Ontario Society of Professional Engineers

Safe Drinking Water & the Role of Professional Engineers

Submission to the Walkerton Inquiry – Part II

OSPE Task Group on the Production & Distribution of Safe Drinking Water in Ontario

March 2001

Ontario Society of Professional Engineers

About the Ontario Society of Professional Engineers (OSPE)

OSPE is a member services and advocacy organization, created jointly in 2000 by Professional Engineers Ontario, the regulatory body for engineering in Ontario, and the Canadian Society of Professional Engineers. Its creation was the culmination of a process to separate regulatory and non-regulatory affairs for the profession, and was supported by the Ministry of the Attorney General in Ontario.

The Ontario Society of Professional Engineers seeks to:

- advance the professional and economic interests of engineers;
- raise awareness of the role of professional engineers;
- enhance the profession's image; and
- act as a strong voice on behalf of professional engineers in Ontario.

Safe Drinking Water & the Role of Professional Engineers

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1. Introduction

1(b) About this paper

In August 2000, the Ontario Society of Professional Engineers (OSPE) sought – and was subsequently granted – official standing at Part II of the Walkerton Inquiry, an independent Commission established by the Government of Ontario to examine events leading to contamination of the water supply in Walkerton, Ontario in the spring of 2000.

Several people died and hundreds became ill as a result of drinking water contaminated with *Escherichia coli* O157:H7, a deadly strain of *E. coli*, thought to have found its way from farm waste into the local water supply system.

In its remarks to the Hearing for Standing at the Walkerton Inquiry, OSPE indicated that it intended to convene a task group to look at a number of issues involving engineering, raised by the events in Walkerton, including the following:

- where and how engineers are involved in the water supply system;
- how this involvement has diminished over the past 20 years; and
- the value in having professional engineers take responsibility for certain aspects of water treatment and distribution systems.

This paper is OSPE's review of those issues. It should be noted that the paper was written with the lay reader in mind; hence Part 2 includes a descriptive overview of water supply systems. This was considered necessary in order to provide a context for describing the engineer's role in the design, construction, operation, maintenance renewal, financial management and regulation of water works and water treatment facilities.

This paper is presented in five parts.

Part 1 is the introduction, which describes the context for the Walkerton Inquiry and OSPE's role in it. In addition, Part 1 discusses the engineer's role in water supply systems very briefly, and articulates certain social attitudes and perceptions about the safety of drinking water.

Part 2 is a descriptive overview of water supply systems, intended to provide context for an understanding of the engineer's role in the production and distribution of drinking water. Part 2 includes a section of legislation, regulations and guidelines relevant to water supply systems, and touches on the impact of political pressure on water rates and investment in infrastructure.

Part 3 talks about the role of engineers and engineering in water supply systems, describing their involvement in some detail, and suggests areas where the public interest may be better served if there were a legal requirement that a professional engineer be involved in specific aspects of water works operations.

Part 4 describes the requirements for licensure as a professional engineer, discusses the engineer's primary responsibility to safeguard public health and welfare, including the 'duty to report', and presents a brief discussion on the concept of professional accountability.

Part 5 details some 15 recommendations of the task group.

The paper also includes a bibliography, and a list of organizations and agencies involved in the water supply system (Appendix 1).

1(b) Background

The knowledge and technology needed to produce safe drinking water, and to monitor changes in source quality are well established. Therefore, when water quality problems arise, other factors (systemic problems, standards, regulation and enforcement, human factors, etc.) must be looked at.

This paper examines the role of engineers and engineering in the production and distribution of safe drinking water. To understand where engineers fit in, we have included a brief overview of the water production and delivery system in Ontario. We will show that where once engineers were central to water utilities and water distribution systems, their role has significantly declined in recent years, leaving the system vulnerable, we would suggest.

Historically, engineers have been involved in every aspect of drinking water production: source selection (and protection), design of wells, treatment plants and treatment processes, infrastructure design and renewal, construction, and water delivery.

This involvement starts with geotechnical engineers looking at the hydrogeology of sites and water sources. It runs the gamut of mechanical, electrical and instrumentation/control engineers who design facilities and treatment plants; it includes chemical and process engineers who develop treatment processes, and extends to civil engineers who design and renew water delivery systems (the reservoirs, water mains and pipelines that carry water to our homes or businesses). In addition, engineers are involved in government approval processes, and in developing water regulations and guidelines. Simply put, when you're talking water systems, you're talking engineering.

Today the safety of drinking water is largely taken for granted in North America. Indeed, there exists in the public mind a common belief, also held by some public officials and water system workers that well water (groundwater) drawn from aquifers is "pure" and therefore safe -- and does not require treatment. At one time in our pioneering past, this may have been true, but it can no longer be relied upon.

Unfortunately, this popular myth persists, evidenced by comments at Part I of the Walkerton Inquiry made by the manager of a Walkerton retirement home. JoAnne Todd testified that when she contacted Walkerton's public utilities commission last May to ask about rumours that the town's water was 'bad', she was reassured that "the water in the town was okay -- that there was no way the water in Walkerton could become contaminated because it came from deep wells."[1]

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[1] Toronto Star, Jan. 16, 2000

Recently, Steven Bonk, former President, American Water Works Association (AWWA), and former Director of Water Supply, Regional Municipality of Ottawa Carleton, commented on the popular perception that groundwater is inherently safe: "I am always interested (and dismayed) by the position frequently taken by many parties involved in groundwater (well drillers, water authorities, consumers) that groundwater is so pure, good and protected, there is no need to be concerned with quality or treatment needs. The result, I would suggest, has been a false sense of security in water systems served by groundwater. In some cases this sense of security extends from the water authority to the consuming public, with the result that an interruption in chlorination is not viewed as a potentially serious problem."[2]

Similar views were expressed recently by Hans Peterson, Executive Director, Safe Drinking Water Foundation: "It should be remembered…" he wrote, "that it is the municipalities and rural people themselves (and I am one), that have thought poor water quality was not an issue. Lack of knowledge and complacency have got us into this situation."[3]

This mindset may have led some individuals in the system to regard groundwater testing and reporting as largely unnecessary – in effect, so much 'bureaucratic overkill.' The same attitude, we believe, has contributed in some communities to a casual approach to water system management, and a belief that the risk of contamination to groundwater is more theoretical than real. This attitude may also have contributed to a general downplaying of the need for professional engineering expertise in managing water systems. A common notion is that 'it's not rocket science and anybody can do it'.

On the contrary, we believe that, given government restructuring and downsizing, the drastic reduction in the number of professional engineers employed by the Ministry of the Environment to monitor water operations, and the trend away from stand-alone water utilities to municipal departments where water is just one concern, the need for professional expertise and accountability has never been greater.

2. Overview of the system

2(a) Water source

In comparison to many other countries, the quality of source water in Canada is generally very good -- rarely must an Ontario community rely on a poor quality water source. Indeed, there have been numerous examples over the past 50 years, in which the Ontario Water Resources Commission (forerunner of the Ministry of the Environment), concerned about a community's water quality, took the lead in establishing a safer, more reliable source. In the 1960s and '70s, for instance, OWRC financed and built water pipelines from Lake Erie, to Chatham, from Lake Huron to London, and from Lake Ontario to Peel Region, among others. So abundant is good water in Ontario that there is very little excuse for making do with inferior sources.

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[2] Steven Bonk, private correspondence (e-mail) Dec. 15, 2000, to Professional Engineers Ontario and the Ontario Society of Professional Engineers.

[3] Hans, G. Peterson, PhD, "Is Unsafe Drinking Water Really Less Expensive?", *The Rural Councillor*, Vol. 35 No. 8, October 1, 2000, Saskatchewan Association of Rural Municipalities

That said, it must be noted that source water management in Ontario today leaves much to be desired. Our care and attention to this vital resource has declined in recent years, a trend that cannot be sustained without undermining the trust placed in us to safeguard the environment for future generations. This reduced vigilance is evidenced by the drastic reduction in the number of engineers and scientists at the Ministry of the Environment involved in monitoring source water, and managing water protection programs.

Only a few years ago, MOE supported a number of programs aimed at protecting source waters; these included careful monitoring of the volume of water taken from wells, inspection of all new wells to ensure that surface water could not enter or be drawn into the groundwater system, and management of materials put onto the land. Interestingly, the latter rarely included close monitoring of farm waste and runoff into rivers and lakes.

Aside from water quality, two other factors must be assessed when evaluating potential raw water sources (groundwater or surface water): quantity and risk potential.

Careful assessment of the volume that can be safely extracted from a potential site is required; ideally, this should be done by a professional engineer or multidisciplinary team overseen by a professional engineer. According to Ontario Drinking Water Standards, "the site chosen should be one least subject to municipal and/or industrial pollution, as well as other types of pollution resulting from human activities within the watershed."[4] Some municipalities safeguard their surface water sources by surrounding them with many hectares of protected land (restricted land use). Halifax and Vancouver are two examples. Other cities are less vigilant in this regard -- Saint John, New Brunswick, for instance, has as its source several large ponds, at least one of which is located close to road and rail lines.

2(a)i Ground water sources

Raw water comes from two kinds of sources: groundwater (drawn from aquifers) and surface water (lakes and rivers). Groundwater is accessed by means of wells, either drilled or dug into underground water-bearing formations of soil or rock, known as aquifers. Aquifers are recharged (replenished) by annual rainfalls, the level of groundwater (the "water table") rising and falling in accordance with recharge and extraction rates.

Groundwater is considered suitable as a drinking water source so long as all water is drawn at a depth well below the top of the groundwater table, and surface water is prevented from inadvertently entering the well. The soil and rock above the aquifer (the "over burden") act as a natural filter to remove bacteria and unwanted particles. If surface water somehow enters the well directly, safety is compromised. Protection of well heads and areas around wells is essential; regulations to ensure such protection need strengthening.

Aquifers are much less susceptible to chemical contamination than are surface water sources. Such contamination can happen, however, and is serious. One well-known incident occurred in the early '80s in Waterloo Region when a plant manufacturing rubber products allowed chemicals from its process and waste lagoons to seep into the

[4] Ontario Drinking Water Standards, Ontario Ministry of the Environment, January 2001.

groundwater. This kind of contamination is very difficult to eliminate because not all chemicals in solution can be removed, even by a good aquifer.

Wells in operation for long periods of time without testing or observation, are at risk for both bacterial and chemical contamination.

Approximately 30 per cent of Canadians depend on groundwater supplies as their main source of drinking water.[5] In Ontario the figure is roughly 15 per cent.[6] As a rule, the larger the city, the less likely it is to rely on groundwater. Medium-sized cities may use a combination of groundwater and surface water. Ontario has 13 systems serving populations over 35,000 which use groundwater.[7] Guelph and Waterloo, for example, both have good aquifers, and rely on groundwater. Barrie, with a population exceeding 100,000, though located on the shores of Lake Simcoe, sits adjacent to an excellent aquifer and uses groundwater. A question for municipalities such as Barrie and Waterloo is: 'Who's monitoring industrial, commercial and recreational activities on the aquifer's recharge areas to ensure the aquifer does not become contaminated? Aurora, Orangeville and Midland are three other Ontario cities that rely on groundwater.

Currently, the Ministry of the Environment is conducting studies to learn more about the province's groundwater – the size and locations of aquifers in various areas, their physical characteristics, the types of activities occurring on recharge areas, etc. The largest of these is the Eastern Ontario Water Resources Management Study of groundwater, surface water and infrastructure in an area encompassing some 6,800 square kilometres. This is the largest of 34 studies now underway; most of the others are much smaller studies, involving a few villages.

Over the years, much raw data has been collected about wells, the geological formations they are set in, their size, and pumping rates. Only limited information about groundwater *quality* has been gathered, however. We would encourage the Ontario government to persevere in its efforts to learn more about the province's groundwater – it is time to increase our knowledge of the nature, extent and condition of this important resource.

When groundwater is to be extracted, and a well established, a number of factors must be considered to safeguard the aquifer and ensure responsible use. Water resources, both surface and ground water, are intimately connected. Decisions about the volume to be extracted must be made in full appreciation of the limits of the resource, and within the context of good engineering practice. While other professionals -- hydrogeologists, planners, financial analysts, risk analysts, etc. -- have important roles to play, professional engineering expertise, we would argue, is essential. Sign-off by a licensed professional engineer should be required.

2(a)ii Surface water sources

While surface water is more immediately vulnerable than groundwater to contamination, risk is reduced by vigilant protection of source waters, by use of sophisticated, multiple-

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[5] Steven Bonk,, *Emerging Considerations for Safe Drinking Water in Canada*, Canadian Society for Civil Engineering, Environmental Engineering Division, National Lecture Tour address, 1992

[6] *Fact Sheet*, *The Ontario Clean Water Agency*, Office of Privitization, March 1998

[7] *Survey of Municipal Water rates & Operations Benchmarking in Ontario*, Ontario Water Works Association, 1999

barrier treatment processes, and by frequent monitoring of plant operations, preferably under the direction of a licensed professional engineer.

2(b) Water treatment

Due to the abundance of good quality water in Ontario, there has been little need to employ exotic treatment processes to convert severely polluted water into safe drinking water. This is not the case in some parts of the world, notably Europe, where heavily polluted source water is quite common, necessitating treatment methods of a kind virtually never required here.

Treatment processes fall into four broad categories: coagulation/sedimentation, filtration, disinfection and a variety of processes to remove colour, trace elements and compounds, or to improve taste and odour.

Filtration removes particles that hold bacteria and other impurities, and has been used almost universally in Ontario since the 1970s by systems relying on surface water. Two cities that have opted not to filter their water are North Bay and Sudbury (though the latter is currently in the planning stages for a filtration plant). Outside Ontario, Winnipeg and Saint John, N.B. also do not filter; surprisingly, neither does New York City. Filtration of groundwater is rare.

Filtration often involves the use of aluminum sulphate (alum) or other coagulants, which when added to water cause organic materials to clump together for ease of filtering. Other filtration techniques, including the use of activated carbon, and membrane filtration, help remove unwanted trace elements, colour, compounds, and some solids, for health and/or esthetic reasons. Allowable levels of trace elements and compounds are set out in Ontario's Drinking Water Standards, based on Canadian guidelines.

Thirty to 50 years ago, untreated municipal water systems were common -- particularly systems relying on groundwater, and many situated on the Great Lakes and northern rivers. Today in Ontario, by regulation, all drinking water must be disinfected, regardless of the source. Chlorination is by far the most common method. Unlike other technologies -- ozonation and ultraviolet treatment, for example -- chlorination imparts *residual* protection to water, an important factor in maintaining its safety. Water may be "perfect" as it leaves the treatment plant but without residual protection runs the risk of contamination as it moves through the delivery system. Aging pipelines and reservoirs may harbour bacteria, or breaks and cracks in water mains or pipelines may allow contaminated water to enter the system. Residual chlorine guards against these risks.

In Ontario, the only communal systems not required to treat drinking water are small systems serving campgrounds, trailer parks, assembly halls, gas stations and other private owners supplying fewer than six households.[8] In late 2000, the Ministry of the Environment undertook a series of public consultations to consider practical approaches to dealing with this issue, and is currently considering various options.

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[8] *Protecting drinking water for small waterworks in Ontario*, Discussion Paper, Ministry of the Environment, 2000

2(c) Water consumption

Canadians grow up knowing their country is blessed with abundant water resources; as a result, most of us give little thought to how much we use – or how much we waste. In most Canadian communities, per capita water consumption averages 400-600 litres/day, including institutional, industrial and commercial use, which accounts for 40-60 per cent of the total. Excluding industrial/commercial consumption, we each use approximately 300 litres/day. In coming years, we can expect to see water costs rise as communities come to grips with the need to replace aging infrastructure. We may also see a renewed conservation movement.

2(d) Classification of water and wastewater facilities

Plants and systems in Ontario are divided into the following categories:

1) wastewater collection facilities
2) wastewater treatment facilities
3) water distribution facilities
4) water treatment facilities.

Within each category, facilities are classified as Class I, Class II, Class III or Class IV, based on a point system.[9] Points are determined by a number of factors. For water treatment facilities, these include: size of the population served; average daily flow volume; type of water source (three points for groundwater, five for surface water); raw water quality; types of treatment processes, etc. A facility scoring 30 points or less falls into Class I, while one with 76 points or more is in Class IV. The Walkerton facility is a Class 1 facility; Toronto, a Class IV.

This classification system is used mainly to determine the type of operator needed to take charge of plant operations. There are four classes of operators (Classes I - IV), as determined by the Water and Wastewater Utility Operator Certification Program.[10]

In addition to the classification system described above, water treatment and distribution facilities fall into one of two categories for the purpose of determining the frequency of microbiological testing required. For facilities serving populations of 100,000 or less, a minimum of eight samples plus an additional one sample per 1,000 population, must be taken monthly, at least one per week. For systems serving more than 100,000 population, a minimum of 100 samples plus an additional sample per 10,000 population are required monthly, three per week minimum.

2(e) Ownership of water systems

Communal water systems in Ontario evolved in a variety of ways. Most of the major water systems were built by municipalities themselves in the early to mid 20th century. In the 1960s, the Ontario Water Resources Commission (forerunner of the Ministry of the Environment), in response to water quality concerns, financed, built and operated many new systems, mainly in smaller communities but also in some larger municipalities such as South Peel.

This approach gave way to a program of grants to municipalities, that enabled communities to construct or upgrade their water systems themselves. A complex rating

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[9] Ontario Regulation 435/93 (amended O. Reg. 539/98), *Water Works and Sewage Works*
[10] ibid

system based on “need” (community enhancement, health and environmental risk factors, etc.) was used to distribute large sums of money, and resulted in construction of significant water works. Regrettably, this approach sometimes rewarded communities that had a history of managing their facilities poorly. [Like earlier grant programs, the Ontario SuperBuild Corporation may end up rewarding municipalities that have kept water rates artificially low and failed to invest in infrastructure renewal.]

In 1993, the province created the Ontario Clean Water Agency (OCWA) to operate systems which, until that time had been owned and/or operated by the MOE. This served to separate system operations from system regulation. In the mid-to-late ‘90s, OCWA handed ownership over to the municipalities, though it continues to operate many of these facilities.

The following reflects ownership today:

i) *Owned and operated directly by the municipality*, e.g. Toronto

ii) *Owned by a Public Utility/Utilities Commission (PUC)*, e.g. Windsor – the municipality delegates responsibility to the PUC, but the local municipal council is ultimately responsible; the number of PUCs in Ontario is declining due to amalgamation & restructuring (regionalization), the result of deliberate government strategy.

iii) *Owned by the Government of Canada*: the federal government owns and operates water facilities on military bases, airports, Indian reserves, and national parks, among other sites; these systems may also own and operate adjacent municipal water utilities (by contract) or may sell water to the local municipality.

iv) *Privately-owned* (mainly in rural areas): campgrounds, tourist lodgings, boarding houses, assembly halls, gas stations -- even hospitals, day cares and long-term care facilities.

2(f) Operation of water systems

- *Most common*: the municipality operates its own water utility either directly, or indirectly through a Public Utilities Commission (PUC).

- *Common*: the Ontario Clean Water Agency (OCWA), a provincial Crown corporation, operates municipally-owned utilities on a contract basis, sometimes competing with private sector operators for such contracts; with 760 staff members, OCWA currently operates 429 water and wastewater facilities in the province.[11]

- *Less common*: a private sector corporation operates a municipally-owned utility, e.g. USF Canada runs Goderich’s water & wastewater systems. In 1998, 15 such contracts were in place.[12] Corporations may take an equity position in the system – particularly, in the case of new systems that cannot be easily financed through municipal debt (this model is more common in the U.S.).

[11] *Corporate Profile*, Ontario Clean Water Agency website (www.ocwa.com)
[12] *Fact Sheet, The Ontario Clean Water Agency*, Office of Privitization, March 1998

2(g) Legislation/regulations/guidelines

i) **The *Professional Engineers Act*** includes a definition of engineering and states that activities that fall within the definition must be undertaken by a professional engineer, or must be supervised by a professional engineer who takes responsibility for the work. Some would argue that water system operations are captured within the definition of engineering and therefore must be overseen or supervised by a licensed professional engineer. The definition of engineering is subject to interpretation, however, and there is no universal agreement on what falls within the definition.

ii) ***Canadian Drinking Water Guidelines*** for drinking water quality are produced and updated regularly by a federal-provincial subcommittee[13], based on new research findings and regulatory changes introduced in other jurisdictions; these guidelines set out allowable levels of trace elements and other "foreign" substances. The guidelines are viewed by most municipal water agencies as minimum requirements for drinking water quality.

iii) **The *Ontario Water Resources Act*** is Ontario's principal legislation addressing the management of water resources. The Act includes a general prohibition against the discharge of substances or materials into water that "may impair the quality of the water". Well construction is also regulated under the Act; anyone who constructs wells or operates a well construction business must be licensed by the Ministry of the Environment.

Certificates of Approval are issued by the Ministry of the Environment's Approvals Branch under *the Ontario Water Resources Act*, for the construction and operation of major components of water works systems, including communal wells, pumping stations, treatment plants, reservoirs and pipelines. The MOE may impose certain conditions on the approval of a C of A application, in which case, the conditions become part of the C of A. Inspections to ensure compliance with terms of C of As were once carried out by, or under the supervision of, MOE engineers. In recent years these inspections have been conducted mainly by non-engineering MOE staff.

Regulation 435/93 under the Water Resources Act establishes certification standards for operators of water works; there are four classes of operators under the Water and Wastewater Utility Operator Certification Program. The regulation stipulates that under certain conditions, professional engineers who operate water works may be exempt from the usual experience requirements established for licensed operators. Some managers and operators remain in the system who were originally "grandfathered" without formal training or accreditation, though they are gradually retiring or being replaced.

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[13] Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health

That said, it must be noted that most operators in the Ontario system are well trained and highly competent.

iv) Ontario's 1994 Drinking Water Objectives have now been incorporated into a new **Drinking Water Protection Regulation** introduced in August, 2000 (Ontario regulation 459/00 under the Water Resources Act), giving the objectives the force of law. The regulation includes a requirement that all municipal water systems be assessed, and a report prepared by a professional engineer every three years "to ensure they comply fully with laws intended to protect public health."[14] Engineers' reports are to focus on the potential for microbiological contamination of the water works, and to identify operational and physical improvements required. Assessment of the distribution system is not required except for a review and recommendations regarding test samples.

v) Other legislation

- **Environmental Protection Act (Ontario)**: Engineers are not named in the Act but are given responsibilities in a number of regulations under the Act, specifically, ensuring the structural integrity and safety of landfill sites, and ensuring accurate measurement of wastewater discharges by industries named in the government's Municipal-Industrial Strategy for Abatement (MISA) program.

- **Environmental Assessment Act**: The Act deals with the planning, designing and building of water and sewage works, and sets out a framework for identifying and evaluating the possible impacts that could result from implementation of individual projects. Engineers are not specifically named in the Environmental Assessment Act.

For a more thorough examination of legislation/regulations/guidelines applicable to water works engineering, see the written submission by Professional Engineers Ontario[15] *to the Walkerton Inquiry – Part II.*

2(h) Water rates

Water utilities are generally expected to be self-financing and independent of the municipal tax base. As a rule, water rates should reflect the true cost of operating and maintaining the system, though this is not always the case. Too often political pressure is exerted to keep water rates low, thereby increasing potential risk when infrastructure is not maintained and renewed adequately. If this pattern becomes entrenched, the stage is set for possible system failure; and/or crisis intervention in response to an impending threat. Neither is a desirable option, and should not occur in a well-managed system.

Water works infrastructure is largely hidden from view and easily forgotten, and lasts such a long time that deterioration rarely compromises safety or service *in the short- to mid term.* As a result, spending is easily delayed when other demands seem more

[14] *Media Backgrounder*, *Protecting Ontario's drinking water*, Ministry of the Environment, August 2000
[15] *Submission to the Walkerton Inquiry – Part II*, *The Roles and Responsibilities of Professional Engineers in the Provision of Drinking Water*, Professional Engineers Ontario, March 2001

pressing. The Ontario Municipal Board (OMB) watches municipalities' spending to ensure that debt loads are within acceptable limits; however, no regulatory authority ensures that spending on infrastructure renewal is maintained at adequate levels. In Ontario there is no standardized water works accounting system or agency to monitor spending on infrastructure renewal to ensure that reinvestment is built-in.

In the U.S., since 1999, all local and state governments have been required to properly account for their capital infrastructure assets and provide an annual report. "This new requirement…is designed to improve the way in which public accounts are reported, to more clearly show the real cost of the service being provided," explained senior water works engineer, George Powell in an address to the Ontario Municipal Water Association last year.[16]

Water rates are set by the water utility or municipality, in consultation with management staff and engineer(s). Normally, municipalities monitor water rates in nearby communities to ensure that their own rates are in line. Well-run municipalities develop reserves to cover revenue fluctuations and contingency needs, as well as programs of planned maintenance and capital spending to ensure infrastructure renewal. A 1999 survey of 110 municipal water supply systems, conducted by the Ontario Water Works Association (OWWA), found that a significant percentage have little or no debt and healthy reserves.[17]

A fact of life for many PUCs is the control municipal councils exert over borrowing. Municipalities have the power to approve (or not) borrowing for PUC capital expenditures. Often, PUCs will be advised to create reserves from water revenues, and institute 'pay as you go' policies for capital projects. Of concern to PUCs is the risk that municipal councils will dip into water reserves for other municipal priorities; some PUCs resist building reserves for this reason. Municipal water departments may face similar difficulties.

There is considerable debate among water experts about the merits of stand-alone water utilities (PUCs) versus municipal departments having responsibility for a number of services including water supply. Some of these arguments are included below:

- *Positive*: larger entities possess the critical mass to support necessary expertise, including professional engineering input;
- *negative*: in multi-services departments, water becomes just another item municipalities are responsible for; it is no longer regarded as something "special" and often falls victim to budget constraints;
- *negative*: PUCs sometimes become inward-looking "entities unto themselves", reluctant to share information, etc., and may become obstacles to sound municipal planning.

Canada's water rates are among the lowest in the world; in Ontario, the average household pays approximately $200 annually for water.[18] Scrimping on investment and

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[16] George Powell, P.Eng., CH2M Gore & Storrie Limited, *The State of Ontario's Water Infrastructure*, address to the Ontario Municipal Water Association, Windsor Conference, May 8, 2000

[17] *Survey of Municipal Water Rates & Operations Benchmarking in Ontario,* Ontario Water Works Association, 1999

[18] ibid

operating expenditures may not affect quality in the short run, but it increases the likelihood that water quality problems will eventually occur.

2(i) Safe drinking water – whose responsibility is it?

Ultimately the delivery of safe drinking water is the responsibility of each municipality (mayor, council, & elected or appointed PUC board members)[19]. This essential point is sometimes forgotten, perhaps due to the province's historical role in approving capital projects, providing grants, inspecting facilities, monitoring water plant operations, and acting as the watchdog over the water testing and reporting system. By implication, there's an assumption that the province is ultimately responsible for drinking water quality; however, this is not the case.

Under the *Health Protection and Promotion Act*, the Medical Officer of Health has the ultimate authority in judging whether water is safe for human consumption.[20]

It is important to recognize that even the best water systems cannot guarantee safe water every minute of every day without fail. This means that those responsible for delivering safe water *mus*t be prepared to issue a 'boil water" order when necessary – sometimes on the basis of strong suspicion, pending test results. There may be times when water from a particular source must be shut off until test results are available; however, water delivery must be maintained for fire fighting purposes. Notification of all users, of a boil water order or advisory, is critical.

2(j) Components of water supply systems

- surface water/groundwater sources
- intake pipes
- wells
- pumping stations
- treatment plants
- pipelines
- reservoirs
- elevated tanks (water towers)
- transmission mains (24"-100+"), trunk mains (12"-20"), local (street) mains (6"-8")
- hydrants
- private service connections

2(k) Where systems are vulnerable – threats to safety

2(k)i Production side

There are numerous potential entry points for contamination, including the following:

- source contamination – surface water (lakes & rivers) and aquifers
- well integrity
- unplugged test holes (wells)
- abandoned, deteriorated wells;

[19] *Ontario Drinking Water Standards*, (section 2.3 Responsibility for water quality)
[20] *Ontario Health Protection and Promotion Act*, Chapter 10, Part 3, Sections 10, 11, 12 and 13

- equipment failure, e.g. chlorination machines
- sewage plant discharge (both treated and untreated flows)
- storm drainage (urban and rural)
- spills, farm runoff.

Events leading to the deaths of seven Walkerton, Ontario residents in May 2000, due to contaminated drinking water, raise serious questions about the management of farm wastes and their potential to contaminate rural water systems. Large commercial farming enterprises pose a serious environmental threat if not managed judiciously. For engineers the issue centres on the proper design of structures and processes for the handling and utilization of farm wastes.

A 1997 Factsheet published by the Ministry of Agriculture, Food and Rural Affairs, *Hiring a Professional Engineer for Farm Projects*, urges farmers to consider using the services of a professional engineer when designing farm structures. "Many management decisions dealing with capital items require timely engineering input on structural, functional, economic and environmental needs. It makes good sense to get sound, professional advice from a practicing professional engineer who specializes in Agriculture… Money spent on plans will usually save more money than they cost in the long run."[21]

Despite this good advice, it is common for farm owners to construct their own ponds, reservoirs, holding tanks and other structures, without engineering input or approval of any kind. This, we believe, poses a potential environmental hazard, and should be addressed. Consideration should be given to a requirement that farm structures and storage containers (including drainage ditches, ponds, storage or holding tanks, sewage and waste systems) and processes to digest, thicken and spread wastes, be designed by a professional engineer or other qualified person. A further mechanism is needed to ensure that structures are built in accordance with approved designs, and that processes are implemented as intended.

The Water Resources Act specifically exempts pollution due to farm waste from requirements of the Act. There is a mechanism, however, to address pollution problems caused by farm waste. The Farm Pollution Advisory Committee, a joint committee of the Ministry of the Environment and the Ministry of Agriculture, Food and Rural Affairs, established under the authority of the *Environmental Protection Act*, attempts to resolve such problems when voluntary co-operation by the farmer involved is not forthcoming.

2(k)ii Distribution side (threats to safety)

It is commonly assumed that once water has moved from a treatment facility into the distribution system, it is safe and remains so. This is not necessarily the case. Possible hazards include:

1. dead end water mains where water may reside in pipes for long periods of time and become "stale" (residual chlorine levels drop leaving water vulnerable);

2. sudden drops in pressure due, for example, to overzealous fire fighting, may cause low pressure or even a vacuum, resulting in backflow of contaminated water into the system;

[21] H.W. Fraser, J. Johnson, and D. Trudell, *Hiring a Practicing Professional Engineer for Farm Projects*, Factsheet, Ontario Ministry of Agriculture, Food and Rural Affairs Sept. 1997

3. poor circulation of treated water in reservoirs and elevated water tanks, resulting in stale water (low chlorine or non-existent residuals);

4. reservoir contamination (particularly open reservoirs);

5. deteriorated/rusty mains that may harbor bacteria or allow contaminated water to enter the system;

6. modifications within industrial establishments, e.g. potable water connected mistakenly to the process stream (known as "cross-connections"); note: Canada lags far behind other industrialized countries in cross-control programs;

7. household cross-connections between potable & non-potable systems causing backflow into distribution side; cisterns with their own pumps for household use and connected to the municipal supply may be the culprit in this case; and

8. unapproved connections and unapproved replacement of system components.

3. Engineers' involvement

3(a) A little history

Many advances in potable water production and treatment were originally developed by engineers, often based on tried and true 'rules of thumb' – techniques that had been found to work. Only in the past 50 years or so has scientific research caught up to these practical approaches, often confirming what had been established empirically.

The following is a brief summary of water treatment and water works construction in Ontario, gleaned from a number of sources; much of it is reproduced (word for word) from an article by R. Koci and D. Munchee[22] which was reprinted by the Ministry of the Environment as a "Facts" sheet in the 1980s; other sources are footnoted separately:

- The first piped water in Ontario was established in 1837 in Toronto as a private operation. The water was pumped without treatment from Lake Ontario, and used mainly for fire fighting. Twenty years later 11 per cent of homes in Toronto relied on this source.

- In the 1850s scientists began to suspect that water could carry disease; in 1853 a cholera outbreak in London, England that claimed 11,000 lives was traced back to a contaminated public well.

- During the 2nd half of the 19th century, Thomas C. Keefer is recalled as the most outstanding civil engineer of the era, and Canada's first expert on water supply. He constructed the Montreal water supply system, and worked as a consultant on projects in many Ontario cities, including Toronto, St. Catharines, Hamilton, Ottawa

[22] Robert Koci and Denise Munchee, "Ontario's Quest for Clean Water", *Legacy*, vol.12 No.3 (reprinted by the Ministry of the Environment as a "FACTS" sheet in the 1980s)

and London. Keefer founded the Canadian Institution of Civil Engineers, and was a founding member of the American Society of Civil Engineers.

- In 1873 the municipality of Toronto took over the operation of the piped water supply from the original private operator; by 1900 there were 110 water supply systems in Ontario, 66 run by municipalities.

- In the last two decades of the 19th century and the first two decades of the 20th century, much effort went into developing effective filtration systems.

> Inventors paraded an amazing number of filters…Our City fathers could not have been anything but impressed and bewildered by their claims and advantages. [23]

- In Toronto, water chlorination began in 1910; very quickly, the incidence of typhoid and similar diseases began to decline (typhoid deaths dropped from 44.2 to 0.9 per 100,000 population between 1910 and 1928[24]).

> [This] improvement was the result of a few devoted civil engineers whose achievements are generally overlooked in the annals of history…The real improvements, however, had to wait for the decade after World War I, the 1920s, and these improvements were the work of two outstanding Canadian civil engineers, Willis Chipman and Albert Berry.[25]

- Chipman was responsible for the design of more than 50 water and sewage works in Canada, while Berry was the first to recognize that chlorination was necessary to reduce the incidence of typhoid. In 1926, Dr. Berry became director of sanitary engineering for Ontario's first Department of Health, and is considered a visionary in the field of water treatment. Through his efforts, Ontario became a world leader in the chlorination of water and pasteurization of milk.

- By 1930, 70 Ontario municipalities had sewage treatment plants and 237 had water works. During the depression years, however, construction of new systems virtually ceased and failed to keep pace with urban growth.

- During the 1930s, a major effort by engineers was to find ways of improve the operation of filters by pre-treating water with alum prior to filtration; in ensuing years many other pre-treatment methods were developed.

- During World War II industrial waste was recognized as a source of water contamination.

- In 1943, the Ontario government amended the Municipal Act to allow municipalities to pay for water projects with "user pay" financing, rather than from general tax revenues, and by 1950 low cost loans for sanitary works were available through the Municipal Improvement Agency for sanitary works. From 1969 on, the province

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[23] Robert A. Goodings, P.Eng., "Historical development of water treatment in Canada", *Water & Sewage*, 1984

[24] ibid

[25] op. cit., Koci & Munchee, p. 3

provided financial assistance to municipalities for water works; projects that supplied treated water from central works to several area municipalities were encouraged.

- In 1956, Premier Leslie Frost established the Ontario Water Resources Commission. Its mission: to build, finance and operate water treatment and sewage disposal systems, and to supervise and control the use of the province's water resources. Dr. Berry was OWRC chief engineer and general manager from 1956 until his retirement in 1963.

- By 1972, there were 455 public water supply systems in Ontario, 70 operated by the province. That year OWRC's mandate was transferred to the newly formed Ontario Ministry of the Environment.

- Once disinfection using chlorination was well established (though not universal), the vanguard of water works engineering turned to the removal of turbidity (suspended particles that can harbour microbes), unwanted colour, dissolved minerals, heavy metals, dissolved radionuclides and particles such as asbestos. In the 1980s the focus turned to the removal of synthetic organics.[26]

- By the 1970s, some 23 Canadian municipalities (mainly in Quebec) had adopted ozonation for disinfecting their drinking water.

When expansion of water and sewage systems slowed in the 1970s and '80s, public attention turned to environmental issues and conservation, and the central role of engineers within municipal organization structures diminished. As a result, municipal engineers have experienced a significant decline in their influence within municipal bureaucracies, and at the political level.

By the late 20th century, deterioration of water works infrastructure had begun to set in. The need for vigilant monitoring and renewal of infrastructure was not always fully appreciated by water system managers and municipal politicians.

3(b) Where are engineers involved? What do they do?

Engineers and engineering are involved in virtually every aspect of drinking water production and distribution. This involvement can be loosely divided into three main areas:

1) technical, i.e., source protection/monitoring water system design, construction, operation, maintenance and renewal;
2) regulatory, i.e., standards, approvals; and
3) financial, i.e., the economics of water production & distribution, in particular, evaluating cost-effectiveness of various system options, the planning of new and replacement facilities, developing operating and capital works budgets.

3(b)i Design

Design criteria for wells, water treatment plants (including treatment processes) and components of the delivery system, are established by the Ministry of the Environment, and final designs are approved by the ministry. This process generally involves municipal engineers (in larger centres), an outside consulting firm hired by the

[26] op. cit., Robert A. Goodings

municipality, and MOE engineers. Provincial design criteria are adapted to specific project requirements in this iterative process.

At one time the Ministry of the Environment played a large role in the design process. It produced design guidelines and conducted research into operating problems, including leading edge work on treatment processes. These functions have now moved significantly to municipalities and their consultant(s), or have been taken up by private interests developing proprietary technology.

Consultants involved in design work often include a team of specialist engineers representing a range of disciplines (civil, structural, geology, etc.). In addition, engineers play an important role in peer review and value engineering -- assessment of the design and capacity of a treatment plant, for instance, in light of population projections, etc.

3(b)ii Construction

As a rule, the design engineers continue their involvement through the construction phase, while the contractor will generally have its own engineer(s). In addition, suppliers employ engineers who assist clients, designers and contractors in the selection of appropriate materials and equipment. MOE staff monitor work during construction, with a particular view to environmental problems such as water and air pollution.

A similar array of engineers is involved in design and construction on the distribution side of the system (reservoirs, trunk mains, water mains, etc.).

There are two general approaches to building water works infrastructure:

i) *design/build*: here the consulting engineer (outside consulting firm responsible for the design) and the contractor (firm that builds the structures) are partners on the project – this is a relatively new approach;

ii) *Traditional*: here the engineering firm that designs the project is retained separately from the contractor that builds it.

3(b)iii Commissioning period

The consulting engineer or firm is responsible for developing an operations manual for plant operators, covering site-specific procedures. Once a project is built and in service, fine-tuning is invariably required. The consulting engineer or firm that designed the project must certify that the project meets specifications, before final payments can be made. In addition, environmental impacts must be “confirmed” to ensure the project meets expectations; this work is done by MOE staff. If the project fails environmental tests, further work will be necessary.

Throughout this period, depending on the size and complexity of the project, several groups of engineers may be involved, including municipal engineers, consulting engineers, contracting engineers (who work for the contractor or builder of the project) and MOE engineers.

3(b)iv Ongoing operations

Though engineers are always involved in the design of water treatment plants and delivery systems, the picture is less clear when it comes to ongoing operations. In larger municipalities, staff who look after day-to-day operations (whether PUC employees or city staff) are normally managed by a professional engineer. This may not always be true for facilities administered by the Ontario Clean Water Agency (OCWA), or operated by a private sector firm. In the case of smaller facilities run by PUCs or municipalities themselves, the managers may or may not call in a consulting engineer to monitor operations and infrastructure on a regular basis. Some municipalities are bent on avoiding this cost.

At one time, in addition to regular monitoring by private sector engineers retained by municipalities, periodic inspections of water works operations were conducted by provincial engineers (MOE and its predecessor, the Ontario Water Resources Commission). The culture was such that an ongoing dialogue was maintained by MOE field staff, facility managers and their engineering staff and/or consultants. Today this collaborative working relationship has all but disappeared.

For large and small facilities alike, there is no actual requirement embedded in legislation or provincial regulations that a professional engineer be involved in ongoing operations and/or monitoring of water works facilities. Some will argue that such operations are captured within the definition of engineering in *the Professional Engineers Act*, and therefore must be supervised by a licensed professional engineer. As previously noted, however, the definition is subject to interpretation and produces wide differences of opinion as to which activities fall within the definition. This is seen by some as a deficiency of the legislation.

As mentioned previously, MOE's role in plant inspections and monitoring of operations is much reduced. Very few (if any) engineers remain among ministry field staff, while many municipalities, for financial reasons, are reluctant to retain engineers -- this being one professional service they think they can do without. Engineers may be called in only when emergencies arise, such as when serious taste and odour problems occur. Except in very large facilities, engineering has all but disappeared from the operations side of water works management. Clearly, we have all but abandoned preventative engineering and replaced it with crisis management.

3(b)v Infrastructure

As we begin this new century, "staggering numbers are emerging across the globe about the need for infrastructure spending."[27] In the U.S., the Water Infrastructure Network, a coalition of 29 organizations involved in water and wastewater infrastructure, estimates that over the next 20 years, US $460 billion will be needed for renewal of water and wastewater infrastructure.[28] In Ontario, a 1992 study by the Ontario Water Services Secretariat estimated the province's infrastructure investment cost for water and wastewater at $19 billion.[29]

Some municipalities such as the old City of Toronto have done an excellent job over the years of infrastructure renewal, with dedicated programs and budgets "held sacred" for

[27] op. cit. George Powell, quoting the U.S. Environmental Protection Agency
[28] *Clean & Safe Water for the 21st Century*, Water Infrastructure Network, April 2000
[29] op. cit. George Powell

upgrading and replacement. Others have shirked this responsibility – finding infrastructure renewal an easy target for cost-cutting.

In earlier years, the collaborative working relationship between MOE regional staff, municipal engineers and public works managers meant the ministry was well informed about local capital needs and potential risk to public safety. This led to development of a variety of financial assistance programs, which enabled many communities to upgrade their infrastructure and treatment facilities to meet water quality standards. Today ministry staff are less attuned to local capital needs (and operating problems). This reality, coupled with ongoing fiscal constraints faced by municipalities, creates a situation of some concern.

The role of engineers in infrastructure renewal is less clearly defined than it is in the original design and construction of facilities. Other than the new (August 2000) requirement that an engineer assess and report on the condition of water works systems every three years, there is no actual requirement in legislation or regulations that a professional engineer be involved in the design process and decision-making for replacements, modifications, extensions and upgrades to water systems. This is seen by some as a serious oversight.

A few years ago, system components could be replaced only with approval by the MOE. Often, by the time items need replacing, they have been *in situ* for a very long time, and simply replacing them with what was there before may not be adequate. Standards have changed, and decisions on how to proceed will often require engineering input. This also holds true when treatment processes and emergency back-up systems require upgrading. Allowable levels of trace elements and compounds, for instance, are constantly changing; when this happens, engineering judgement may be required to determine whether changes to treatment methods are needed and how this can best be accomplished.

On the distribution side, proper management requires continuous monitoring of the condition of the infrastructure, regular cleaning and maintenance, and ongoing infrastructure renewal. Periodic assessment of the capability of the system to supply water for fire fighting is also required. System owners and operators should be informed about the condition of the system on a regular basis, and each year a maintenance and renewal plan should be developed and implemented. Involvement by a professional engineer in overseeing the integrity of the distribution system is highly desirable.

3(b)vi Engineers & financial management of water systems

Setting water rates that take into account the need for infrastructure upgrades and renewal is not a straightforward task. It requires:

- knowledge of the physical components of a system;
- operating technologies;
- life cycle analysis and depreciation; and
- an understanding of the kinds of problems likely to develop if renewal is neglected.

In many municipalities, a stronger engineering component is needed in fiscal planning for water rates and infrastructure renewal programs. Engineering input is also required in determining costs to meet new standards -- reduction of contaminants/chemicals to lower levels, for example. Engineering judgement may also be of value in minimizing the risk of spending large sums unnecessarily or inappropriately.

3(b)vii Regulation/enforcement/standard setting

Engineers & the Ministry of the Environment
In past years, the Ministry of the Environment (MOE) provided, at no cost to municipalities, significant guidance, monitoring, and expert advice on the operation of municipal water works, particularly in smaller communities. Within the Ministry there existed a resident group of water experts (scientists and engineers) who provided leadership, innovation and direction on the management of the water systems. This knowledge was disseminated throughout the province (and internationally). Municipalities came to rely on it, and some to believe (mistakenly) that the provincial government is ultimately responsible for ensuring that municipal drinking water is safe.

This group of experts was also integral to the policy-making process, intervening when necessary to forestall unwise policy/program decisions that threatened to compromise the integrity of water systems. With government cutbacks, this pool of expertise, which fermented ideas and "cross-pollinated" with other ministry staff, was dispersed, resulting in the loss of a valuable provincial asset. Many of these experts were professional engineers -- now gone, due to cutbacks and downsizing, or retired and never replaced.

When MOE underwent cutbacks in the '90s, its staff were providing a range of services to local water utilities -- services that senior decision-makers in the ministry may not have been aware of, including:

- monitoring surface and ground water
- baseline research
- training of engineers & operators
- dissemination of information
- networking with international bodies
- input to the policy process
- acting as technical advisors to regulators, i.e. those developing guidelines & regulations
- assessment of risks associated with contemplated changes to processes & procedures, e.g. changes to monitoring and testing
- administration of capital assistance programs (grants)
- ongoing contact with system managers and operators, thereby keeping the ministry informed of capital needs and potential quality problems; conversely informing system owners of their responsibilities.

The ministry's Operations Division, which at one time operated water and sewage systems for many Ontario municipalities, once employed as many as 70 engineers. Today, its successor, the Ontario Clean Water Agency (OCWA), which administers many of those systems, employs only a handful. Part of this reduction is accounted for by the elimination of various grants programs administered by engineers. Nevertheless, the downsizing of engineering capability has been staggering.

In the early '90s, professional engineers in the public service received substantial salary increases (up to 40 per cent), with the result that many positions were downgraded to eliminate the requirement for a professional designation (known as "decredentializing"). Less qualified people moved into these redefined positions and gradually engineers disappeared from the Ministry of the Environment, except in the Approvals Branch and a few doing specialized policy work. In the ministry's regional offices, engineers are now all but extinct – and a measure of professional accountability has been eliminated with them. Apparently, government did not regard engineers as an important and necessary internal resource. Today there are very few, if any, engineers in senior levels at the ministry.

Hand-in-hand with the elimination of engineers from MOE's regional offices was the closure of the regional Water Resources Laboratories in Toronto, London, Thunder Bay, Sudbury and Kingston. These government-run labs provided numerous services to municipalities (free of charge), including water sample testing. They were an important resource to the system in terms of research, expertise, internal technology transfer, and dissemination of information. In addition, collaborative relationships developed between researchers, field staff, plant managers and operators; research projects often originated in problems brought to the labs by ministry field staff.

Times change, and few would argue with the need for governments to become more streamlined and to encourage private sector initiative. It must be recognized, however, that off-loading to the private sector has its limitations. The need to generate revenues dictates that industry does only what it gets paid for. Consulting engineers do not monitor the environment on their own accord, and only rarely do they develop new processes and treatments. If the government intends to encourage further privitization, and public-private partnerships, consideration must be given to the need for balance between public sector leadership and entrepreneurial energy.

In addition, when significant change is contemplated, a well-thought-out transition plan is needed to ensure that everyone involved understands their specific responsibilities with respect to water quality, and that policies and procedures are in place to ensure those responsibilities are met. The people of Ontario deserve nothing less.

4. What do professional engineers add?

4(a) Licensure

In addition to graduation from an accredited engineering program, a professional engineer (P.Eng.) has met the requirements for registration ("licensure") established by the *Professional Engineers Act* and administered by Professional Engineers Ontario, the regulatory body for engineering in Ontario. These requirements include four years of appropriate work experience, and successful completion of the Professional Practice Exam on law and ethics as applied to engineering.

A little known fact outside the engineering world is that not all engineering graduates go on to become licensed. Today, approximately 40 per cent of graduates eschew licensure (estimates vary), though these graduates sometimes call themselves engineers and may even do engineering work. By law, however, if their work falls within the definition of engineering as described in the Act, they should do so only under the supervision of a licensed professional engineer. Only licensed professionals may use the title, P.Eng.

Professional engineers subscribe to an ethic which dictates that their first and foremost responsibility is to safeguard public welfare and safety. Further, they must only undertake work for which they are qualified by virtue of training and experience -- to do otherwise is to risk disciplinary action.

4(b) Duty to report
Regulations under the Professional Engineers Act define professional misconduct as including: "failure to make reasonable provision for the safeguarding of life, health or property of a person who may be affected by the work for which the practitioner is responsible, and failure to act to correct or *report* a situation which the practitioner believes may endanger the safety or welfare of the public."[30] The latter is known as the "duty to report" and is an important part of the engineer's creed.

An issue related to the 'duty to report' is the potential conflict an engineer may face between the duty to maintain confidentiality regarding aspects of a client's business, and the engineer's duty to protect public welfare. The Act is clear that in such situations, duty to the public, i.e. duty to report, is paramount. While engineers are constantly mindful of this responsibility, one can surmise that some form of protection for those who exercise this duty, i.e. "whistle-blowing" legislation, would be helpful.

4(c) Professional accountability
A direct result of reduced involvement by professional engineers in the ongoing operations and monitoring on water systems, we believe, is reduced professional accountability within the system. Professional accountability implies a higher order of accountability than simple adherence to the demands and dictates of one's employer. It goes beyond personal integrity and striving for excellence (though these are important attributes). It means accountability to one's profession, peers, professional regulatory body, and ultimately (and most importantly), to society at large.

Unlike some other practitioners and technologists whose competence may be limited to a narrow band of expertise, a qualified water systems engineer (P.Eng.) possesses a broader understanding of system components, physical parameters, and the impact that events or conditions in one part of the system may have upon another. As the Walkerton episode has amply demonstrated, limited knowledge can have catastrophic consequences.

5. Recommendations

1. Stronger programs and greater vigilance by government and/or government agencies is needed to protect water sources of all types.

2. Consideration should be given to a requirement that farm structures and storage containers (including drainage ditches, ponds, storage or holding tanks, sewage and waste systems) and processes to digest, thicken and spread wastes, be designed by a professional engineer or other qualified person. A further mechanism is needed to ensure that structures are built in accordance with approved designs, and that processes are implemented as intended.

3. Consideration should be given to requiring a professional engineer's seal ("stamp") before water can be extracted via a well, pump house or water treatment plant , i.e.

[30] Ontario Regulation # 941 , sections 72-(2)(b) and 72-(2)(c)

before such an installation goes into service (this would require a change to the *Ontario Water Resources Act*). Currently, the only requirement is that such installations adhere to “sound engineering principles”, (*Ontario Drinking Water Objectives*) but there is no actual requirement that a professional engineer be involved. [Note: The Ministry of Environment and Energy’s 1994 document, *Water Management Policies, Guidelines, and Provincial Water Quality Objectives* (15 pages), updated in 1999, makes no mention of engineers.]

4. A requirement under the *Ontario Water Resources Act* that water treatment plants, wells, and other water facilities be designed by a licensed professional engineer, should be considered.

5. A provision under the *Ontario Water Resources Act* should be considered requiring that original designs for water facilities and distribution systems be sealed (“stamped”) by a professional engineer, and kept on record; the same should apply to designs for modifications and replacements to treatment plants and components of distribution systems.

6. A provision under the *Ontario Water Resources Act* should be considered requiring that a licensed professional engineer monitor the ongoing operation of water treatment plants and water distribution systems to identify problems and ensure adequate maintenance and renewal.

7. A provision under the *Ontario Water Resources Act* should be considered requiring that a licensed professional engineer be involved in the decision-making leading to the design and replacement of components of water systems, e.g. replacement of pipelines or chlorinators.

8. Ontario’s new water quality regulation (Ontario Regulation 459/00) introduced in August 2000, includes a requirement that all municipal water systems be assessed, and a report prepared by a licensed professional engineer every three years. More frequent reporting should be considered, and should include all parts of the distribution system.

9. A licensed professional engineer should be involved in corrective action for problems originating on the distribution side of the system, i.e. identifying the problem and developing a solution. Methods used to detect the problem and deal with it should be documented and maintained on record.

10. Some municipalities might consider the advantages of grouping together in a single organizational entity (inside or outside the municipal organization structure), certain user-pay, technical services, such as water, sewage and electricity, in order to attain the critical mass and economies of scale needed to support in-house professional expertise, including professional engineering.

11. Consideration should be given to introducing a standardized water works accounting system or agency to monitor spending on infrastructure renewal, to ensure that reinvestment in infrastructure is built into water rates. Short-term and long-term financial planning should include professional engineering input.

12. In addition to current classifications based on operator certification requirements and frequency of microbiological testing, water treatment plants and distribution systems

should be classified according to the degree of supervision/monitoring by a professional engineer required.

13. In the absence of engineering oversight by MOE regional offices, consideration should be given to creating an engineering position similar to that of the Medical Officer of Health, whose principal function would be to safeguard public health and safety – in matters related to engineering (including drinking water quality); this engineering officer would be independent of the local municipal organization structure, and would exercise independent authority.

14. Local boards of health should consider the potential benefits of actively recruiting licensed professional engineers to serve as volunteer board members, in order to provide the engineering perspective on municipal health issues having an engineering component.

15. Consideration should be given to the development of “whistle-blowing” legislation, i.e. protection for engineers (and possibly other professionals) who exercise their ‘duty to report’ in order to protect public welfare.

NOTE: *A number of the recommendations above suggest that consideration be given to requiring that professional engineers undertake certain activities within the water supply system. We note as a precedent the Occupational Health and Safety Act, which includes numerous requirements for approval/review/design by a professional engineer (many have come about due to accidents in the manufacturing and construction industries).*

One example is a recent amendment to the OH&S Act which requires that a Pre-start Health and Safety Review be conducted by a professional engineer prior to manufacturing equipment going into service, following installation or modification. In 2000, the Ministry of Labour completed stakeholder consultations to determine the kinds of situations that would trigger an engineering review, demonstrating that it is possible to define circumstances that would (and would not) require such reviews. A similar approach could be taken in defining circumstances in water supply operations, maintenance and infrastructure renewal that require intervention by a professional engineer.

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Appendix 1 Organizations/agencies involved in drinking water supply

1. American Public Works Association (APWA)
2. Association of Geoscientists of Ontario
3. Canadian Bottled Water Association
4. Canadian Water and Wastewater Association (CWWA)
5. Ontario Clean Water Agency (OCWA)
6. Ontario Groundwater Association
7. Ontario Municipal Engineers Association
8. Ontario Municipal Water Works Association (OMWA)
9. Ontario Water Works Association (OWWA)
10. Professional Engineers Government of Ontario (PEGO)
11. Professional Engineers Ontario (PEO)
12. Safe Drinking Water Foundation
13. Water Environment Association of Ontario

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