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Drinking Water Quality Standards in Ontario – Are They Tough?

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SUMMARY

The Government of Ontario has started the process of legislating the Ontario Safe Drinking Water Act, as recommended in the second part of the Walkerton Report. Several regulations have been passed in the current year. However, the question still remains as to whether we have established safe drinking water standards compared to other jurisdictions.

In this report, several chemical parameters with potential risk to human health including heavy metals and organic pollutants like insecticides, herbicides and other persistent organic chemicals are compared. There are a few examples like beryllium, molybdenum, nickel, endothall, endrin, hexachlorobenzene and toxaphene, for which, no standard is set by authorities either in Ontario or in Canada. Most of these chemicals have the potential to cause serious health problems.

A matter of even more serious concern is the higher Maximum Acceptable Concentration (MAC) values of most of the pesticide residues and other persistent organic chemicals. These chemicals are highly persistent in the environment and are found in animal tissues at several locations in Canada. Most of these chemicals are carcinogenic and possibly cause immunotoxicity and endocrine disruption affecting reproductive and nervous systems. The presence of these chemicals in drinking water is, therefore, completely unacceptable. The Ontario standard limits as well as the Canadian guideline values for most of the carcinogenic organic chemicals are higher than the USEPA standard and/or WHO guideline value. There are at least nine organic chemicals for which the MAC values in Ontario are at least one order of magnitude higher than the MAC suggested by WHO. We, therefore, wonder if the available scientific data on health risk associated with the ingestion of specific parameters are not properly evaluated or that we have a different definition of risk.

No new organic chemical having pronounced health effects has been considered for inclusion in the Ontario Drinking Water Standards by the Ontario Ministry of the Environment in the Safe Drinking Water Act. Further, none of the existing organic chemicals has been revised for tougher standards. The Ontario standards seem to be derived from the Canadian Drinking Water Guidelines determined by the federal-provincial agenda. As the federal-provincial agenda is based on consensus and not only on scientific inputs, there is a need to go beyond this agenda by adopting more scientific method for formulation of standards. If safe drinking water remains a top priority of the Ontario government, there must be adequate legislation regarding the standards.

Introduction

Protection of drinking water quality is the constitutional responsibility of the Government. Traditionally, the provincial governments in Canada have taken the lead in regulating most aspects of the safety of drinking water. This lead responsibility by the provinces is consistent with the allocation of powers set out in the Constitution. In particular, section 92 of the Constitution provides the province with a broad jurisdiction over drinking water safety (O'Connor, 2002). Accordingly, the provincial governments legislate on drinking water standards, water treatment and distribution. However, the Federal Government has set guidelines that serve as the basis for formulation of standards in the provinces and territories. The process of developing guidelines for different microbiological, chemical/physical and radiological parameters is based on risk management concepts and involves the scientific assessment of the health risk associated with the ingestion of specific parameters in drinking water.

The people of Ontario had the self-complacency of drinking safe water from the tap until the Walkerton incident in May 2000, when seven people died and about 2300 people fell sick due to bacterial contamination of drinking water. This led to the Walkerton Inquiry by Justice Dennis O'Connor, who recommended efficient treatment, distribution and monitoring among other things to ensure the safety of Ontario's drinking water.

In Ontario, a version of the Canadian Drinking Water Quality Guidelines was incorporated as an objective into the Ontario Drinking Water Objectives (ODWO) until shortly after Walkerton, when they were extended and incorporated into law under Ontario Water Resources Act (O'Connor, 2002). Drinking Water Standards were established to protect the public health through the provision of safe drinking water. As stated in the provincial document, water intended for human consumption shall not contain disease-causing organisms or unsafe concentrations of toxic chemicals or radioactive substances (MOE, 2001). However, the Walkerton incident and subsequent Walkerton Inquiry Report have raised questions about monitoring the quality of drinking water. The Government of Ontario started the process of legislating the Ontario Safe Drinking Water Act in October 2002, as recommended in the second part of the Walkerton Report. The Premier of Ontario announced on October 29, 2002, "the government will introduce legislation with tough new standards to protect Ontario's drinking water" (Ontario, 2002). While introducing the Safe Drinking Water Act in the Ontario provincial parliament later the same day, the Environment Minister announced, "Safe drinking water remains a top priority of this government and the government is committed to ensuring that Ontario has, and enforces, the best and toughest clean water policies in the world" (MOE, 2002). However, the question still remains as to whether we have established the safest and toughest drinking water standards compared to other jurisdictions, as claimed by our Premier and the Minister of the Environment.

A clean drinking water policy includes tough regulatory standards for drinking water quality, efficient treatment, monitoring, analysis, reporting, and above all, transparency in the whole process. In the present paper, we have considered the first aspect, i.e. the policy on regulatory standards. A few different standards and guidelines have been compared to determine the existing gaps in the Ontario Drinking Water Standards. The Ontario Drinking Water Standards (ODWS), the new Ontario Drinking Water Standards (NODWS) under Safe

Drinking Water Act, 2002, United States Environment Protection Agency Drinking Water Standards (USDWS), United States Environment Protection Agency Drinking Water Quality Goals (USDWG), Canadian Drinking Water Quality Guidelines (CDWG) and World Health Organization Drinking Water Quality Guidelines (WHODWG) were chosen for the study. A few selected chemical parameters with potential risk to human health including heavy metals and organic pollutants like insecticides, herbicides and other persistent organic chemicals were compared. The purpose was to review some of the standards set by the authorities, identify the missing parameters and parameters with higher concentration limits and also to identify any health risk associated with these parameters.

Standards and Guidelines

The Canadian Drinking Water Quality Guidelines (CDWG) have been established by the Federal-Provincial-Territorial Committee on Drinking Water and approved by the Federal-Provincial-Territorial Committee on Environmental and Occupational Health. The Committee is comprised of representatives from all provinces and territories as well as from Health Canada and Environment Canada. Each recommended guideline value and its accompanying health risk assessment has been evaluated for its practicality and impacts and is established through a consensus development process (Canada, 2002).

The Drinking Water Standards in Ontario are based on the Canadian Drinking Water Quality Guidelines with a few modifications. These standards were established to assist with meeting the legislated requirements governing water works under the Ontario Water Resources Act in order to provide safe drinking water (MOE 2001). Ontario participates in the development of CDWG and adopts them as Ontario drinking water standards. They are regularly reviewed by the Ontario Ministry of the Environment (Broomer, 2003). However, it is unclear as to what procedure or methodology is followed when an existing parameter of CDWQG is not adopted or a new parameter is included in the Ontario standards. It is also unclear what additional scientific data are considered for this process of modification. Ontario Drinking Water Standards published by the Ontario Ministry of the Environment (Publication No. 4065e) do not mention the methodology adopted by the Ministry for such deviation from CDWG. O'Connor (2002) has recommended in Part 2 of the Walkerton Report the creation of an advisory council for this purpose. This has not yet been established. There is provision for it in the Safe Drinking Water Act and when it is established, the current process for standard setting will accommodate it (Broomer, 2003).

The drinking water standards established by the USEPA specify the maximum contaminant level (MCL) of different parameters in drinking water. These are enforceable standards in USA, i.e. legal action can be taken for violation of the MCL for any specific parameter. These standards are based on considerations of health risk as well as available treatment technology and cost. The Maximum Concentration Level Goal established by the USEPA denotes the level of a contaminant, below which there is no known or expected risk to health. These goals allow a margin of safety and are not legally enforceable (EPA, 2002).

The World Health Organization Drinking Water Quality Guidelines (WHODWG) were established through participation of numerous institutions and experts. For each contaminant or parameter, a draft document evaluating the risks for human health from exposure to the contaminant in drinking water was prepared. Canada was one of the countries that prepared such evaluation documents. The draft evaluation documents were reviewed by several scientific institutions and selected experts and finally approved by the Review Group. During the preparation and review of evaluation documents, careful consideration was given to previous risk assessments carried out by the International Program on Chemical safety (IPCS), the International Agency for Research on Cancer, the joint FAO/WHO Meetings on Pesticide Residues and joint FAO/WHO Expert Committee on Food additives (WHO, 1996).

In the present study, the standards and guidelines (Tables 1 and 2) are taken from the Ontario Drinking Water Standards (MOE 2001), the new Drinking Water Protection Regulation under the Safe Drinking Water Act, 2002 (MOE 2003b), United States Environmental Protection Agency list of contaminants and their maximum contaminant level (EPA 2002) and World Health Organization's guidelines for drinking water quality (WHO 1996).

Source of Chemicals in Drinking Water

Pathogenic contamination of water represents the most significant risk to human health; however, there have been numerous cases of poisoning and disease outbreaks due to direct or indirect ingestion of water contaminated with chemicals. There are historical examples of Minamata and Itai-Itai diseases, but in general, health problems associated with chemical contaminants arise only after prolonged periods of exposure, unless contamination is severe. Significantly, some of these chemical contaminants are potential carcinogens and some are causative agents of endocrine disruption, potentially causing developmental and reproductive problems.

Drinking water in Canada and Ontario mostly originates from surface water, although close to 30% of Ontario's residents rely on ground water as a source of drinking water (Goss et al., 1998). A number of chemical compounds have been identified in ground and surface waters in North America. Chemical Contaminants in water originate from both point sources and non-point sources. Point sources are discrete and easily identifiable sources, such as industrial, municipal sewage treatment plants, mining and drilling. Non-point sources, which are diffuse in nature, include agricultural activities, forestry, urban runoff, combined sewer overflows and atmospheric deposition. In addition, there are other activities like construction and habitat modification which form both point and non-point sources of pollution through soil erosion and sedimentation. Chemicals coming from point and non-point sources to ground or surface waters find their way into the drinking water through numerous pathways (Ritter *et al*., 2002).

Inorganic Chemicals

Toxic metals such as cadmium, chromium, mercury and anions like nitrate, sulphate, cyanide and fluoride are examples of inorganic chemicals likely to contaminate drinking water. Some of these are present in natural water due to soil erosion and runoff. For example, sulphate is commonly found in unpolluted water at low concentrations. However, most of the toxic inorganics come from manures, fertilizers and discharges from various industries. Some chemicals such as bromate and chlorite are also formed as byproducts during the disinfection process. Some inorganics like fluoride are essential for human health, albeit up to certain concentration. However, most of the toxic metals and anions have the potential to cause serious health related problems and their presence in drinking water is undesirable. It is, therefore, necessary to regulate the concentration of these chemicals in the drinking water. On comparing the Ontario standards with other standards and guidelines, we found the following differences (Table 1).

There was no standard for antimony in Ontario till May 2003, although an interim maximum acceptable concentration (IMAC) of 0.006 mg/L was established by the Canadian Drinking Water Quality Guidelines as early as 1997. This value equals the standard value set by the USEPA. Discharges from petroleum refineries and fire retardants are the known sources of antimony in drinking water. Ontario is home to several petroleum refineries that fall within the airshed of Lake Ontario, which is one of the major sources of drinking water in Ontario. The lake water is, therefore, likely to be contaminated with antimony, although some dilution is expected to occur. Antimony could result in adverse health effects such as an increase in blood cholesterol and a decrease in blood sugar (EPA, 2000). Neither the existing drinking water standards nor the drinking water standards proposed in January 2003 (MOE, 2003a) under the Safe Drinking Water Act, 2002 included a standard for antimony; however, antimony has lately been adopted by MOE in May 2003. The reason why it was not adopted earlier is not clear. According to MOE, the supporting document for Antimony was not made available by Health Canada to Ontario till 2003 (MOE, 2003c). An IMAC was established by the CDWG in 1997 and Ontario was a party in this process. Was the IMAC established without any supporting document? Or, should we blame Health Canada who took six years to provide this document to the province?

Beryllium is another toxic metal for which no standard has been established in Ontario. The Canadian Drinking Water Quality Guidelines have also skipped this metal. Discharges from metal refineries and coal burning factories and also discharges from electrical, aerospace and defence industries release this toxic metal to the environment. Although beryllium is included as a parameter for the Ontario Provincial Water Quality Monitoring Network and the Drinking Water Surveilance Program, its presence in drinking water is not regulated by an established standard. Beryllium is a toxic metal having the potential to form intestinal lesions if present in the drinking water (EPA, 2002). The USEPA has established a MCL of 0.004 mg/L for beryllium.

Neither the Ontario Drinking Water Standards nor the Canadian Drinking Water Quality Guidelines have included the metal thallium. This is a metal responsible for hair loss, changes in blood and also liver, intestine and liver problems (EPA, 2002), and is found in the leaching from ore-processing sites, discharges from electronics, glass and drug factories. The USEPA has fixed a MCL of 0.002 mg/L while the Maximum Concentration Level goal is set at 0.0005 mg/L.

The new Ontario Drinking Water Standards (MOE, 2003b) in Ontario include the revised MAC for uranium (0.02 mg/L), which is lower than the previous MAC value of 0.1 mg/L and the USEPA standard of 0.03 mg/L. However, this is still higher than the WHO guideline value of 0.002 mg/L. The other chemicals for which the standards have been established or revised are bromate and fluoride. Although Ontario has now set a standard for bromate, there is no standard for chlorite, another disinfection by-product.

Arsenic, barium, boron and cadmium are the metals for which the MAC value is higher than the guideline values recommended by WHO. Molybdenum and nickel are the other two metals missing in the list of standards in Ontario as well as the Canadian Guidelines.

MAC for cyanide (0.2 mg/L) is higher than the WHO Guideline value of 0.07 mg/L although it conforms to the Canadian Drinking Water Quality Guidelines as well as the USEPA standards. As cyanide is a highly toxic inorganic ion responsible for nerve damage and thyroid problems (EPA, 2002), this is a matter of concern.

Some Inorganic Chemicals for which no MAC is Currently Set in Ontario

Beryllium
Molybdenum
Nickel
Thallium
Chlorite

Organic Chemicals

Organic chemicals likely to contaminate drinking water are typically sourced from pesticide residues, discharge from various industries, leachate from landfills and runoff from other sources. The major environmental problem associated with these organic chemicals is their high degree of persistence and their resistance to biodegradation. Many of these chemicals, if present in the source water, could form secondary toxic organics during the disinfection process (Canada, 1995). Although it would be ideal to have drinking water completely devoid of toxic organic chemicals, it is highly crucial that their concentrations be adequately regulated by the Government. The difference observed in the standard and guideline values of organic chemicals are presented in table 2.

Atrazine has been detected in Ontario's drinking water (Goss *et al.*, 1998). Runoff from row crops, where atrazine has been applied, is identified as the primary source of contamination. The residues of this herbicide, when present in drinking water, could adversely affect the cardiovascular system and could cause reproductive problems as well. However, the interim MAC for atrazine (0.005 mg/L) established by the Ontario Drinking Water Standards as well as Canadian Drinking Water Quality Guidelines is higher than the USEPA standard of 0.003 mg/L and the WHO guideline value of 0.002 mg/L. As atrazine could cause damage to cardiaovascular and reproductive systems (EPA, 2002), there is a need to establish firm standards for this chemical. Recent scientific research has indicated adverse impacts of atrazine on aquatic ecosystem (Graymore *et al.*, 2001). Justice O'Connor also warned in his report that atrazine might be a health risk in some parts of Ontario (O'Connor, 2002)

Similarly, the MAC for carbofuran (0.09 mg/L) is also higher than the US standard of 0.04 mg/L and WHO guideline value of 0.007 mg/L. Carbofuran is a broad spectrum carbamate pesticide used in agriculture for the control of pests and the treatment of soil at planting time to control root maggots, wireworms and some species of nematodes. The intake of carbofuran could lead to problems with blood, nervous and reproductive systems (EPA, 2002).

The interim MAC for cyanizine (0.01 mg/L) fixed by the Ontario Drinking Water Standards and the Canadian Drinking Water Quality Guidelines is much higher than the WHO guideline value of 0.0006 mg/L. Cyanizine, a triazine herbicide like atrazine, is used for weed control in crop and non-crop areas.

The interim MAC of 0.01 mg/L set by the Ontario Drinking Water Standards and the Canadian Drinking Water Quality Guidelines for another triazine herbicide, simazine, is also much higher than both the USEPA standard of 0.004 mg/L and the WHO guideline of 0.002 mg/L. Simazine is used for pre-emergence weed control in annual row crops. Simazine is the least soluble of all the triazine herbicides and is easily leached into the groundwater where it remains persistent for years (MOE, 2001).

The MAC for 1,1 dichloroethylene (0.014 mg/L) set by both the Ontario Drinking Water Standards and the Canadian Drinking Water Quality Guidelines is much higher than the USEPA standard of 0.007 mg/L. This chemical is discharged from chemical factories and is known to cause liver problems (EPA, 2002). No MAC has been set by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines for the cis and trans isomers of 1,2 dichloroethylene. These two chemicals, typically discharged from chemical factories, are also capable of causing liver problems (EPA, 2002).

The MAC value established by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines for Diquat (0.07 mg/L) is also higher than the respective MAC value set by USEPA (0.02 mg/L). Diquat is a bipyridilium herbicide used primarily as a crop desiccant in seed crops. Also used as an aquatic herbicide, this chemical has the potential of causing the development of cataracts, if ingested (EPA, 2002).

The MAC fixed for Dinoseb (0.01 mg/L) by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines is also higher than the respective MAC value set by USEPA (0.007 mg/L). Although Dinoseb is no longer in use in Ontario, it is used in nearby areas in the US as a herbicide on soybean and vegetable crops. This chemical may cause reproductive difficulties (EPA, 2002).

The interim MAC of 0.1 mg/L is fixed by the Ontario Drinking Water Standards as well as the Canadian Drinking Water Quality Guidelines for 2,4 D (2,4 dichlorophenoxy acetic acid). This value is higher than both the USEPA standard value of 0.07 mg/L and WHO guideline value of 0.03 mg/L. 2,4 D is capable of causing serious kideney, liver or adrenal gland problems (EPA, 2002) and is a commonly used chlorophenoxy herbicide applied on cereal crops and lawns for the control of broadleaf weeds.

The MAC for lindane (0.004 mg/L) by the Ontario Drinking Water Standards is much higher than USEPA standard of 0.0002 mg/L. Surprisingly, no MAC is set for lindane by the Canadian Drinking Water Quality Guidelines. This organochlorine insecticide, the gamma-isomer of hexachlorocyclohexane, is used on cattle, lumber and gardens. It is also used for seed treatment and in the pharmaceutical preparations of human lice and mite shampoos. Known to cause liver or kidney problems (EPA, 2002), lindane is highly persistent in the soil and aquatic environment (WHO, 2003).

Both Ontario and Canada have fixed a much higher MAC (0.003 mg/L) for heptachlor plus its metabolite heptachlor epoxide than the USEPA and WHO. USEPA has set separate guidelines for heptachlor (0.0004 mg/L) and heptachlor epoxide (0.0002 mg/L). This soil insecticide, although banned in Canada in 1969, is a highly persistent organochlorine compound with potential health hazards including kidney damage and an increased risk of cancer (EPA, 2002).

The MAC limit for methoxychlor (0.9 mg/L) by the Ontario Drinking Water Standards as well as the Canadian Drinking Water Quality Guidelines is also higher than the USEPA standard of 0.04 mg/L. This organochlorine insecticide is used on fruits, vegetables, alfalfa and livestock, and as a larvicide or adulticide against black flies and mosquitoes. It is capable of causing reproductive difficulties and damage to liver, kidney and heart tissues (EPA, 2002). Although described as non-persistent and non-accumulative in biological tissues by the Government of Ontario (MOE, 2001), methoxychlor residues might persist in topsoil for up to 14 months. Anaerobic biodegradation products of methoxychlor have half-lives ranging from 1 week to 2 months. In water, methoxychlor is lost mainly through volatilization, the half-life for volatilization from shallow waters being 4-5 days. However, aerobic degradation of methoxychlor is much slower; the half-lives are longer than three months. Methoxychlor may be ingested by some aquatic organisms and bio-accumulated, except in fish (WHO, 2003).

The IMAC for metolachlor (0.05 mg/L) established by both Ontario and Canada is higher than the WHO guideline value of 0.01 mg/L. Known to contaminate both surface and ground water, metolachlor has already been detected in drinking water samples from Ontario (Goss *et al.*, 1998)

The MAC established by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines for pentachlorophenol (0.06 mg/L) is also higher than both the USEPA standard of 0.001 mg/L and the WHO guideline value of 0.009 mg/L. Capable of causing liver or kidney problems and an increased risk of cancer (EPA, 2002). Pentachlorophenol has been extensively used as a pesticide and wood preservative.

Similarly, MAC values for trichloroethylene (0.05 mg/L) and tetrachloroethylene (0.03 mg/L) set by Ontario Drinking Water Standards as well as the Canadian Drinking Water Quality Guidelines are higher than USEPA standard limit of 0.005 mg/L for both these chemicals. Both trichloroethylene and tetrachloroethylene are used in metal cleaning/ degreasing operations and in dry cleaning find their way to water sources through discharge from factories and dry cleaners. They have the potential to cause liver problems and an increased risk of cancer (EPA, 2002). The fact that both Canada and Ontario have a less strict standard for trichloroethylene than the United States in spite of the fact that its occurrence in the Ottawa River was brought to attention of authorities by the Sierra Legal Defence Fund (Mittelstaedt, 2002) and this

Compromising with Public Health? – Higher MAC in Ontario for these Organic Chemicals with Potential Health Hazard

Aldrin + Dieldrin
Atrazine
Carbofuran
1,1 Dichloroethylene
Cyanizine
DDT
Diquat
Dinoseb
2,4 D
Heptachlor + Heptachlor epoxide
Lindane
Methoxychlor
Metolachlor
PCBs
Pentachlorophenol
Simazine
Trichloroethylene

was also included in the Walkerton Inquiry Report (O'Connor, 2002).

Polychlorinated biphenyls (PCBs) are among the most ubiquitous and persistent pollutants in the global ecosystem. Although no longer manufactured or used, PCBs were extensively used in the past for a variety of purposes. The residues of these highly persistent chemicals still pose a threat to aquatic environments. However, the Ontario Drinking Water Standards as well as the Canadian Drinking Water Quality Guidelines have fixed the interim MAC fixed for PCBs at 0.003 mg/L, which is much higher than the USEPA standard of 0.0005 mg/L. PCBs are known to cause skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties (EPA, 2002) and also an increased risk of cancer (EPA, 2002; Rothman *et al*., 1997). Studies have shown higher levels of PCBs in people of Ontario (Kearney *et al*., 1999). Although contaminated fish is the primary source of human intake of PCB, ingestion through contaminated drinking water cannot be ruled out.

The MAC values prescribed by Ontario for the highly persistent organochlorine pesticides Aldrin (plus its metabolite dieldrin) and DDT (and its metabolites) are also one magnitude higher than the respective WHO guideline values.

Ontario has set a MAC for chlordane (0.007 mg/L), which is higher than the USEPA standard (0.002 mg/L). It is also higher than the WHO guideline value of 0.0002 mg/L by one order of magnitude. Although Chlordane is capable of causing liver or nervous problems and an increased risk of cancer (EPA, 2002), this chemical has not been included by the Canadian guidelines.

Neither the Ontario Drinking Water Standards nor the Canadian Drinking Water Quality Guidelines has fixed a MAC limit for endrin. Although the use of endrin is banned since long, it belongs to the highly persistent organochlorine group of pesticides. Endrin causes serious liver problems (EPA, 2002).

Dalapon, endothall and toxaphene are other examples of pesticides for which no MAC has been prescribed by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines. Toxaphene, used as an insecticide on cotton and cattle, could cause kidney, liver or thyroid problems and an increased risk of cancer (EPA, 2002). Dalapon, used as a herbicide, has got the potential for minor kidney changes (EPA, 2002). The other herbicide endothall, which could contaminate water bodies through runoff, creates stomach and intestinal problems when ingested (EPA, 2002). Although some of these chemicals are not used in Ontario, they are used in the United States. Therefore, they are likely to contaminate water bodies that are common to the U.S. and Ontario, such as the Great Lakes.

1,2 Dichloropropane (1,2 DCP) is another highly toxic chemical for which no MAC has been set by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines. Discharge from chemical factories is the major source of this contaminant in water. It has been detected in surface water and drinking water in many parts of the world including North America (WHO, 1998). The USEPA has set a goal of zero concentration for 1,2 Dichloropropane in drinking

Organic Chemicals for which no MAC is set in Ontario

Dalapon
1,2 Dichloroethylene
1,2 Dichloropropane
Endothall
Endrin
Hexachlorobenzene
Toxaphene

water while the MAC is 0.005 mg/L. This chemical has the potential to enhance the risk of cancer (EPA, 2002). It also affects the central nervous system, liver and kidney (WHO, 1998)

There is no standard set by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines for hexachlorobenzene. Discharges from metal refineries and agricultural chemical factories are the principal sources of hexachlorobenzene. It is capable of causing liver or kidney problems, reproductive difficulties and is known to increase the risk of cancer (EPA, 2002).

Discussion and Conclusions

In general, the MAC for metals and anions by the Ontario Drinking Water Standards or the Canadian Drinking Water Quality Guidelines are on par with the USEPA standards. In a few cases, such as barium and chromium, the MAC values prescribed by Ontario or Canada are even lower than the respective limits set by USEPA, however, the value for barium still exceeds the WHO guideline value.

There are a few examples like beryllium, molybdenum and nickel for which no standard has been set by authorities either in Ontario or in Canada. Most of these metals have the potential of causing serious health problems, and therefore the potential to attract the attention of the authorities for action. Contamination of Ontario surface water and groundwater by a few of these metals such as nickel, are well known (Nriagu *et al*., 1998), although MOE maintains that there is no requirement to monitor for nickel and molybdenum (MOE, 2003c).

Ontario has a tougher standard than the USEPA and/or WHO for a few organic chemicals such as aldicarb and benzo(a)pyrine. However, the fact that higher MAC values are prescribed by Ontario for most of the pesticide residues and other persistent organic chemicals, is a matter of serious concern. These chemicals are highly persistent in the environment and are found in animal tissues at several locations in Canada, even in the Arctic region (Braune *et al*., 1999, Macdonald *et al*., 2000, Hobbs *et al*., 2001, Hoekstra, 2003). Most of these chemicals are carcinogenic and possibly cause immunotoxicity and endocrine disruption affecting reproductive and nervous systems (Carpenter, 1998)). Their presence in drinking water is completely unacceptable as evinced by the Maximum Contaminant Level Goal (MCLG) of zero set by the USEPA.

As stated by the USEPA office of water, MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. When determining an MCLG, the EPA considers the risk to sensitive subpopulations (infants, children, the elderly, and those with compromised immune systems) of experiencing a variety of adverse health effects If there is evidence that a chemical may cause cancer, and there is no dose below which the chemical is considered safe, the MCLG is set at zero. In case a chemical is carcinogenic but a safe dose can be determined, the MCLG is set at a safe level above zero (EPA, 2002).

Again, while establishing a legal standard, the USEPA goes through several steps to first determine whether setting a standard is appropriate for a particular contaminant, and if so, what the standard should be. Peer-reviewed science and data support an intensive technological evaluation, which includes many factors: occurrence in the environment; human exposure and risks of adverse health effects in the general population and sensitive subpopulations; analytical methods of detection; technical feasibility; and impacts of regulation on water systems, the economy and public health (EPA, 2002).

For substances that are considered to be carcinogenic, the WHO guideline value is the concentration in drinking water associated with an excess lifetime cancer risk of 10^{-5}, i.e. one additional cancer per 100, 000 of the population that ingests drinking water containing the substance at the guideline value for 70 years (WHO, 1996). These values are based on computer models and are rough estimates of cancer risk.

For other toxic chemicals, the guidelines are based on a tolerable daily intake (TDI), which is an estimate of the amount of a substance in food or drinking-water, expressed on a body weight that can be ingested daily over a lifetime without appreciable health risk. In developing the guideline values for potentially hazardous chemicals, a daily *per capita* consumption of 2 L by a person weighing 60 kg was generally assumed. The higher intakes, and hence exposure, for infants and children apply for only a limited time. This period may, however, coincide with greater sensitivity to some toxic agents and less for others. Irreversible effects that occur at a young age will hold a great social and public health significance than those that are delayed. Where it was judged that this segment of the population was at a particularly high risk from exposure to certain chemicals, the guideline value was derived on the basis of a 10-kg child consuming 1 L per day or a 5-kg infant consuming 0.75 L per day. The corresponding daily fluid intakes are higher than for adults on a body weight basis (WHO, 1996).

Derivation of MAC for the Canadian Drinking Water Guidelines was based on a daily intake of 1.5 L of drinking water by a 70-kg adult, although intake by the most sensitive subpopulation e.g. pregnant women and children was considered where appropriate (Canada, 2002). Different methods of calculating ADI could result in minor differences in MAC values; however, this would not explain huge differences. Again, assuming 1.5 L of drinking water intake for the calculation of ADI may not be just right.

There are nine organic chemicals for which the MAC values in Ontario are at least one order of magnitude higher than the MAC suggested by WHO. As the Ontario standard limits as well as the Canadian guideline values for most of the carcinogenic organic chemicals are higher than the USEPA standard or WHO guideline value, we wonder if the available scientific data are not properly evaluated or that we have a different definition of risk. In such a case, we are of the view that it would be more prudent to depend on the evaluation of scientific data by other prominent jurisdictions like the USA or the international evaluation by WHO. It is beyond argument that when the extent of danger is not accurately established, it is preferable to err on the side of caution rather than err on the side of risk in accordance with the internationally recognized *Precautionary Principle*.

It may be noted that WHO has recently reviewed the guidelines (WHO, 2003). Guideline values for some of the parameters such as, diquat and heptachlor have been dropped, however, health based values have been established for these chemicals.

Justice O'Connor has recommended (recommendation 26) adopting standards for contaminants that are not on the current federal-provincial agenda (O'Connor, 2002). However, no new organic chemical having pronounced health effects has been considered for inclusion in the Ontario Drinking Water Standards by the Ontario Ministry of the Environment in the Safe Drinking Water Act. Further, none of the existing organic chemicals has been revised for tougher standards.

The process of developing drinking water guidelines in Canada is a flexible process that must accommodate diverse needs of federal, provincial and territorial jurisdictions. Although Health Canada is responsible for preparing the health risk assessments based on careful consideration of the available scientific data, the Federal-Provincial Subcommittee on Drinking Water is accountable for the evaluation and approval of the drinking water guideline values. The guidelines are finally established through a consensus development process and certain guideline values are modified to satisfy the needs of the jurisdictions involved. As this federal-provincial agenda is based on consensus and not only on scientific inputs, there is a need to go beyond this agenda by adopting more scientific method for formulations of standards. Justice O'Connor has also hinted to this regard in his report. He has also recommended setting up an Advisory Council for this purpose, which has yet to be established. Again, regular monitoring of surface water, groundwater and treated drinking water for residues of chemicals is a prerequisite for any review. At present, monitoring programs for the detection of pesticide residues in treated drinking water are virtually nonexistent in Ontario, although metals and disinfection by-products are measured (Ritter *et al*., 2002). Also, there is no systematic monitoring of organic contaminants in surface waters of Ontario (Molot *et al*., 2001)

According to MOE (MOE, 2003c), however, the Ministry has a significant database for the monitoring of pesticides and other parameters for which there are no established standards under the Drinking Water Surveillance Program. The average concentrations of most of the chemicals for which there are no established standards in Ontario are well below the respective detection limits. The ministry is well aware of the concentration of these chemicals. We are of the opinion that the people of Ontario should be aware of the concentration of these chemicals in water and sole awareness by the Ministry is insufficient. The detailed reports of the Drinking Water Surveillance Program need to be posted on the Ministry's website.

We also disagree with the notion of MOE that there is no requirement to monitor for chemicals such as, beryllium, thallium, molybdenum, nickel, 1,2 dichloropropane, and hexachlorobenzene or to establish a standard for these chemicals as average concentration of these chemicals are below respective detection limits. Considering the range of concentrations would be more useful than considering the average concentrations. Again, According to the USEPA Office of Water, legally enforceable drinking water standards (called Primary Standards by the USEPA) are developed to protect drinking water quality by limiting the levels of specific contaminants that are known or anticipated to occur in water and can adversely affect public health. The above listed chemicals are anticipated to occur in water and have known adverse effects on health.

An argument put forward by the MOE is that WHO does not consider the technology component and its guidelines are only health based. While establishing a standard in Ontario, availability of treatment methods and the cost of monitoring are taken into account. This argument does not hold good for many chemicals like beryllium, thallium, 1,2 dichloropropane, hexachlorobenzene and toxaphene as methods are available for their treatment and MOE is already monitoring these chemicals in the drinking water (MOE, 2003c).

Monitoring and Reporting is an integral part of maintaining drinking water standards. Results of monitoring of drinking water must be readily available to the public. The results of the Provincial Water Quality Monitoring Network should also be available so that the public is aware of the quality of the source water for drinking water plants. Recent release of hundreds of kilograms of vinyl chloride monomer from a Canadian company into the St. Clair River during the blackout of August 2003 (AP, 2003; DFP, 2003), discharge of ethylene dichloride in June 2003, and spill of benzene in April 2003 to the same river (AP, 2003) cast doubt over the monitoring and reporting mechanism of MOE. It was reported by the press that some residents along the river fell ill because of these chemicals. It may be noted that vinyl chloride and benzene are known carcinogens.

It is also necessary to monitor the components of the environment for new chemicals as different types of chemicals are introduced to our environment each year. Recent research reports have raised concern about the presence of pharmaceuticals (Christensen, 1998; Hirsch *et al*., 1999; Zuccato *et al*., 2000; Dietrich *et al*., 2002), personal care products (Weigel *et al*., 2002), hormones (Ternes *et al*., 1999), and rare earth elements (Bau and Dulski, 1996; Kümmerer and Helmers, 2000; Nozaki *et al*., 2000) in the environment. All these chemicals introduced to the environment eventually find their way into drinking water (Heberer, 2002; Webb *et al*., 2003).

While introducing the Safe Drinking Water Act in the Ontario provincial parliament in October 2002, the Environment Minister announced, "Safe drinking water remains a top priority of this government and the government is committed to ensuring that Ontario has, and enforces, the best and toughest clean water policies in the world" (MOE, 2002).

We appreciate the intention and initiatives taken by the Government of Ontario, particularly MOE, to address all of the recommendations from the Walkerton Inquiry. However, we are of the opinion that it is too early to claim that Ontario has the best and toughest clean water policies in the world. Words must be substantiated by adequate legislation regarding the standards and efficient monitoring as well. Obviously the drinking water standards in Ontario are not the toughest as many of the MAC values are higher than the MAC prescribed by USEPA and/or WHO. If we set standards with higher maximum acceptable concentrations, we would deceive ourselves by believing that we have the best and toughest clean water standards in the world.

Suggestions

- The Advisory Council for Drinking Water Standards should be formed as soon as possible as recommended in the Walkerton Inquiry Report. The scientific evidences, priorities and methodologies should be examined in detail to establish new tough standards in Ontario.

- The annual report of the Drinking Water Surveillance Program should be more elaborate and include the ranges of concentration of all chemicals monitored with adequate interpretation. It should be available to the public on the Ministry's website.

- The Government in power should ensure that standards are in place before it claims that Ontario has achieved the toughest clean water standards in the world. It also needs to have established a completely reliable and transparent system throughout the province.

As mentioned earlier in this report, a clean drinking water policy includes tough regulatory standards for drinking water quality, efficient treatment, monitoring, analysis, reporting, and above all, transparency in the whole process. In the present paper, we have considered only one aspect. Other aspects of the clean water policy will be considered in future reports.

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Table 1
DRINKING WATER STANDARDS AND GUIDELINES (INORGANIC)

(All standard/guideline MAC values are expressed as mg/L)

	Arsenic	Antimony	Barium	Boron	Beryllium	Cadmium	Chromium	Lead	Mercury	Molybdenum	Nickel	Selenium	Thallium	Uranium	Bromate	Chlorite	Cyanide	Fluoride
Ontario DWQS (2001)	0.025^{i}		1.0	5.0^{i}		0.005	0.05	0.01	0.001			0.01		0.1			0.2	1.0±.2
Ontario DWQS (Safe Drinking Water Act, 2002)	0.025	0.006*	1.0	5.0^{i}		0.005	0.05	0.01	0.001			0.01		0.02	0.01		0.2	1.5
Canadian DWQG	0.025^{i}	0.006^{i}	1.0	5.0^{i}		0.005	0.05	0.01	0.001			0.01		0.02^{i}	0.01^{i}		0.2	1.5
USEPA DWQS	0.01	0.006	2.0		0.004	0.005	0.1	0.015	0.002			0.05	0.002	0.03	0.01	1.0	0.2	4.0
USEPA DWQG		0.006	2.0		0.004	0.005	0	0	0.002			0.05	0.0005	0.0	0.0	0.8	0.2	4.0
WHO DWQG	0.01^{i}	0.005^{i}	0.7	0.5		0.003	0.05^{i}	0.01	0.001	0.07	0.02^{i}	0.01		0.002^{i}	0.025^{i}	0.2^{i}	0.07	1.5

Superscript i denotes interim maximum acceptable concentration
* Adopted in May 2003

Table 2
DRINKING WATER STANDARDS AND GUIDELINES (ORGANIC)

(All standard/guideline MAC values are expressed as mg/L)

	Alachlor	Aldicarb	Aldrin + Dieldrin	Atrazine	Benzene	Benzo(a)pyrene	Carbofuran	Carbon Tetrachloride	Chlordane	Cyanazine	Dalapon	DDT + Metabolites	1,2Dichlorobenzene	1,4Dichlorobenzene	1,2Dichloroethane	1,1Dichloroethylene	1,2Dichloroethylene cis	1,2Dichloroethylene trn	Dichloromethane	2,4 D (Dichlorophenoxyacetic acid)	1,2 Dichloropropane	Dinoseb	Diquat
Ontario DWQS (2001)	0.005[i]	0.009	0.0007	0.005[i]	0.005	0.00001	0.09	0.005	0.007	0.01[i]		0.03	0.2	0.005	0.005[i]	0.014			0.05	0.1[i]		0.01	0.07
Ontario DWQS (Safe Drinking Water Act, 2002)	0.005	0.009	0.0007	0.005	0.005	0.00001	0.09	0.005	0.007	0.01		0.03	0.2	0.005	0.005	0.014			0.05	0.1		0.01	0.07
Canadian DWQG		0.009	0.0007	0.005[i]	0.005	0.00001	0.09	0.005		0.01[i]			0.2	0.005	0.005[i]	0.014			0.05	0.1[i]		0.01	0.07
USEPA DWQS	0.002			0.003	0.005	0.0002	0.04	0.005	0.002		0.2		0.6	0.075	0.005	0.007	0.07	0.1	0.005	0.07	0.005	0.007	0.02
USEPA DWQG	0.0			0.003	0.0	0.0	0.04	0.0	0.0		0.2		0.6	0.075	0.0	0.007	0.07	0.1	0.0	0.07	0.0	0.007	0.02

WHO DWQG	0.02	0.01	0.00003	0.002	0.01	0.0007	0.007	0.002	0.0002	0.0006		0.002		0.3	0.03				0.02	0.03	0.04[i]		0.10

Superscript i denotes interim maximum acceptable concentration

Table 2 (Contd.)

DRINKING WATER STANDARDS AND GUIDELINES (ORGANIC)

(All standard/guideline MAC values are expressed as mg/L)

	Endothall	Endrin	Heptachlor +H.E.	Heptachlor	Heptachlor Epoxide	Hexachlorobenzene	Lindane	Methoxychlor	Metolachlor	Metribuzin	Monochlorobenzene	Nitrilotriacetic acid (NTA)	Pentachlorophenol	PCBs	Picloram	Simazine	Tetrachloroethylene	Tetrachlorophenol	Toxaphene	Trichloroethylene	Tricholorphenol	Trifluarin	Trihalomethanes	Vinyl Chloride
Ontario DWQS (2001)			0.003				0.004	0.9	0.05[i]	0.08	0.08	0.4	0.06	0.003[i]	0.19[i]	0.01[i]	0.03	0.1		0.05	0.005	0.045[i]	0.1[i]	0.002
Ontario DWQS (Safe Drinking Water Act, 2002)			0.003				0.004	0.9	0.05	0.08	0.08	0.4	0.06	0.003	0.19	0.01	0.03	0.1		0.05	0.005	0.045	0.1	0.002
Canadian DWQG								0.9	0.05[i]	0.08	0.08	0.4	0.06		0.19[i]	0.01[i]	0.03	0.1		0.05	0.005	0.045[i]	0.1[i]	0.002
USEPA DWQS	0.1	0.002		0.0004	0.0002	0.001	0.0002	0.04			0.1		0.001	0.0005	0.5	0.004	0.005		0.003	0.005			0.1	0.002
USEPA DWQG	0.1	0.002		0.0	0.0	0.0	0.0002	0.04			0.1		0.0	0.0	0.5	0.004	0.0		0.003	0.0				0.0

WHO DWQG			0.00003			0.001	0.002	0.02	0.01		0.3	0.2	0.009^{i}			0.002						0.02		0.005

Superscript i denotes interim maximum acceptable concentration