

Effective disinfection is dependent on contact time, dose, pH, temperature, and disinfectant demand. Assessment of disinfection should consider all four parameters; this is normally done by calculating CT values (CT = concentration × time) to determine whether effective residual concentrations of disinfectant are achieved for adequate contact times to attain target levels of pathogen inactivation at specified temperatures and pH. (Tables of CT values for inactivation of *Giardia* and viruses by free chlorine and other disinfectants have been published by the U.S. Environmental Protection Agency.)

#### A1.2.3.7 *Protection of Distribution System*

Protection of the distribution system from any ingress of contamination is important in maintaining the quality of water leaving the treatment plant and ensuring a safe water supply to consumers. Although not an ideal CCP, control of activities in the distribution system is necessary to prevent any recontamination from occurring.

Integrity of construction, use of approved materials, use of appropriate maintenance and repair procedures, and maintenance of backflow prevention should be monitored and adequately controlled including appropriate documentation. In addition, operational parameters that can be readily measured include disinfectant residual, thermotolerant coliforms (or *E. coli*), and hydrostatic pressure. For activities that require adherence to operational procedures, appropriate training of staff responsible for the distribution system, including contractors, is essential.

### A1.2.4 Prevention Strategies – Multiple Barriers (Framework, Section 3.1)

In assessing the effectiveness of existing management strategies from catchment to consumer and evaluating alternate and additional management strategies, it is essential to consider the important principles of multiple barriers, prevention at source rather than downstream control, and the validation of suggested preventive strategies.

Application of multiple barriers to prevent contaminants from entering the water supply system and/or to control transmission through the system is universally recognized as a critical and fundamental tenet for effective drinking water quality management and for ensuring the supply of safe drinking water.

The strength of multiple barrier systems is that a failure of one barrier may be compensated for by effective operation of the remaining barriers, thus minimizing the likelihood of contaminants passing through the entire treatment system and being present in sufficient amounts to cause harm to consumers.

The level of protection planned to control a hazard should be proportional to the associated risk and each barrier should provide an additional margin of safety. As figure A1-1 demonstrates, the multiple barrier approach is one in which the overall risk of an incident occurring is significantly reduced by implementing and optimizing several barriers throughout the entire water supply system from catchment to consumer.

Ensuring the safety of a water supply entails a wide-ranging program of protection, treatment and monitoring with barriers to the entry and transmission of contaminants (particularly micro-organisms) throughout the system.

Traditional barriers include

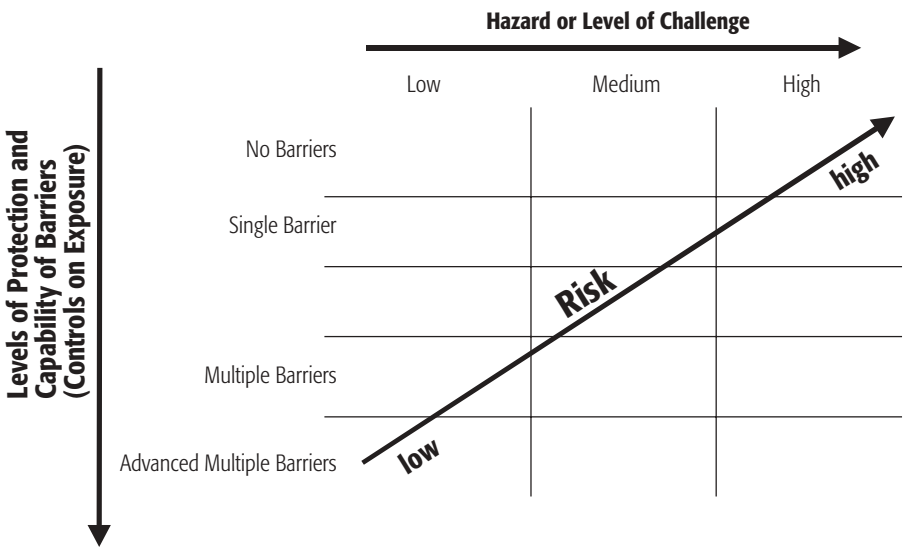
- catchment management and source water protection,
- detention in protected reservoirs/storages,
- extraction management,
- coagulation, flocculation, sedimentation, and filtration,
- disinfection, including an adequate disinfection residual, and
- protection of the distribution system/reticulation maintenance.

Water can be affected at each of these points, but they are all interrelated and therefore require integrated management. The security provided by the multiple barrier approach is reliant on each individual barrier being maintained at all times with any failures or faults being rectified as soon as possible.

The level of protection and types of barriers required will be different for each water supply system. While there is some flexibility in choosing barriers, they often are dictated by the characteristics and quality of the raw water source (see box A1–5).

Each of the barriers is discussed briefly in the following sections.

**Figure A1-1 Reduction of Risk through Multiple Barriers**




**Source:** Framework, fig. 3.1 (S.E. Hrudey, 2001, "Drinking water quality: a risk management approach," *Water,* vol. 28, no. 1, pp. 29–32.)

### A1.2.4.1 *Catchment Management and Source Water Protection*

Catchment management and source water protection provide the first barrier for the protection of water quality. Catchment management usually involves a coordinated approach to develop short-term and long-term plans to enhance water quality and eliminate or control any potential sources of pollution.

In addition to minimizing risks from contamination, effective catchment management offers several additional advantages including reducing the degree of treatment required, the quantity of chemicals used in treatment, minimizing costs of water treatment, and reducing the creation of treatment by-products.

Intelligent management of land use and water resources in catchments is essential to a safe water supply. The extent to which catchment pollution can be controlled or remediated, however, is often limited in practical terms wherever there are competing water uses and pressure for increased development in the catchment.

**Box A1-5 Selection of Multiple Barriers**

Large parts of Melbourne are supplied with high quality source water from a highly protected catchment. Melbourne Water focuses much of its attention and resources on maintaining prevention of contamination at the source. The series of barriers for the majority of the system include

- protected forested catchments for harvesting of water with no human or livestock access,
- large catchment reservoirs with long detention times,
- additional retention time in seasonal storage systems,
- disinfection of water prior to it entering the distribution system, and
- closed distribution systems.

In contrast, Adelaide is supplied with surface water derived from multi-use catchments and the River Murray where there is limited control over activities with potential impacts on water quality. As a result, the barriers applied are heavily weighted toward water treatment and downstream control to remove turbidity and micro-organisms. These include use of multiple reservoir storages, coagulation, flocculation, sedimentation, filtration, disinfection with long contact times before supply, provision of residual disinfectant through large parts of distribution systems, and effective maintenance in the distribution system.

Whether water is drawn from surface catchments or underground sources, it is important that the characteristics of the local catchment or aquifer be understood and the activities that could lead to water pollution be identified and managed. Hazard identification and risk assessment should include threats to both the quality and quantity of water (having regard to both point and diffuse sources of pollution) and future land use activities.

Surface and groundwater sources should be protected from contamination. Possible sources of contamination include

- animal (livestock) waste from farming, feedlots, dairies,
- human waste from urban development and septic tanks,
- recreational activity on reservoirs,
- agricultural and forestry use of fertilizers and pesticides,
- industry,
- mining and quarrying runoff,
- disposal of hazardous wastes, and
- accidental spills.

Any such activities, or others that may pollute, should be identified and controlled or, where feasible, excluded from the catchment. Clearing of vegetation should be carefully controlled as this can result in soil erosion and increased water salinity and turbidity.

Diffuse sources of pollution arising from agricultural and animal husbandry activities are more difficult to manage than point sources of pollution, but their effect on water quality can be minimized by the use of best agricultural practices such as fencing of streams, use of riparian zones, and off-stream watering of stock. Cooperation with landowners and agricultural advisers in the development of joint land and water management programs is therefore essential.

For large river systems protection may be possible only over limited reaches in the vicinity of the raw water offtake or reservoir inlet.

Many Australian surface waters typically carry large amounts of particulate matter, mainly dispersive clays and plant and algal debris. This presents a problem because

- suspended matter is aesthetically undesirable;

- micro-organisms readily attach themselves to particles, and can utilize adsorbed nutrients, thus enabling them to survive longer than unattached micro-organisms;

- suspended particles can be a vehicle for the adsorption and transport of many pollutants, including some pesticides and heavy metals; and

- suspended particles can interfere with disinfection processes by exercising a high demand for the disinfectant and screening pathogenic micro-organisms from disinfectant action.

Water sources with high loadings of suspended solids usually require coagulation, sedimentation, and filtration before disinfection. Turbidity of 1.0 NTU is the maximum recommended concentration at the time that the water enters the distribution system.

Groundwater in deep or confined aquifers is usually protected from local sources of contamination, microbiological quality tends to be high, and chemical quality remains reasonably stable over long periods of time. Providing that chemical quality is suitable and the water is extracted through well-constructed and -maintained bores, it is usually safe for drinking without treatment. In longer reticulation systems, disinfection may be used to provide protection against contamination introduced during distribution.

However, groundwater supplies may contain high concentrations of naturally occurring elements with health or aesthetic impacts. Groundwater containing high salinity may be unpalatable, while high levels of nitrates, arsenic, boron, fluoride, and radionuclides may make water unfit for use. Anoxic groundwaters with high loadings of reduced iron and manganese can be associated with dirty water and severe staining problems. Water with high levels of carbon dioxide or hydrogen sulphide is extremely corrosive and may require aeration and buffering.

While groundwater from depth is generally microbiologically safe and chemically stable, shallow or unconfined aquifers can be subject to contamination from discharges or seepages associated with agricultural practices (pathogens, nitrates, and pesticides), septic tank discharges (pathogens and nitrates), and industrial wastes.

Where groundwater is at risk from pollution, the highest standards of protection are needed, from the wellhead out to the aquifer infiltration area. The prime objective should be prevention, as most forms of groundwater pollution are difficult to reverse and remediation is often a lengthy and expensive exercise.

A water supplier should ensure that a comprehensive catchment management plan (see box A1-6) based on mitigating any existing and potential future risks is developed and implemented. This must include an emergency response plan for responding to major pollution events such as spillages or contamination. Where practical, catchment management plans should have elements that aim to enhance the quality of water harvested over time.

Catchment management plans should be developed in consultation with the community and relevant agencies such as planning authorities, catchment boards, environmental and water resource regulators, road authorities, and emergency services. It may be useful or necessary to divide large catchments into smaller, more manageable units, or sub-catchments. Where this is done, it is important to ensure that in combination the various plans provide an integrated approach across the entire catchment.

#### A1.2.4.2 *Detention in Protected Reservoirs/Storages*

Storage of water in protected reservoirs can improve water quality by reducing numbers of fecal micro-organisms through settling and inactivation, including solar (UV) disinfection. Most pathogenic micro-organisms of fecal origin do not survive indefinitely in the environment. Substantial die-off of enteric bacteria will occur if water can be stored for at least three to four weeks before being used for drinking water supplies. Enteric viruses and protozoa will survive for longer periods (weeks to months).

In addition to die-off, storages also allow suspended material in the raw water to settle. As well as improving clarity, this also can reduce the numbers of enteric micro-organisms. A combination of die-off and settling during long storage (1–6 months) can provide over 2-log removal of *E. coli, Giardia,* and viruses, and 1–2-log removal of *Cryptosporidium.* Improved water clarity makes subsequent disinfection more effective and efficient while reducing the formation of disinfection by-products.

Removal of suspended solids and micro-organisms is dependent on hydrological and limnological characteristics and can be reduced substantially by short-circuiting of the storage. Hydraulic residence times and potential for short-circuiting need to be determined.

Storages can also provide a buffer against the impacts of short-term peaks of turbidity and contamination associated with events such as heavy rainfall. In some cases it may be possible to avoid transferring water from rivers and streams when water quality is poor (e.g, immediately following heavy rainfall).

Reservoirs should be managed to minimize deterioration related to stratification and growth of algae. Cyanobacteria are generally most problematic for producing taste and odour problems and for producing dangerous toxins. Reservoir mixing is often essential to prevent cyanobacteria from gaining a competitive advantage leading to cyanobacterial blooms.

Unless storages are protected from public access, there is an increased risk that the supply may become contaminated. For example, fecal material from human waste can be washed into the storage and pass quickly into the distribution system, bypassing or short-circuiting the normal protective detention time of the storage. Other problems, such as malicious or accidental contamination of storages with toxic material and vandalism of plant and equipment, have occasionally been reported where public access is uncontrolled.

#### A1.2.4.3 *Extraction Management*

The withdrawal of water at an extraction point may be from a bore, lake, reservoir, or river. Careful design and management of the extraction process and avoiding poor quality water can greatly minimize risk and prevent potential problems in subsequent treatment processes.

Where there are a number of water sources available there may be flexibility to enable the best quality of water to be selected for treatment and supply. In reservoirs and lakes, contaminants such as algal blooms can concentrate in layers or pockets associated with temperature gradients. Extraction management through the use of multiple take-off points can provide protection against localized contamination either horizontally or vertically through the water column.

**Box A1-6 Management of Catchments and Aquifer Intake Areas**

Catchment Management Plan

A Catchment Management Plan should be developed and maintained. This should include, where appropriate, the following elements:

1. Preparation and review of land use planning controls jointly with the planning authority.
2. Establishment of agreed processes and criteria for managing development applications.
3. A clear statement of responsibilities of different agencies and agreed coordination processes.
4. A Catchment Management Policy to guide employees, the community and other agencies.
5. Identification of water quality hazards, estimation of risks and relevant management strategies.
6. A monitoring program to identify pollution sources, maintain quality control, provide support for on ground works, and collect long-term data to determine trends.
7. Regular inspections with documented results to monitor catchment conditions and land use changes.
8. Strategies for working with landowners to establish good relationships, optimize water quality and maintain their viability.
9. A community awareness program to support the Catchment Management Plan.
10. Agreed and tested emergency response plans for a range of incidents with the relevant emergency services.

Best Practices

Planning regulations should prohibit high-risk development in catchments and aquifer intake areas (e.g., intensive animal feedlots). Planning policy should set the protection of water quality as an explicit objective of local legislation with formal referral of development applications that may create a water quality risk to the drinking water supplier. Policy also should address the issue of long-term incremental development.

Urban development, agro-industry, and general industry should be scrutinized carefully to ensure that they will not impact on water resources. On-site wastewater disposal systems should be permitted only where the applicant has satisfied the relevant authorities that the site is suitable and the process sustainable with minimal risk to the water supply. Disposal systems should be designed, installed, and maintained correctly and inspected regularly. Defects should be reported and rectified.

Where appropriate, formal agreements should be required to ensure approval conditions are complied with and recorded on land titles to alert potential purchasers of the obligations associated with the property. Streams should be fenced off to prevent stock access and buffer strips provided to minimize nutrient runoff. Off-stream watering points should be provided for stock.

Community Awareness

Landowners can be encouraged to protect stream banks and provide buffer strips through community awareness programs and by subsidizing tree planting and fencing works. Management of point sources such as dairy effluent and stockyard runoff is essential and requires cooperation of local landowners as well as close collaboration with agricultural agencies. Demonstration projects that aim to show the benefits of collecting and using this material are useful. Support for local landcare groups is a low-cost opportunity to develop community awareness and reduce pollution risks.

### A1.2.4.4 *Coagulation, Flocculation, Sedimentation, and Filtration*

Coagulation, flocculation, sedimentation, and media-based filtration are key steps in conventional water treatment and provide removal of particles including bacteria, viruses, and protozoa. The degree of removal depends on optimal operation, avoidance of flow surges and turbidity spikes, and monitoring of each of the processes. Water of a constant quality should be produced irrespective of the quality of raw water. These processes can be expected to achieve at least a 2-log reduction of viruses, *Giardia,* and *Cryptosporidium*. For micro-organisms that are highly resistant to disinfection (e.g., *Cryptosporidium*), filtration may be the final barrier to their transmission.

Treatment may range from simple direct sand filtration to the standard practice of coagulation with a flocculant (such as alum, iron compounds, polyelectrolytes, and other organic flocculants), followed by sedimentation and filtration through graded sand or a combination of anthracite and sand.

In contrast to conventional media-based processes, membrane filtration (micro-, ultra-, or nano-) provides a direct physical barrier and generally achieves a greater removal of micro-organisms. However, this level of removal may not be required, and this type of treatment is relatively expensive.

Treatment plants should be operated by trained and skilled personnel. Failure of water treatment processes should be regarded as representing a potential failure to remove microbial contaminants.

### A1.2.4.5 *Disinfection*

Disinfection of drinking water to prevent waterborne disease has been practised for most of this century and remains the single most important activity in system management for providing a safe supply, particularly from surface water sources.

A range of processes is available for disinfection, including ozone, ultraviolet irradiation, and chlorine dioxide; however, chlorination and chloramination are the most common. These methods are very effective in killing bacteria and can be reasonably effective in inactivating viruses (depending on type) and *Giardia*. *Cryptosporidium* is not inactivated by the concentrations of chlorine and chloramines that can be safely used in drinking water, while the effectiveness of ozone and chlorine dioxide is limited. However, results indicate that UV light might be effective in inactivating infectivity of *Cryptosporidium*.

An adequate disinfectant residual should also be maintained throughout the distribution system to provide protection against the ingress of contamination through faults in the system. A persistent residual (such as that provided by chloramination) in remote sections of the supply will guard against recontamination and prevent colonization. Chloramination has proved successful in eliminating *Naegleria fowleri* from water and sediments in long pipelines.

Maintaining a residual throughout reticulation systems will optimize disinfection and limit regrowth problems and is recommended, but in practice this may be extremely difficult to achieve at all points of a hydraulically complex system. In addition, while maintaining microbiological control is the highest priority, there is also a need to consider the issue of minimizing the production of disinfection by-products.

### A1.2.4.6 *Alternative Treatment Options*

Alternative processes such as dissolved air flotation, activated carbon, membrane filtration, ozone/BAC, and combined oxidants may provide effective barriers.

The need for, and utility of, such processes should be assessed on a case-by-case basis. Pilot-scale evaluation should be pursued before committing to full-scale implementation of these newer alternative technologies.

### A1.2.4.7 *Protection of the Distribution System/Reticulation Maintenance*

The structural integrity and cleanliness of reticulation systems must be maintained in order to minimize any decline in water quality after treatment and to prevent external contamination. This can be influenced by plumbing regulations, construction specifications, and maintenance practices.

Water distribution systems should be fully enclosed to prevent ingress of contamination. This also will assist in maintaining a disinfectant residual. Storages and tanks should be securely roofed with external drainage. Backflow prevention policies should be applied and monitored and there should be effective procedures to repair faults and burst mains in a manner that will prevent ingress of contamination. Adequate positive pressure should be maintained throughout the distribution system. Appropriate security needs to be put in place to prevent unauthorized access and/or interference with water storages.

Corrosion of pipes can affect both public health and the aesthetic quality of water and will increase the cost of providing safe water. Cadmium and lead, both potentially toxic metals, occur in tap water almost entirely as a result of leaching caused by corrosion. Other metals, if present, can also be the product of corrosion: copper (causing blue stains on fixtures and metallic taste), iron (causing red-brown stains on fixtures and metallic taste), and zinc (causing metallic taste).

Corrosion in the distribution system can support and promote the development of biofilms, which can protect bacteria and other micro-organisms from disinfection as well as providing an environment for growth. Non-pathogenic coliforms can grow in biofilms. In addition, biofilms can cause aesthetic problems, including off-tastes, odours, and staining. Growths of micro-organisms can also cause additional corrosion.

Proper training of maintenance workers (including contractors) responsible for the distribution system is essential because of the potential for contamination during repairs and recommissioning.

See table A1-5 for an indication of removals of enteric pathogens using the multiple barrier approach. Further examples of management strategies and preventive measures are outlined in table A1–6.

### A1.2.5 Risk Management (Framework, Section 6)

Considered and controlled responses to incidents or emergencies that can compromise the safety of water quality are essential for protecting public health, as well as maintaining customer confidence and company reputation. While

**Table A1-5 Estimated Removals of Enteric Pathogens Using the Multiple Barrier Approach**

| Enteric organisms | Estimated reduction in numbers of enteric pathogens | | | | Estimated overall removal** |
|---|---|---|---|---|---|
| | Watershed protection | Reservoir detention | Filtration | Disinfection* | |
| Bacteria | 0.5–1 log | ~1 log per 10 days storage. Retention for over 60 days will provide almost complete removal. | 0.5–1 log | Complete inactivation can be achieved by a range of disinfectants including chlorine, chloramines, UV, given sufficient doses and contact times. | Complete removal achievable |
| Giardia | 0.5–1 log | 1.5–2.5 log long-term detention (1–6 months) | conventional: 2.5 log direct: 2 log membrane: >4 log | chlorine: 1–2 log ozone and chlorine dioxide: 2 log | Removal of 5.5–8 log achievable |
| Cryptosporidium | 0.5–1 log | 1–2 log long-term detention (1–6 months) | conventional: 2 log DAFF: 2 log membrane: >4 log | ozone: 0.5–2 log chlorine dioxide: 0.5–1 log UV light: 3 log chlorine and chloramines ineffective | Removal of 3.5–7 log removal achievable |
| Viruses | Complete removal of human enteric viruses if human waste excluded. | 1–2 log long-term detention (1–6 months) | Conventional: 2 log Direct: 1 log Membrane (depending on pore size): >4 log | chlorine, UV light, ozone, and chlorine dioxide: 3 log | Removal of 5 log achievable |

* log reductions based on standard doses and minimum contact times of 30 minutes
** using standard technology (catchment control, detention, conventional filtration, chlorination)

preventive strategies (including redundant equipment and facilities) are intended to prevent incidents and emergency situations from occurring, some events cannot be anticipated or controlled, or they have such a low probability that providing backup systems would be too costly. For these incidents, there must be an adaptive capability to respond to the unforeseen circumstances in a constructive and efficient manner.

**Table A1-6 Examples of Preventive Strategies – Catchment to Consumer**

| | | |
|---|---|---|
| *Source Water*<br>• Use of an appropriate source water<br><br>*Catchments*<br>• Ownership and control of catchment area<br>• Registration of chemicals used in catchments<br>• Control of human activities within catchment boundaries<br>• Control of wastewater effluents<br>• Involvement in land use planning procedures<br>• Participation of community and landowners within the catchment area<br>• Regular inspections of catchment areas<br>• Protection of waterways (fencing out livestock, buffer zones, riparian zones<br>• Runoff interception<br>• Use of planning regulations to regulate potential water polluting developments<br><br>*Distribution Systems*<br>• Regular maintenance of equipment<br>• Availability of backup systems (power supply)<br>• Maintaining an adequate disinfectant residual<br>• Cross connection and backflow prevention devices implemented<br>• Fully enclosed distribution system and storages<br>• Secondary disinfection<br>• Appropriate repair procedures including subsequent disinfection of water mains<br>• Maintaining adequate system pressure | *Water Extraction and Storage Systems*<br>• Control of water extraction Alternate selection of water source<br>• Use of available water storage for periods of heavy rainfall<br>• Appropriate location and protection of intake<br>• Proper well construction including casing, sealing and wellhead security<br>• Proper location of wells in aquifer<br>• Water storage systems to maximize detention times<br>• Infiltration wells<br>• Enclosed water storages<br>• Prevention of unauthorized access<br>• Destratification of water storage<br>• Diversion of stormwater downstream from intake<br>• Roofed storages and reservoirs with appropriate stormwater collection and drainage<br>• Securing tanks from access by animals<br>• System maintenance<br>- reservoir cleaning/scouring<br>- pipeline flushing<br>- fittings maintenance<br><br>*Monitoring*<br>• Quality assurance and validation procedures for sampling and testing<br>• Calibration and maintenance of equipment<br>• Appropriate monitoring strategies for periods of heavy rainfall and high winds | *Water Treatment System*<br>• Coagulation/flocculation and sedimentation<br>• Alternative treatment<br>• Use of approved water treatment chemicals and materials<br>• Control of water treatment chemicals<br>• Regular assessment of hazards and risks<br>• Use of skilled and trained operators<br>• Process controllability of equipment<br>• Availability of backup systems<br>• Water treatment process optimization including<br>- chemical dosing<br>- filter backwashing<br>- flow rate<br>- minor infrastructure modifications<br>• Use of tank storage in periods of poor quality raw water<br><br>*Consumers*<br>• Information dissemination<br>- drinking water quality<br>- plumbing and appliances<br>- best practice agricultural methods<br>- backflow prevention<br>- point of use devices |

Wherever possible, emergency scenarios should be identified and incident and emergency protocols, including communication and notification procedures, should be planned and documented. It is vital that protocols are developed prior to the occurrence of any incident or emergency to enable efficient, effective, and rapid responses that will minimize the impacts on the community. Establishing procedures 'on the run' is a recipe for disaster and the potential loss of public confidence.

Actions and protocols should be developed in consultation with relevant regulatory agencies and other stakeholders. In an emergency situation there will not be time to establish confidence and good will if these have not been established during normal operation. An investment in advance for building trust and understanding with parties who will be partners in responding to an emergency will pay important benefits for more effective action when an emergency arises.

Incident and emergency response protocols must be communicated to all relevant personnel, and copies of documented procedures should be available to all personnel.

### A1.2.5.1 *Incident and Emergency Response Protocols (Framework, Section 6.2)*

A water supplier should regard incident and emergency response as a priority and commit the necessary resources to developing emergency response plans. The development of an appropriate incident and emergency response plan involves a review of the hazards and events that can lead to emergency situations. These include events such as

- non-compliance with regulatory criteria,
- accidents that increase levels of contaminants (e.g., spills in catchment, incorrect dosing of chemicals),
- equipment breakdown and mechanical failure,
- prolonged power outages,
- extreme weather events (e.g., flash flooding, cyclones),
- natural disasters (e.g., fire, earthquakes, lightning damage to electrical equipment), and
- human actions (e.g., serious error, sabotage, strikes).

Potential incidents and emergencies should be defined and incident and emergency response plans should be developed and documented in advance to respond to these events. Plans should involve consultation with relevant regulatory agencies and stakeholders and should be consistent with existing government emergency response arrangements. Key areas to be addressed in incident and emergency response plans include clearly specified

- response actions including increased monitoring,
- responsibilities and authorities internal and external to the organization,
- plans for emergency water supplies,
- communication protocols and strategy including notification procedures (internal, regulatory body, media and public), and
- mechanisms for increased health surveillance.

Training in emergency response is important to ensure that employees have the skills and knowledge to manage effectively any potential incidents and emergencies. Incident and emergency response plans, particularly communication protocols, should be reviewed regularly and practised to improve preparedness. Furthermore, testing the effectiveness of incident and emergency response allows the necessary modifications to be made to make the plan more effective and efficient before an emergency occurs.

Following any incident or emergency situation, an investigation should be undertaken and a debriefing with all involved staff should be conducted to discuss performance and address any issues or concerns. The investigation should consider factors such as

- What was the initiating cause of the problem?
- How was the problem first identified or recognized?
- What were the most critical actions required?
- What communication problems arose and how were they dealt with?
- What were the immediate and longer-term consequences?
- How well did the protocol function?

Appropriate documentation and reporting of the incident or emergency should also be established. The organization should learn as much as possible from the incident to improve preparedness and planning for future incidents. Review of the incident may indicate necessary amendments to existing protocols.

Community consultation and communication is essential for restoring consumer confidence and water supplier credibility after an incident or emergency situation. All employees should be kept informed during any incident, as they provide informal points of contact for the community. Notifications advising the end of an incident/emergency and information regarding the cause of the incident and the actions taken to minimize future occurrences are necessary activities for allaying community concerns. Interviews and surveys of a representative portion of the community are also valuable for establishing consumer perceptions.

Box A1-7 provides an example of an emergency response protocol.

#### A1.2.5.2 *Incident and Emergency Response Communication (Framework, Section 6.1)*

Effective communication is critical to managing incidents and emergencies. Clearly defined protocols for both internal and external communications should be established in advance, with involvement of relevant agencies, including health and regulatory agencies. These protocols should include a contact list of key people, agencies, and businesses; detailed notification forms and procedures for internal and external notification; and a reporting and decision-making structure both within and outside the organization (definition of responsibilities and authorities). These contact lists should be updated regularly (e.g., every six months) to ensure that they are accurate.

Maintaining customer confidence and trust during and after an incident or emergency is essential, and this can largely be affected by how a water supplier responds to such events. A public and media communication strategy should be given careful consideration in advance of any incident or emergency situation occurring. Draft public and media notifications should be prepared in advance, with care taken to ensure that any written statements are clear, accurate, easily understood, and formatted for the target audience. An appropriately trained and authoritative contact should be designated to handle all communications in the event of an incident or emergency.

**Box A1-7 Water Incident Communication and Notification Protocol**

In South Australia a protocol has been established between the Department of Human Services (Health), SA Water, the EPA, and the Department of Water Resources to ensure effective communication between government agencies in the event of incidents associated with reticulated water supplies. The protocol also includes notification to other relevant bodies such as catchment water management boards and local authorities.

Incidents are classified:

*Type 1* – potentially serious with either human health or environmental risks, or

*Type 2* – lesser incidents representing a low risk to human health or possible low impact and localized environmental harm.

The protocol includes agreed criteria for both raw water (cyanobacterial blooms, high numbers of *Cryptosporidium*, unacceptable concentrations of health-related chemicals, detection of pesticides, etc.) and treated drinking water (high turbidity in filtered water; chlorinator failure; detection of high concentrations of health-related chemicals, pesticides, *Cryptosporidium, Naegleria fowleri*, persistent *E. coli,* coliform bacteria, etc.).

The protocol defines the role of a water incident coordinator placed in the Department of Human Services and specifies which minister or agency will take the lead in dealing with and communicating incidents. (Incidents with health concerns are led by the Department of Human Services, those with environmental concerns by the EPA, and those with operational concerns by SA Water).

Reporting requirements for individual agencies are defined, as well as communication requirements and protocols for the agencies, the water incident coordinator, offices of the ministers, and the lead minister.

The testing agency (SA Water for drinking water) is required to report all Type 1 incidents immediately to the water incident coordinator and provide confirmation in writing within 24 hours by email or fax. The coordinator ensures that all appropriate agencies have been notified and that relevant ministers are notified by their agencies as soon as possible, and in any event within 24 hours.

Type 2 incidents are normally only notified to relevant agencies and generally do not require ministerial advice.

The protocol includes a list of 24-hour contacts for all agencies. Copies of the protocol are provided to all emergency contacts and relevant officers. The protocol is updated and reissued every six months.

### A1.2.6 Standard Operating Procedures (Framework, Section 4)

The effectiveness of preventive management strategies is highly dependent upon the design and implementation of associated process control programs. To consistently achieve a high quality water supply it is essential to have effective control over the processes and activities that govern drinking water quality and safety. This is particularly important for those activities that have been defined as critical control points (see section A1.2.4 – Prevention Strategies).

Operations must be optimized and controlled on a continuous basis, as even short periods of suboptimal performance can represent a serious risk to public health. Therefore, continuous performance and ensuring that barriers are capable at all times are a critical requirement for the provision of a safe drinking water supply.

A process control program supports the preventive strategies by detailing the specific operational factors that will ensure that all processes and activities are carried out effectively and efficiently. This includes a description of all preventive strategies and their functions together with

- establishment and documentation of effective operational procedures,
- use and maintenance of suitable equipment,
- use of approved materials and chemicals in contact with drinking water,
- establishment of a monitoring protocol for operational performance, including selection of operational parameters and criteria and the routine review of data, and
- establishment of preventive and corrective actions to control excursions in operational parameters.

Two additional requirements for effective process control are the skills and training of operations staff and the documentation of all procedures. Operators should be proficient and have the ability to interpret water treatment and water quality changes and to respond appropriately in accord with established procedures.

All components of a process control program should be documented, with controlled copies readily accessible to all appropriate personnel. Documentation should include

- description of all preventive strategies and their purpose,
- operational procedures for all activities,
- resource requirements,
- responsibilities and authorities,
- schedules and timelines,
- data and records management requirements,
- maintenance procedures,
- operational parameters and criteria,
- operational monitoring protocols and procedures for review of data,
- preventive and corrective actions to be implemented, and
- internal and external communication and reporting requirements.

Documentation should be collated into an operations manual. This manual can take several forms, with examples including operations guidelines, an operations and maintenance manual, a water quality control program, and a process control program. One option could be to organize the manual into programs dealing with the various elements of the water supply system. Drinking water quality management programs will vary with each water supply system but could, for example, include the following:

- a catchment management program for the protection and management of the catchment and source waters

- an intake/reservoir management program for the protection and management of storage reservoirs, dams, borefields, and/or river intakes

- a treatment plant operations program for the operation and management of treatment plants

- a service reservoir and distribution system program for the operation and management of service reservoirs and the protection and management of distribution systems

- a maintenance program for the regular inspection and maintenance of the water supply from catchment to consumer

#### A1.2.6.1 *Operational Procedures*

Managing a water supply system to continuously deliver safe drinking water is dependent on attention to detail of operational procedures. Operational procedures formalize the activities that are essential to ensure consistent water quality. All activities and processes should be described in detail including functions and performance requirements for each component from catchment to consumer. Defined procedures are required for the operation of all of the processes and activities (both ongoing and periodic) and will necessarily incorporate control measures, verification procedures, and maintenance requirements.

Operational procedures are particularly important for those measures established as critical control points.

Appropriate training and adherence to documented operational procedures are important considerations in maintaining controlled operations. Procedures are most effective when operations staff are involved in their development, documentation, and verification. This participation will help ensure that all relevant activities are included, and will enhance operator training and awareness in addition to creating commitment to operational and process control.

Operational procedures documentation should be visible and readily available to employees. As a suggestion, documents should be assembled in a manner that will enable any required modifications to be made more easily. Having the operations manual reside on computers, rather than in binders, can create significant efficiencies.

#### A1.2.6.2 *Equipment Capability*

The capability of equipment is an important consideration in maintaining process control. Where treatment processes exist, a water supplier should ensure that the equipment and infrastructure associated with flocculation, sedimentation, filtration, disinfection, etc. are adequately designed and provide the necessary capacity (size, volume, detention times) to handle peak flow rates and not limit performance. Unit processes should not be hydraulically overloaded or subjected to rapid changes in hydraulic loading as these conditions compromise their effectiveness.

Equipment and infrastructure also must be capable of providing process flexibility and controllability. Requirements include

- the availability and use of online measuring devices that monitor operational parameters continuously;
- automation where possible to rapidly respond to any changes in water quality;
- instrumentation with 24-hour monitored alarms to indicate when critical limits have been exceeded;
- backup equipment if failure of processes occurs and backup generators in the event of a power failure;
- the capability to control various plant flow rates, including filtration rates and backwash rates;
- the capability to control the addition of chemicals at various dosages and application points and to feed the various types of chemicals required;
- effective mixing facilities;
- adequate inlet and outlet configurations and placement; and
- appropriate filter media (or membrane porosity) and adequate surface wash/backwash capability.

When performance-limiting factors are design related, major capital improvements are not always warranted, and in many cases with minor modifications and improved process control many of the limitations can be corrected. Design of new equipment and processes should undergo validation through appropriate research and development.

The use and maintenance of suitable monitoring equipment are also important aspects to providing accurate process control information. Such equipment needs to be sufficiently accurate and sensitive enough to perform at the levels required. For example, turbidimeters need to be accurate within the required operating range (i.e., if filtered water turbidities are to be between 0.1 and 0.5 NTU, the turbidity meter should accurately measure values within this range to be able to quickly detect changes in turbidity). Control of monitoring equipment, including its regular calibration and maintenance, must be performed to ensure that data collected are representative and accurate.

Operations personnel should understand how monitoring equipment works so that causes of spurious results can be recognized and rectified.

Monitoring equipment must be capable of detecting loss of control of processes. It is desirable wherever possible that monitoring be online and continuous and alarms be provided to indicate when operational criteria have been exceeded. Additionally, failure of monitoring equipment should not compromise the system. Particularly at CCPs, a system should be in place to detect failure and provide backup of monitoring equipment.

All equipment, including measuring and monitoring equipment, requires suitable calibration and maintenance to ensure continuing process capability. Procedures and records for calibration and maintenance of equipment should be established and documented.

### A1.2.6.3 *Materials and Chemicals*

Materials and chemicals used in water treatment have the potential to affect drinking water quality. The choice and use of water treatment chemicals and the materials that come into contact with water are important process control considerations.

Examples of chemicals that are purposely added to water for specific operational processes include disinfection and oxidation chemicals, coagulants and flocculants, softening chemicals, neutralization and scale prevention chemicals, algicides, antioxidants, and fluoridation chemicals. Other contaminants may occur indirectly when water comes into contact with materials such as filter media, protective coatings, linings and liners, joining and sealing materials, pipes and fittings, valves, and meters.

Only appropriate chemicals and materials should be used in water treatment. Materials should comply with the NSF standard for potable water. Water treatment chemicals and materials should be evaluated for potential contamination. General considerations include data on impurities, chemical and physical properties, maximum dosages, behaviour in water, and migration and concentration buildup from materials used.

The products used in water systems should be subjected to a system of continuous quality control. Chemical suppliers should be evaluated and selected

based on their ability to supply product in accordance with required specifications. Documented procedures for control of chemicals (including the purchasing, verification, handling, storage, and maintenance of chemicals) should be established to assure their quality at the point of application. Responsibilities for testing and quality assurance of chemicals (supplier, purchaser, or both) should be clearly defined in the purchase contracts.

#### A1.2.6.4 *Operational Monitoring*

Operational monitoring includes the planned sequence of measurements and observations to assess and verify the performance of preventive strategies. Although compliance requirements may be included (e.g., turbidity of filtered water), the general intent of operational monitoring is different from compliance monitoring. Effective operational monitoring is critical for confirming that the barriers for controlling hazards are functioning properly and effectively. Data from operational monitoring are used as triggers for immediate short-term preventive and corrective actions to operational processes to improve drinking water quality.

Operational monitoring of water quality should be considered for all aspects of the water supply system from catchment to consumer and can include both measurement and observation. Observational monitoring may include, for example, the regular inspections of the catchment for integrity of fences, inspections of plant equipment, inspection of wellhead protection areas and bore construction, etc. Measurement monitoring involves the use of suitable operational parameters to ensure that operational processes are functioning effectively. Monitoring generally should be concentrated at critical control points where control can be applied to immediately mitigate any potential hazards that arise.

Key elements of operational monitoring are

- development of operational monitoring plans from catchment to consumer detailing strategies and procedures,

- identification of the operational parameters and criteria that will be used to control processes and, where necessary, trigger immediate short-term preventive and corrective actions, and

- review and interpretation of results to evaluate the need for preventive and corrective actions.

*Operational Monitoring Plan* An operational monitoring plan should be developed and documented to monitor control of CCPs and other preventive strategies from catchment to consumer by scheduled measurement or observation. An operational monitoring plan details the strategies and procedures to follow, and it considers

- operational parameters to be monitored,
- sampling location and frequency,
- sampling methods and equipment,
- establishing schedules for systematic, non-random sampling,
- requirements for checking and interpreting results,
- clearly defined responsibilities and use of qualified staff,
- documentation and records management including how monitoring results are recorded and stored, and
- reporting and communication requirements.

The use and maintenance of suitable equipment, including its regular calibration and maintenance, are equally important aspects to providing accurate and representative data.

*Operational Parameters and Criteria* Parameters should be selected to reflect operational effectiveness and to indicate failure of barriers and provide an indication of potential contamination. Where possible, parameters that can be used to predict ultimate output quality should be chosen so that there is lead time for action if necessary.

Operational monitoring should focus on those parameters that can be readily measured and responded to rapidly. Online and continuous monitoring of operational parameters should be pursued or developed wherever possible to provide an immediate indication of performance. At critical control points, continuous monitoring is considered necessary and is recommended to allow rapid response to problems. For example, where filtration is used, continuous monitoring of turbidity from each individual filter and from the product water outlet of the plant in addition to disinfectant residual are considered important to ensuring the effectiveness of treatment. For operational parameters that are deemed less critical or for parameters that are more stable, grab samples may be used.

Examples of some parameters that can be used for operational monitoring from catchment to consumer are listed in table A1-7.

Once parameters that will control performance of operational processes have been identified, target criteria (performance goals) should be established for each preventive measure. Target criteria can be quantitative (numerical) or qualitative (descriptive). Any deviation of operational performance from established targets should result in appropriate actions taken to remediate potential problems.

For operational monitoring of critical control points, critical limits also must be defined which ensure the CCP is under control (see box A1-8). A critical

**Table A1-7 Examples of Operational Parameters**

| Operational parameter | Treatment step/process/Critical control point | | | | | |
|---|---|---|---|---|---|---|
| | Raw water | Coagulation | Sedimentation | Filtration | Disinfection | Distribution system |
| pH | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Turbidity (or particle count) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Temperature | ✓ | | ✓ | | ✓ | ✓ |
| Dissolved oxygen | ✓ | | | | | |
| Stream/river flow | ✓ | | | | | |
| Rainfall | ✓ | | | | | |
| Thermotolerant coliforms | ✓ | | | | ✓ | ✓ |
| Total coliforms | ✓ | | | | ✓ | ✓ |
| Heterotrophic bacterial count | | | | | ✓ | ✓ |
| Colour | ✓ | | | | | |
| Conductivity (TDS) | ✓ | | | | | |
| Alkalinity | ✓ | ✓ | ✓ | | | |
| Organic carbon | ✓ | | ✓ | | | |
| Algae | ✓ | | | | | |
| Chemical dosage | | ✓ | | | ✓ | |
| Flow rate | | ✓ | ✓ | ✓ | ✓ | |
| Net charge | | ✓ | | | | |
| Streaming current value | | ✓ | | | | |
| Headloss | | | | ✓ | | |
| CT | | | | | ✓ | |
| Disinfectant residual | | | | | ✓ | ✓ |
| Disinfection by-products | | | | | ✓ | ✓ |
| Pressure | | | | | | ✓ |

limit is defined as a prescribed tolerance that must be met to ensure that a CCP effectively controls a potential health hazard. When critical limits have been exceeded or deviated from, a potential health hazard may exist or could develop and should automatically result in a corrective action being instituted to resume control of the process.

**Box A1–8 Special Considerations for Monitoring at Critical Control Points**

Operational monitoring at CCPs requires special attention to several factors. Some of the key considerations are

- identification of appropriate parameters that will be used to control operational processes. Parameters should focus on those that can be readily measured and responded to rapidly (e.g., temperature, pH, turbidity, particle count, disinfectant residual, flow, and pressure).
- defining critical limits that represent boundaries for safety. Critical limits should be validated.
- sampling points representative of the water being sampled.
- adequate frequency of sampling. Online and continuous monitoring of key parameters (e.g., turbidity, disinfectant residual) should be used wherever possible.
- use of appropriate equipment and ensuring that equipment is well maintained and calibrated.
- a well-designed monitoring program to monitor the critical limits and ongoing review of monitoring results.
- appropriate preventive and corrective actions documented for when parameters have deviated from critical limits. Ideally, 24-hour monitored alarms should be provided to indicate when critical limits have been exceeded.
- use of skilled and qualified staff to monitor parameters and make appropriate adjustments to operational processes. The use of automation where possible can ensure rapid responses.
- documentation of all elements of operational procedures, including operational monitoring, responsibilities and authorities, schedules and timelines, recording and interpretation of results, and corrective actions taken.

Critical limits should not be confused with target criteria. Targets are something that a water supplier attempts to meet, whereas critical limits on CCPs represent absolute boundaries for safety. They are set so that when exceeded or deviated from they represent an out-of-control hazard. Ideally, critical limits are numerical limits set in terms of maxima, minima, or ranges; however, where numerical data are not available, critical limits may be more subjective and rely on the appropriate skills and experience of operations staff.

Validation of critical limits is necessary. Various resources can provide information on critical limits. Literature, collaborative research findings, local experimental data, historical data and findings, etc. should be used to define critical limits. Critical limits are individual and site-specific and will depend on raw-water sources and water quality variations, management strategies, treatment processes used, and distribution system complexity. Critical limits for some CCPs have been defined by numerical values prescribed in various drinking water guidelines and standards (e.g., filtered water turbidity criteria, disinfection CT values, numbers of thermotolerant coliforms in drinking water). For other CCPs, however, system-specific experimental data may need to be collected before the critical limit can be defined.

Adoption of stringent targets (performance goals) will focus staff on optimum plant performance and will also reduce the chances of exceeding critical limits and numerical guideline values. Standard practice is to use turbidity goals lower than required limits For example, to ensure that an upper limit of 0.5 NTU is achieved in filtered water, a water treatment plant could be operated to produce filtered water at 0.3 NTU.

*Results Analysis* Operational monitoring results must be documented appropriately and results reviewed and interpreted frequently to verify operational performance. Results analysis should confirm that records are complete and accurate and that critical limits have not been exceeded. Results indicating loss of process control should result in appropriate corrective actions and process adjustments being instituted to maintain quality. Those responsible for interpreting and recording operational results should clearly understand how they should be assessed.

A system of regular reporting of results to relevant staff and departments should also be implemented. Graph or trend charts can be used to enhance the interpretation of operational monitoring results. Comparison of current results with past trends may be valuable in identifying any site-specific patterns associated with poor performance.

### A1.2.6.5 *Operational Preventive and Corrective Action*

Preventive and corrective action includes planning of appropriate procedures in advance for immediate preventive and corrective action to re-establish process control when operational monitoring indicates that target criteria or critical limits have not been met for a particular operational activity or CCP. These operating procedures should be documented and include instructions on required adjustments and process control changes and should clearly define responsibilities and authorities, including communication and notification requirements.

Procedures (protocols) should include the range of actions to be taken in response to exceedance of criteria. Where appropriate, these actions may include re-sampling, additional monitoring, or checking other operational monitoring. Where required, a preventive or corrective action should be implemented to re-establish process control and then verified to ensure its effectiveness. The effect of the preventive or corrective action, and what adjustments or action may be needed further along in the supply system, also should be considered. Incident and emergency responses should be prepared in the event that normal preventive and corrective actions can not re-establish operational performance in an appropriate time to prevent unacceptable drinking water quality from reaching consumers.

Though it is not possible to anticipate and document procedures for every possible event, it is suggested that planning be undertaken for the types of events that can be identified. For other events, systems incorporating rapid communication should be developed. Examples of corrective actions for which operational procedures should be documented include

- selection of alternate raw water source, if available,
- altering plant flow rate (e.g., reducing loading),
- jar testing for coagulant control and optimization,
- altering mixing intensity,
- instituting additional sampling,
- changing treatment chemicals,
- using auxiliary chemicals such as coagulant aids, flocculant aids, filtration aids,
- adjusting pH,
- varying chemical feed rates and feed points,
- adjusting filtration loading rate or operation,
- increasing disinfectant dose,

- secondary or booster disinfection,
- mains flushing and localized disinfection, and
- notification of the health authority and provision of details of the problem and remedial action taken.

Where possible, the underlying cause of the problem should be identified and measures implemented to prevent future occurrences. An analysis of the causes may define some solutions, such as modifying an operating procedure, treatment plant adjustments, training, etc. Finally, details of the incident should be recorded and reported (internal and external as necessary).

### A1.2.7 Verification of Drinking Water Quality (Framework, Section 5)

Verification involves monitoring the quality of drinking water supplied to consumers to determine compliance with established criteria and requirements. Monitoring can incorporate testing of drinking water quality (system performance monitoring) as well as assessment of consumer satisfaction.

In addition to providing essential information on the ultimate quality of water being supplied to consumers, verification also serves as a useful indication of problems within the water supply system (particularly the distribution system) and the necessity for any immediate short-term corrective actions or incident and emergency response.

#### A1.2.7.1 *Drinking Water Quality Monitoring*

Drinking water quality monitoring is a wide-ranging assessment of the quality of water in the distribution system and as supplied to the consumer. It includes the regular testing performed for assessing conformance with guideline levels and compliance with regulatory criteria or agreed levels of service. The 2000 ODWS is the definitive reference in Ontario on standard values for water quality parameters.

Monitoring of drinking water quality constitutes the final check that the barriers and preventive measures implemented are working effectively (see box A1–9). Demonstrating compliance will provide regulators and consumers with confidence about the safety of the water.

Drinking water quality monitoring differs from operational monitoring not only in purpose but also in terms of the water quality characteristics to be measured, sampling locations, and frequency of sampling. As it is neither physically nor economically feasible to test for all drinking water quality parameters on an equal and frequent basis, monitoring effort and resources should be planned carefully and directed at significant or key characteristics and monitored with appropriate frequency.

A number of tables in *Ontario Drinking Water Standards* provide a comprehensive list of parameters to be monitored: table A – microbiological organisms, table B

**Box A1-9 Limitations of Drinking Water Quality Monitoring**

Monitoring of drinking water quality does not guarantee the safety of water supplies. Rather, is should be regarded as a check that the barriers and preventive measures that protect public health are implemented and working effectively. Monitoring for drinking water quality should never be used as a replacement for any of the barriers or as a reason for removing them.

Reliance on monitoring of drinking water for the protection of public health has important limitations that should be recognized. First, monitoring is limited in scope. There exists a wide range of parameters that could be monitored; however, it is neither technically feasible nor economically desirable to monitor for every possible parameter. Monitoring is also irregular and infrequent and only represents single points in time (i.e., only a very small proportion of water is sampled). It is quite possible that contamination can occur between sampling events and be missed by the monitoring program.

Additionally, reliance on monitoring of treated water assumes that the numerical guideline values are, by themselves, a sufficient measure of drinking water quality. In reality, there remain substantial limitations in our knowledge of the relationship between those parameters and public health outcomes. Furthermore, it is not an effective response to contamination of drinking water by any known or unknown contaminant that does not have a prescribed guideline value (e.g., *Cryptosporidium*).

The most significant limitation of drinking water quality monitoring, however, is that corrective actions are initiated only after monitoring reveals that guideline values have been exceeded. Therefore, this type of monitoring promotes a reactive rather than preventive approach.

– volatile organics, table C – inorganics, table D – pesticides and PCBs. Table 5 covers sampling and analysis requirements.[61]

Frequent exceedance of such parameters (e.g., taste and odour) is likely to be indicative of problems that may require further investigation to determine their health significance.

Where sampling is performed depends on the water quality characteristic being sampled. For characteristics where the concentration does not change greatly within the distribution system, sampling the water at the treatment plant may be sufficient. For characteristics that vary in concentration during distribution, however, sampling throughout the distribution system including the point of supply to the consumer should be undertaken. It should be noted that the behaviour of some parameters (e.g., DBPs, chlorine residual, microbial quality) during distribution may vary from one system to another and is likely to require system-specific investigation.

Drinking water quality monitoring procedures should be developed and documented for the regular testing of water in the distribution system and as supplied to the consumer. Monitoring data should be representative, reliable, and fully validated (see box A1-10). Careful consideration should be given to the water quality characteristics to be analyzed, sampling locations, frequency, analytical tests and methods, recording and maintenance of results, and evaluation and reporting of results. Guidance on developing drinking water quality monitoring is provided in *Ontario Drinking Water Standards.*

#### A1.2.7.2 *Short-term Evaluation of Results*

Drinking water quality performance evaluation entails the daily reviewing of compliance monitoring to assess the day-to-day management of the drinking supply. It is an important element for verifying that the quality of water supplied to consumers is in compliance with relevant requirements.

Monitoring results should be reviewed within appropriate time frames and compared with previous results and drinking water quality criteria. Procedures for performance evaluation and how results should be recorded and interpreted should be established and documented. Responsibilities and reporting

[61] Ontario, Ministry of the Environment, 2000a.

mechanisms should be identified. Compliance criteria should be established and communicated so that those responsible for interpreting and recording results clearly understand how they should be assessed and, if required, how and where results should be communicated. In some cases this could involve reporting to health or water quality regulators.

### A1.2.7.3 *Corrective Action*

Corrective action includes the documentation and training of staff in appropriate procedures, including clearly defined responsibilities and authorities, in advance for immediate corrective action when monitoring of drinking water quality indicates non-compliance or provides early warning of potential problems.

**Box A1-10 Reliability of Data**

As monitoring is only as good as the data collected, every effort should be made to ensure that data collected are representative, reliable, and fully validated. Appropriate procedures should be in place and the following must be considered:

Sampling Plan
- parameters measured, sampling locations, sampling frequency
- qualifications and training of personnel
- approved sampling methods and techniques
- quality assurance and validation procedures for sampling
- statistical validity

Analytical Testing
- qualifications and training of personnel
- suitable equipment
- approved test methods and laboratories
- quality assurance and validation procedures (e.g., positive and negative control samples, interlaboratory comparisons)
- laboratory to be accredited by the Standards Control Council for analysis of ODWS parameters

Monitoring Equipment
- calibration and inspection procedures to ensure control of monitoring equipment

If the short-term evaluation of drinking water quality performance indicates that compliance requirements have been violated, an investigation should be initiated and, if necessary, a corrective action implemented. Corrective actions should be implemented as quickly as possible. Failure to do so or failure of the action may lead to the development of a more serious situation that, depending on the issue, could require incident and emergency response protocols to be instituted. Implementation of corrective action could also be required in response to consumer feedback.

Corrective actions for non-compliance should be developed in consultation with relevant regulatory authorities and other stakeholders. Examples of corrective actions in response to non-compliance include

- disinfection of tanks,
- flushing and maintenance of the distribution system,
- temporarily shutting down the plant if adequate storage is available,
- increased or booster/secondary disinfection,
- enhanced filtration, and
- investigative/sanitary surveys of distribution systems.

Significant system failures that pose a health risk or adversely affect water quality for an extended period should be immediately reported to the relevant health authority (see section A1.2.5 – Risk Management).

### A1.2.8 Documentation and Reporting (Framework, Section 10)

Appropriate documentation provides the foundation for the establishment and maintenance of effective drinking water quality management systems. Documentation should

- demonstrate that a systematic approach is established and is implemented effectively,
- develop and protect the organization's knowledge base,
- provide an accountability mechanism and tool,
- facilitate review and audits by providing written evidence of the system, and
- establish due diligence and credibility.

Documentation also provides a basis for effective communication within the organization as well as with the community and various stakeholders. A system of regular reporting, both internal and external, is important to ensure that the relevant people receive information needed to make informed decisions about the management or regulation of drinking water quality.

#### A1.2.8.1 *Documentation and Records Management*

Appropriate documentation is required for all aspects of drinking water quality management. Documents should describe how procedures are performed and should include detailed information on process control. A water supplier should ensure that all relevant documentation is read, understood, and adhered to by employees.

The documented system should include process documentation including specific operational procedures and criteria, monitoring procedures and forms, corrective actions, etc., as well as preventive strategies and information related to CCPs, incident and emergency response plans, details of training programs, procedures for evaluating results and reporting, communication protocols, and the drinking water quality policy.

Operation of systems and processes necessarily leads to the generation of data that needs to be recorded. Efficient record keeping is an essential tool for indicating and forewarning of potential problems and providing evidence that the system is implemented effectively.

Activities that generate records include operational and drinking water quality monitoring, preventive and corrective actions, incident and emergency response, training, research and development, drinking water quality performance evaluations, assessment of the water supply system (flow diagrams, potential hazards, etc), community consultation, and audits and reviews.

Documentation and records systems should be kept as simple and focused as possible. It should be ensured that a system is in place to control all documents and records. Mechanisms should be established to periodically review and where necessary revise documents to reflect changing circumstances. Documents need to be controlled to ensure current versions are in use and obsolete documents are discarded.

Records of all activities pertaining to the performance of drinking water quality management should be stored so that they can be easily accessed and reviewed and are protected against damage, deterioration, or loss. A system must be in place to assure that employees are properly trained to fill out records and that records are regularly reviewed by a supervisor, signed and dated.

Documents and records can be stored in a variety of forms (e.g., written documents, electronic files and databases, visual specifications (flow charts, posters, etc), video and audiotapes). Computer based documentation should be considered to allow for faster and easier access as well as to facilitate updating and keeping information current.

#### A1.2.8.2 *Reporting*

Reporting includes both the internal and external reporting of the organizational activities pertinent to the implementation and performance of drinking water quality management. Internal reporting is to enable effective decision making at the various levels of the organization, including operations staff and management, senior management, and the board of directors. Internal reporting is also required to communicate information on decisions to employees throughout the organization.

A water supplier should define internal reporting requirements and establish an internal reporting system for communication between the various levels and functions of the organization. Documented procedures (including definition of responsibilities and authorities) should be established for periodic operational reporting (daily, weekly, monthly, etc.). They should include summaries of monitoring data, performance assessment, and significant operational problems for the period. Results from audit and management reviews should also be communicated to those within the organization responsible for performance.

External reporting ensures that drinking water quality management is open and transparent and includes reporting to regulatory bodies, consumers, and other stakeholders in accordance with requirements.

The regulator should be notified of spills in catchments, interruptions to supply, process failures, failure to meet agreed levels of service, detection of significant

contaminant concentrations, the persistent presence of microbiological indicators, etc. The health authority can then ensure that any health concerns are reported to the community. Protocols for public notification and issuing health advisories should be developed jointly between the health authority and water supplier.

Annual reports should be produced for consumers, regulatory authorities, and stakeholders that summarize drinking water quality performance over the preceding year against numerical guideline values or agreed levels of service and identify water quality trends and problems. Reports should also provide a summary of system failures and the action taken to resolve them. Reporting publicly on a water supplier's performance ensures a high level of transparency and public accountability.

The annual report should specify to whom the water supplier reports and is accountable, statutory or legislative requirements, and minimum reporting requirements. It should also include the statement that monitoring has been carried out in accordance with the ODWS, standards set by the regulator, and/or to the requirements outlined in agreed levels of service. Annual reports also provide a mechanism for feedback and encourage consumers and stakeholders to provide comment. The reports should contain sufficient information to enable individuals or groups to make informed judgments about the quality of drinking water and contribute to the priorities that will be given to improving drinking water quality.

### A1.2.9 Evaluation and Audit (Framework, Section 11)

The evaluation and audit of drinking water quality (long-term) and management by a water supplier is required to ensure that preventive strategies are accurate, effective, and implemented appropriately. A review of long-term drinking water quality data and management procedures provides assurance that the planned objectives of drinking water quality and safety are being achieved, and it also identifies opportunities for improving operational processes and overall drinking water quality performance.

### A1.2.9.1 *Long-term Evaluation of Results*

Operational and water quality monitoring data cannot provide insight into performance unless they are systematically reviewed. Consumer confidence in performance will also depend on being able to provide assurance that performance data are reviewed on a regular basis and improvements planned in response to problems identified.

The long-term evaluation of results is intended to use the results of a planned monitoring program to assess water quality data collected over an extended period of time (typically the preceding 12 months). There will inevitably be occasions when operational criteria or numerical guideline values are exceeded; however, each incident must be assessed and dealt with immediately on a case-by-case basis.

Assessing the performance of a water supply system from the source to the consumer over an adequate period of time enables assessment of general performance against the numerical guideline values and agreed levels of service, to identify emerging problems and trends and to determine what priority will be given to improving drinking water quality.

Operational and drinking water quality data collected over time should be collated to allow observation and trending of data. In addition to an effective monitoring program, performance evaluation of the water supply system from catchment to consumer requires a statistical evaluation of results. Graphs and trend charts using a 'control chart' format are useful tools to enhance the interpretation of results.

Appropriate procedures should be established for the evaluation of operational and water quality monitoring results to assess performance over time. Mechanisms for evaluation should be documented and responsibilities, accountabilities, and reporting requirements defined.

Evaluation of results should be reported internally to senior management and externally to consumers and regulatory authorities in accordance with requirements (see section A1.2.8.2 – Reporting).

### A1.2.9.2 *Drinking Water Quality Management Audit*

Auditing is the systematic evaluation to determine if activities are performing well and producing the required outcomes. It also includes an assessment of whether the management system is suitable to achieve planned objectives and is being implemented effectively. Auditing provides valuable information on those aspects of the system that are effective as well as identifying opportunities for improvement of the management system, its implementation, and resulting drinking water quality performance.

Periodic internal and external auditing of all aspects of the drinking water quality management system is required to confirm the performance of a water supplier with respect to its implementation (i.e., that the management system is accurate, that it is being implemented properly, and that its performance is effective). Auditing is necessary to ensure that errors or systematic poor operational practices are revealed.

A water supplier should establish and document procedures for internal audits of the management of drinking water quality. This involves a review of the system, plans, operational procedures, monitoring programs, and the records generated to ensure that the system is being correctly implemented and is effective at achieving the desired objectives. Internal audits identify areas for improvement and facilitate external audits.

The frequency and schedule of audits, as well as the responsibilities and requirements associated with conducting audits and communication of audit results should be defined. The audit and review process can take place over time but it should be comprehensive.

Drinking water agencies should also seek to establish and formalize external auditing mechanisms and procedures for their management of drinking water quality. In addition to demonstrating the commitment to the highest standards possible, external auditing by independent agencies is necessary for establishing credibility and maintaining customer confidence.

External audits may include evaluation of the entire system or specific aspects of drinking water quality management (operational audits, management system audits, performance audits, compliance of drinking water quality monitoring, effectiveness of incident and emergency response, etc.). External auditing could

be achieved by peer review or be undertaken by an approved independent third party.

Audit results should be appropriately documented and communicated to management and personnel responsible for the department or function being audited. Results of audits should also be presented as part of senior management review.

# Appendix 2 Template for the Annual Report for the Total Quality Water Management System

## A2.1 Mission Statement for Water Utility

- Drinking water quality policy commitment
- Overview of the utility's strategic plan in support of that mission statement
- Performance against plan as detailed in sections below

## A2.2 Total Quality Water Management System in Operation

- Performance indicators for service levels and water quality as developed by the Task Force to be Ontario-specific including
  - hazard identification and critical control points in that water utility
  - prevention strategies in place at the water utility
  - risk management and incident communications in place
  - sustainable asset management plan for that water utility
  - drinking water quality monitoring and reports
  - total Quality Water Management System plan for improvement identified
  - results of any third party evaluations and audits

## A2.3 Performance Management System

- Deliverables, progress and expenditures identified for
  - training and certification and/or re-certification
  - leadership development completion
- Report on the safety of the workplace and any infractions under health and safety legislation
- Report on human resource development initiatives, such as recognition and reward programs

## A2.4 Financial Management

- All financial aspects of actual expenditures and achievements against plan as developed by the task force to be Ontario-specific
- User-pay phased in implementation plan

## A2.5 Customer Relations

- Description of the approach adopted for customer involvement from five-step approach developed by the task force for use by the water utilities
- Report on public education and communication activities in the year
- Summary of consumer reports as provided for under the operation clean water program

## A2.6 Partnerships

- Describe contribution to industry research, education, and development work on benchmarks

## A2.7 Effective Governance

- Profile members
- Time committed to offer the oversight (meetings, special sessions, consultation)
- Vacancies and new appointments orientation
- Assessment of effectiveness

# Appendix 3 Literature Review Summary

## A3.1 Introduction

The authors conducted a literature review to investigate the types of systems in place across the world in both drinking water and other industries. The following topics were of specific interest:

- quality systems
- financial models
- management and leadership fundamentals
- governance structure
- regulatory bodies
- communication techniques
- training and certification

The goal of the review was to evaluate existing best practices and determine which, if any, system had elements that could be applicable to the water industry for the proposed model water utility. No single model incorporated, at least explicitly, all the elements that the authors believe are necessary for the Total Quality Water Management System (TQWMS).

In perusing the literature, the authors concentrated on a list of criteria to which the model would have to address itself:

- The needs of the customer (specifically education, communication, satisfaction, and participation)

- Scale (the size of a water utility, to be determined by the structure of the drinking water sector)

- Leadership (ability to foster positive change) and management competence (abilitiy, knowledge, and skill sets required for management of any successful competitive business)

- Culture of continuous improvement (improving product quality and service, reducing risks and costs)

- Technical considerations (evolving education and training of employees, emergency response and crisis management)

- Process capability (individual and combined technologies and equipment properly selected for the purpose and able to provide the desired level of water treatment)

- Risk management (reducing technical risk to reasonable levels and having open and frank discussions with the public about risk and its implications)

- Quality management (development and application of a system to ensure production of highest quality drinking water)

- Standards (representation of contaminants in drinking water and their maximum acceptable levels)

- Financing and asset management (ability of the drinking water infrastructure to be self-supporting and meet future demand)

- Governance (process and structure for overseeing the direction and management of an organization so that it carries out its mandate and objectives effectively)

- Accountability (clear identification of responsibilities and roles of employees, managers, government, regulators, and the public with regard to drinking water quality and safety)

- Regulation (determining and enforcing behaviour and standards)

Apart from the Australian Framework, which has been well covered throughout this paper, many models in various applications proved to be pertinent or of interest.[62] A number of them stood out in terms of quality and prevalent use, and they contributed to the roots of the proposed management system.

## A3.2 Relevant Models

### A3.2.1 American Productivity and Quality Center

APQC provides information, resources, and forums for information exchange to help manage the transition to quality-based systems for management and

[62] Note that the Australian Framework incorporates elements of a number of these models.

employees. The mission of this 20-year-old organization is to "work with people and organizations to improve productivity and quality."[63] Among other things, it specializes in benchmarking and best practices.

### A3.2.2 Asset Management Plan

Ofwat, the water regulator for England and Wales (see section A3.2.17), is responsible for approving a five-year recurring asset management plan for each water utility. The plan is developed by the utility and approved by Ofwat as part of the procedure to obtain a certificate to operate the drinking water system. The intent is to ensure that utilities do not overstate costs, which would result in higher revenue requirements and, ultimately, to increased rates for customers.

### A3.2.3 Association for Quality and Participation

This 24-year-old international not-for-profit organization specializes in business information and training. It has developed a curriculum to teach managers the skill of leading during the time of change to a quality system.[64] The changes highlighted by AQP include creating "new structures for measurement, accountability, teamwork, service and product consistency, communication, and process improvements." The AQP program could aid in the transition from the current system (whatever it happens to be) to the new quality-based and self-critical system.

### A3.2.4 Auditor General of Canada

The December 2000 report of the auditor general examined the effectiveness of governance of federal crown corporations.[65] The auditor general recommended that the process for appointing board members be strengthened to ensure the necessary skills and capability, that the timing of appointments be done in such a way as to ensure that there is always a "nucleus of seasoned directors" in place, that the board leads in the recruitment and review of performance of the CEO, and that a corporate strategic plan be the cornerstone of operations.

---

[63] See the APQC Web site [cited January 2002], <www.apqc.org/>.
[64] See the AQP Web site [cited January 2002],<www.aqp.org>.
[65] Chapter 18 – Governance of Crown Corporations [cited January 2002], <www.oag-bvg.gc.ca/domino/reports.nsf/html/0018ce.html/$file/0018ce.pdf>.

### A3.2.5 Canadian Blood Services

Canadian Blood Services is an independent agency that owns and operates the blood supply in Canada.[66] As such, it is a highly regulated organization that is intimately related with both government agencies (health services) and the public. It provides for electing members of the public to its board;

### A3.2.6 Canadian Food Inspection Agency

The Canadian Food Inspection Agency (CFIA) administers its HACCP program (see section A3.2.12) by way of its Food Safety Enhancement Program.[67] Canadian food manufacturers are accountable to the CFIA for quality programs and HACCP. Depending on the type of food being processed, the manufacturer may also be accountable for standards and regulations that fall under other government departments including Fisheries and Oceans, Agriculture Canada, and Environment Canada. The CFIA has agreements with other government agencies to prevent inspection overlap and avoid duplication.

### A3.2.7 Chartered Institute of Public Finance and Accountancy

This UK institute (CIPFA) has developed *Corporate Governance: A Framework for Public Service Bodies,* a document that sets out the principles and standards of good corporate governance.[68] It is intended as a best-practice example that is not prescriptive but offers guidance on how to translate the principles and practices of good governance into action.

The Fédération des Experts Comptables Européens furthered this framework in *Approaches to Corporate Governance in the Public Sector* for use in European countries.[69] With the aim of achieving better-quality decision making and performance, this work recognizes that corporate governance in a risk-based environment is about more than control and accountability; it is also about service improvement and innovation. Most recently, the CIPFA framework has been modified and adapted for use by local authorities in the United Kingdom in

---

[66] Canadian Blood Services [cited January 2002], <www.bloodservices.ca/>.
[67] CFIA Food Safety Enhancement Program [cited January 2002], <www.inspection.gc.ca/english/ppc/psps/haccp/haccpe.shtml>.
[68] Chartered Institute of Public Finance and Accountancy, 1995.
[69] Fédération des Experts Comptables Européens, 2001.

*Corporate Governance in Local Government: A Keystone for Community Governance – Framework and Guidance Notes.*[70]

### A3.2.8 Citizens First Survey

Sponsored by all levels of Canadian governments, this survey invites citizens' views of the quality of service they receive from municipal, provincial, and federal governments in a variety of service areas. It also assesses the effectiveness of communication and access to information using the telephone and Internet. The first survey, done in 1998, was repeated with a larger sample size in 2000, and the next is scheduled for 2002. This allows governments to measure priorities and satisfaction over time. Overall survey results are available publicly.[71] Comparisons are possible between levels of government and with other similar governments.

The Citizens First survey allows for involvement of a large, representative sample of the population to comment on service areas of priority and perceived quality.

### A3.2.9 Dobell and Powell Papers

Dobell proposes a recipe for public involvement in the risk assessment process that ultimately leads to the adoption of policy or implementation of a course of action resulting in the public's accepting a course of action with known elements of risk.[72] Dobell believes that the public, once informed, has the ability to act in a manner so as to ensure long-term net benefit to the community.

Powell also summarizes detailed guidelines for risk communication.[73]

Dobell supports the concept of transparency and promotes it for all levels in the water sector, including the standards-setting body (government), the regulator (usually government or government-owned), and the water utility.

---

[70] Chartered Institute of Public Finance and Accountancy and Society of Local Authority Chief Executives and Senior Managers, 2001.
[71] The complete 1998 survey is on the Canadian Centre for Management Development Web site [cited January 2002], <www.ccmd-ccg.gc.ca/publica/publi_e.html>. See items P84E (full version) and P83E (summary).
[72] Dobell, 2002.
[73] Powell et al., 2002.

### A3.2.10 D'Ombrain Paper

D'Ombrain states that the difference between the cost of water delivered to the customer and the price that the customer pays for that water has compromised the safety of the drinking water in Ontario.[74] The system of loans and grants has distorted the relationship between the actual cost of drinking water and what the customer pays. D'Ombrain believes that funding does not necessarily have to be separated from policy, and that one regulator (as per Ofwat in England and Wales) could administer both duties. He also believes that the province has an obligation to finance municipal water and sewage facilities regardless of size.

D'Ombrain argues that although the regulatory regime must include provision for enforcement, to the extent possible the operating principle should be reliance on prevention. The regulator should be a safety net where, for the most part, utilities are performing at or near optimum levels to ensure the highest quality of water is delivered to the customer. The regulator and the government agency directing the policy of the regulator should also be subject to regular auditing to ensure that they are performing as per their mandate.

### A3.2.11 Drinking Water Inspectorate – England and Wales

The Drinking Water Inspectorate (DWI), of the Department for Environment, Food and Rural Affairs, enforces the Water Quality Regulations.[75] It operates under a public code for enforcement, which sets out the levels of service that water companies and members of the public can expect to receive from the inspectorate. This code reflects the principles of good enforcement set out by the Better Regulation Unit in the cabinet office of the government of the United Kingdom. With DWI's role clearly stated vis-à-vis the complementary responsibilities of Ofwat, the regulatory structure in England and Wales enables an efficient reporting and accountability process.

The DWI is responsible for inspection of water suppliers in England and Wales. As a result of regular consumer surveys, the DWI has produced information (via fact sheets on paper and on the Web) on water standards and provides easily understood explanations of testing and what the results mean. The DWI surveys identify the priority areas for public education.

[74] d'Ombrain, 2002.
[75] See the DWI Web site [cited January 2002], <www.dwi.gov.uk/>.

The DWI encourages individual utilities to take a leadership role in improving their water quality, their customer relations, and all aspects of their operation.

The DWI conducts an annual assessment of the quality of drinking water supplied by each of the water companies. It ensures that each company complies with the UK drinking water standards. The assessment is based on information supplied regularly by the water companies and includes the results of compliance tests. The DWI will also carry out inspections if warranted by the information provided or by a complaint or incident. It prepares an annual public report in plain language to describe the performance of each water company against the water quality standards.

Every water company is required to have copies of its record of compliance with standards in its office, where customer service staff is to be available to explain the meaning of test results. In addition, these records are submitted to the local government

### A3.2.12 HACCP

Hazards Analysis Critical Control Points (HACCP), an internationally recognized food safety program, offers a proven systematic approach to assessing problem areas in the water supply chain. Its assessment and corrective action protocols make it a useful quality management tool.

Although using HACCP in the water industry would require some adaptations from the food program, processing water is not dissimilar to processing food: a base product requires some processing to be made marketable or acceptable for public consumption, and the product is distributed to the public. The Canadian Food Information Agency's Food Safety Enhancement Program is principally concerned with HACCP in the processing plant, but HACCP can be applied from watershed to customer tap in the water industry.[76]

### A3.2.13 Haldimand-Norfolk Transition Board

During the transition process in Haldimand-Norfolk, Ontario, a project team examined the governance structures in place elsewhere in the province and

[76] For details on HACCP, see the FSEP Web site [cited January 2002], <www.inspection.gc.ca/english/ppc/psps/haccp/haccpe.shtml>.

made recommendations on effective governance for council, committees, and boards. The recommendations included an accountability framework for local boards.[77]

### A3.2.14 ISO 9000 and ISO 14000

A fundamental tenet of ISO 9000 and ISO 14000 is continuous improvement, achieved by systematically analyzing and documenting each process and finding ways to improve it. The programs can be summarized very simply: "Say what you do and do what you say."

Under ISO 9000, a company develops its own quality system – internally or with the help of external consultants – to ensure that its products or services are produced in the way and to the level of quality that the company wants.

Certification to ISO 9000 standards does not ensure a good product. The program is intended to ensure that once a good product or process is developed the same high standard is achieved in every iteration. Because the business is completely documented, improvements can be more easily identified and implemented – an essential part of continuing evolution and improvement of in drinking water production. The program also enables integration of new staff, as protocols are documented and in place to aid in training.

### A3.2.15 Joint Committee on Corporate Governance

The Joint Committee was established in July 2000 to review the current state of corporate governance in Canada, compare Canadian and international best practices, and make recommendations for changes. Its final report, *Beyond Compliance: Building a Governance Culture,* was released on November 22, 2001.[78] Key recommendations for improving effectiveness of governance include independent board leadership, clear mandate and responsibilities for the board, demonstrated time commitment to serve, and accountability and reporting to shareholders.

---

[77] Haldimand-Norfolk Transition Board, 2000, *A Model for Governance: The Final Report of the Project Team on Governance* (n.p.: [Haldimand-Norfolk Transition Board]).

### A3.2.16 New South Wales, Australia

In 1997 the New South Wales government conducted an audit on the governance practices of public boards, including water corporations. The audit identified the need for transparent and consistent processes for appointment to boards, and for the skills, knowledge, and expertise required for the operation of that organization to be reflected in the board membership. A rigorous approach was required for reporting on practices and transparent accountability for decision making. The audit office concluded that it was necessary to enhance governance practices to ensure efficient and effective management of public organizations.[79]

### A3.2.17 Ofwat (Office of Water Services – England and Wales)

Ofwat is the economic regulator for the water industry in England and Wales.[80] Its two councils (one of which comprises members from the general public) provide a common voice for customers and ensure that the water suppliers maintain good customer relationship practices.[81]

Ofwat licenses water utilities and has the power to revoke licences in the event of non-compliance with any one of the conditions of the licence. The utilities are accountable to their customers directly, to their customers via Ofwat, and to Ofwat itself.

### A3.2.18 Ontario Clean Water Agency

The Ontario Clean Water Agency (OCWA) operates and maintains more than 400 facilities in more than 200 municipalities. It provides highly trained, fully certified staff.

[78] Toronto Stock Exchange, Joint Committee on Corporate Governance, 2001.

D'Ombrain argues that a central agency such as OCWA is best able to provide emergency response services to the water industry, especially to smaller utilities.[82] The inference is that because the central agency would also hold knowledge for crisis management only one group of specialists would have to be trained in emergency response.

### A3.2.19 Partnership for Safe Water

This U.S. partnership includes the EPA, American Water Works Association, Association of Metropolitan Water Agencies, National Association of Water Companies, and Association of State Drinking Water Administrators.[83] Recognizing that optimum performance may go beyond simply meeting regulations, the main objective is to have water utilities assess individual plants to look at ways providing optimum water quality with existing infrastructure. A requirement for admission to the program is for senior management to buy into the concept of improvement for sake of quality, not regulatory conformance.

The program provides a utility with a detailed self-assessment framework that will result in recommendations (self-generated) for improvement of the current plant. Peer review is available at an additional cost. Through peer review external expertise and experience would be available to suggest additional innovative process and operational improvements.

### A3.2.20 QualServe

This voluntary quality improvement program was formed to optimize performance of drinking water treatment plants and delivered water quality.[84] It provides a systematic approach to optimization, using self-assessment, peer review, benchmarking (future, in progress), accreditation (planned), and customer satisfaction surveys (planned). The first goal listed by QualServe is "Increase customer satisfaction."

Participating utilities have to have the initiative to join and participate in the program, which substantially depends on motivating employees and managers

---

[79] New South Wales, Audit Office, 1997, *Corporate Governance in Practice,* performance audit report ([Sydney]: Audit Office). See the NSW Audit Office Web site for recommendations arising out of this audit [cited January 2001], <www.audit.nsw.gov.au/crpg2-97/contents.htm>.
[80] Ofwat [cited January 2002], <www.ofwat.gov.uk/>.

to perform functions outside their normal duties. This demands good leadership. Buying into the concept of improvement by senior management is required for participation in the program.

The provision for peer review, as in the Partnership for Safe Water program, would make external expertise and experience available to suggest additional innovative process and operational improvements.

### A3.2.21 Sancton and Janik Paper

Sancton & Janik identify the trends in organization for water supply and some of the changing locus of responsibility.[85] The effect of municipal amalgamations in Ontario has been to move the water supply function from the public utility commission to direct control of municipal councils. This poses a new challenge for elected councils, particularly in smaller municipalities, in that they must have the skills, knowledge, and experience to determine what is in the best interest of the community.

Sancton and Janik offer two possible solutions: smaller municipalities can find another means of providing water to their communities (such as contracting with OCWA or an approved company), and larger municipalities can establish their own companies. Both solutions raise the question of governance and accountability.

### A3.2.22 Six Sigma

The Six Sigma concept, developed and popularized by General Electric, strives for only 3.4 defects per one million opportunities – practically perfection.[86] Although the defining criteria of Six Sigma are difficult to apply to drinking water, the quality improvement process could have legitimacy, and it has elements common to other quality programs.

[81] Note that under the privatized system in England and Wales the regulated water utilities have a commitment to customer service that includes customer satisfaction surveys, communication and education, and special consideration for customers with unique needs.

Six Sigma has two sub-methodologies: DMAIC (define, measure, analyze, improve, control) and DMADV (define, measure, analyze, design, verify). DMAIC is used to improve processes that do not meet the prescribed level of quality, and DMADV is used when introducing new products. The concepts and protocols used in each of these methodologies could be applied to drinking water systems.

### A3.2.23 Sustainable Asset Management

Sustainable asset management, a model proposed by Pollution Probe, simply accounts for the full cost of producing, administering, and delivering drinking water, and of maintaining and expanding the drinking water infrastructure.[87] The full cost must be determined so that it can be recovered from the customer.

### A3.2.24 Water UK

Water UK promotes the views of water utilities as whole. It offers a list of principles that it believes constitutes a good regulator: transparency, accountability, targeting, consistency, proportionality, a clear legislative mandate, efficiency, expertise. It also believes that regulations should be reproducible, non-prejudicial, non-retrospective, timely, and flexibile.[88]

---

[82] d'Ombrain, 2002.
[83] Partnership for Safe Water [cited January 2002], <www.epa.gov/safewater/psw/psw.html>.
[84] QualServe program [cited January 2002]. <www.awwa.org/qualserve/>.

# Appendix 4 A Matrix of Confusion

The following commentary demonstrates the multiple layers of confusion that exist in the myriad roles of the Ontario Ministry of the Environment in particular, and governments in general. This commentary serves as a useful backdrop to understand many of the solutions proposed in the model water utility. The authors recommend that the Ministry of the Environment's role be of single focus – the regulator.

## A4.1 The Drinking Water Regulatory Role in Ontario

The provincial Ministry of the Environment (MOE) has been the dominant influence in Ontario's drinking water since its inception in the early 1970s:

- The MOE established the Ontario Drinking Water Objectives, based on Health Canada's Canadian drinking water guidelines. Individual objectives recommended the maximum allowable concentration (MAC) of a contaminant and the water quality testing required. (The objectives were superseded in August 2000 by the Ontario Drinking Water Standards, which were largely based on the objectives).

- The MOE requires that any additions or modifications to water treatment works, reservoirs, watermains, etc. be subject to an approvals process and receive a certificate of approval (COA) prior to construction. A COA is permanent until its conditions are exceeded, usually on the basis of exceeding capacity requirements because of community growth.

- The MOE developed the operator certification program and determines the certification level required to operate plants and distribution systems.

- The MOE has historically administered grant funding by senior levels of government for water works.

- The MOE issues extraction permits (the Permit to Take Water), which are issued in perpetuity.

- The MOE is responsible for ensuring that drinking water in the province is safe to drink.

- The MOE (and its successor in plant operation, the Ontario Clean Water Agency) operates hundreds of water and wastewater treatment plants throughout the province on behalf of municipalities.

- The MOE establishes design criteria for treatment facilities and distribution systems through its published design guidelines and the approvals process. The design guidelines for water systems were last updated in 1982.

### A4.1.1 The MOE as Drinking Water Standards Setter

Most drinking water in Ontario, originating as surface water from lakes and rivers, is subjected to various treatment processes designed to improve the aesthetic quality and to eliminate pathogens. Until the detection of chlorine-resistant parasitic cysts such as *Giardia* and *Cryptosporidium,* it was believed that chlorination was capable of inactivating pathogens. A major outbreak of cryptosporidiosis in 1994, infecting more than 300,000 people in Milwaukee, Wisconsin, prompted revisions to U.S. drinking water regulations, as the water had been filtered and chlorinated to then-acceptable standards throughout the incident. The source of contamination was linked to runoff from an animal feedlot. Subsequent outbreaks of this disease occurred in Waterloo and Collingwood, Ontario, and more recently in North Battleford, Saskatchewan. These outbreaks were also linked to pollution discharges.

Drinking water research has shown that there can be a wide variety of pathogens in our source waters, and that traditional methods used to remove or inactivate these pathogens may not be as effective as once believed. Perhaps of even greater concern is that the tests used to confirm that the water is safe to drink are time consuming and often costly, and they may be specific to only one pathogen. Thus, the focus of drinking water treatment has been shifting toward risk reduction in the treatment process and protection of the source water, both surface and underground.

Ontario's drinking water quality requirements do not seem to have kept pace with health risk, despite the introduction of new drinking water regulations in August 2000:

- There are still no requirements for treatment techniques to control *Cryptosporidium.* There are no requirements to analyze source waters to

determine the presence of *Cryptosporidium* or *Giardia*. Requirements to treat for *Giardia* have been in the U.S. *Safe Drinking Water Act* regulations since 1991. Proposed requirements to treat for *Cryptosporidium* are to be implemented by 2006.

- Low turbidity of treated water is one of the most basic indicators of proper surface water treatment. The provincial turbidity goal of 1 NTU for particulates in filtered surface water is applicable to only 95% of production and is based on the blended plant effluent. From a health risk perspective, the goal should be closer to 0.1 NTU, with 100% compliance by each process unit. Halifax, Nova Scotia, required this level of performance in a public-private partnership project as early as 1995. Leading Ontario utilities operate consistently at this performance level.

- The regulations still require only coliform bacteria analyses as indication that water is free of pathogens.

Perhaps a summary on the weak state of Canadian drinking water guidelines can be found in the design criteria used for drinking water treatment plants provided for First Nations communities in British Columbia. Funded (both capital and operating costs) by federal taxes, all plants are designed for full compliance with U.S. Environmental Protection Agency drinking water requirements.

### A4.1.2 The MOE Approvals and Permitting Processes

The MOE approvals and permit process has inherent weaknesses in that the permits have been granted in perpetuity. This stifles the ability of the regulator to require upgrades to treatment processes or modifications to extraction volumes based on evolution of understanding and experience.

Another concern has been the practice of treatment facility COAs documenting physical facilities rather than the quality of drinking water to be produced. It should be noted that subsequent to the Walkerton incident the MOE is proposing to modify its approval process by issuing "consolidated COAs," which will have drinking water quality regulations attached as conditions, for three-year terms. Although none have yet been issued, the new COA appears to be a renewable licence to operate a drinking water system.

A final concern is the implied responsibility of the MOE for satisfactory performance of designs receiving approval. This places the MOE in a vulnerable position should approved facilities have performance shortcomings.

### A4.1.3 The Grant-Funding Programs

Grant funding programs have historically provided significant capital assistance for treatment facilities for small communities and for regional schemes with rapid growth rates. Unfortunately, these grants have rarely been applicable to rehabilitation of the buried infrastructure, and the funding formulas for treatment facilities have had no attached conditions to require that leakage rates be controlled or that water revenues be sufficient to maintain the value of the grant-funded asset. Thus, treatment plants have been provided to municipalities whose unaccounted-for-water can be over 50%. There is no assurance that the increased cost of maintaining these oversized assets will be borne by local water revenues.

### A4.1.4 The Training and Certification Programs

In 1993 the MOE enacted a "Triple E" (education/experience/examination) program for certification of water treatment and distribution system operators. All existing operators who had worked as operators for the required time were automatically grandfathered, obtaining certification without meeting any educational or examination requirements. While many grandfathered operators were, and still are, extremely competent, the risk to public health suggests that the grandfathering approach be corrected.

### A4.1.5 The Structure and Scope of the MOE

The MOE has a broad mandate in Ontario's drinking water: it has been designer, funding agent, approver, operator, standards setter, investigator, and enforcer. There has been considerable discussion over the lack of funding for the MOE. A higher priority, however, should be assigned to the structure, responsibilities, and potential for conflicts of interest:

- Can the standards setter and the regulator (inspector/enforcer) be one and the same? Models from other jurisdictions suggest that these two

functions should be kept separate. Drinking water quality standards should be established on the basis of health risk and not linked to the enforcement process. As a parallel, we ask the OPP to enforce the speed limit on highways, not to set the limit.

- Can the regulatory function be linked to the design of treatment facilities? This link can place the regulator in a compromising position. And maintaining design guidelines is an expensive proposition in light of today's rapidly changing technologies. Models from other jurisdictions rely on industry associations (such as CSA, AWWA, WEF) to continually publish up-to-date research directions and design guides.

- Can the regulatory function be seen to have any links to specific plant operating authorities? The MOE no longer owns or operates any drinking water treatment plants. The province, however, operates hundreds through the Ontario Clean Water Agency (OCWA), which competes against public and private utilities for operations contracts in Ontario. The issue here is the perception that the provincial regulatory function is compromised by the provincial operational function.

## A4.2 The Watershed and Groundwater Management Roles in Ontario

The delivery of safe drinking water to the public starts with source water protected from pathogenic waste discharges. The management of surface and groundwater in Ontario falls into a multi-jurisdictional structure:

- The federal government, through the Department of Fisheries and Oceans (DFO), has the responsibility for "fisheries" throughout Canada via the *Fisheries Act.* Fisheries in this context refers to aquatic life, rather than commercial harvesting. In effect, DFO is responsible for ensuring that all surface waters in Ontario are capable of sustaining the type of fish life that was present before contamination by humans. DFO assesses surface waters with various designations, such as "warm-water fishery" and "cold-water fishery," and establishes water quality requirements for each designation. DFO is federally funded.

- The provincial Ministry of Natural Resources (MNR) has responsibility to work with DFO and conservation authorities to restore waterways in Ontario to support fisheries. The MNR is provincially funded.

- Conservation authorities – organized on a watershed basis – fall under the MNR and cover most of Ontario. Their roles include management of surface waters. Conservation authorities are funded by constituent municipalities and by the MNR.

- The MOE is responsible for regulating point-source discharges (wastewater treatment plants, combined sewer overflows, industrial lagoons, etc.) to waterways through its COA process. Discharge impacts on receiving waters are compared with the provincial water quality objectives for the receiving water. If the receiving water quality still meets the objectives, the discharge is permitted. For receivers that do not already meet the objectives (Policy 2 receivers), the discharge of the problematic constituents will be restricted so as not to worsen the condition of the water. Additional treatment or better dispersion or dilution might be required to meet the provincial objectives. COAs are issued in perpetuity until the conditions are contravened.

- The MOE is responsible for regulating sub-surface discharges to the ground and groundwater (landfills, spray irrigation, exfiltration lagoons) through its COA process.

- Septic tank/exfiltration bed systems must be installed to meet Ontario Ministry of Municipal Affairs and Housing design guidelines. Construction is inspected by the local health unit, which issues an approval certificate as part of the building permit process. Once the certificate is received, there are no inspection or compliance responsibilities to ensure that the tank has been pumped or the field bed is still working. Recently, municipalities have had the option to take on this responsibility.

- Biosolids (from wastewater treatment plants) and septage wastes can be disposed of on agricultural land that has received a COA from the MOE.

- Liquid discharges from agricultural land are considered non-point discharges and are not regulated. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) publishes guidelines to good practice for distribution to farmers.

- Liquid discharges from waste produced by farms and factory farm complexes are considered non-point discharges and are not regulated. OMAFRA distributes guidelines to good practice for handling these wastes.

- Groundwater monitoring for quality is not the responsibility of the province. Private well owners can obtain testing of their water for coliform bacteria from the Ministry of Health at no charge. The ministry records all sample results on its database.

### A4.2.1 The Regulatory Structure

The regulatory structure appears to be confusing and inconsistent. For point-source discharges, several regulators may have jurisdiction. The jurisdictions have different emphases in different parts of the province, depending on the proximity to, and funding of, the local office. In some areas there appears to be duplication of services; in other situations there is a lack of services. In any case, it would appear that there are opportunities to simplify and level the regulatory structure.

While the permitting side of the regulatory function appears strong, there seems to be a lack of enforcement at both the federal and provincial levels.

For non-point discharges, there is a lack of monitoring, regulation, permitting, and (understandably) enforcement. In some areas of the province, this has contributed to ridiculous situations. The South Nation River watershed, for example, is a Policy 2 receiver (it does not meet phosphorous-loading objectives). The point-source discharges from municipal and industrial pipes into the river contribute less than 1% of the total phosphorous loading, yet municipalities are required to reduce their phosphorous discharges if they wish to expand their communities. Over 99% of the phosphorous discharge to the watershed comes from non-point sources, predominantly agricultural.

Other jurisdictions consider the impact of all pollution sources on a watershed basis and do not allow exemptions.

### A4.2.2 The Approach to Managing Surface Water Quality

The approach of establishing provincial water quality objectives was intended to meet a goal of steadily improving the province's most polluted waterways and resulting ultimately in all waterways reaching at least a minimum level of quality. Communities on smaller waterways construct advanced wastewater treatment facilities, while those adjacent to large waterways, such as the Great Lakes usually have simpler, cheaper processes simply by virtue of the dilution volume available. Thus, the policy inadvertently may be contributing to the "dilution as a solution to pollution" scenario.

Given the advances in technology and 'clean manufacturing,' it might be appropriate to establish water quality standards that steadily improve and to replace the COAs with licences to operate for fixed term periods.

### A4.2.3 The Scope of the MOE

The MOE carries out a somewhat similar role in wastewater and associated areas as it does in the drinking water arena. The MOE sets standards, provides design guides, approves designs, manages grant funding programs, and is responsible for ensuring that the waste emitters are compliant with MOE requirements. The OCWA (formerly the MOE operations group) operates hundreds of wastewater treatment plants under contract with municipalities. The issue here is the same as on the drinking water side: Does the clustering of all these roles compromise the responsibility of the regulatory function and contribute to the perception that waste discharges will not be treated equally?

## References

American Water Works Association. 1994. *Emergency Planning for Water Utility Management.* 3rd ed. Manual M19. Denver: AWWA.

Australia. EnHealth Council. 2000. *Environmental Health Risk Perception in Australia* [online]. Public consultation. [Cited January 2002.] <www.health.gov.au/pubhlth/publicat/document/metadata/envrisk.htm>.

Australia. NHMRC/ARMCANZ Co-ordinating Group. 2001. *Framework for Management of Drinking Water Quality: A Preventive Strategy from Catchment to Consumer* [online]. Public consultation. Canberra: Australian Government Printing Services [Cited December 2001.] <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.

Canada. Health Canada. 1996. *Guidelines for Canadian Drinking Water Quality.* 6th ed. Ottawa: Supply & Services Canada.

Canada. Office of the Auditor General. 2000. *Governance of Crown Corporations* [online]. [Cited October 2001.] <www.oag-bvg.gc.ca/domino/reports.nsf/html/0018ce.html>.

Chartered Institute of Public Finance and Accountancy. 1995. *Corporate Governance: A Framework for Public Service Bodies.* [London]: CIPFA.

Chartered Institute of Public Finance and Accountancy and Society of Local Authority Chief Executives and Senior Managers. 2001. *Corporate Governance in Local Government: A Keystone for Community Governance – Framework and Guidance Notes.* [London]: CIPFA and SOLACE.

Clean Water Action, Clean Water Fund, and California Public Interest Research Group Charitable Trust. 2001. *Measuring Up II – An Evaluation of Water Quality Information Provided to Consumers in California.* San Francisco: CWA.

Dobell, Rod. 2002. *Social Risk, Political Rationality, and Official Responsibility: Risk Management in Context.* Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 13. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Doyle, E., et al. 2002. *Production and Distribution of Drinking Water*. Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 8. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Fédération des Experts Comptables Européens. 2001. *Approaches to Corporate Governance in the Public Sector.* Brussels: Fédération des Experts Comptables Européens.

Fields, Bill. 1998a. "Getting Organized – The Performance Management System." *The Business Owner* (November 1998). N.p.: Publishing Alliance Inc.

———. 1998b. "ISO 9000 – Are You Ready?" *The Business Owner* (April 1998). N.p.: Publishing Alliance Inc.

———. 1998c. "The Role Of Leadership In An Imperfect World." [Presentation to the Association for Services Management International, Toronto chapter, November 1998.] N.p.: [ASMI].

———. 1999a. "The Art Of Delegating – Achieving Employee Responsibility And Accountability." *The Business Owner* (November 1999). [Toronto]: Publishing Alliance Inc.

———. 1999b. "Structure Follows Vision – Eliminating Organizational Drift." *The Business Owner* (March 1999). N.p.: Publishing Alliance Inc.

———. 2000a. "Motivating Employees – The Secret Pill." *The Business Owner* (February 2000). N.p.: Publishing Alliance Inc.

———. 2000b. "Your Employees – Asset Or Liability?" *The Business Owner* (September 2000). N.p.: Publishing Alliance Inc.

Fields, Bill, and Maureen O'Leary-Pickard. 2001. *Human Resources Management* [unpublished].

Goss, Michael J., Kimberley S. Rollins, Kenneth McEwan, J. Ralph Shaw, and Helen Lammers-Helps. 2002. *The Management of Manure in Ontario with Respect to Water Quality.* Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 6. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Haldimand-Norfolk Transition Board. 2000. *A Model for Governance: The Final Report of the Project Team on Governance.* [N.p.: Haldimand-Norfolk Transition Board].

Hoffbuhr, Jack W. 2001. "The Regulatory Paradox." *Journal of the American Water Works Association.* Vol. 93, no. 5.

Hrudey, S.E. 2001. "Drinking Water Quality: A Risk Management Approach." *Water.* Vol. 28, no. 1, pp. 29–32.

Johns, Carolyn. *Policy Instruments to Manage Non-Point-Source Water Pollution: Comparing the United States and Ontario.* Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 11. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Martin, Roger L., Mary Ann Archer, and Loretta Brill. 2002. *Why do People and Organizations Produce the Opposite of What They Intend?* Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 20. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

New South Wales. Audit Office. 1997. *Corporate Governance in Practice.* Performance Audit report. [Sydney]: Audit Office.

d'Ombrain, Nicholas. 2002. *Machinery of Government for Safe Drinking Water in Ontario*. Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 4. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Ontario. Ministry of the Environment. 2000a. *Ontario Drinking Water Standards* [online]. PIBS 4065e. Revised January 2001. [Cited July 2001.] <www.ene.gov.on.ca/envision/WaterReg/Pibs4065.pdf>.

———. 2000b. *Training Requirements for Sampling Drinking Water* [online]. Fact sheet. [Cited October 2001.] <www.ene.gov.on.ca/envision/news/factdec6.htm>.

Ontario Sewer and Watermain Construction Association. 2001. *A Nine Step CPR Plan For Ontario's Water and Sewage Systems.* Mississauga: OSWCA.

Pollution Probe. 2001. *The Management and Financing of Drinking Water Systems: Sustainable Asset Management.* Submission to the Walkerton Inquiry. Toronto: Pollution Probe.

Powell, Douglas A., Katija A. Blaine, Liz Gomes, Sarah E. Grant, Bonnie LaCroix, and Shane Morris. 2002. *Water Warnings: Communication in Drinking Water–Related Public Health Emergencies.* Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 12. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Ritter, Len, Paul Sibley, Keith Solomon, and Ken Hall. 2002. *Sources, Pathways, and Relative Risks of Contaminants.* Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 10. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Sancton, Andrew, and Teresa Janik. 2002. *Provincial-Local Relations and Drinking Water in Ontario*. Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 3. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Strategic Alternatives, in association with Michael Fortin, Enid Slack Consulting Inc., and Mike Louden. 2002. *Financing of Water Infrastructure*. Toronto: Ministry of the Attorney General. Walkerton Inquiry Commissioned Paper 16. Walkerton Inquiry CD-ROM. <www.walkertoninquiry.com>.

Tompkin, R.B. 1992. "Corrective Action Procedures for Deviations from the Critical Control Point Critical Limits." In *HACCP – Principles and Applications*, eds. M.D. Pierson and D.A. Corlett, Jr. N.p.: Chapman & Hall. Pp. 72–82

Toronto Stock Exchange. Joint Committee on Corporate Governance. 2001. *Beyond Compliance: Building a Governance Culture*. Toronto: TSE.

United States. Environmental Protection Agency. Office of Water. 2000. *Total Maximum Daily Load (TMDL) Program* [online]. [Cited October 2001.] <www.epa.gov/owow/tmdl/>.