

# **Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines**

**June 2003**



**Ministry of the  
Environment**

## TABLE OF CONTENTS

1. ONTARIO DRINKING-WATER QUALITY STANDARDS, OBJECTIVES AND GUIDELINES .....	1
1.1 Introduction.....	1
1.2 Types of standards, objectives and guidelines.....	1
2. WATER QUALITY CHARACTERISTICS .....	3
2.1 Microbiological characteristics.....	3
2.2 Chemical characteristics .....	4
2.3 Physical characteristics .....	5
2.4 Radioactive characteristics.....	5
2.5 Aesthetic characteristics and other considerations .....	6
3. WATER MONITORING.....	6
3.1 Raw water characterization.....	6
3.2 Rationale for water monitoring.....	6
Table 1 - Microbiological Standards .....	8
Table 2 - Chemical Standards.....	8
Table 3 - Radionuclide Standards.....	11
Table 4 - Chemical/Physical Objectives and Guidelines.....	12
APPENDIX A - Description of Individual Parameters .....	15
ANNEX A - Microcystin-LR Flow Chart .....	37
GLOSSARY .....	38

## **1. ONTARIO DRINKING-WATER QUALITY STANDARDS, OBJECTIVES AND GUIDELINES**

### **1.1 Introduction**

The primary purpose of the Ontario Drinking Water Standards, Objectives and Guidelines is to provide information for the protection of public health through the provision of safe drinking water. Water intended for human consumption shall not contain disease-causing organisms or unsafe concentrations of toxic chemicals or radioactive substances. Water should also be aesthetically acceptable and palatable. Taste, odour, turbidity and colour are parameters that, when controlled, result in water which is clear, colourless and without objectionable or unpleasant taste or odour. Other aspects of water quality such as corrosiveness, a tendency to form incrustations and excessive soap consumption should be controlled on the basis of economic considerations because of their effects on the distribution system and/or the intended domestic and industrial use of the water.

Parameters and their associated standards and objectives are listed alphabetically in Tables 1 through 4. A brief description is provided for these parameters in Appendix A. Some parameters, such as alkalinity, pH and taste, which do not have specific objectives, are listed because for them there is an ideal condition or range for water treatment plant operation or aesthetic water quality.

This document is intended to provide supporting documentation for the Ontario Drinking-Water Quality Standards Regulation O. Reg. 169/03 and serve as a reference for the design and operation of water treatment plants to produce water that continuously satisfies the standards, objectives and guidelines of drinking-water quality. This document also makes reference to the Procedure for Disinfection of Drinking Water in Ontario.

This document should also serve as a reference for professional engineers preparing Engineers' Evaluation Reports as in accordance with Schedule 21 of the Drinking-water Systems Regulation O. Reg. 170/03 or for a Ministry engineer in reviewing applications for approval of drinking-water systems.

In carrying out their responsibilities related to drinking water, the owner/operator of a drinking-water system should consider the drinking-water quality standards, objectives and guidelines to assess acceptability of the water.

### **1.2 Types of standards, objectives and guidelines**

Standards, objectives and guidelines are considered to be the minimum level of drinking-water quality and in no way should be regarded as implying that allowing the degradation of a high quality water supply to the specified level or range is acceptable. The standards, objectives and guidelines described herein have been derived from the best information currently available. Society continues to introduce new chemicals into the environment that have a potential to

contaminate drinking water supplies. Advances in technology may identify new micro-organisms that are pathogenic or that affect the quality of drinking water. Standards, objectives and guidelines are reviewed as new data becomes available. Criteria used to evaluate the safety of drinking water are continually reassessed as new parameters are identified and health effects research advances. Drinking-water quality criteria must consider all factors that affect the quality of water and the public health significance.

This document addresses the following types of health-based standards:

### **Maximum Acceptable Concentration (MAC)**

The MAC is established for parameters which when present above a certain concentration, have known or suspected adverse health effects. The length of time the MAC can be exceeded without health effects will depend on the nature and concentration of the parameter.

### **Interim Maximum Acceptable Concentration (IMAC)**

The IMAC is established for parameters either when there are insufficient toxicological data to establish a MAC with reasonable certainty, or when it is not feasible, for practical reasons, to establish a MAC at the desired level.

Ontario Regulation 169/03 under the *Safe Drinking Water Act* prescribes MACs and IMACS as standards of Ontario Drinking-water Quality.

### **Turbidity**

The substances and particles that cause turbidity can be responsible for significant interference with disinfection, can be a source of disease-causing organisms and can shield pathogenic organisms from the disinfection process.

Turbidity is an important indicator of treatment efficiency and the efficiency of filters in particular. A significant relationship has been demonstrated between turbidity increases and the number of *Giardia* cysts and *Cryptosporidium* oocysts breaking through filters. Operational Guidelines for turbidity as an indicator of the efficiency of filters in relation to credits for *Giardia* cysts and *Cryptosporidium* oocysts removal have been provided in the “Procedure for Disinfection of Drinking Water in Ontario”.

Ontario Regulation 170/03 prescribes turbidity as an adverse result if the drinking-water system is required to provide filtration, and a result indicates that turbidity exceeds 1.0 Nephelometric Turbidity Units (NTU) in:

- i. a grab sample of water taken from a filter effluent line: or,

- ii. the latter of two samples of water from a filter effluent line taken 15 minutes apart and tested by continuous monitoring equipment.

The aesthetic objective, established for turbidity, is applicable to all water at the point of consumption (see Table 4).

This document addresses the following types of objectives:

### **Aesthetic Objective (AO)**

AOs are established for parameters that may impair the taste, odour or colour of water or which may interfere with good water quality control practices. For certain parameters, both aesthetic objectives and health-related MACs have been derived.

### **Operational Guidelines (OG)**

OGs are established for parameters that, if not controlled, may negatively effect the efficient and effective treatment, disinfection and distribution of the water.

The MACs / IMACs for microbiological parameters are listed in Table 1, chemical parameters in Table 2 and radionuclides in Table 3. Aesthetic objectives and operational guidelines are listed in Table 4. These parameters are discussed in Appendix A.

## **2. WATER QUALITY CHARACTERISTICS**

### **2.1 Microbiological characteristics**

The microbiological quality of drinking water is the most important aspect of drinking water because of its association with waterborne diseases. Typhoid fever, cholera, enteroviral disease, bacillary and amoebic dysentery, and many varieties of gastrointestinal diseases, can all be transmitted by water. Numerical limits for viruses and protozoa are not proposed at this time, however, it is desirable that no virus or protozoa be present in drinking water and therefore minimum removal or inactivation of *Giardia* cysts, *Cryptosporidium* oocysts and viruses is required in accordance with the Drinking-water Systems Regulation, O. Reg. 170/03 and the Procedure for the Disinfection of Drinking Water in Ontario.

Microbiological examination of drinking water is of value in determining the cause of objectionable tastes and odours, clogging of filters, and restricted flow within a water supply system. Low concentrations of microorganisms may reside in water distribution systems after drinking water treatment. These organisms have not been found to correlate with illness or outbreaks of disease, but may be indicative of bacterial regrowth. The population of microorganisms within a water supply system can be controlled to some extent by reducing

nutrients entering the system, maintaining the distribution system integrity and keeping the distribution system clean.

Bacterial re-growth and certain species of algae, protozoa and other microorganisms can cause problems within the water treatment plant and distribution system such as clogged filters and unpleasant taste and odour. In addition, iron bacteria can cause discoloration, turbidity, taste problems or form slime and iron oxide accumulations in pipes, thus reducing the capacity of the system. Sulphate reducing bacteria can contribute to the corrosion of water mains and create taste and odour problems. Macro-organisms such as nematodes, which may not pose a direct health risk, may harbour pathogenic viruses and bacteria shielding them from disinfectants.

Nuisance organisms are particularly difficult to control once they become established within the distribution system. It is difficult to specify any quantitative limit on these organisms because individual species of microorganisms differ widely in their ability to produce undesirable effects. Many of the problems caused by nuisance organisms are covered by the objectives on the physical characteristics of water.

## **2.2. Chemical characteristics**

Certain chemicals are potentially toxic and may adversely affect human health. Heavy metals and substances such as cyanide, some commonly occurring organic compounds and many less common organic and organometallic parameters are potentially hazardous in drinking water. It is desirable to control the intake of these potentially toxic chemicals from drinking water because the intake from other sources such as milk, food or air may be difficult to avoid. In general, total environmental exposure, food intake, and possible adverse effects from long-term exposure have been taken into consideration in deriving the standard.

Inorganic parameters may be naturally present in water or be present as a result of industrial, urban or agricultural activities, or other discharges.

Organic parameters are present to some degree in all municipal water supplies. Industrial and municipal waste, urban and agricultural run-off, and the natural decomposition of biological matter all contribute to the organic content. Synthetic organic chemicals can also be present in drinking water as a result of certain water treatment practices. Most synthetic organic chemicals detected in drinking water are present at low concentrations.

Drinking water should be free of pesticides and every effort should be made to prevent pesticides from entering raw water sources.

The presence of some chemical parameters may be aesthetically objectionable, interfere with water treatment processes, corrode distribution systems or stain fixtures and plumbing. Colour, taste and odour problems tend to be associated with high levels of organic substances.

### **2.3 Physical characteristics**

Physical characteristics are most often used by consumers to judge water quality. The acceptability of drinking water to consumers still depends to a large degree on colour, clarity, taste, odour and temperature.

Physical characteristics may have an effect on or could be associated with other aesthetic parameters. Colour, for example, may be related to the presence of iron or manganese. Temperature affects taste and odour perceptions. Corrosion and incrustations, which, in turn, affect colour, taste and odour, can be directly related to pH.

The physical characteristics of water, colour, odour, taste and temperature are primarily aesthetic parameters but they may have indirect impact on health related parameters. For example, temperature affects the rate of growth of micro-organisms, while some colour-producing and naturally occurring organic parameters are precursors for disinfection by-products such as trihalomethanes.

The substances and particles that cause turbidity can be responsible for significant interference with disinfection, can be a source of disease-causing organisms and can shield pathogenic organisms from the disinfection process

A raw water supply which is ground water with very low organic content may contain inorganic-based turbidity, which may not seriously hinder disinfection. For such waters, an Operational Guideline for turbidity is not established. Since groundwater quality is inherently stable, any significant variation in turbidity, excluding pump startup, should be investigated and analyzed immediately for the potential of surface water influence and the presence of organic particles.

Inorganic turbidity formed during the disinfection process or post-disinfection treatment processes through oxidation and chemical participation would not likely interfere with disinfection effectiveness.

Certain physical characteristics may also interfere with treatment processes resulting in increased operating costs.

### **2.4 Radioactive characteristics**

There are more than 200 radionuclides. Some occur naturally while others are products from human activities such as mining and nuclear energy production.

Ingestion of radionuclides in drinking water may cause cancer in individuals exposed and hereditary genetic changes in their children. The probability of inducing such effects is assumed to be proportional to the radiation doses delivered to sensitive organs and tissues. It is assumed that no threshold exists below which the probability of induced effects is zero.

In Ontario, standards have been set for radionuclide concentrations to protect consumers of drinking water from unacceptable risks. In keeping with the philosophy of the International Commission on Radiological Protection (ICRP), levels should be as low as is reasonably achievable given the economic and social considerations, but should not exceed the standard.

## **2.5 Aesthetic characteristics and other considerations**

The water quality characteristics discussed in this section do not directly affect the safety of a water supply but may cause aesthetically objectionable effects or render water unsuitable for domestic use. The primary goal in setting objectives on the basis of aesthetic considerations is to produce a drinking water that is pleasant to consumers. Compliance with these objectives may result in associated health benefits. Pleasing aesthetic qualities will promote consumer confidence in their drinking-water system and discourage the use of unregulated water sources.

Aesthetic objectives (AO) have been derived for a number of chemical and physical parameters/characteristics that affect the aesthetic quality of drinking water or interfere with good water quality control practices. The existence of objectives as defined above should not be regarded as implying that the quality of the drinking water may be degraded to the specified levels. In fact, a continuous effort should be made to promote the highest possible quality in drinking water. An aesthetic objective should not be exceeded when more suitable supplies are, or can be made available at a reasonable cost.

## **3. WATER MONITORING**

### **3.1 Raw water characterization**

In a multiple barrier system for providing safe drinking water, the selection and protection of a reliable, high quality drinking water source is the first barrier. When considering the suitability of a raw water supply, a raw water characterization that includes an analysis of all physical, chemical and microbiological parameters included in Tables 1, 2 and 4 should be conducted. Testing for gross alpha and gross beta should be undertaken to determine whether the testing for the radionuclides listed in Table 3 is required. In addition, this characterization will enable the design of any further treatment that may be required, including impacts that any parameter may have on the treatment processes.

### **3.2 Rationale for water monitoring**

The basic objective of water monitoring is to determine whether drinking water delivered to the consumer is safe and aesthetically pleasing. Monitoring is carried out to:

- assess compliance with Ontario legislation, regulations, policies, legal instruments

- and guidelines;
- control the treatment process to ensure achievability of the desired water quality and to monitor treatment efficiency by measuring and recording:
  - flow rates (e.g. filter rate, backwash rate, chemical feed rate, air flow rate, etc.); and,
  - operational parameters (e.g. elapsed time, turbidity, particle count, pH, temperature, conductivity, residual aluminum, disinfectant residual, UV light dose etc.);
- define cause and effect relationships, thereby aiding in the identification of appropriate remedial action;
- determine ongoing trends and identify changes in water quality;
- provide an early warning of the development of deteriorating conditions;
- identify treatment needs and modifications in frequency of monitoring as a result of change and/or degradation of the raw water source; and
- secure public confidence and respond to complaints.

There are three basic locations at which drinking-water systems should be sampled:

- raw water prior to treatment;
- treated water leaving the treatment facility;
- at applicable process unit control points within the treatment facility and;
- distribution water delivered to the consumer.

Sampling of the distributions system should occur throughout the system at varied locations to ensure a representative cross section of system is being monitored. Samples should not normally be taken from the same points on each occasion.

Raw water sampling and analysis provides: a measure of source water quality which allows assessment and adjustment of treatment processes; information on the source of contaminants; and long-term trend analysis in source water quality. When combined with the treated water data, the treatment ability and efficiency in the removal of chemical contaminants and removal or inactivation of pathogenic organisms can be assessed and the creation of by-products from the treatment process or unwanted residuals from treatment chemicals identified.

A free flowing sample taken at the consumer's tap provides information on those parameters that are known to change during distribution (e.g., THMs, disinfectant residual) and a measure of the effect of the distribution system on drinking water quality.

It should be noted that, depending on the source (ground or surface water), raw water quality and other site specific considerations, the list of parameters, frequency of sampling and number of sampling locations may vary greatly from site to site.

<b>TABLE 1 – MICROBIOLOGICAL STANDARDS</b>	
<b>PARAMETER</b>	<b>MAC</b>
<i>Escherichia coli</i> ( <i>E. coli</i> )	not detectable
Fecal Coliform	not detectable
Total Coliform	not detectable
General bacteria population expressed as background colony counts on the total coliform membrane filter	200 colony forming units (CFU) per 100 millilitres
General bacteria population expressed as colony counts on a heterotrophic plate count	500 colony forming units (CFU) per millilitre

<b>TABLE 2 – CHEMICAL STANDARDS</b>		
<b>PARAMETER</b>	<b>MAC (mg/L)</b>	<b>IMAC (mg/L)</b>
Alachlor		0.005
Aldicarb	0.009	
Aldrin + Dieldrin	0.0007	
Antimony		0.006
Arsenic		0.025
Atrazine + N-dealkylated metabolites		0.005
Azinphos-methyl	0.02	
Barium	1	
Bendiocarb	0.04	
Benzene	0.005	
Benzo(a)pyrene	0.00001	
Boron		5
Bromate		0.01
Bromoxynil		0.005
Cadmium	0.005	
Carbaryl	0.09	
Carbofuran	0.09	
Carbon Tetrachloride	0.005	
Chloramines	3	
Chlordane (Total)	0.007	

<b>TABLE 2 – CHEMICAL STANDARDS</b>		
<b>PARAMETER</b>	<b>MAC (mg/L)</b>	<b>IMAC (mg/L)</b>
Chlorpyrifos	0.09	
Chromium	0.05	
Cyanazine		0.01
Cyanide(free)	0.2	
Diazinon	0.02	
Dicamba	0.12	
1,2-Dichlorobenzene	0.2	
1,4-Dichlorobenzene	0.005	
Dichlorodiphenyltrichloroethane (DDT)+metabolites	0.03	
1,2-Dichloroethane		0.005
1,1-Dichloroethylene(vinylidene chloride)	0.014	
Dichloromethane	0.05	
2,4-Dichlorophenol	0.9	
2,4-Dichlorophenoxy acetic acid(2,4-D)		0.1
Diclofop-methyl	0.009	
Dimethoate		0.02
Dinoseb	0.01	
Dioxin and Furan		0.000000015 <sup>a</sup>
Diquat	0.07	
Diuron	0.15	
Fluoride	1.5 <sup>b</sup>	
Glyphosate		0.28
Heptachlor + Heptachlor Epoxide	0.003	
Lead	0.01 <sup>c</sup>	
Lindane (Total)	0.004	
Malathion	0.19	
Mercury	0.001	
Methoxychlor	0.9	
Metolachlor		0.05
Metribuzin	0.08	
Monochlorobenzene	0.08	

<b>TABLE 2 – CHEMICAL STANDARDS</b>		
<b>PARAMETER</b>	<b>MAC (mg/L)</b>	<b>IMAC (mg/L)</b>
Microcystin-LR	0.0015	
Nitrate (as nitrogen)	10.0 <sup>d</sup>	
Nitrite (as nitrogen)	1.0 <sup>d</sup>	
Nitrate + Nitrite (as nitrogen)	10.0 <sup>d</sup>	
Nitrilotriacetic Acid (NTA)	0.4	
N-Nitrosodimethylamine (NDMA)		0.000009
Paraquat		0.01
Parathion	0.05	
Pentachlorophenol	0.06	
Phorate		0.002
Picloram		0.19
Polychlorinated Biphenyls (PCB)		0.003
Prometryne		0.001
Selenium	0.01	
Simazine		0.01
Temephos		0.28
Terbufos		0.001
Tetrachloroethylene (perchloroethylene)	0.03	
2,3,4,6-Tetrachlorophenol	0.1	
Triallate	0.23	
Trichloroethylene	0.05	
2,4,6-Trichlorophenol	0.005	
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0.28	
Trifluralin		0.045
Trihalomethanes	0.100 <sup>e</sup>	
Uranium	0.02	
Vinyl Chloride	0.002	

Short forms:  
mg/L - milligrams per litre

**Footnotes:**

- a) Total toxic equivalents when compared with 2,3,7,8-TCDD (tetrachlorodibenzo-p-dioxin).
- b) Where fluoride is added to drinking water, it is recommended that the concentration be adjusted to 0.5 - 0.8 mg/L the

Technical Support Document for Ontario Drinking-water Quality Standards, Objectives and Guidelines

optimum level for control of tooth decay. Where supplies contain naturally occurring fluoride at levels higher than 1.5 mg/L but less than 2.4 mg/L the Ministry of Health and Long Term Care recommends an approach through local boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources.

- c) This standard applies to water at the point of consumption. Since lead is a component in some plumbing systems, first flush water may contain higher concentrations of lead than water that has been flushed for five minutes.
- d) Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen).
- e) This standard is expressed as a running annual average of quarterly samples measured at a point reflecting the maximum residence time in the distribution system.

<b>TABLE 3 – RADIONUCLIDE STANDARDS</b>					
<b>NATURAL RADIONUCLIDES</b>					
<b>PARAMETER</b>	<b>MAC (Bq/L)</b>	<b>PARAMETER</b>	<b>MAC (Bq/L)</b>	<b>PARAMETER</b>	<b>MAC (Bq/L)</b>
Beryllium-7	4000	Radium-226	0.6	Thorium-234	20
Bismuth -210	70	Radium-228	0.5	Uranium-234	4
Lead-210	0.1	Thorium-228	2	Uranium-235	4
Polonium-210	0.2	Thorium-230	0.4	Uranium-238	4
Radium-224	2	Thorium-232	0.1		
<b>ARTIFICIAL RADIONUCLIDES</b>					
<b>PARAMETER</b>	<b>MAC (Bq/L)</b>	<b>PARAMETER</b>	<b>MAC (Bq/L)</b>	<b>PARAMETER</b>	<b>MAC (Bq/L)</b>
Americium-241	0.2	Iodine-125	10	Selenium-75	70
Antimony-122	50	Iodine-129	1	Silver-108m	70
Antimony-124	40	Iodine-131	6	Silver-110m	50
Antimony-125	100	Iron-55	300	Silver-111	70
Barium-140	40	Iron-59	40	Sodium-22	50
Bromine-82	300	Manganese-54	200	Strontium-85	300
Calcium-45	200	Mercury-197	400	Strontium-89	40
Calcium-47	60	Mercury-203	80	Strontium-90	5
Carbon-14	200	Molybdenum-99	70	Sulphur-35	500
Cerium-141	100	Neptunium-239	100	Technetium-99	200
Cerium-144	20	Niobium-95	200	Technetium-99m	7000
Cesium-131	2000	Phosphorus-32	50	Tellurium-129m	40
Cesium-134	7	Plutonium-238	0.3	Tellurium-131m	40
Cesium-136	50	Plutonium-239	0.2	Tellurium-132	40
Cesium-137	10	Plutonium-240	0.2	Thallium-201	2000

Chromium-51	3000	Plutonium-241	10	Tritium	7000
Cobalt-57	40	Rhodium-105	300	Ytterbium-169	100
Cobalt-58	20	Rubidium-81	3000	Yttrium-90	30
Cobalt-60	2	Rubidium-86	50	Yttrium-91	30
Gallium-67	500	Ruthenium-103	100	Zinc-65	40
Gold-198	90	Ruthenium-106	10	Zirconium-95	100
Indium-111	400				

**Notes on Table 3:**

Radionuclide concentrations that exceed the MAC may be tolerated for a short duration, provided that the annual average concentrations remain below the MAC and the restriction (see immediately below) for multiple radionuclides is met.

Restrictions for multiple radionuclides - If two or more radionuclides are present, the following relationship based on International Commission on Radiological Protection (ICRP) Publication 26, must be satisfied and if not satisfied, it shall be considered to be exceedence of an MAC.

$$\frac{c_1}{C_1} + \frac{c_2}{C_2} + \dots + \frac{c_i}{C_i} \leq 1$$

Where,  $c_1$ ,  $c_2$ , and  $c_i$  are the observed concentrations, and  $C_1$ ,  $C_2$  and  $C_i$  are the maximum acceptable concentrations for each contributing radionuclide.

<b>PARAMETER</b>	<b>AO</b> (mg/L - unless otherwise specified)	<b>OG</b> (mg/L - unless otherwise specified)
1,2-Dichlorobenzene	0.003 <sup>a</sup>	
1,4-Dichlorobenzene	0.001 <sup>a</sup>	
2,4-Dichlorophenol	0.0003 <sup>a</sup>	
2,3,4,6-Tetrachlorophenol	0.001 <sup>a</sup>	
2,4,6-Trichlorophenol	0.002 <sup>a</sup>	
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	0.02 <sup>a</sup>	
Alkalinity (as CaCO <sub>3</sub> )		30-500
Aluminum		0.1

<b>TABLE 4 – CHEMICAL / PHYSICAL OBJECTIVES AND GUIDELINES</b>		
<b>PARAMETER</b>	<b>AO</b> (mg/L - unless otherwise specified)	<b>OG</b> (mg/L - unless otherwise specified)
Chloride	250	
Colour	5 TCU	
Copper	1	
Dissolved Organic Carbon	5	
Ethylbenzene	0.0024	
Hardness (as CaCO <sub>3</sub> )		80-100
Iron	0.3	
Manganese	0.05	
Methane	3L/ m <sup>3</sup>	
Monochlorobenzene	0.03 <sup>a</sup>	
Odour	Inoffensive	
Organic Nitrogen		0.15
pH		6.5-8.5 (no units)
Pentachlorophenol	0.03 <sup>a</sup>	
Sodium	b	
Sulphate	500 <sup>c</sup>	
Sulphide	0.05	
Taste	Inoffensive	
Temperature	15 °C	
Toluene	0.024	
Total Dissolved Solids	500	
Turbidity	5 NTU <sup>d</sup>	e
Xylenes	0.3	
Zinc	5	

Short Forms:

NTU - Nephelometric Turbidity unit

**Footnotes:**

- a) Refer to Table 2 for standard
- b) The aesthetic objective for sodium in drinking water is 200 mg/L. The local Medical Officer of Health

Technical Support Document for Ontario Drinking-water Quality Standards, Objectives and Guidelines

- should be notified when the sodium concentration exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets
- c) When sulphate levels exceed 500 mg/L, water may have a laxative effect on some people
  - d) Applicable for all waters at the point of consumption.
  - e) The Operational Guidelines for filtration processes are provided as performance criteria in the Procedure for Disinfection of Drinking Water in Ontario.

## **APPENDIX A – DESCRIPTION OF INDIVIDUAL PARAMETERS**

Detailed supporting documentation for most of the parameters listed can be obtained through Health Canada at [http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch\\_pubs/dwgsup\\_doc/dwgsup\\_doc.htm](http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/dwgsup_doc/dwgsup_doc.htm).

### **Alachlor** (herbicide)

The interim maximum acceptable concentration (IMAC) for alachlor in drinking water is 0.005 mg/L. This IMAC was developed in February 1985 by Health Canada, at the request of the Ontario government, in response to detection of this herbicide in municipal and private drinking water. Alachlor is a chloroacetanilide herbicide used mainly on corn and soybeans to control the growth of weeds. It is applied to cornfields prior to corn emergence to kill annual grasses. Alachlor is a proven animal carcinogen and a possible human carcinogen. In November of 1985, the use of alachlor was banned in Canada.

### **Aldicarb** (insecticide)

The maximum acceptable concentration for aldicarb in drinking water is 0.009 mg/L. Aldicarb is a carbamate insecticide used in relatively low quantities for the control of specified insects. It was used on potatoes as well as on sugar beets and greenhouse ornamentals for aphid and root maggot control. Since aldicarb is highly soluble in water, persistent and mobile in soils, it has a high potential to enter ground water supplies. Available evidence suggests that aldicarb is not carcinogenic. The use of aldicarb was withdrawn by the manufacturer in the late 1980s.

### **Aldrin + Dieldrin** (insecticide)

The maximum acceptable concentration for aldrin+dieldrin in drinking water is 0.0007 mg/L. Aldrin and dieldrin are organochlorine pesticides used to control soil insects. Aldrin is not often found in aquatic systems because it quickly oxidizes to dieldrin, which is very persistent. Most uses of aldrin and dieldrin were banned in Ontario in 1969 except for termite control under appropriate circumstances. This remaining use was banned in Ontario in April 1994.

### **Alkalinity** (inorganic)

Alkalinity is a measure of the resistance of the water to the effects of acids added to water. The recommended operational range for alkalinity in coagulant-treated drinking water is 30 to 500 mg/L expressed as calcium carbonate. Alkalinity over 30 mg/L assists floc formation during the coagulation process. In some circumstances chemicals must be added to boost alkalinity before addition of a coagulant. Water with low alkalinity may tend to accelerate natural corrosion leading to "red water" problems whereas high alkalinity waters may produce scale incrustations on utensils, service pipes and water heaters. Water treatment processes, which do not use a coagulant generally, do not require alkalinity measurement or adjustment.

### **Aluminum** (inorganic)

Aluminum in untreated water is present in the form of very fine particles of aluminosilicate clay. These clay particles are effectively removed in coagulation/filtration. Aluminum found in coagulant treated water is due to the presence of aluminum left over from use of the coagulant. Optimization of treatment should be applied to reduce this “residual” aluminum to under the operational guideline of 0.1 mg/L. High residual aluminum can cause coating of the pipes in the distribution system resulting in increased energy requirements for pumping, interferences with certain industrial processes and flocculation in the distribution system.

Medical studies have not provided clear evidence that residual aluminum has any effect on health.

### **Antimony** (inorganic)

The interim maximum acceptable concentration for antimony in drinking water is 0.006 mg/L. The standard is set to protect against increased blood cholesterol and decreased blood glucose, as well as prevention of nausea, vomiting and diarrhea upon short-term exposure. Antimony is rarely detected in Ontario drinking water.

### **Arsenic** (inorganic)

The interim maximum acceptable concentration for arsenic in drinking water is 0.025 mg/L. Arsenic is a known carcinogen and must therefore be removed by treatment where present at levels over this concentration.

Arsenic is sometimes found at higher levels in ground water in hard rock areas (e.g. Canadian Shield) in Ontario through the natural dissolution of arsenic containing minerals, in some mine drainage waters and in some mine leachates. Arsenic is present at very low concentrations in most surface waters.

### **Atrazine** (herbicide)

The interim maximum acceptable concentration for atrazine plus N-dealkylated metabolites in drinking water is 0.005 mg/L. Atrazine, a triazine pesticide, is used mainly as a pre-emergent herbicide on corn for annual grass control. Atrazine is highly persistent and moderately mobile in soil.

### **Azinphos-methyl** (insecticide)

The maximum acceptable concentration for azinphos-methyl in drinking water is 0.02 mg/L. Azinphos-methyl, an organophosphorus insecticide, is a broad spectrum insecticide used against foliage-feeding insects.

### **Barium** (inorganic)

The maximum acceptable concentration for barium in drinking water is 1.0 mg/L. Barium is a common constituent in sedimentary rocks such as limestone and dolomite where it is accompanied by strontium and much larger amounts of calcium. As a result, hard water contains small amounts of barium but seldom at concentrations greater than 1 mg/L. Most treatment methods used for water softening are effective for barium removal.

### **Bendiocarb** (insecticide)

The maximum acceptable concentration for bendiocarb in drinking water is 0.04 mg/L. Bendiocarb is a carbamate insecticide used to control specific insects in buildings and greenhouses.

### **Benzene** (organic)

The maximum acceptable concentration of benzene in drinking water is 0.005 mg/L. Benzene is present in small amounts in gasoline and other refined petroleum products. Long term exposure to high levels of benzene has been shown to increase cancer risk. Benzene is reported to occur in vehicle emissions and cigarette smoke. Drinking water is not considered a significant source of benzene because objectionable taste and odour discourages consumption.

### **Benzo(a)pyrene** (organic)

The maximum acceptable concentration for benzo(a)pyrene in drinking water is 0.00001 mg/L. Benzo(a)pyrene is formed during the incomplete burning of organic matter and is found in poorly adjusted diesel exhaust and in coal/coking tar. Benzo(a)pyrene is classed as a PAH (polycyclic aromatic hydrocarbon) and has strong carcinogenic properties.

### **Boron** (inorganic)

The interim maximum acceptable concentration for boron in drinking water is 5.0 mg/L. Boron in water is most commonly found as borate. Acute boron poisonings have resulted from the use of borates as antiseptic agents and from accidental ingestion, however the amount consumed was much higher than would be encountered through drinking water. Infants, the elderly and individuals with kidney diseases are most susceptible to the toxic effects of boron compounds.

### **Bromate** (inorganic)

The interim maximum acceptable concentration for bromate in drinking water is 0.010 mg/L. Bromate is not a natural component of water, but may be formed during the disinfection of drinking water using ozone or a combination of ozone and hydrogen peroxide. The concentration of bromide in raw water is a major factor in the formation of bromate. The major natural sources of bromide in groundwater are salt intrusion and bromide dissolution from

sedimentary rocks. Sewage and industrial effluent as well as road and agricultural runoff may also contribute to elevated bromide levels in surface waters.

### **Bromoxynil** (herbicide)

The interim maximum acceptable concentration for bromoxynil in drinking water is 0.005 mg/L. Bromoxynil is a hydroxybenzotrile herbicide used in Ontario for the control of specific weed seedlings in grain crops.

### **Cadmium** (inorganic)

The maximum acceptable concentration for cadmium in drinking water is 0.005 mg/L. Cadmium is a relatively rare element that is extremely unlikely to be present as a significant natural contaminant in drinking water. Cadmium compounds used in electroplated materials and electroplating wastes may be a significant source of drinking water contamination. Other than occupational exposure and inhalation from cigarette smoke, food is the main source of cadmium intake.

### **Carbaryl** (insecticide)

The maximum acceptable concentration for carbaryl in drinking water is 0.09 mg/L. Carbaryl is a commonly used broad spectrum carbamate insecticide used in agriculture and forestry for control of foliar pests and as a home and garden product for specific garden and lawn pests. It is also used for ectoparasite control on livestock and pets. Available evidence suggests that carbaryl is not carcinogenic.

### **Carbofuran** (insecticide)

The maximum acceptable concentration for carbofuran in drinking water is 0.09 mg/L. Carbofuran, trade-name Furadan, is a broad spectrum carbamate insecticide used in agriculture for control of foliar pests. It may also be used to treat soil at planting time to control root maggot, wireworm and some species of nematodes.

### **Carbon tetrachloride** (organic)

The maximum acceptable concentration for carbon tetrachloride in drinking water is 0.005 mg/L. Carbon tetrachloride is likely to be found only in ground water from old industrial sites where chlorinated solvents were made or used. It is a well-known liver toxin and is classified as probably carcinogenic to humans.

### **Chloramines**

The maximum acceptable concentration for chloramines in drinking water is 3.0 mg/L. Chloramines are produced when ammonia is added to chlorinated water during the disinfection process. Chloramine is a very weak disinfectant that is most suited for use as a stable distribution system disinfectant. Chloramination usually results in the production of lower levels of trihalomethanes and other chlorination by-products in the drinking water.

### **Chlordane (insecticide)**

The maximum acceptable concentration for chlordane in drinking water is 0.007 mg/L. Chlordane is an organochlorine insecticide that was once used extensively in agriculture as a soil insecticide and for domestic control of cockroaches, ants and termites. Chlordane is very persistent in soil. The use of chlordane in Ontario was banned in 1994.

### **Chloride (inorganic)**

Chloride is a common non-toxic material present in small amounts in drinking water and produces a detectable salty taste at the aesthetic objective level of 250 mg/L. Chloride is widely distributed in nature, generally as the sodium (NaCl), potassium (KCl) and calcium (CaCl<sub>2</sub>) salts.

### **Chlorpyrifos (insecticide)**

The maximum acceptable concentration for chlorpyrifos in drinking water is 0.09 mg/L. Chlorpyrifos is a commonly used organophosphorus insecticide used for the control of insects on agricultural crops, for domestic use and for flea and tick control. Available evidence suggests that chlorpyrifos is not carcinogenic.

### **Chromium (inorganic)**

The maximum acceptable concentration for chromium in drinking water is 0.05 mg/L. Trivalent chromium, the most common and naturally occurring state of chromium, is not considered to be toxic. However, if chromium is present in raw water, it may be oxidized to a more harmful hexavalent form during chlorination. Chromium in the more highly oxidized form may be present in older yellow paints and in residues from plating operations and around old recirculating water cooling systems.

### **Colour (physical)**

The aesthetic objective for colour in drinking water is 5 TCU (True Colour Units). Water can have a faint yellow/brown colour which is often caused by organic materials created by the decay of vegetation. Sometimes colour may be contributed to by iron and manganese compounds produced by processes occurring in natural sediments or in aquifers. The presence

of organic materials is the main cause of disinfection by-products when water is treated with chlorine.

### **Copper** (inorganic)

The aesthetic objective for copper in drinking water is 1.0 mg/L. Copper occurs naturally in the environment but is rarely present in raw water. Copper is used extensively in domestic plumbing in tubing and fittings and is an essential trace component in food. Drinking water has the potential to be corrosive and to cause copper to dissolve in water. At levels above 1.0 mg/L, copper may impart an objectionable taste to the water. Although the intake of large doses of copper has resulted in adverse health effects such as stomach upsets, the levels at which this occurs are much higher than the aesthetic objective.

### **Cyanazine** (herbicide)

The interim maximum acceptable concentration for cyanazine in drinking water is 0.01 mg/L. Cyanazine is a triazine herbicide registered for control of weeds in crop and non-crop areas.

### **Cyanide** (inorganic)

The maximum acceptable concentration for cyanide in drinking water is 0.2 mg/L measured as free cyanide. Cyanide is widely used in the metal plating and refining industry, and industrial effluents are the major potential sources of cyanide contamination. Cyanide at levels less than 10 mg/L is readily detoxified in the body to thiocyanate. Lethal toxic effects of cyanide usually occur only when this detoxification mechanism is overwhelmed. The maximum acceptable concentration for free cyanide provides a safety factor of approximately 25. Adequate chlorination will oxidize cyanide and reduce it to a level below this limit.

### **Diazinon** (insecticide)

The maximum acceptable concentration for diazinon in drinking water is 0.02 mg/L. Diazinon is an organophosphorus insecticide that is used to control foliar and soil dwelling pests. It is also used for control of flies in barns and for ant and cockroach control.

### **Dicamba** (herbicide)

The maximum acceptable concentration for dicamba in drinking water is 0.12 mg/L. Dicamba is a benzoic acid herbicide that is used for control of broadleaf weeds in grains, corn, flax, sorghum, pastures and weed control in lawns.

### **1,2-Dichlorobenzene** (organic)

The maximum acceptable concentration for 1,2-dichlorobenzene in drinking water is 0.2 mg/L

and the aesthetic objective is 0.003 mg/L. Although health effects from 1,2-dichlorobenzene are negligible below 0.2 mg/L, it does impart an unpleasant taste to water if present above 0.003 mg/L. It is used in a variety of specialty chemical blends (degreasing agents, imported dye carriers). There is sufficient evidence to suggest that 1,2-dichlorobenzene is probably non-carcinogenic.

#### **1,4-Dichlorobenzene (organic)**

Dichlorobenzene is a persistent synthetic material with a strong “medicinal” smell. It has been used widely in toilet pucks and mothballs. The maximum acceptable concentration for 1,4-dichlorobenzene in drinking water is 0.005 mg/L. At levels above the aesthetic objective of 0.001 mg/L, 1,4-dichlorobenzene imparts an unpleasant taste to the water.

#### **DDT (Dichlorodiphenyltrichloroethane) and Metabolites (insecticides)**

The maximum acceptable concentration of DDT and its metabolites in drinking water is 0.03 mg/L. Its persistence in the environment and concerns with potential bio-magnification resulting in potential widespread damage to the environment resulted in use restrictions in North America by the late 1960's. DDT was banned in Ontario in 1988.

#### **1,2-Dichloroethane (organic)**

An interim maximum acceptable concentration for 1,2-dichloroethane in drinking water is 0.005 mg/L. It is principally used as a starting material in the production of vinyl chloride, as a solvent and a fumigant. It is released into the environment via atmospheric emissions and the discharge of industrial waste waters. There is some information which suggests that 1,2-dichloroethane is an animal carcinogen, but inadequate data to determine human carcinogenicity.

#### **1,1-Dichloroethylene (vinylidene chloride) (organic)**

The maximum acceptable concentration for 1,1-dichloroethylene (1,1-dichloroethene, vinylidene chloride, 1,1-DCE) in drinking water is 0.014 mg/L. This chemical is not produced in Canada, however it is imported for use in the food packaging industry and the textile industry for furniture and automotive upholstery, drapery fabric and outdoor furniture.

#### **Dichloromethane (organic)**

The maximum acceptable concentration for dichloromethane in drinking water is 0.05 mg/L. Methylene chloride is an alternative name for dichloromethane. It is used extensively as an industrial solvent for paint-stripping and as a degreasing agent. There is sufficient data to show that dichloromethane is an animal carcinogen, but inadequate data to determine human carcinogenicity.

### **2,4-Dichlorophenol** (organic)

Chlorophenols are highly odorous synthetic materials which are most often present in drinking water due to the action of chlorine on phenolic precursors. Lighter phenols are found in water only as a result of industrial contamination. The maximum acceptable concentration for 2,4-dichlorophenol in drinking water is 0.9 mg/L and the aesthetic objective is 0.0003 mg/L. At levels above 0.0003 ug/L, 2,4-dichlorophenol will impart an unpleasant taste to the water.

### **2,4-D (2,4-Dichlorophenoxy acetic acid)** (herbicide)

The interim maximum acceptable concentration for 2,4-D in drinking water is 0.1 mg/L. 2,4-D is a commonly used chlorophenoxy herbicide used for control of broadleaf weeds in cereal crops and lawns.

### **Diclofop-methyl** (herbicide)

The maximum acceptable concentration for diclofop-methyl in drinking water is 0.009 mg/L. Diclofop-methyl is a chlorophenoxy derivative that is used for control of annual grasses in grain and vegetable crops. It is relatively soluble in water.

### **Dieldrin + Aldrin** (insecticide)

Refer to Aldrin + Dieldrin

### **Dimethoate** (insecticide)

The interim maximum acceptable concentration for dimethoate in drinking water is 0.02 mg/L. Dimethoate is an organophosphorus miticide and insecticide used on a wide range of plants for control of mites and both sucking and leaf-feeding insects. It is also used for fly control in livestock pens. Concentrated preparations can be painted on the trunk and main limbs of large trees to control leaf miner.

### **Dinoseb** (herbicide)

The maximum acceptable concentration for dinoseb in drinking water is 0.01 mg/L. Dinoseb is a contact herbicide and desiccant. Dinoseb is no longer used in Ontario.

### **Dioxins** (organic)

The interim maximum acceptable concentration for dioxin, the commonly used name for any chlorinated dibenzodioxin or dibenzofuran, in drinking water is 0.000000015 mg/L (expressed as 2,3,7,8-TCDD toxicity equivalents (TEQ)/L). Dioxins are formed in very small amounts in combustion processes, particularly combustion of chlorine containing materials such as scrap tires and, potentially, in some poorly controlled industrial processes such as bleached paper

manufacturing.

### **Diquat** (herbicide)

The maximum acceptable concentration for diquat in drinking water is 0.07 mg/L. Diquat is a bipyridilium herbicide used primarily as a crop desiccant in seed crops and as an aquatic herbicide.

### **Dissolved Organic Carbon (DOC)** (Organic)

The aesthetic objective for dissolved organic carbon (DOC) in drinking water is 5 mg/L. High DOC is an indicator of possible water quality deterioration during storage and distribution due to the carbon being a growth nutrient for biofilm dwelling bacteria. High DOC is also an indicator of potential chlorination by-product problems. Coagulant treatment or high pressure membrane treatment can be used to reduce DOC.

### **Diuron** (herbicide)

The maximum acceptable concentration for diuron in drinking water is 0.15 mg/L. Diuron is a substituted urea-based herbicide used for the control of vegetation in crop and non-crop areas, including industrial sites and rights-of-way. It is moderately soluble in water.

### ***Escherichia coli*** (microbiological)

*Escherichia coli* should not be detected/present in any drinking water sample. *Escherichia coli* is a fecal coliform and can be detected using methods such as membrane filtration, presence/absence and MPN. Since *Escherichia coli* is present in fecal matter and prevalent in sewage, but is rapidly destroyed by chlorine, it is a strong indicator of recent fecal pollution. Contamination with sewage as shown by positive E-coli tests would strongly suggest presence of pathogenic bacteria and viruses, as well as more chlorine resistant pathogens such as *Giardia* and *Cryptosporidium*, which are much more difficult to detect.

### **Ethylbenzene** (organic)

The taste/odour related aesthetic objective for ethylbenzene in drinking water is 0.0024 mg/L. Ethylbenzene is a component of the BTEX gasoline additive used for octane rating boosting. It is also used in solvent based paint formulations.

### **Fecal coliform** (microbiological)

Fecal coliforms should not be detected in any treated drinking water sample. The fecal coliform group is a portion of the coliform group that is capable of fermenting lactose at 44 to 45 °C within 48 hours. *Escherichia coli* is the fecal coliform most frequently associated with recent fecal pollution. The presence of fecal coliforms in drinking water is an indication of sewage

contamination.

### **Fluoride** (inorganic)

Where fluoride is added to drinking water, it is recommended that the concentration be adjusted to 0.5 - 0.8 mg/L, the optimum level for control of tooth decay. Where supplies contain naturally occurring fluoride at levels higher than 1.5 mg/L mg/L but less than 2.4 mg/L the Ministry of Health and Long-Term Care recommends an approach through local boards of health to raise public and professional awareness to control excessive exposure to fluoride from other sources. Levels above the MAC must be reported to the local Medical Officer of Health.

### **Glyphosate** (herbicide)

The interim maximum acceptable concentration for glyphosate in drinking water is 0.28 mg/L. Glyphosate is a broad-spectrum, non-selective herbicide used for weed control on rights-of-way, forestry plantations and in-site preparations for planting of crops, as well as for domestic control of plants. It is very soluble in water.

### **Hardness** (inorganic)

The operational guideline for hardness in drinking water is set at between 80 and 100 mg/L as calcium carbonate. This value is set to aid in water source selection where a choice exists. Hardness is caused by dissolved calcium and magnesium, and is expressed as the equivalent quantity of calcium carbonate. On heating, hard water has a tendency to form scale deposits and can form excessive scum with regular soaps. However, certain detergents are largely unaffected by hardness. Conversely, soft water may result in accelerated corrosion of water pipes. Hardness levels between 80 and 100 mg/L as calcium carbonate (CaCO<sub>3</sub>) are considered to provide an acceptable balance between corrosion and incrustation. Water supplies with a hardness greater than 200 mg/L are considered poor but tolerable. Hardness in excess of 500 mg/L in drinking water is unacceptable for most domestic purposes (see the entry below for sodium).

### **Heptachlor + Heptachlor epoxide** (insecticide)

The maximum acceptable concentration of heptachlor + heptachlor epoxide in drinking water is 0.003 mg/L. Heptachlor is an organochlorine insecticide once used in agriculture for control of soil insects. Heptachlor use has been banned in Canada since 1969.

### **Heterotrophic Plate Count** (microbiological)

The HPC (heterotrophic plate count) is a lab culture method of measuring the viable aerobic bacterial content in water. Samples are incubated for 48 hours on a selected nutrient at 35° Celsius. Levels of bacteria detected by this test should not exceed 500 colonies per mL of sample. HPC testing can be used to monitor disinfection efficiency at water treatment plants

and to measure water quality deterioration in distribution systems and in reservoirs. (Standard plate count is an older name for HPC testing.)

### **Iron** (inorganic)

Iron may be present in ground water as a result of mineral deposits and chemically reducing underground conditions. It may also be present in surface waters as a result of anaerobic decay in sediments and complex formation. The aesthetic objective for iron, set by appearance effects, in drinking water is 0.3 mg/L. Excessive levels of iron in drinking water supplies may impart a brownish colour to laundered goods, plumbing fixtures and the water itself; it may produce a bitter, astringent taste in water and beverages; and the precipitation of iron can also promote the growth of iron bacteria in water mains and service pipes. Iron based coagulants such as ferric sulfate can be highly effective in treatment processes at removing particles from water and leave very little residual iron in the treated water.

### **Lead** (inorganic)

The maximum acceptable concentration for lead in drinking water is 0.01 mg/L. This applies to water at the point of consumption since lead is only present as a result of corrosion of lead solder, lead containing brass fittings or lead pipes which are found close to or in domestic plumbing and the service connection to buildings. Lead ingestion should be avoided particularly by pregnant women and young children, who are most susceptible.

It is recommended that only the cold water supply be used for drinking/consumption and only after five minutes of flushing to rid the system of standing water. Corrosion inhibitor addition or other water chemistry adjustments may be made at the treatment plant to reduce lead corrosion rates where necessary.

### **Lindane** (insecticide)

The maximum acceptable concentration for lindane in drinking water is 0.004 mg/L. Lindane is an organochlorine insecticide used for seed treatment. It may also be used in pharmaceutical preparations of human lice and mite shampoos. The chemical name for lindane is gamma-BHC (an isomer of hexachlorocyclohexane).

### **Malathion** (insecticide)

The maximum acceptable concentration for malathion in drinking water is 0.19 mg/L. Malathion is a wide spectrum organophosphorus insecticide used on fruits and vegetables, as well as for mosquito, fly, flea and tick control. It has low mammalian toxicity.

### **Manganese** (inorganic)

The colour related aesthetic objective for manganese in drinking water is 0.05 mg/L. Like iron,

manganese is objectionable in water supplies because it stains laundry and fixtures black, and at excessive concentrations causes undesirable tastes in beverages. Manganese is present in some ground waters because of chemically reducing underground conditions coupled with presence of manganese mineral deposits. Manganese is also occasionally present, seasonally, in surface waters when anaerobic decay processes in sediments is occurring.

### **Mercury (inorganic)**

The maximum acceptable concentration for mercury in drinking water is 0.001 mg/L. Possible sources of mercury in drinking water include air pollution from coal combustion, waste incineration and from metal refining operations and from natural mineral deposits in some hard rock areas. Food is the major source of human exposure to mercury, with freshwater fish being the most significant local source.

### **Methane (organic)**

The aesthetic objective due to gas bubble release and violent spurting from taps for methane is 3 L/m<sup>3</sup>. Methane may be a problem in ground water since it can cause mechanical damage by causing water hammer. Methane occurs naturally in some ground water and acts as a stimulant for microbiological fouling in the distribution system. Methane is not detected in dissolved organic carbon (DOC) analysis and its carbonaceous content is, therefore, additional to any DOC result. If methane is allowed to accumulate in confined areas, the potential for explosive combustion exists.

### **Methoxychlor (insecticide)**

The maximum acceptable concentration for methoxychlor in drinking water is 0.9 mg/L. Methoxychlor is an organochlorine insecticide. It is non-persistent and non-accumulative in biological tissues, making it an attractive insecticide for use on products nearing harvest, in dairy barns for housefly control and as either a larvicide or adulticide against black flies and mosquitoes.

### **Metolachlor (herbicide)**

The interim maximum acceptable concentration for metolachlor in drinking water is 0.05 mg/L. Metolachlor is a selective herbicide used for pre-emergence and pre-plant broad leaf weed control in corn, soybeans, peanuts, grain sorghum, pod crops, woody ornamentals and sunflowers.

### **Metribuzin (herbicide)**

The maximum acceptable concentration for metribuzin in drinking water is 0.08 mg/L. Metribuzin is a triazine herbicide used for control of broad leaf weeds and grasses infesting agricultural crops. It is used selectively on soybeans, tomatoes and potatoes, all crops that are

highly sensitive to most other triazine herbicides.

### **Microcystin-LR**

The maximum acceptable concentration (MAC) for the cyanobacterial toxin microcystin-LR in drinking water is 0.0015 mg/L. This guideline is believed to be protective of human health against exposure to other microcystins (total microcystins) that may also be present.

Cyanobacterial toxins are toxins produced by cyanobacteria or blue-green algae. Water bodies that have historically exhibited algal blooms should be visually monitored for bloom formation and hence toxin production during the peak season (usually late May to early October) and follow the steps outlined in Annex A.

### **Monochlorobenzene or Chlorobenzene (organic)**

The maximum acceptable concentration for chlorobenzene in drinking water is 0.08 mg/L and the taste related aesthetic objective is 0.03 mg/L. Chlorobenzene is used in the production of chloronitrobenzene and diphenyl ether, as a rubber intermediate, and as a solvent in adhesives, paints, waxes, polishes and inert solvents. It is also used in metal cleaning operations and may be present in industrial discharges.

### **Nitrate (inorganic)**

The maximum acceptable concentration of nitrates in drinking water is 10 mg/L as nitrogen. Nitrates are present in water (particularly ground water) as a result of decay of plant or animal material, the use of agricultural fertilizers, domestic sewage or treated wastewater contamination, or geological formations containing soluble nitrogen compounds. There is a risk that babies and small children may suffer blood related problems (methaemoglobinaemia) with excess nitrate intake. The nitrate ion is not directly responsible for this condition, but must first be reduced to the nitrite ion by intestinal bacteria. The nitrite reacts with the iron of haemoglobin in red blood cells which are then prevented from carrying oxygen to the body tissues.

Nitrate poisoning, in terms of methaemoglobinaemia, from drinking water appears to be restricted to susceptible infants. Older children and adults drinking the same water are unaffected. Most water-related cases of methaemoglobinaemia have been associated with the use of water containing more than 10 mg/L nitrate as nitrogen. In Canada, no cases of the condition have been reported where the nitrate concentration was consistently less than the maximum acceptable concentration. Where both nitrate and nitrite are present, the total nitrate plus nitrite-nitrogen concentration should not exceed 10 mg/L. In areas where the nitrate content of water is known to exceed the maximum acceptable concentration the public should be informed by the appropriate health authority of the potential dangers of using the water for infants.

### **Nitrite (inorganic)**

The maximum acceptable concentration of nitrite in drinking water, 1.0 mg/L as nitrogen, is based, as with nitrate, primarily on the relationship between nitrite in water and the incidence of infantile methaemoglobinaemia. Nitrite is fairly rapidly oxidized to nitrate and is therefore seldom present in surface waters in significant concentrations. Nitrite may occur in ground water, however if chlorination is practiced the nitrite will usually be oxidized to nitrate.

### **NTA (Nitrilotriacetic Acid) (organic)**

The maximum acceptable concentration for NTA in drinking water is 0.40 mg/L. NTA is mainly used in laundry detergents, most of which is eventually disposed of in domestic wastewater. In general, the toxicity of NTA is very low, however, an increased incidence of urinary tract tumours was found in rats and mice that had been fed very large doses of NTA. Risk assessment, together with the relatively poor absorption of ingested NTA by humans, suggests that the risk associated with a NTA level in drinking water of below 0.40 mg/L is negligible.

### **NDMA (N-Nitrosodimethylamine) (organic)**

The interim maximum acceptable concentration for NDMA is 0.000009 mg/L. NDMA is rarely used industrially but has been used as an antioxidant, as an additive for lubricants and as a softener of copolymers. It has been detected in some foods particularly smoked foods and very occasionally in treated river/lake water in heavily farmed locations. NDMA is an animal carcinogen.

### **Odour (physical/chemical)**

The contamination of drinking water with offensively odorous substances may have an easily identified cause such as paint solvent odour or odour from diesel fuel or gasoline. In these cases, systems must be flushed to clear the contaminants and contaminating surfaces stripped and repainted. Another common source of musty odours is from harmless, but very smelly substances produced by certain algae. These materials from algae are present in some surface waters from late summer into fall and can sometimes be partly removed using activated carbon treatment. Another common source of odours is sulfide (see below) which is found in some ground waters but not in surface waters. Numerous other substances could cause odour and these are sometimes very hard to identify and correct. The odour of drinking water should be inoffensive.

### **Organic Nitrogen (organic)**

The operational guideline for organic nitrogen in drinking water is 0.15 mg/L. Organic nitrogen is calculated by the difference between the total Kjeldahl nitrogen and the ammonia nitrogen. High levels may be caused by septic tank or sewage effluent contamination. This form of

contamination is often associated with some types of chlorine- worsened taste problems. Organic nitrogen at levels above 0.15 mg/L would be typically associated with DOC contribution of 0.6 mg/L. Organic nitrogen compounds frequently contain amine groups which can react with chlorine and severely reduce its disinfectant power. Certain chlorinated organic nitrogen compounds may be responsible for flavour problems that are associated with chlorophenol. Taste and odour problems are common with organic nitrogen levels greater than 0.15 mg/L.

### **Paraquat** (herbicide)

The interim maximum acceptable concentration for paraquat in drinking water is 0.01 mg/L. Paraquat is a highly toxic, bipyridil herbicide used as a contact herbicide and for desiccation of seed crops. It is also used for non-crop and industrial weed control. It is a pre-emergent herbicide used in "no-till" situations or before planting or crop emergence. It is also registered for aquatic use to control cattails, bulrushes and grasses.

### **Parathion** (insecticide)

The maximum acceptable concentration for parathion in drinking water is 0.05 mg/L. Parathion is an extremely toxic, organophosphorous broad spectrum insecticide used in agriculture against foliar pests and the adult stage of root maggots. In some instances, resistance to parathion has developed and parathion is no longer effective.

### **Pentachlorophenol** (organic)

The maximum acceptable concentration for pentachlorophenol in drinking water is 0.06 mg/L and the taste/odour based aesthetic objective is 0.03 mg/L. Pentachlorophenol is rarely found in commercial use today but was used extensively as a pesticide and wood preservative. It is the most environmentally persistent of the chlorophenols.

## **Pesticides**

Pesticides can be grouped by chemical composition. Pesticides which contain chlorine tend to persist in the environment and may become concentrated in food chains causing health effects in animals such as predators at the top of the chains. Some chlorophenoxy herbicides and cholinesterase-inhibiting compounds, including organo-phosphorus chemicals and carbamates, have a high acute toxicity to mammals. Many of these, however, hydrolyse rapidly in water to form harmless or less harmful products.

Additional information on pesticides can be found on the World Wide Web at:

The EXtension TOXicology NETwork	( <a href="http://ace.orst.edu/info/extoxnet/">http://ace.orst.edu/info/extoxnet/</a> )
Pest Management Regulatory Agency	( <a href="http://www.hc-sc.gc.ca/pmra-arla/">http://www.hc-sc.gc.ca/pmra-arla/</a> )
Ontario Pesticides Advisory Committee	( <a href="http://www.opac.gov.on.ca/">http://www.opac.gov.on.ca/</a> )

### **pH** ( physical-chemical)

pH is a parameter that indicates the acidity of a water sample. The operational guideline recommended in drinking water is to maintain a pH between 6.5 and 8.5. The principal objective in controlling pH is to produce a water that is neither corrosive nor produces incrustation. At pH levels above 8.5, mineral incrustations and bitter tastes can occur. Corrosion is commonly associated with pH levels below 6.5 and elevated levels of certain undesirable chemical parameters may result from corrosion of specific types of pipe. With pH levels above 8.5, there is also a progressive decrease in the efficiency of chlorine disinfection and alum coagulation.

### **Phorate** (insecticide)

The interim maximum acceptable concentration for phorate in drinking water is 0.002 mg/L. Phorate is an organophosphorus insecticide used for control of sucking insects, larvae of the corn rootworm and leaf-eating beetles.

### **Picloram** (herbicide)

The interim maximum acceptable concentration for picloram in drinking water is 0.19 mg/L. Picloram is a phenoxy alkanolic acid herbicide used for broadleaf weed and brush control on right-of-ways and roadsides. Picloram can be persistent in soil for up to a year after application.

### **PCBs (Polychlorinated Biphenyls)** (organic)

The interim maximum acceptable concentration for PCBs in drinking water is 0.003 mg/L. PCBs are among the most ubiquitous and persistent pollutants in the global ecosystem. In the past, PCBs have been marketed extensively for a wide variety of purposes but are no longer manufactured or used. The available information suggests that drinking water containing PCB, at a concentration of 0.003 mg/L or less, does not pose a health risk.

### **Prometryne** (herbicide)

The interim maximum acceptable concentration for prometryne in drinking water is 0.001 mg/L. Prometryne is a methylthiothiazine herbicide which is used to selectively control annual grasses and broadleaf weeds in crops and non-crops. It can be applied both as a pre-emergent and post-emergent herbicide.

### **Radionuclides** (radiological)

There are 78 new and revised standards (see Table 3) for both natural and artificial radionuclides. They are derived from a 50-year committed effective dose of 0.1 millisievert (mSv) from one year's consumption of water and are expressed in activity concentration units of becquerels per litre (Bq/L). The derivation of radiological guidelines conforms to international radiation protection methodologies. The approach accounts for the total lifetime exposure that will result

from any radionuclide ingested in one year, based on its retention in human tissue. The limits are designed to protect human health from the carcinogenic effects of exposure to radionuclides via drinking water.

### **Selenium** (inorganic)

The maximum acceptable concentration for selenium in drinking water is 0.01 mg/L. Selenium occurs naturally in waters at trace levels as a result of geochemical processes such as weathering of rocks. It is difficult to establish levels of selenium that can be considered toxic because of the complex inter-relationships between selenium and dietary constituents such as protein, vitamin E and other trace elements. Food is the main source of selenium intake other than occupational exposure. Selenium is an essential trace element in the human diet. Drinking water containing selenium at the maximum acceptable concentration of 0.01 mg/L would be the source of only 10 per cent of total selenium intake. The maximum acceptable concentration, therefore, is considered to provide a satisfactory factor of safety against known adverse effects.

### **Simazine** (herbicide)

The interim maximum acceptable concentration for simazine in drinking water is 0.01 mg/L. Simazine is a triazine herbicide which 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 to ground water where it may persist for years.

### **Sodium** (inorganic)

The aesthetic objective for sodium in drinking water is 200 mg/L at which it can be detected by a salty taste. Sodium is not toxic. Consumption of sodium in excess of 10 grams per day by normal adults does not result in any apparent adverse health effects. In addition, the average intake of sodium from water is only a small fraction of that consumed in a normal diet. A maximum acceptable concentration for sodium in drinking water has, therefore, not been specified. Persons suffering from hypertension or congestive heart disease may require a sodium-restricted diet, in which case, the intake of sodium from drinking water could become significant. It is therefore recommended that the measurement of sodium levels be included in routine monitoring programs of water supplies. The local Medical Officer of Health should be notified when the sodium concentration exceeds 20 mg/L, so that this information may be passed on to local physicians.

Softening using a domestic water softener increases the sodium level in drinking water and may contribute a significant percentage to the daily sodium intake for a consumer on a sodium restricted diet. It is recommended that a separate unsoftened supply be retained for cooking and drinking purposes.

### **Sulfate** (inorganic)

The aesthetic objective for sulfate in drinking water is 500 mg/L. At levels above this concentration, sulfate can have a laxative effect, however, regular users adapt to high levels of sulfate in drinking water and problems are usually only experienced by visitors and new consumers. The presence of sulfate in drinking water above 150 mg/L may result in noticeable taste. The taste threshold concentration, however, depends on the associated metals present in the water. High levels of sulfate may be associated with calcium, which is a major component of scale in boilers and heat exchangers. In addition, sulfate can be converted into sulfide by some anaerobic bacteria creating odour problems and potentially greatly accelerating corrosion.

### **Sulfide**(inorganic)

The odour related aesthetic objective for sulfide in drinking water is 0.05 mg/L as H<sub>2</sub>S(hydrogen sulphide). Although ingestion of large quantities of hydrogen sulfide gas can produce toxic effects on humans, it is unlikely that an individual would consume a harmful dose in drinking water because of the associated unpleasant taste and odour. Sulfide is also undesirable in water supplies because, in association with iron, it produces black stains on laundered items and black deposits on pipes and fixtures. Lower levels of sulfide can be removed effectively from most well water by aeration. Sulfide is oxidized to sulfate in well-aerated waters over a period of hours and consequently sulfide levels in surface supplies are usually very low.

### **Taste**

Taste and odour are intimately interrelated, and consumers frequently mistake odours for tastes. In general, the sense of taste is most useful in detecting the ionic inorganic constituents of drinking water, whereas the sense of smell is most useful in detecting volatile organic constituents. Taste and odour problems constitute the largest category of consumer complaints. Changes in the taste of drinking water may indicate possible contamination of the raw water supply, treatment inadequacies, excessive biological activity due to sediment accumulation, encrustations and/or loss of chlorine residual in the distribution system. A numerical limit for taste has not been specified because there is no accepted method for the quantitative measurement of taste and there is considerable variation among consumers as to which tastes are acceptable. Water provided for public consumption should have an inoffensive taste.

### **Temephos** (insecticide)

The interim maximum acceptable concentration of temephos in drinking water is 0.28 mg/L. Temephos is an organophosphorus insecticide used to control mosquito and blackfly larvae. It is only slightly soluble in water.

### **Temperature** (physical)

An aesthetic objective is set for maximum water temperature to aid in selection of the best water

source or the best placement for a water intake. It is desirable that the temperature of drinking water should not exceed 15°C because the palatability of water is enhanced by its coolness. Low water temperatures offer a number of other benefits. A temperature below 15°C will tend to reduce the growth of nuisance organisms and hence minimize associated taste, colour, odour and corrosion problems. In summer and fall, water temperatures may increase in the distributed water due to the warming of the soil and/or as a result of higher temperatures in the source water. Low temperature facilitates maintenance of a free chlorine residual by reducing the rates of decay of the chlorine. Low water temperature is not necessary to produce water of an acceptable quality.

### **Terbufos** (insecticide)

The interim maximum acceptable concentration of terbufos in drinking water is 0.001 mg/L. Terbufos is an organophosphorus insecticide used for insect control in corn.

### **Tetrachloroethylene** (perchloroethylene)(organic)

The recommended maximum acceptable concentration for tetrachloroethylene in drinking water is 0.03 mg/L. Tetrachloroethylene is no longer produced in Canada but continues to be imported primarily as a solvent for the dry cleaning and metal cleaning industries. It has been found in ground water, primarily after improper disposal or dumping of cleaning solvents.

### **2,3,4,6-Tetrachlorophenol** (organic)

The maximum acceptable concentration of 2,3,4,6-tetrachlorophenol in drinking water is 0.1 mg/L and the aesthetic objective is 0.001 mg/L. At levels above the aesthetic objective, it will impart an unpleasant taste to the water. 2,3,4,6-tetrachlorophenol was used extensively, along with pentachlorophenol, to preserve wood.

### **Toluene** (organic)

The taste/odour related aesthetic objective for toluene in drinking water is 0.024 mg/L. Toluene is used in gasoline and other petroleum products and in the manufacture of benzene derived medicines, dyes, paints, coating gums, resins and rubber. It may be found in industrial effluents.

### **Total Coliform** (microbiological)

The coliform group of bacteria has been the most commonly used indicator of water quality. The coliform group consists of all aerobic and facultatively anaerobic, gram-negative, oxidase-negative, non-spore forming, rod-shaped bacteria that ferment lactose in a broth medium with gas formation within 48 hours at 35°C. Most coliforms also produce the enzyme β-D galactosidase which can be detected with a colour forming reagent. The group generally comprises the genera *Escherichia*, *Klebsiella*, *Enterobacter* and *Citrobacter*. The presence of these bacteria in drinking water is indicative of inadequate filtration/disinfection or in the

distribution system a continuing loss of the chlorine residual.

MPN (Most Probable Number), MF and P/A are methods that may be used to detect and measure coliform populations in drinking water. The tests have slightly different sensitivities to the various bacteria. Occasionally samples will produce positive results in one test and not with the others. In all cases where discrepancies are found, results from the method producing the positive result will be used in assessing the water quality.

#### **Total Dissolved Solids (inorganic)**

The aesthetic objective for total dissolved solids in drinking water is 500 mg/L. The term "total dissolved solids" (TDS) refers mainly to the inorganic substances dissolved in water. The principal constituents of TDS are chloride, sulphates, calcium, magnesium and bicarbonates. The effects of TDS on drinking water quality depend on the levels of the individual components. Excessive hardness, taste, mineral deposition or corrosion are common properties of highly mineralized water. The palatability of drinking water with a TDS level less than 500 mg/L is generally considered to be good.

#### **Triallate (herbicide)**

The maximum acceptable concentration for triallate in drinking water is 0.23 mg/L. Triallate is a thiocarbamate herbicide used for control of wild oats in grain crops, mustard and sugar beets.

#### **Trichloroethylene (organic)**

The maximum acceptable concentration for trichloroethylene in drinking water is 0.05 mg/L. Most trichloroethylene use is in dry cleaning. Some is used in metal degreasing operations and in tetrachloroethylene production. Trichloroethylene may be introduced into surface and ground water through industrial spills and illegal disposal of effluents.

#### **2,4,6-Trichlorophenol (organic)**

The maximum acceptable concentration of 2,4,6-trichlorophenol in drinking water is 0.005 mg/L and the taste related aesthetic objective is 0.002 mg/L. It is used in the manufacture of pesticides. The data is sufficient to classify 2,4,6-trichlorophenol as an animal carcinogen but inadequate for human carcinogenicity. The maximum acceptable concentration has been set taking into account additional safety factors.

#### **2,4,5-T (2,4,5-Trichlorophenoxy acetic acid) (herbicide)**

The maximum acceptable concentration for 2,4,5-T in drinking water is 0.28 mg/L and the aesthetic objective is 0.02 mg/L. 2,4,5-T is a phenoxy alkanoic acid herbicide that was once an important stem/foilage treatment for deciduous brush control on roadsides and power lines. 2,4,5-T is no longer used in Ontario.

### **Trifluralin** (herbicide)

The interim maximum acceptable concentration for trifluralin in drinking water is 0.045 mg/L. Trifluralin is a dinitroaniline herbicide used for weed control in summer fallow and for controlling annual grasses in wheat, barley and canola. Trifluralin is very insoluble in water.

### **Trihalomethanes** (organic)

The maximum acceptable concentration (MAC) for trihalomethanes (THMs) in drinking water is 0.10 mg/L based on a four quarter moving annual average of test results. Trihalomethanes are the most widely occurring synthetic organics found in chlorinated drinking water. The four most commonly detected trihalomethanes in drinking water are chloroform, bromodichloromethane, chlorodibromomethane and bromoform. Primarily, trihalomethanes in drinking water are produced by the reaction of chlorine and the naturally occurring organics (precursors) left in the water after filtration.

### **Turbidity** (physical)

Control of turbidity in drinking-water systems is important for both health and aesthetic reasons. The substances and particles that cause turbidity can be responsible for significant interference with disinfection, can be a source of disease-causing organisms and can shield pathogenic organisms from the disinfection process.

Turbidity is an important indicator of treatment efficiency and the efficiency of filters in particular. A significant relationship has been demonstrated between turbidity increases and the number of *Giardia* cysts and *Cryptosporidium* oocysts breaking through filters. Operational Guidelines for turbidity as an indicator of the efficiency of filters in relation to credits for *Giardia* cysts and *Cryptosporidium* oocysts removal have been provided in the “Procedure for Disinfection of Drinking Water in Ontario”.

The effect of turbidity on disinfection efficiency, including potential for disinfection by-products, is related to the type and nature of the particles in the water. A raw water supply which is surface water or ground water under direct influence of surface water is likely to contain organic particles that cause turbidity and adversely affect disinfection efficiency. A significant factor in the formation of disinfection by-products is the organic or humic component of turbidity.

Raw water supply which is ground water with very low organic content may contain inorganic-based turbidity, which may not seriously hinder disinfection. For such waters, an Operational Guideline for turbidity is not established. Since ground water quality is inherently stable, any significant variation in turbidity, excluding pump startup, should be investigated and analyzed immediately for the potential of surface water influence and the presence of organic particles.

Inorganic turbidity formed during the disinfection process or post-disinfection treatment processes through oxidation and chemical participation would not likely interfere with disinfection effectiveness. Therefore the most meaningful location for taking a turbidity sample is before the disinfection process and where applicable after filtration.

Turbidity in excess of 5.0 NTU becomes visible to the naked eye and as such a majority of consumers may object to its presence. Therefore, an aesthetic objective of 5.0 NTU has been set for all waters at the point of consumption.

#### **Uranium** (inorganic)

The maximum acceptable concentration of uranium in drinking water is 0.02 mg/L. Uranium is normally present in biological systems and aqueous media as the uranyl ion ( $\text{UO}_2^{2+}$ ). Ingestion of large quantities of uranyl ion may result in damage to the kidneys. The uranyl ion may also be responsible for objectionable taste and colour in water, at much higher levels than the concentrations which may cause kidney damage.

#### **Vinyl Chloride** (chloroethene) (organic)

The maximum acceptable concentration of vinyl chloride in drinking water is 0.002 mg/L. Vinyl chloride is a synthetic chemical with no known natural sources. It is classified as a human carcinogen. It is used in making PVC (polyvinyl chloride) plastic items such as water main pipe, siding and many other common plastic items all of which are now made in such a way that there is no trace of vinyl chloride present in them.

#### **Xylenes** (organic)

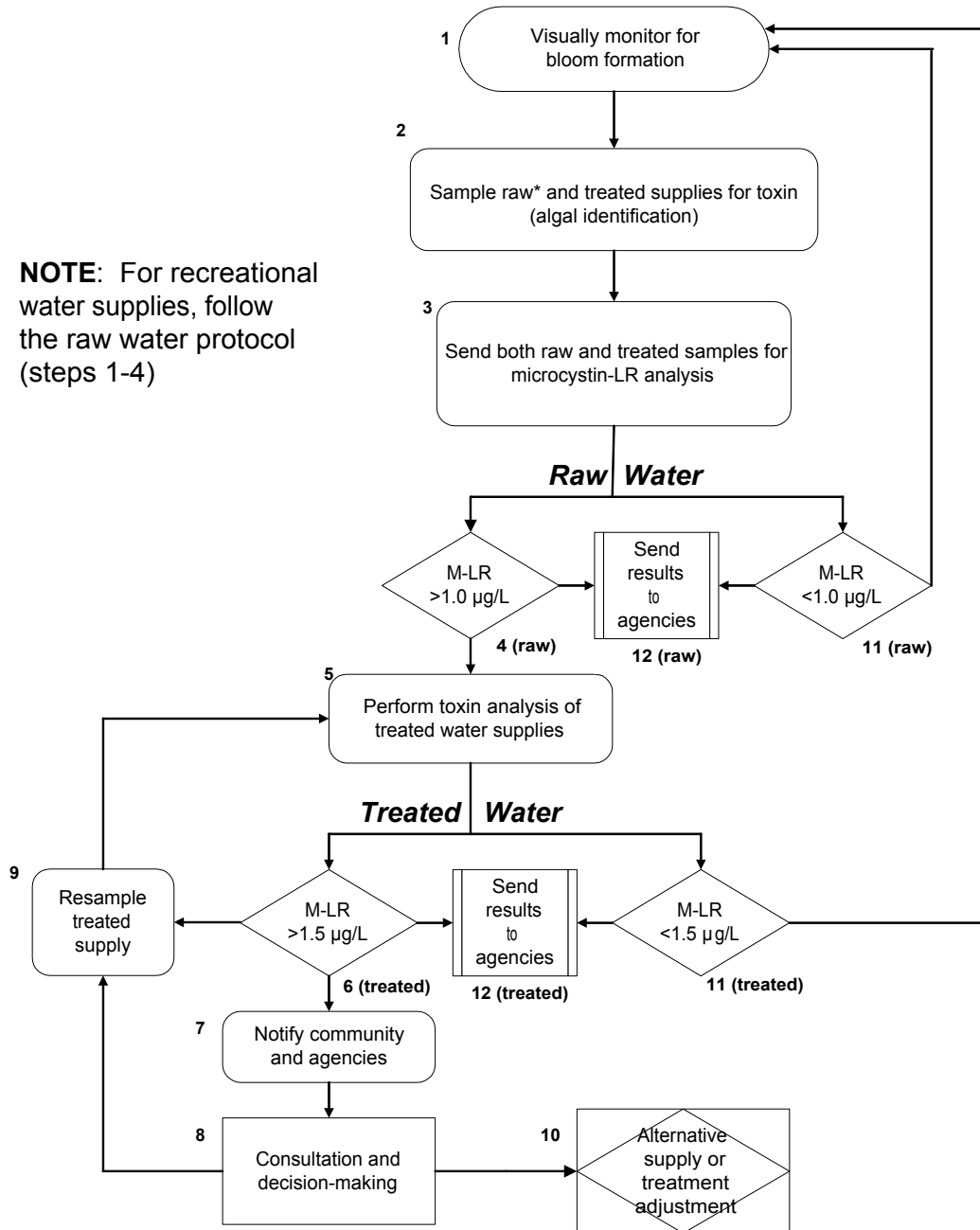
There are three isomers of dimethyl benzene, which are almost identical chemically and are collectively called xylenes. The odour related aesthetic objective for total xylenes in drinking water is 0.3 mg/L. Xylenes are used as industrial solvents and as an intermediate for dyes and organic synthesis. They are a component of household paints and paint cleaners and gasoline and other petroleum products.

#### **Zinc** (inorganic)

The taste related aesthetic objective for zinc in drinking water is 5.0 mg/L. The concentration of zinc may be considerably higher at the consumer's tap in standing water because of corrosion taking place in galvanized pipes, but this can be cleared easily by brief flushing. Corrosion control using small concentrations of zinc based inhibitors has been found effective in some water systems.

**ANNEX A**  
**Cyanobacterial Toxins -- Microcystin-LR**  
**Flow Chart**  
**- Water Supplies for Human Consumption -**

**NOTE:** For recreational water supplies, follow the raw water protocol (steps 1-4)



\* A field kit could be used for screening. A validation sample should be sent to a laboratory for confirmation of actual levels following a positive field test.

## GLOSSARY

**Aerobic Bacteria** - bacteria that require oxygen for growth and can grow under an air atmosphere (21% oxygen).

**Aesthetic**- aspects of drinking water quality (namely taste, odour, colour and clarity) that are perceivable by the senses.

**Algae** - simple chlorophyll-bearing plants, most of which are aquatic and microscopic in size.

**Alkalinity** - measure of a water's ability to neutralize acid; generally made up of bicarbonate and carbonate ions.

**Alpha particle** - a charged particle emitted from the nucleus of an atom and having a mass and charge identical to a helium nucleus. Gross alpha particle activity is the total radioactivity from alpha particle emission as inferred from measurements on a dry sample.

**Anaerobic bacteria** - bacteria that do not use oxygen to obtain energy and cannot grow under an air atmosphere.

**Antiseptic** - a substance used to destroy or prevent the growth of infectious microorganisms on or in the body.

**Bacteria** - a group of diverse and ubiquitous procaryotic single-celled organisms.

**Becquerel (Bq)** - unit of radioactivity which expresses the rate of disintegration of a radionuclide; one becquerel equals one nuclear transformation per second and corresponds to approximately 27 picocuries.

**Beta particle** - a charged particle emitted from the nucleus of an atom with the mass and charge of an electron. Gross beta particle activity is the total radioactivity resulting from beta particle emission as inferred from measurements on a dry sample.

**Biofilm** - microbial cells attach to pipe surfaces and multiply to form a film or slime layer on the pipe which can harbour and protect coliform bacteria from disinfectants.

**Carcinogen** - parameter for which the evidence from studies indicates that there is a causal relationship between exposure and occurrence of cancer, whether in animals or humans.

**Cholinesterase** - an esterase (enzyme) present in all body tissues which hydrolyses acetylcholine into choline and acetic acid. Acetylcholine affects nerve impulse transmissions therefore substances that impair the function of cholinesterase enzymes are neurotoxic.

**Carbamate** - a salt or ester of carbamic acid.

**Colloid** - particulate or insoluble material in a finely divided form that remains dispersed in a liquid for an extended time period.

**Conventional Filtration** - a mode of water treatment to remove particles which consists of coagulant addition, rapid mixing, coagulation, flocculation, sedimentation and filtration.

**Contamination** - the introduction of materials which makes otherwise potable water unfit or less acceptable for use.

**Corrosion** - in the context of drinking water distribution, corrosion is the deterioration and leaching of metal from a pipe surface as a result of its reaction with the aquatic environment.

**Cryptosporidium** - a protozoan parasite that produces an environmentally stable oocyst that is highly resistant to disinfection, but can be removed by effective treatment, which includes filtration.

**Desiccant** - a drying agent capable of absorbing moisture from the atmosphere in a small enclosure.

**Detoxification** - the process of removing or neutralizing a poison.

**Disinfection** - effective destruction by chemical or physical processes of non-spore forming organisms capable of causing disease. Spore forming bacteria and parasitic cysts are usually resistant to traditional methods of disinfection.

**Ectoparasite** - a parasite that lives on the surface of the host body.

**Filter** - a porous media through which a liquid may be passed to effect removal of suspended materials.

**Fumigant** - a chemical compound which acts in the gaseous state to destroy insects and their larvae and other pests.

**Fungi** - a group of diverse and widespread unicellular and multicellular eucaryotic microorganisms.

**Gastrointestinal diseases** - diseases related to the portion of the digestive system including the stomach, intestine and all accessory organs.

**Gamma Radiation** - short wavelength electromagnetic radiation emitted from the atomic nucleus.

**Giardia** - small, flagellated, protozoan parasites that inhabit the small intestines of a variety of animals. Giardia is the most commonly reported intestinal parasite in North America causing nausea, diarrhoea, uneasiness in the upper intestine, malaise and perhaps low-grade fevers and chills. A well-managed water treatment system providing effective filtration and disinfection should control contamination by *Giardia*.

**Gram-negative** - referring to bacteria not holding the colour of the primary stain when treated by the Gram staining procedure.

**Ground water** - water located in the saturated zone of the earth's crust.

**Ground water under the direct influence of surface water** - ground water having incomplete or undependable subsurface filtration of surface water and infiltrating precipitation.

**Herbicide** - chemical agent that destroys or inhibits plant growth.

**Hydroxybenzotrile** - an organic liquid with an almond colour.

**Incrustation** - deposition of a crust or hard coating on a surface.

**Insecticide** - any chemical or natural agent that kills insects.

**Larvicide** - an agent that kills larvae.

**Macroorganism** - aquatic organism that can be seen without the aid of a microscope and can include copepod, cladoceran, oligochaete, mollusca and aquatic insects.

**Membrane Filter (MF)** - a method for the enumeration of bacteria in water. A measured volume of water is filtered through a sterilized membrane which is then transferred to the surface of an appropriate agar medium and incubated. Upon incubation, retained bacteria give rise to visible colonies on the membrane surface.

**Methaemoglobinaemia** - a condition caused by the presence in the blood of methaemoglobin, an altered haemoglobin which is unable to transport oxygen.

**Microorganism** - a microscopic organism that cannot be seen without the aid of a microscope, including bacteria, protozoa, fungi, viruses and algae.

**Most Probable Number (MPN)** - a method for statistically estimating the number of bacteria in water. It is not an actual count of the bacteria.

**Nematode** - member of the class Nematoda, the roundworms, some of which are parasites. Free-living nematodes are abundant in soil and water.

**Non-point Source** - discharge of pollutants which cannot be traced back to a specific source, for example agricultural or urban run-off.

**NTU (Nephelometric Turbidity Unit)** - unit of measure for turbidity in a water sample.

**Occupational exposure** - exposure to a parameter at the workplace.

**Organochlorine** - an organic compound containing one or more chlorine atoms.

**Organophosphorus** - an organic compound containing one or more phosphate groups.

**Oxidize** - a process where the loss of electrons or hydrogen atoms or the combination with oxygen occurs.

**Parameter** - measurable or quantifiable characteristic or feature.

**Parasite** - an organism that lives on or in the body of another from which it obtains its nutrients.

**Pathogen** - an organism capable of eliciting disease symptoms in another organism.

**Pesticide** - a chemical or mixture of chemicals used to kill unwanted species of plants or animals.

**pH** - index of hydrogen ion activity, pH is defined as the negative logarithm of hydrogen ion concentration in moles per litre. A solution of pH from 0 to less than 7 is acid, pH of 7 is neutral, pH from above 7 to 14 is alkaline.

**Phenol** - an organic chemical with a sharp burning taste, used to make a variety of other organic chemicals, resins, and as a solvent and chemical intermediate.

**Picocurie** -  $10^{-12}$  curies (a curie is the unit of radioactivity contained in any quantity of material yielding  $3.7 \times 10^{10}$  radioactive disintegrations per second).

**Pollution (water)** - causing or inducing objectionable conditions in any watercourse and affecting adversely the environment and use or uses to which the water thereof may be put.

**Presence/Absence (P/A) Test** - a qualitative procedure used to determine the presence or absence of coliforms in water.

**Protozoa** - unicellular, non-photosynthetic, nucleated organisms, such as amoeba, ciliates and flagellates.

**Raw Water** - surface or ground water that is available as a source of drinking water but has not received any treatment.

**Radioactive** - capable of emitting radioactivity, the spontaneous nuclear disintegration with emission of corpuscular or electromagnetic radiation or both.

**Radionuclide** - any man-made or natural element which emits radiation in the form of alpha or beta particles or as gamma rays.

**Spore** - a reproductive unit lacking a preformed embryo that is capable of germinating directly to form a new individual. A resistant body formed by certain microorganisms; a resistant resting cell; a primitive unicellular reproductive body.

**Surface Water** - water that rests on the earth's surface.

**TCU (True Colour Units)** - the measurement of colour using the platinum cobalt scale. The colour of water resulting from parameters which are totally in solution not to be mistaken for apparent colour resulting from colloidal or suspended matter.

**Toxicological** - relating to the study of poisons, including their nature, effects, detection and methods of treatment.

**Triazine** - an organic heterocyclic compound containing a six-member ring formed from carbon and containing three nitrogen atoms.

**Trivalent** - having a valency of three.

Ontario Drinking-water Quality Standards, Objectives and Guidelines

**Urea** - the major end product of nitrogen excretion in mammals or the synthesis of industrial ammonia and carbon dioxide used as a source of non-protein nitrogen for ruminant livestock and as a nitrogen fertilizer.

**Virus** - group of sub-microscopic agents that infect plants and animals, usually manifesting their presence by causing disease, and are unable to multiply outside the host tissues.