WATER MANAGEMENT

Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment

November 1978
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Ministry of the Environment

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Introduction

In 1970. the Ontario Water Resources Commission published a booklet entitled "Guidelines and Criteria for Water Quality Management in Ontario". This publication is a revised and expanded edition of the 1970 booklet, organized to reflect current policies for water management in Ontario. There are four main components, namely:

1) Surface water quality management;
2) Surface water quantity management;
3) Ground water quality management; and
4) Ground water quantity management.

These four management programs are closely interrelated. In managing the water resources of the Province both the quality and quantity aspects of surface and ground waters must be considered. The programs which have been developed reflect these inter-relationships. In each program, a Goal statement is presented, and the Policies adopted to achieve the Goal are outlined. Following this are the detailed "Implementation Procedures" for carrying out the Policies.

This publication outlines the water management program of the Ontario Ministry of the Environment. Other aspects of water management not under the jurisdiction of the Ministry of the Environment are covered by other Federal and Provincial agencies, particularly the Ontario Ministry of Natural Resources.

NOTE: The water quality Objectives and criteria contained in this booklet are under continual review and will be revised periodically. To ensure that you have the current information, contact the Water Resources Branch, 135 St. Clair Avenue West, Toronto, Ontario (Tel. 965-6954), or any of the Ministry's regional offices.

Surface Water Quality Management

The surface waters of Ontario are put to many uses, and each use has specific water quality requirements. Water quality must be managed, preserved, and restored where necessary to permit the greatest number of uses, based on the best interests of the people of Ontario. In addition, Ontario borders on inter-provincial and international waters, and the implications of the Province's activities must be considered in that context. For example, the Province has agreed that the revised Specific Water Quality Objectives contained in the Great Lakes Water Quality Agreement shall be used in environmental programs to achieve and maintain Great Lakes water quality. Moreover, under the Canada-Ontario Accord, Ontario will establish and enforce effluent requirements for specific industrial groups and pollutants, to be developed by the Federal Government in consultation with the provinces.

GOAL

TO ENSURE THAT THE SURFACE WATERS OF THE PROVINCE ARE OF A QUALITY WHICH IS SATISFACTORY FOR AQUATIC LIFE AND RECREATION.

Water which meets the water quality criteria for aquatic life and recreation (designated as the Provincial Water Quality Objectives, Table I), will be suitable for most other beneficial uses, such as drinking water and agriculture. For the few parameters, where better water quality is required to protect these other beneficial uses in a given location, the appropriate criteria shall be applied in that location.

POLICIES

1 . Areas with Water Quality Better than the Objectives

In areas which have water quality better than the Provincial Water Quality Objectives, water quality shall be maintained at or above the Objectives.

2. Areas with Water Quality Not Meeting the Objectives

Water quality which presently does not meet the Provincial Water Quality Objectives shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives.

3. Effluent Requirements

Effluent requirements will be established on a case-by-case basis. In establishing effluent requirements, the characteristics of the receiving water body will be considered, as will Federal and Provincial effluent regulations and guidelines where applicable. The effluent requirements so derived will be incorporated into Certificates of Approval (under Section 42, Ontario Water Resources Act) and will specify both waste loadings and concentrations.

4. Hazardous Substances

Special preventive measures are required to deal with the release of known or potentially hazardous substances. Accordingly, the Ministry's policy is to:

1) prevent the release of those substances listed in Table 2 which are hazardous if released in any concentration;

2) ensure that special measures are taken on a case-by-case basis to minimize the release of any substances for which Provincial Water Quality Objectives have not yet been established.

5. Mixing Zones

A mixing zone is defined as an area of water contiguous to a point source where the water quality does not comply with the Provincial Water Quality Objectives. Terms and conditions related to a mixing zone will he designated on a case-by-case basis and may be specified in Certificates of Approval, control orders, requirement and directions, or approvals to proceed under the Environmental Assessment Act. The size of the mixing zone shall be minimized to the greatest possible degree and under no circumstances is the mixing zone to be used as an alternative to treatment.

Surface Water Quantity Management

The protection and control of surface water quantity is another key component of Ontario's surface water management strategy for two reasons. Firstly, control of water quantity is needed in some areas to avoid conflicts among various users. Secondly, water quantity and quality management are closely related, inasmuch as the amount and physical characteristics of water available is an important aspect of water quality. Surface water quantity management in Ontario involves a combination of common law, land patent, and federal and provincial statutes. The main involvement of the Ministry of the Environment in this field is through the water taking permit system authorized by Section 37 of the Ontario Water Resources Act.

GOAL

TO ENSURE A FAIR SHARING OF THE AVAILABLE SUPPLY OF WATER TO PROTECT BOTH WITHDRAWAL AND IN-PLACE USES OF WATER.

POLICIES

1. Water Quality-Quantity Inter-relationships

The withdrawal of water from and discharge of water to surface water bodies will be controlled to assist in maintaining or restoring water quality for the protection of aquatic life and recreation.

2. Permits to Take Water

Surface water takings will be controlled to prevent interference with other uses of water wherever possible and to resolve such problems if they do occur.

3. Surface Water Conservation

All reasonable and practical measures should be taken to conserve the quantity of surface water, in order to maximize its availability for existing or potential beneficial uses.

Ground Water Quality Management

Ground water in Ontario is an important source of water for various uses, including domestic, public, agricultural and industrial water supplies. Ground water is often the primary source of rural and urban water supplies in the Province, especially in southern Ontario, and is frequently an important component of streamflow, especially during dry weather periods.

In general, restoration of ground water quality is not merely difficult, it is also extremely expensive. For practical purposes, and with present control technology, ground water contamination in most cases can be considered long term once it occurs. Thus, the costs associated with a goal of protection of ground water quality are insignificant compared to the alternative of quality restoration. In addition, current evaluation techniques are not sufficiently advanced to adequately determine, for basin planning purposes, what waste loadings can he allowed and still meet water quality criteria at points down gradient. Accordingly, Ontario's ground water quality management program reflects the fact that ground water differs from surface water in some significant respects.

GOAL

TO PROTECT THE QUALITY OF GROUND WATER FOR THE GREATEST NUMBER OF BENEFICIAL USES.

In the majority of cases, human consumption will be the most important use of water to be protected, but there are other ground water uses such as agriculture with specific water quality requirements which will also be protected. Appropriate criteria for these two uses are given in Tables 4 and 5. In addition, protection of aquatic life (Table 1) is a consideration in cases where ground water is a significant component of streamflow.

POLICIES

1. Regulated* Sources of Contamination

The waste control requirements for proposed regulated waste discharges will be established on a case-by-case basis. As a general policy, water quality degradation will be controlled in order to protect reasonable uses, existing or proposed, of both ground and surface waters. The Ministry requirements relating to the quantity and the quality of the discharge will be specified and control measures may also be stipulated in the Certificate of Approval.

The treatment or elimination of pollutants from existing activities will be required where it is demonstrated that such measures are practicable and necessary to correct use impairment and will prevent further degradation or improve water quality. Where such measures are not practicable, the Ministry may require replacement of the affected supplies.

2. Unregulated** Sources of Contamination

All reasonable measures shall be undertaken to reduce or prevent the contamination of ground water by proposed or existing unregulated activities.

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* Regulated refers to those activities which require specific approval under the Ontario Water Resources Act or the Environmental Protection Act.

** Unregulated refers to those activities which do not require specific approval under the Ontario Water Resources Act or the Environmental Protection Act.

Ground Water Quantity Management

The importance of water quantity management was outlined in the surface water section. An additional reason for ground water quantity management is that ground water is often an important component of streamflow. The Ministry of the Environment has primary responsibility for ground water quantity management in the Province.

GOAL

TO ENSURE THE FAIR SHARING AND CONSERVATION OF GROUND WATER.

POLICIES

1. Permits to Take Water

Ground water takings will be controlled to prevent water supply interference wherever possible through a water taking permit program under Section 37 of the Ontario Water Resources Act.

2. Resolution of Interference Problems

In the event that a ground water taking authorized by permit interferes with another water supply obtained from any adequate source that was in use prior to the issuance of the permit, the party causing the interference shall restore the affected supply or reduce the taking to eliminate the interference.

3. Ground Water Conservation

All reasonable and practical measures shall be taken to promote the conservation of ground water.

Provincial Water Quality Objectives

The Provincial Water Quality Objectives are a set of narrative and numerical criteria designed for the protection of aquatic life and recreation in and on the water. They represent a desirable level of water quality that the Ministry strives to maintain in surface waters of the Province. They are often the starting point in deriving waste effluent requirements. The Objectives are set out in Table 1.

The Objectives for protection of recreational water uses are based on public health and aesthetic considerations. With respect to aquatic life the Objectives are set at such values as to protect all forms of aquatic life and all aspects of the aquatic life cycles. The clear intention is to protect all life stages during indefinite exposure to the water. With the exception of dissolved oxygen, temperature classification of organisms is not considered relevant to the application of criteria. Numerous studies have found that the biological variation of response within species to a toxicant is as great or greater than the biological variation among species. Consequently, criteria will be applied equally to "warm water" species and "cold water aquatic organisms". This approach will also incorporate the variation of sensitivity occurring when "warm water" species are exposed to contaminants under low temperature conditions and when "cold water" species are exposed under high temperature conditions.

Ideally, water quality objectives should be established based on "no negative effect" data derived from chronic long-term tests on sensitive organisms. However, current understanding of chemical dynamics and effects on aquatic life are limited to a few species and contaminant levels that are lethal in short term tests. Therefore, the numerical Objectives in Table 1 are generally derived from short-term toxicity data and "application factors". Data from short-term toxicity tests are usually expressed as median lethal concentrations (LC_{50}), indicating the concentration of test material that caused death to 50 per cent of the test organisms within a given period of time. An application factor can be defined as the ratio of the maximum concentration having no negative effect on the test organism to the 96 hour LC_{50} concentration. This approach to establishing water quality objectives is not ideal, but is a practical method of making

an estimate of a safe concentration from limited toxicity data. The application factors commonly used are:

Concentrations of materials that are nonpersistent or have noncumulative effects should not exceed 0.1 of the 96-hour LC_{50} at any time or place after mixing with the receiving waters. The 24-hour average of the concentration of these materials should not exceed 0.05 of the 96-hour LC_{50} after mixing. For toxicants which are persistent or cumulative, the concentrations should not exceed 0.05 of the 96-hour LC_{50} at any time or place, nor should the 24-hour average concentration exceed 0.01 of the 96-hour LC_{50}.

Objectives in Table 1 represent minimum water quality conditions and are based on data produced by exposing healthy stress-free organisms to one variable at a time. The Objectives do not account for additive effects of more than one chemical nor for additional environmental stress arising from temperature and predation factors. Consequently, water with a quality at or near the Objectives for several parameters may not protect aquatic life because of synergistic effects.

Each Objective has been set on the basis of a scientific rationale. Supporting discussions on establishing Objectives have been taken from several sources and are compiled into a single document, available from the Ministry of the Environment, entitled: "Rationale for the Establishment of Ontario's Provincial Water Quality Objectives". The scientific data base used for setting the Objectives is constantly changing and new information may result in modification to a stated Objective from time to time.

It is not practical to treat all effluents so they meet the Objective concentrations. Therefore, some volume of water must be provided for dilution or modification of the waste effluent before the Objectives can be met. Within the mixing zone, where the Objectives are not met, there will be some damage or loss to the aquatic environment. Nevertheless, at no point should conditions be immediately lethal so that swimming organisms cannot evade the area. The mixing zone mainly represents a loss of habitat, but it must not be allowed to become an area where aquatic life is killed or seriously

damaged. Procedures have been established for managing the mixing zones.

In addition to the specific water quality Objectives listed in Table 1, there are five general conditions which should be met:

All waters shall be free from substances attributable to man-caused point source or non-point source discharges in concentrations that:

1. Settle to form objectionable deposits;

2. Float as debris, scum, oil or other matter to form nuisances;

3. Produce objectionable colour, odour, taste or turbidity;

4. Injure, are toxic to or produce adverse physiological or behaviour responses in humans, animals or plants; or

5. Produce undesirable aquatic life or result in the dominance of nuisance species.

Implementation Procedures

The purpose of this section is to spell out in detail the intent of the water management policies and to specify procedures adopted to implement the policies. These Implementation Procedures will be reviewed on a continuous basis and revised whenever warranted.

Surface Water Quality Management

Policies 1 and 2 are designed to: (a) maintain water quality where it is presently better than the Objectives; (b) upgrade or enhance water quality that presently does not meet the Objectives.

Areas possessing water quality better than the Provincial Water Quality Objectives shall be designated as such if water quality monitoring data indicate that all parameters are better than their Objectives. Areas with quality worse than the Objectives will be so designated if one or more of the Objectives are not met. The analysis of data shall be made in accordance with procedures for determining what constitutes non-compliance based on statistically valid sampling data.

POLICY 1 — AREAS WITH WATER QUALITY BETTER THAN THE OBJECTIVES

In areas where water quality is better than the Provincial Water Quality Objectives, mechanisms for control of effluent discharges shall be established in accordance with the Implementation Procedures outlined for Policy 3. Although some lowering of water quality is permissible, violation of the Provincial Water Quality Objectives will not be allowed.

POLICY 2 — AREAS WITH WATER QUALITY NOT MEETING THE OBJECTIVES

Evaluations of existing conditions in problem areas shall be conducted and remedial measures shall be taken to upgrade water quality to the Provincial Water Quality Objectives as stipulated under Policy 3. The Ministry will require that all reasonable and practical measures be taken to reduce waste loadings. Where new or expanded discharges are proposed, no further degradation will be permitted and all practical measures shall he undertaken to upgrade water quality. However, it is recognized that, in exceptional circumstances, it may not be technically feasible, physically possible or socially desirable to achieve this condition in all water bodies in the Province.

Accordingly, in exceptional cases, where it is clearly demonstrated that all reasonable and practical measures to attain the Provincial Water Quality Objectives have been undertaken but where:

1) the Provincial Water Quality Objectives are not attainable because of natural background water quality; or
2) the Provincial Water Quality Objectives are not attainable because of irreversible man-induced conditions; or
3) to attain or maintain the Provincial Water Quality Objectives would result in substantial and widespread adverse economic and social impact; or
4) suitable treatment techniques are not available:

then deviations from Policy 2 may be allowed, subject to the approval of the Director, Water Resources Branch, in consultation with the Regional Director.

Where public hearings into proposals for new or expanded discharges are held under Sections 7 or 12 of the Environmental Assessment Act or Sections 43 and 44 of the OWR Act, such hearings may be utilized to consider this issue.

Restoration Techniques

Although water quality restoration techniques can be used to improve water quality, there must be adequate treatment of all waste inputs, and restoration

techniques shall not be considered a substitute for proper treatment. In the event that all practical measures have been made to control waste inputs, but residual pollution exists. restoration techniques may be applied.

Approval for the application of any water quality restoration technique shall be required.

Examples of some restoration techniques are: hypolimnetic aeration, destratification, dilution/flushing, drawdown, dredging, nutrient inactivation/ precipitation, pH adjustment, and weed harvesting.

POLICY 3 — EFFLUENT REQUIREMENTS Approach to Establishing Effluent Requirements

For a desired level of water quality, every river or lake has a definable dilution, dispersion or assimilation (self-purification) capacity for receiving waste discharges. Efficient use of this capacity is a key to optimizing water pollution control programs. The emphasis of the Ministry's water quality management program is to set effluent requirements based on the waste receiving capacity of a waterbody and the Provincial Water Quality Objectives, with consideration also given to the federal or provincial effluent regulations or guidelines and controls on non-point sources of pollution.

In establishing effluent requirements, the procedures outlined below will be followed:

1) Appropriate site-specific receiving water assessments will be conducted to determine the effluent requirement based on the waste assimilative capacity of the receiver.
2) The above-determined effluent requirement will be compared to:
   - the federal effluent regulations or provincial effluent regulations or guidelines for proposed new or expanded effluent discharges: or
   - the federal effluent guidelines or provincial effluent regulations or guidelines for existing effluent discharges.
3) If the effluent requirement determined by the receiving water assessment is more stringent than the effluent requirement stipulated in the federal or provincial effluent regulations or guidelines, the requirement derived from the assessment will be imposed;

if the effluent requirement determined by the receiving water assessment is less stringent than the requirements stipulated in the federal or provincial effluent guidelines or regulations, the most stringent will be imposed.

4) For proposed new or expanded discharges, the effluent requirement derived from the above procedures, in both waste loadings and concentrations, will be incorporated into a Certificate of Approval.

5) For existing discharges in areas with water quality worse than the Provincial Water Quality Objectives, the Ministry will develop a pollution control program with each discharger that would meet the effluent requirement determined from the above procedures. If such a program cannot be agreed to, effluent requirement and other control measures will be stipulated in control orders or requirement and directions, subject to the procedures specified for Policy 2.

In establishing effluent requirements, many considerations must be taken into account. The more important of these considerations are outlined below.

Non-Point Sources

Historically, control of urban point sources (i.e. municipal and industrial wastewaters) has received primary attention in water pollution abatement. However, there is growing concern over the significance and need for control of non-point sources of pollution (including atmospheric input of pollutants). Accordingly, in establishing effluent requirements for point sources, consideration must he given to the effects of contaminant inputs from non-point sources on receiving water quality. Conservation and remedial measures will he required for the control of non-point sources if they are shown to cause or contribute significantly to violations of the Provincial Water Quality Objectives.

Target Dates

Target dates for the installation of effluent control measures will be established in the context of technological and economic constraints.

Assessment Techniques

In essence, a waterbody's dilution/assimilation capacity for wastes depends on waste characteristics and a host of physical, chemical and biological factors, such as the flow or volume of the waterbody and the waste discharges, dispersion of effluent, depth and width of the waterbody, type of substrate, algal growths, benthic deposits

or organic sludges, etc.

Assessment techniques are the mechanism to be used in estimating a waterbody's assimilative capacity and establishing effluent requirements to meet the Provincial Water Quality Objectives. Either simple dilution formulae or more sophisticated mathematical models can be used as assessment techniques, depending on the circumstances. For example, with a dilution ratio greater than 10 to 1 , simple dilution formulae may be adequate for estimating effluent requirements for discharges with a high degree of treatment (e.g. secondary treatment) and which do not contain hazardous substances. With a dilution ratio less than 10 to 1, more complex assessment techniques may be required to estimate assimilative capacity. Further, under complex situations (e.g. multiple uses of water, flood control requirements, etc.), sophisticated mathematical models may be used to estimate assimilative capacity and effluent requirements. The Thames River Study (MOE, 1975) is an example. Pertinent manuals for conducting stream surveys, for establishing assimilative capacity using the modelling approach, and a number of case studies have been published by the Ministry of the Environment and can be consulted as reference materials (see Bibliography).

In areas with water quality better than the Objectives, it is a good general principle not to allocate the entire assimilative capacity of a receiving waterbody. The need for maintenance of a reserve capacity should be established on a case-by-case basis.

In addition to meeting the Provincial Water Quality Objectives (including the toxicity test requirements outlined below), a thorough receiving water assessment is required before the discharge of effluents containing toxic substances will be permitted. Such an assessment should include studies of the potential accumulation and concentration of the substances in the environment (such as bed sediments and aquatic flora and fauna), synergistic effects with other substances and physical factors (such as temperature changes or radiant energy) that may affect the environmental impact of contaminants.

Hazardous substances have accumulated in the environment as a result of past discharges and accidental losses. Many of these substances (such as PCB, DDT, and mercury) may cause long-term undesirable health or environmental effects. Wherever practicable, measures should be taken to minimize the potential adverse impact of such past releases. For example, the dredging of contaminated sediments should be regulated as outlined in the MOE's Marine Construction Guidelines to provide safe, confined disposal of hazardous substances.

Toxicity Testing

Bioassay tests may be required to identify discharges deleterious to aquatic organisms. Undiluted industrial effluents or other discharges which induce more than 50% mortality over 96 hours under static test conditions may require more rigorous biological testing to determine if additional treatment is needed to afford adequate protection to the environment. Biological responses other than mortality may also be used to demonstrate impairment.

Federal Effluent Regulations and Guidelines

Federal effluent regulations and guidelines for the industrial sector are based on the policy that national effluent requirements represent a minimum acceptable baseline level of effluent quality developed on the basis of best practicable technology. All guidelines and regulations under the Fisheries Act are developed by task forces consisting of representatives from Federal and Provincial governments and the industries concerned.

Under the Canada-Ontario Accord, Ontario has agreed to establish and enforce requirements at least as stringent as the agreed Federal baseline requirements and to conduct surveillance of effluents. The Federal effluent requirements will be applied at new and expanded production facilities and will be applied as a minimum as rapidly as possible in all other cases. To date, Federal effluent requirements have been developed for the following industrial categories: Pulp and Paper Effluent, Chloralkali Mercury, Petroleum Refinery Effluent, Fish Processing Effluent, Metal Mining Liquid Effluent, Meat and Poultry Plant Liquid Effluent, Potato Processing Plant Liquid Effluent and Metal Finishing Liquid Effluent.

Procedures for the Taking and Discharge of Cooling Water

(a) Method of Removal

The design and location of the water intake must be such that entrainment of fish, including larval fish and eggs, and other aquatic life is minimized. Scientific studies must demonstrate to the satisfaction of the Ministry that the intake design and location are optimal for minimizing entrainment. These studies will be required for each intake that will draw in excess of 10 m^3 /sec. The Ministry reserves the right to require these studies for intakes of lower capacity, particularly for intakes from inland waters.

(b) Method of Disposal

Discharge of waste heat shall be into such areas and locations and in such quantities as may be allowed by the Ministry on a case-by-case basis. The method of discharge shall be such that rapid mixing occurs with the receiving water, thus minimizing the area affected. Scientific studies must demonstrate to the satisfaction of the Ministry that the discharge design and location are optimal for minimizing the area affected by the discharge and the environmental impact of the discharge. These studies will be required for each discharge with a capacity greater than 10 m^3/sec. The Ministry may require these studies for discharges of lower capacity, particularly for discharges to inland waters. Fish residency in the immediate area of the discharge, including the mixing zone, is to be minimized. A discharge of waste heat should not affect the water temperature of any water intake or fish spawning area.

(c) Contaminants in Discharge Water

The use of cooling water for waste disposal shall be minimized. Such waste as may be permitted to be disposed of in this manner shall be at such levels as determined by application on a case-by-case basis to the Ministry. Substances used as biocides in condenser cleaning will only be permitted in the cooling water at residual levels to be approved by the Ministry of the Environment on a case-by-case basis.

(d) Alternative Cooling Facilities

In those instances where significant effects can be clearly predicted, alternative cooling facilities are to be employed. In those instances where potential harmful effects may arise, but cannot be clearly predicted, generating stations should be initially designed so that alternative cooling facilities can be added at such time as evidence indicates sufficient adverse effects.

(e) Circulation Patterns

The taking and discharge of cooling water and structures built for these purposes shall not alter the local existing circulation patterns such that other water uses, sedimentation, spawning or fishing grounds are adversely affected.

(f) Beneficial Uses

Wherever possible, all or part of the waste heat discharge shall be used in a beneficial way.

POLICY 4 - HAZARDOUS SUBSTANCES

The term "hazardous substances" applies to chemicals considered threats to man and the environment. A hazardous substance can be defined as a substance which (individually or in combination with other substances) can cause death, disease including cancer. behavioural abnormalities, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformities in organisms or their offspring. In addition to the above, the consequences of contamination of the environment by hazardous substances include a loss of valuable species, restrictions on important socio-economic activities and a variety of irreversible ecological changes that threaten man's future use and enjoyment of the environment.

About two million chemical compounds are known and each year thousands more are developed by the chemical industry, many of which are introduced commercially. Very little is known about the possible health and environmental effects of most of these compounds. Many are not hazardous but the sheer number of chemical compounds, the diversity of their use, and the adverse effects already encountered by some have made chemical contaminants in our environment an important concern.

To control the problem of hazardous substances in the environment requires the following tasks:

- identification of potentially hazardous substances:
- assessment of the impact of the substances:
- control and regulation of the manufacture, processing, importing. use and disposal of the substances:
- monitoring of the substances in the environment and analysis and interpretation of the monitoring data: and
- establishment of environmental criteria, such as the Provincial Water Quality Objectives, for the protection of water uses, etc.

To date, due to resource and data limitations, some of the above important tasks have been carried out to only a limited extent for a few chemicals such as PCB, DDT, and mercury, Adequate knowledge concerning the degree of safety or hazard of many chemicals is not available and may take years or even decades to develop. Further, control technology for many substances may not be practicable under many

circumstances. In light of these limitations, the Ministry has adopted a policy which emphasizes that preventive measures be taken in dealing with the releases of both known and potentially hazardous substances.

To implement this preventive policy, the Ministry must rely largely upon existing knowledge about many substances. Presently, scientific data are available for establishing criteria for the substances included in the Provincial Water Quality Objectives (Table 1). Some of these substances are hazardous if released in sufficient amount. For the control of these substances, the Objectives and the Implementation Procedures outlined for Policy 3 shall be used in setting effluent loadings and concentrations.

Based upon current scientific knowledge, other compounds are classified into one of the following two categories for control purposes:

1) Substances with Zero Tolerance Limits

It has been established that the substances listed in Table 2, if released *in any concentration* can bio-accumulate or concentrate in the aquatic environment to levels which are harmful or lethal to organisms. To provide long-term protection to aquatic organisms and man, any release of these substances *should be completely eliminated.* However, it is recognized that trace concentrations of these substances may be found in municipal effluents and other sources and may not be completely removed by current practicable technology; further, some contaminants, such as mercury, may occur in surface waters due to natural conditions. Accordingly, the intent of this policy is to prohibit any new discharges of these substances and to reduce all existing releases to the lowest practicable levels.

Although Provincial Water Quality Objectives are specified in Table 1 for some of the substances included in Table 2, the Objectives are intended as guidance for dealing with past releases or accidental losses, but not for new releases.

2) Substances with Undefined Tolerance Limits

All substances not included in Table 2 or the Provincial Water Quality Objectives (Table 1) may pose an adverse effect on health or the environment. Presently, there are not enough scientific data for establishing water quality Objectives for these substances. Accordingly, the release of all such substances shall be

evaluated on a case-by-case basis, and special measures should be taken to protect the environment.

At the present time, substances listed in Table 3 are of primary concern in this regard.

Note: The controlled application of approved biocides for the control of nuisance organisms shall be permitted provided it is authorized by the Ministry under Section 6 of the Pesticides Act.

POLICY 5 — MIXING ZONES

Terms and conditions related to the mixing zones may be outlined in Certificates of Approval, based on the minimum requirements outlined below. Inherent in these conditions, a mixing zone may not be used as an alternative to adequate treatment. The mixing zone dimensions will be kept as small as possible while ensuring that the Provincial Water Quality Objectives are met at the boundary of the mixing zone.

1. Mixing zones should not contain:
   - materials which form objectionable deposits, i.e. scums, oil or floating debris;
   - substances producing objectionable colour, odour, taste or turbidity;
   - substances which produce objectionable growths of nuisance plants and animals;
   - substances which render the mixing zone aesthetically unacceptable.

2. The presence of a mixing zone should in no way pose a threat to the species survival of any organism in the receiving water outside the mixing zone.

3. No conditions within the mixing zone should be permitted which:
   a) are rapidly lethal to important aquatic life (resulting in conditions which result in sudden fish kills and mortality of organisms passing through the mixing zones); or
   b) cause irreversible responses which could result in detrimental post-exposure effects; or
   c) result in bioconcentration of toxic materials which are harmful to the organism or its consumer: or
   d) attract organisms to the mixing zones, resulting in a prolonged and lethal

exposure period.

4. A mixing zone shall not be allowed to create a barrier to the migration of fish and aquatic life.

5. Rapid changes in the water quality which could kill organisms by shock effects must not be present. Such conditions could have the effect of creating a higher toxicity value.

6. Municipal and other water supply intakes and recreational areas, as a general rule, should not lie within a mixing zone. However, knowledge of the effluent characteristics and the type of discharge associated with the mixing zone could allow such a mixture of uses.

7. Mixing zones may overlap unless the combined effects exceed the conditions specified in these mixing zone guidelines.

8. Limitations on mixing zones should be established by the Ministry on a case-by-case basis, where "case" refers to both local considerations and the waterbody as a whole or segments of the waterbody.

9. Existing biological, chemical, physical and hydrological conditions should be known when considering the location of a new mixing zone or limitations on an existing one.

10. The design and location of the outfall should be considered on a case-by-case basis to reduce the impact of the mixing zone on the receiving waters.

11. Total loadings into all the mixing zones within a river, lake or segment thereof, must not exceed the acceptable loadings from all point-source discharges required to maintain satisfactory water quality.

Implementation Procedures

Surface Water Quantity Management

POLICY 1 — WATER QUALITY-QUANTITY INTER-RELATIONSHIPS

1. A primary purpose of the surface water quantity management program is to ensure that a sufficient supply of water is maintained to provide an adequate quantity of water for downstream uses. However, the quantity of water available is also an important aspect of water quality. Accordingly, streamflow reduction should be controlled to avoid water quality impairment as well as to avoid interference with withdrawal uses. Conversely, streamflow augmentation from either surface or ground water sources can be considered as a potential means of water quality improvement. In addition, controls on land-use practices, discharges of water from urban drainage, agricultural drainage and similar artificial discharges will be encouraged to prevent water quality degradation and to minimize any increase in peak flows.

POLICY 2 — PERMITS TO TAKE WATER

1. Under Section 37 of the Ontario Water Resources Act, the Ministry of the Environment administers a water permit program, under which most takings in excess of 10,000 gallons (50,000 litres) in a day require authorization by means of a Permit to Take Water. While the water permit legislation is designed to manage the use of water resources in the Province, it does not supersede the common-law riparian rights to the use of water, but is an added control. Thus, while riparian rights are not superseded, they may be limited in some cases by the water permit legislation. Other takings which are generally exempt from the water permit legislation, but which are found to interfere seriously with other users, can be prohibited without a permit and thus brought under the provisions of a water permit. The only exception to this provision is the taking of water by an individual for ordinary household purposes, livestock watering, and firefighting.

2. An application for a water permit is reviewed in light of information concerning the availability of the supply, the use to which the water is to be put, and the effects of the proposed taking on existing uses.

3. When evaluating the relative priority of uses in an area where there is insufficient water to meet established and new uses, the taking of water for private domestic and farm purposes is considered the most important use, generally followed by municipal water supply. The taking of water for industrial, commercial and irrigation purposes is regulated by the availability of the supply, the efficiency of use and established uses in an area. The use of water for pollution control, flood control. tire protection, recreation, and wildlife preservation are also important considerations.

4. Permits for stream takings shall contain a schedule of decreasing withdrawal rates and a requirement that the taking of water be carried out in such a manner that downstream flow is not stopped or reduced to a rate that will interfere with downstream uses of water or the natural functions of the stream.

5. A permit for a taking from the Great Lakes, their interconnecting channels, inland lakes, and ponds unconnected to a watercourse shall contain a requirement that if the taking interferes with the use of water by other persons, the terms and conditions of the permit may be altered.

6. Other special terms and conditions relating to a taking may be stipulated on a case-by-case basis to deal with special circumstances.

7. A majority of surface water quantity interference problems in the Province involve a stoppage or serious reduction in flow caused by the storage of water by damming and the taking of water for irrigation. Ponds should be filled or refilled during spring runoff, or works should be installed to maintain a portion of the flow at all times in order to prevent or resolve interference problems. Some problems caused by direct takings are resolved by a reduction in the rate of takings. If the problem becomes recurrent, it may be necessary to require that off-stream storage works be constructed, so that peak requirements can be met using the storage capacity, supplemented by re-filling from the stream at a slow rate during low-flow periods. Another approach is to require the

installation of works to maintain streamflow at all times. The minimum flow requirement is established on a case-by-case basis, taking into account the available supply and downstream requirements.

8. If streamflow interference results from simultaneous takings by several takers (e.g. for irrigation) attempts may be made to arrange for the takers to agree to a schedule of taking on alternate days, or at different times of the day, so that each obtains a fair share of the limited supply. Alternatively, all parties taking from the stream may be required to reduce their taking to a lower rate.

9. When water is taken from streams which cease to flow seasonally due to natural causes, downstream flow must be maintained whenever there is an inflow. The release of water from storage to maintain downstream flow is not required when there is no inflow.

POLICY 3 — SURFACE WATER CONSERVATION

1. In significant flowing well areas where a large proportion of the streamflow during the summer months is dependent on ground water discharge from flowing wells, special management practices should be undertaken to conserve ground water and thereby protect streamflows. Uncontrolled flow from new flowing wells will be regulated by requiring the installation of flow control devices.

2. Large-scale ground water development close to streams will be allowed only after due regard to the maintenance of sufficient streamflow to protect downstream uses.

Implementation Procedures

Ground Water Quality Management

POLICY I — REGULATED SOURCES OF CONTAMINATION

I. This policy applies to proposed discharges from activities such as landfill, deep well disposal, spray irrigation, or sludge utilization or disposal operations, septic tank systems and mine tailings. The type and degree of control required will be governed by the potential effects of the discharge and by the restrictions these effects might otherwise have on drinking water supplies and other water uses in the area. Degradation of ground water quality will be controlled to protect both existing and potential, reasonable uses of water on adjacent property. Appropriate criteria for drinking water and agriculture are specified in Table 4 and Table 5.

Policy 1 also applies to the discharge of contaminants from existing activities which were not subject to control measures at their inception, or which are now having a demonstrated effect which was not perceived at the time they were approved. These problems will be evaluated on a case-by-case basis and treatment or elimination of the source of pollutants will be required where, in the opinion of the Ministry of the Environment, such measures are feasible and will prevent further degradation or improve water quality. However, ground water contamination can be considered in most cases to be long term once it occurs. Accordingly, when the foregoing measures are found to be unfeasible, the Ministry may require the replacement of supplies (e.g. by providing piped water from an alternate supply).

POLICY 2 — UNREGULATED SOURCES OF CONTAMINATION

1. This policy applies to operations not covered by Policy 1, and includes contamination from proposed or existing salt storage areas, from crop fertilization, and from undetected or unreported leaks and spills.

Control of these sources of pollution is a difficult but important aspect of the ground water quality management program. Although definitive solutions to many of these problems are not yet available, various studies are currently addressing these issues. Pending the results of these and other studies, all reasonable measures shall be undertaken to reduce or prevent the contamination of ground water from these sources. More specific measures will be implemented in future as they become available.

GENERAL

I. In cases where urban runoff or treated sewage are to be recharged to ground water, the chemical suitability of the recharge waters should be determined to ensure that toxic chemicals are not present in excessive amounts.

2. An applicant for a waste disposal facility may be required to monitor ground water quality to provide background data on natural water quality and to ensure compliance with the terms and conditions of a Certificate of Approval. In the event of non-compliance, implementation of a contingency plan will be required.

3. Public hearings, as provided for in the Ontario Water Resources Act, the Environmental Protection Act and the Environmental Assessment Act, will be held as part of the decision-making process related to ground water quality management.

Implementation Procedures

Ground Water Quantity Management

POLICY 1 — PERMITS TO TAKE WATER

1. Points 1, 2 and 3 of the surface water quantity management implementation procedures related to Policy 2 (page 24) also apply to the ground water quantity management program.

2. Permits to Take Water from ground water sources contain a requirement that if the taking interferes with other water supplies obtained from any adequate sources that were in use prior to the issuance of the permit, the permittee shall restore the affected supplies or reduce the taking so as to eliminate the interference.

3. Large scale ground water development close to streams will be allowed only after due regard to the maintenance of sufficient streamflow to protect downstream uses.

POLICY 2 — RESOLUTION OF INTERFERENCE PROBLEMS

1. The free flow from a flowing well is not protected in the event of interference by another ground water taking. Restoration of a water supply from a well that formerly flowed is required, provided that the well was capable of meeting the daily water demands on a continuous basis by a combination of its storage, water yielding and pumping capabilities, prior to interference.

2. If the taking of water from wells causes interference with streamflow, restoration of supplies is required if water uses are seriously interfered with.

3. The restoration of a water supply is not required in an area where a property has community water service available if the interference is caused by the

construction or operation of works for the improvement and service of the community, such as municipal wells, sewers, water mains, roads and bridges. Where interference in a water serviced area is caused by an operation not associated with a community improvement, restoration of a water supply is required.

4. Parties causing short-term interference with existing well supplies where water service is or is not available are required to make available a temporary supply of water to those experiencing interference. This applies to interference resulting from such operations as pumping tests, excavation dewatering, and other short-term water takings.

5. Ground water encountered during construction projects and excavations where ground water may flow by gravity either out of the excavation or along granular trench bedding, can cause serious interference with water supplies by lowering well water levels. The person whose works cause the problem may be required by notice under Section 37 of the OWR Act to stop or control the leakage, or to take such measures as the notice may require, such as to restore the affected supply.

POLICY 3 — GROUND WATER CONSERVATION

I. All operators of high capacity wells under permit shall be required to measure the withdrawals from the wells. In addition, the installation and monitoring of observation wells may be required if deemed necessary in important aquifers supporting large takings for municipal, irrigation, commercial, and industrial uses in order to establish trends and predict future shortages. The monitoring of pumping and non-pumping levels in production wells may also be required, if deemed necessary, to provide valuable supporting data.

2. Artificial ground water recharge should be encouraged wherever practical to conserve ground water.

3. Ground water conservation is essential in significant flowing-well areas where a large proportion of the streamflow during the summer months is dependent

on ground water discharge from flowing wells. In these areas, special management practices should be undertaken to conserve ground water and thereby protect streamfiows. The uncontrolled flow from new flowing wells will not be allowed.

4. Explicit statements respecting ground water conservation should be incorporated into appropriate planning policies and official plans, and all parties proposing or reviewing proposed projects in such areas should ensure that appropriate conservation measures are undertaken.

5. Protection of areas with high infiltration rates is generally a good management practice. in evaluating proposals for development in significant infiltration areas, the effects on infiltration rates and the quality of the infiltrating water should be considered.

Table 1: Provincial Water Quality Objectives

INORGANICS AND OTHER PARAMETERS

Alkalinity and pH — Alkalinity should not be decreased by more than 25% of the natural concentrations. The pH should be maintained within the range 6.5-8.5.

*Ammonia — Concentrations of un-ionized ammonia should not exceed 0.02 mg/L for the protection of aquatic life.

The percentages of un-ionized ammonia in aqueous ammonia solution for different temperature and pH conditions are listed below:

Temperature °C	pH 6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
5	0.013	0.040	0.13	0.39	1.2	3.8	11.	28.	56.
10	0.019	0.059	0.19	0.59	1.8	5.6	16.	37.	65.
15	0.027	0.087	0.27	0.86	2.7	8.0	22.	46.	73.
20	0.040	0.13	0.40	1.2	3.8	11.	28.	56.	80.
25	0.057	0.18	0.57	1.8	5.4	15.	36.	64.	85.
30	0.081	0.25	0.80	2.5	7.5	20.	45.	72.	89.

For example, at 20°C and pH 8.0, a total ammonia concentration of 0.5 mg/L would give an un-ionized concentration of 0.5 x 3.8/100 = 0.019 which is less than the un-ionized Objective of 0.02.

Chlorine — Total residual chlorine, as measured by the amperometric (or equivalent) method, should not exceed 0.002 mg/L.

Cyanide — Concentrations of free cyanide in unfiltered sample should not exceed 0.005 mg/L.

* Under certain temperature and pH conditions, the total ammonia criterion for the protection of aquatic life may be less stringent than the criteria for other beneficial uses.

Dissolved Gases

To protect aquatic organisms, the total dissolved gas concentrations in water should not exceed 110 percent of the saturation value for gases at the existing atmospheric and hydro-static pressures.

Dissolved Oxygen

At no time should dissolved oxygen concentrations be less than the values specified below:

Temp. °C	Dissolved Oxygen Concentration Warm Water Biota		Cold Water Biota	
	% Saturation	mg/L	% Saturation	rng/L
0	54	8	47	7
5	54	7	47	6
10	54	6	47	5
15	54	6	47	5
20	57	5	47	4
25	63	5	48	4

In situations where additional physical and/or chemical stresses are present these minimum levels may prove inadequate and more stringent Objectives may be necessary.

In some hypolimnetic waters, dissolved oxygen is naturally lower than the above-specified concentrations. Such a condition should not be altered by adding oxygen demanding materials causing a depletion of dissolved oxygen.

Hydrogen Sulfide

Concentration of undissociated hydrogen sulfide should not exceed 0.002 mg/L, at any time or place, to protect aquatic life.

Oil and Grease

Oil or petrochemicals should not be present in concentrations that:

- can be detected as a visible film, sheen, or discolouration on the surface;
- can be detected by odour;
- can cause tainting of edible aquatic organisms;

	can form deposits on shorelines and bottom sediments that are detectable by sight or odour. or are deleterious to resident aquatic organisms.
Phenols	Concentrations of phenols should not exceed 1 µg/L to protect against tainting of edible fish flesh.
Phosphorus, Total	Current scientific evidence is insufficient to develop a firm Objective at this time. Accordingly, the following phosphorus concentrations should only be considered as general guidelines which should be supplemented by site-specific studies: To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 µg/L; A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less. This should apply to all lakes naturally below this value; Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 µg/L.
Radionuclides	Radiation exposure should be kept as low as reasonably achievable, economic and social factors being taken into account. The Provincial Water Quality Objectives for radionuclides are based on drinking water requirements, which are derived from dose-response relationships as recommended by the International Commission on Radiological Protection (ICRP) in Publication 26.

Objectives* are as follows:

Radionuclide**	Provincial Water Quality Objective*** Becquerels/Litre
Cesium $_{137}$	50
Iodine $_{131}$	10
Radium $_{226}$	1
Strontium $_{90}$	10
Tritium	40,000

* The radionuclide objectives are based on the total concentration of an unfiltered water sample.

** If two or more radionuclides affecting the same organ or tissue are found to be present, the following relationship based on the Inter-national Commission on Radiological Protection Publication 26 should be satisfied:

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

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.

*** Radionuclide concentrations exceeding the maximum acceptable concentrations may be tolerated provided that the duration of the increase is short and that the annual average concentrations remain below this level and meet the restriction for multiple radionuclides.

Note:

For further information on the radionuclide objective as related to potable water supplies, reference should be made to the MOE publication "Ontario Drinking Water Objectives".

Temperature

1) General

The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

2) Waste Heat Discharge

(a) Ambient Temperature Changes

The temperature at the edge of a mixing zone shall not exceed the natural ambient water temperature at a representative control location by more than 10°C (18°F). However, in special circumstances, local conditions may require a significantly lower temperature difference than 10°C (18°F). Potential dis-chargers are to apply to the Ministry of the Environment for guidance as to the allowable temperature rise for each thermal discharge. This Ministry will also specify the nature of the mixing zone and the procedure for the establishment of a representative control location for temperature recording on a case-by-case basis.

(b) Discharge Temperature Permitted

The maximum temperature of the receiving body of water. at any point in the thermal plume outside a mixing zone, shall not exceed 30°C (86°F) or the temperature at a representative control location plus 10°C (18°F) or the allowed temperature difference, which-ever is the lesser temperature. These maxi-mum temperatures are to be measured on a mean daily basis from continuous records.

Taking and Discharging of Cooling Water Users of cooling water shall meet both the Objectives for temperature outlined above and the "Procedures for the Taking and Discharge of Cooling Water" as outlined in the Implementation Procedures for Policy 3 (page 15).

Turbidity	Suspended matter should not be added to surface water in concentrations that will change the natural Secchi disc reading by more than 10 percent.

HEAVY METALS

The following metal Objectives (except for mercury) are based on the total concentration of an unfiltered water sample. It is recognized that metals may not be toxic in particulate or bound form. It is quite possible for the total concentration in a given surface water to exceed the Objective without damaging any aquatic fife. However, in the absence of any standard technique to measure the toxic components, it is assumed that all of the metal is in a toxic form unless specific data show otherwise. Further, an asterisk is placed before three parameters, namely arsenic, chromium and selenium, which have Objectives for aquatic life protection that are less stringent than the criteria for other beneficial uses.

*Arsenic	Concentrations of Arsenic in an unfiltered sample should not exceed 100 µg/L to protect aquatic life.
Beryllium	For the protection of aquatic life, concentrations of beryllium should not exceed 11 µg/L in an unfiltered sample of hardness less than 75 mg/L of $CaCO_3$ and not exceed 1100 µg/L in an unfiltered sample of hardness greater than 75 mg/L of $CaCO_3$.
Cadmium	Concentrations of cadmium in an unfiltered sample should not exceed 0.2 µg/L to protect aquatic life.
*Chromium	Concentrations of chromium in an unfiltered sample should not exceed 100 µg/L to protect aquatic life.
Copper	Concentrations of copper in an unfiltered sample should not exceed 5 µg/L to protect aquatic life.
Iron	Concentration of iron in an unfiltered sample should not exceed 300 µg/L to protect aquatic life.
Lead	The toxicity of lead is highly dependent on the alkalinity of

the water. The toxicity declines as the alkalinity increases. The total lead concentration should not exceed the values given below:

Alkalinity mg/L as $CaCO_3$	Maximum lead Concentration µg/L
Up to 20	5
20 to 40	10
40 to 80	20
greater than 80	25

Mercury — Concentrations of total mercury in *filtered* water should not exceed 0.2 µg/L nor should the concentrations of total mercury in whole fish exceed 0.5 µg/g (See Table 2).

Nickel — Concentrations of nickel in an unfiltered sample should not exceed 25 µg/L to protect aquatic life.

*Selenium — Concentrations of Selenium in an unfiltered sample should not exceed 100 µg/L to protect aquatic life.

Silver — Concentrations of silver in an unfiltered sample should not exceed 0.1 µg/L to protect aquatic life.

Zinc — Concentrations of zinc in an unfiltered sample should not exceed 30 µg/L to protect aquatic life.

Unspecified Non-Persistent Toxic Substances and Complex Effluents — For non-persistent compounds or mixtures with no Objectives because of a lack of specific data, their concentration should not exceed 0.05 of the 96 hour LC_{50} value for any ap-proved test species.

PESTICIDES

The wide-spread use of pesticides for the control of undesirable plant and animal life will continue for the foreseeable future. Ideally, application practices and pesticide formulations strive for maximum impact on the specific target organisms. However, strict adherence to sound application practices do not necessarily ensure an effective containment of the chemicals used. The physico-chemical properties of substances and

environmental transport processes have introduced the pesticide chemicals into the aquatic environment, often with undesirable side-effects on non-target communities of the biota. The risks to aquatic ecosystems depend on the chemical and physical properties of the pesticides, type of formulations method and rate of application and the nature of receiving waters. While acute toxicity data and usage characteristics are considerations in environmental assessments, organic compounds with bioaccumulative potential and resistance to degradation have so far presented the greatest hazard to human and aquatic life.

The following are Objectives for pesticides in widespread use in Ontario. Objectives for several other pesticides with sufficient data for establishing Objectives are also listed. Several pesticides commonly used in Ontario, which do not have criteria listed here due to lack of sufficient data, are listed in Table 3. Criteria will be established for these compounds upon collection and review of biological data but until that time objectives of generic compounds should be used as guidelines for acceptable concentrations.

	Maximum Concentration in µg/L (unfiltered sample)	Remark
Actively Used Herbicides in Ontario:		
Dicamba (Banvel)	200.0	
Diquat	0.5	
Diuron	1.6	
Dalapon	110.0	
Simazine	10.0	
2,4-D (BEE)	4.0	
Actively Used Insecticides in Ontario:		
Chlordane	0.06	
Chlorphyrifos (Dursban)	0.001	
Diazinon	0.08	
Endosulphan	0.003	
Fenthion (Baytex)	0.006	
Guthion	0.005	
Malathion	0.1	
Methoxychlor	0.04	
Pyrethrum	0.01	

	Maximum Concentration in µg/L (unfiltered sample)	Remark
Other Pesticides Not Actively Used in Ontario:		
Aldrin/Dieldrin	0.001	a
DDT and Metabolites	0.003	b. See Table 2
Endrin	0.002	a
Heptachlor and Heptachlor epoxide	0.001	a
Lindane	0.01	a
Toxaphene	0.008	
Parathion	0.008	

a. The edible portion of fish should not *exceed* 0.3 µg/g for the protection of human consumers of fish.

b. The whole fish (wet weight basis) should not exceed 1 µg/g for the protection of fish consuming birds.

INDUSTRIAL ORGANICS

Thousands of synthetic organic chemicals are in daily use as raw materials, products and additives. The potential hazards posed by many industrial organics are poorly understood because many. of these compounds are ill-defined, being by-products of a main reaction and of little commercial concern.

Unlike pesticides which are specifically designed to be toxic to some target organisms in the environment and whose environmental persistence and toxicity are documented and regulated under licencing laws, it is only in recent years that the significance of organic contaminants has become recognized. In general. they de-grade slowly or not at all and are frequently bioaccumulative. Organisms such as fish can accumulate over a period of time, pollutant concentrations thousands or millions of times the minute pollutant level in water (usually as low as a few parts per trillion). This accumulation may have a long-term deleterious effect on aquatic species and on human health.

For the control of industrial organics and other toxic sub-stances, the Ministry will make use of the Implementation Procedures outlined for the "Hazardous Substances" Policy (page 20-22).

The Objectives outlined below for a small number of industrial organics are based on current toxicity data. Adoption of these Objectives does not imply that more stringent criteria will not be necessary in the future if other deleterious effects are detected.

Further. these Objectives are intended as guidance for dealing with past release or accidental losses, but not for new releases.

	Concentration in µg/L (unfiltered sample)	Remark
Dibutylphthalate	4.0	
Diethylhexylphthalate	0.6	
Other Phthalates	0.2	
Dechlorane (mirex)	0.001	*See* Table 2
Polychlorinated Biphenyl	0.001	See Table 2

SWIMMING AND BATHING USE OF WATER

Aesthetics — Water used for swimming, bathing and other recreational activities should be aesthetically pleasing. The water should be devoid of debris, oil, scum and any substance which would produce an objectionable deposit, colour. odour, taste or turbidity.

Discharge of Waste Materials — Discharge of waste and offensive materials due to land drainage or due to direct application to the water body must be curtailed or controlled in order to maintain recreational usage.

pH — Because both alkaline and acid waters may cause eye irritation, the pH of the water used for recreational purposes should be within the range of 6.5 and 8.5.

Water Clarity — The water in bathing areas should be sufficiently clear to estimate depth or to see sub-merged swimmers who may require assistance. To achieve this degree of safety, water clarity should be such that, if the bottom of the bathing area is not visible, the water should have a Secchi disc transparency of at least 1.2 m.

Public Health Considerations — The use of water for swimming, bathing and other recreat-ional activities requiring immersion of the user should not cause disease(s) or infection(s) in the human user. Such disease(s), which may occur in the gastro-intestinal tract.

the eye, ear, nose or throat or in the skin, could be caused by pathogens including bacteria, fungi, protozoa or viruses contained in the water.

A potential health hazard is defined as a situation where there is a high risk of contracting a disease from use of the water. In these situations: confirmation of the hazard should be sought; potential users should be notified by the appropriate authority: immediate corrective action should be started; and surveillance of the water quality should continue until the corrective action is completed and the water quality can he declared safe for recreational use.

Water quality impairment is defined as a situation where there is a risk of disease from use of the water but where a less restrictive course of action can be followed. In these situations: confirmation of the impairment should be sought; corrective action should be started; and surveillance of the water quality should be maintained.

Because inadequately treated sewage and fecal matter are a primary source of disease-causing organisms, a potential health hazard exists if a sanitary survey discloses that inadequately treated sewage, fecal matter or other hazardous substances are being or may be discharged into the water. The sanitary survey should consist of an on-site inspection of adjacent and upstream areas and of all water flows and potential sources of discharge. The survey should take into account the effects of rainfall, peak user loads, the danger of accidental spillage and sources from other jurisdictions.

Because epidemiological data and outbreak reports are a direct measure of the risk of contracting a disease, a potential health hazard exists when such information (available to the medical officer of health or other appropriate health authority) discloses the presence, within the community served, of an infectious disease which may be spread or is being spread by the use of the water for

recreational purposes.

Because the occurrence of disease-causing organisms is being measured directly, a potential health hazard exists when pathogenic organisms (e.g. *(Pseudomonas aeruginosa. Salmonella typhii,* and Polio virus), can he enumerated and frequently isolated from the water.

Bacteriological water quality indicators are groups of bacteria whose densities in water can he related quantitatively to the presence of sewage or fecal matter, and therefore to the risk of contracting a disease from the pathogens contained therein. The fecal coliforms are one of these indicators. A potential health hazard exists if the fecal coliform geometric mean density for a series of water samples exceeds 100 per 100 ml.

The total coliforms are also water quality indicators. However, increasing evidence suggests that the total coliform group can also be derived from sources other than sewage and fecal matter. Therefore, water quality is considered impaired when the total coliform geometric mean density for a series of water samples exceeds 1000 per 100 ml.

The fecal streptococci are yet another water quality indicator. However, they can best be used in conjunction with the fecal coliforms as an indication of the nature of the potential fecal source. If the ratio of the geometric mean densities of the fecal coliforms to fecal streptococci at the point of discharge exceeds 4, the source of the discharge is likely to be human in origin. A ratio of less than 0.7 suggests that the source is probably of non-human origin. Ratios between these values are difficult to interpret and may indeed be mixtures.

For reliable ratio data, the fecal coliform density should approach or exceed 100 per 100 ml. The ratio must be applied carefully as numerous environmental factors will

influence the densities of both of these organisms.

Other groups of bacteria (e.g. *Pseudomonas, Staphylococcus)* could provide better information concerning the risk of eye, ear, nose, throat and skin infections since these organisms may be indicators of the presence of the causative agents for these diseases.

Sampling

Water samples for bacteriological examination must be collected in sterile bottles under aseptic conditions. Because the water samples are highly perishable, the samples should be kept cool or refrigerated and bacteriological analyses of the samples should be done within 6 hours. The time elapsing between collection and the start of examination in the laboratory should not exceed 24 hours.

A series of at least 10 samples per month per sampling location is recommended, but an increased sampling frequency will be required when the water is used for recreational purposes or when the water is subjected to contamination or discharge.

Table 2: Substances with Zero Tolerance Limits

Mercury
Dichlorodiphenyltrichloroethane
(DDT) and metabolites
Polychlorinated Biphenyl (PCB)
Polybrominated Biphenyl (PBB)
Dechlorane — C_{10} Cl_{12} (Mirex)

Table 3: Substances with Undefined Tolerance Limits

METALS		COMMENTS
Aluminum	-	in most natural waters the ionized or potentially ionizable aluminum would be in the form of anionic or neutral precipitates, concentrations of 0.1 mg/L or greater of these would be deleterious to growth and survival of fish.
Antimony	-	sources are: mine wastes, weathering of rock
	-	very toxic — 96 hr LC_{50} for fish is 9 to 80 mg/L (dependent on hardness)
	-	96 hr LC_{50} for Daphnia is 20 mg/L
Barium	-	would expect it to be in the CO_3 or SO_4 form in natural waters; $BaCl_2$ lethalities to aquatic invertebrates and fish are reported as 96 hr LC_{50} of 10-15 and 50-1500 mg/L; Barium can be concentrated from water to aquatic organisms by a factor of $\approx$150
Boron	-	fish would appear to be very tolerant of high concentrations of borates; lethal concentrations range from 6,250 mg/L to 80,000 mg/L; these concentrations could

		cause injury through osmotic imbalance
Cesium	-	extremely toxic — 48 hr LC_{50} for Daphnia = 7.4 mg/L
Cobalt	-	extremely toxic — 48 hr LC_{50} for Daphnia = 1.32 mg/L
	-	observed growth inhibition in carp at $\geq$ 5 mg/L
Manganese	-	manganese is widely distributed in nature as an oxide, as a sulphide, as a carbonate and as a silicate; no information available on allowable levels for the safety of aquatic life.
Molybdenum	-	moderately toxic — 96 hr LC_{50} for Fathead minnows = 70 to 560 mg/L dependent on salt
	-	no age and body burden correlation
	-	threshold concentration for deleterious effects = 54 mg/L
	-	sources — mineral weathering, milling and processing plant effluents
Strontium	-	moderately toxic48 hr LC_{50} for Daphnia = 75 mg/L
Thallium	-	in both fish and invertebrates it acts as a neuro poison
	-	very toxic — 96 hr LC_{50} for rainbow trout < 10 mg/L
Tin	-	no information available
Vanadium	-	very toxic — 96 hr LC_{50} 10 mg/L for some marine fish

ORGANICS

Acrylonitrile	-	moderately toxic — 24 hr LC_{50} for fish — 20 mg/L
	-	may produce tainting in fish
Alkyl Amines	-	product of synthetic rubber manufacture; moderately toxic to fish — 48 hr LC_{50} < 100 mg/L; degradation products could include ammonia
diethylamine		
dimethylamine		
Aryl Amines	-	many are carcinogenic and mutagenic in Ames test
Benzidine	-	benzidine use in dye and pigment manufacture
ß-Naphthylamine	-	ß-naphthylamine is a contaminant in naphthylamine
Aryl Chlorides		
Dichlorobenzene	-	dichlorobenzene accumulates in fish > 1000 times that of ambient concentration in 48 hours
Hexachlorobenzene		
Trichlorobenzene	-	hexachlorobenzene popular primary manufacturing material
Tetrachlorobenzene		
	-	tri and tetra chlorobenzene proposed as PCB-substitutes in transformers
Aryl Sulfonic Acids	-	industrial surfactants
Dodecylbenzene	-	dodecylbenzene very toxic to fish eggs and fry — 96 hour LC_{50} < 10 mg/L
Azo and Diazo Compounds	-	used in textile manufacture; identified as mutagenic as per Ames test
Benzene and Aliphatic Derivatives	-	accumulate in fish >1000 times that of ambient concentration in 48 hours
	-	benzene 96 hr LC_{50} < 100 mg/L for fish (moderately toxic)
Toluene	-	toluene and xylene 96 hr LC_{50}
Xylene		< 10 mg/L for fish (very toxic)
Diethylbenzene	-	identified in chemical manufacturing

Dimethylbenzene		effluents
Carbon Tetrachloride	-	carcinogenic in Ames test
	-	carcinogenic to mice through oral administration
Chlorinated Ethylenes	-	wide spread occurrence but limited toxicity data
Trichloroethylene		
Tetrachloroethylene		
Chlorophenols	-	present in pulp and paper wastes
	-	extremely toxic — 96 hour LC_{50} < 1 mg/L for fish
Pentachlorophenol		
	-	also cause of taste and odour problems
Furfural	-	pesticide and primary material in plastics manufacture
	-	moderately toxic to fish — 96 hour LC_{50} < 100 mg/L
	-	frequency of use not identified
Haloforms	-	carcinogenic to mouse through oral administration
Chloroform	-	identified in public drinking
Chloro-Bromomethanes		supplies (low concentrations)
Mercaptans	-	identified in bleached kraft effluent
Methylmercaptan	-	extremely toxic to fish — sublethal effects <1 mg/L
Nitrosamines	-	used in herbicides and cutting oils
Dimethylnitrosamine	-	identified as mutagenic and carcinogenic in Ames test
	-	carcinogenic to laboratory mammals
	-	moderately toxic to fish — 24 hour LC_{50} < 1000 mg/L
Nitro Aromatics	-	very potent mutagenic and carcinogenic compounds in Ames test

	-	occurrence and extent of use not determined
Phenols and Derivatives	-	moderately toxic to aquatic biota 96 hour LC_{50} < 100 mg/L
Cresols	-	contribute to taste and odour problems
Polycyclic Aromatic Hydrocarbons	-	identified in chemical manufacturing, steel, petroleum effluents
Napthalene	-	can be accumulated in fish 100-1000 times
Benzo(a)Pyrene		that in water
	-	benzo(a)pyrene potent carcinogen and mutagen
Quinoline	-	product of gas and tar production
	-	very toxic to fish - 96 hour LC_{50} < 10 mg/L
	-	extent of presence not identified
Styrene	-	product of plastics manufacturing
	-	accumulates in fish; probably produces tainting
	-	moderately toxic to fish96 hour LC_{50} < 100 mg/L
	-	styrene oxide mutagenic; Ames test
Sulphonates		
dimethylsulphonate	-	very potent mutagenic and carcinogenic
diethylsulphonate		compounds in Ames test

PESTICIDES		**COMMENTS**
Bayer '73	-	molluscicide, very toxic to fish 96 hour LC_{50} < 10 mg/L
Benomyl (Benilate)	-	fungicide, very toxic to fish and invertebrates - 48 hour LC_{50} < 10 mg/L
Dichlorobenil	-	herbicides, moderately toxic to aquatic biota - 96 hour LC_{50} to fish < 100 mg/L
	-	use may be limited; little record

Disulfoton (Disyston)	-	pesticide, very toxic to fish — 96 hour LC_{50} < 10 mg/L
	-	use may be limited and composition unstable
Kelthane (Dicofol)	-	pesticide, extremely toxic to aquatic invertebrates 96 hour LC_{50} < 1 mg/L
	-	frequency of use not identified
Methyl Parathion (Metaphos)	-	organophosphate pesticide
	-	very toxic to fish - 96 hour LC_{50} < 10 mg/L
	-	degrades in water
	-	extent of use not identified
Naled (Dibrom)	-	organophosphate pesticide
	-	extremely toxic to fish — 96 hour LC_{50} < 1 mg/L
	-	degrades in water
	-	common use in flea control for dogs
	-	entrance to water limited to accidental spill
Rotenone	-	popular pesticide extremely toxic to fish — 96 hour LC_{50} <1 mg/L
PMA	-	turf fungicide on golf courses
TFM	-	lampricide, extremely toxic to fish, 96 hour LC_{50} < 1 mg/L

Herbicides Actively Used in Ontario:	Insecticides Actively Used in Ontario:
Alachlor (Lasso)	Altosid
Amitrole	Carbofuran (Furadan)
Atrazine	Dimilin
Cutrine	Temephos (Abate)
Cyanazine	Fungicides Actively Used
Glyphosate	in Ontario:
Paraquat	
Trifluralin (Treflan)	Captan
2,4,5-T	Dacanil
	Pentachlorophenol

Table 4: Ontario Drinking Water Objectives

NOTE

The contents of this Table have been extracted from the 1983 MOE publication "Ontario Drinking Water Objectives", to which reference should be made for complete information on the physical, chemical and bacteriological requirements and associated sampling procedures related to potable water supplies.

INTRODUCTION

The primary purpose of drinking water objectives is for the protection of public health. Any water intended for human consumption should not contain any disease-causing organisms or hazardous concentrations of toxic chemicals or radioactive substances. Aesthetic considerations may also provide a basis for drinking water objectives since the water should be pleasant to drink. Temperature, taste, odour, turbidity and colour are all important in achieving waters which are aesthetically acceptable and pleasant to drink. Other aspects of water quality such as corrosiveness, 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. The limits described in this table are considered to outline the minimum requirements necessary to fulfill the above objectives.

Table 4A: Maximum Acceptable Concentration (MAC)

This term is used for limits applied to substances above which there are known or suspected adverse health effects. The presence in a drinking water of a substance at a level in excess of its maximum acceptable concentration shall be grounds for rejection of the water unless effective treatment is available. The length of time the maximum acceptable concentration can be exceeded without injury to health will depend on the nature and concentration of the contaminant: however, no drinking water can be permitted to exceed these limits continuously.

Maximum Acceptable Concentrations
Parameters Related to Health

Parameter*	Concentration (mg/L)
Arsenic	0.05
Barium	1.0
Boron	5.0
Cadmium	0.005
Chromium	0.05
Cyanide (Free)	0.2
Fluoride	2.4
Lead	0.05
Mercury	0.001
Nitrate (as N)**	10.0
Nitrite (as N)	1.0
Nitrilotriacetic Acid (NTA)	0.05
Pesticides	
(Aldrin + Dieldrin	0.0007
(Carbaryl	0.07
(Chlordane	0.007
*** (DDT	0.03
(Diazinon	0.014
(Endrin	0.0002
(Heptachlor + Heptachlor Epoxide	0.003
(Lindane	0.004
(Methoxychlor	0.1
*** (Methyl Parathion	0.007
(Parathion	0.035
(Toxaphene	0.005
(2,4-D	0.1
(2,4,5-TP	0.01
Radionuclides** * *	
Selenium	0.01
Silver	0.05
Trihalomethanes*****	0.35
Turbidity	I FTU

* Unless otherwise stated the limits for each substance refer to the sum of all forms present.

** Where both nitrate and nitrite are present, the total nitrate plus nitrite-nitrogen should not exceed 10 mg/L.

*** When more than one of these pesticides is present, the "total pesticides"' shall not exceed the sum of their MAC'S or 0.1 mg/L whichever is the lesser.

**** Maximum acceptable concentrations and target concentrations for radionuclides can be found in Table 4E.

***** The term "trihalomethanes" comprises chloroform, bromodichloromethane, chlorodibromomethane, and bromoform, and their concentration as determined by the gas sparge or purge equivalent method (i.e. actual concentration) should not exceed 0.35 mg/L at any time.

Table 4B: Interim Maximum Acceptable Concentration (I.M.A.C.)

This term is used to describe limits for substances of current concern with known chronic effects in mammals and for which there are no established maximum acceptable concentrations. Although toxicological, epidemiological and health data are available for such substances the data are subject to public and scientific debate before agreement on a maximum acceptable concentration. The I.M.A.C. will generally be a conservative value subject to change as more precise information becomes available.

When a substance is detected at a concentration above its I.M.A.C., it will signal the need for more sampling and investigation. Requirements for corrective action will be on a case-by-case basis.

Interim Maximum Acceptable Concentrations
Parameters Related to Health

Parameter	Concentration (mg/L)
Polychlorinated Biphenyls	0.003
Uranium	0.02

Table 4C: Maximum Desirable Concentration (MDC)

This term is used for limits on substances which, when present at concentrations above the limits, are either aesthetically objectionable to an appreciable number of consumers or may interfere with good water quality control practices. These limits should not be exceeded whenever a more suit-able. supply or treatment process is. or can be made available at a reasonable cost.

The chemical substances shown in this table should not be present in a water supply in excess of the concentrations indicated where, in the judgement of the Ministry, other more suitable supplies are. or can be made available.

Maximum Desirable Concentrations
Parameters Related to Aesthetic Quality

Parameter	Concentration*
Chloride	250
Colour	5 (TCU)**
Copper	1.0
Iron	0.3
Manganese	0.05
Methane	3 L/m^3
Odour	Inoffensive
Organic Nitrogen***	0.15
Phenols	0.002
Sulphate	500
Sulphide	Inoffensive
Taste	Inoffensive
Temperature	15°C
Total Dissolved Solids	500
Total Organic Carbon	5.0
Zinc	5.0

* Unless otherwise indicated, the maximum desirable concentrations are expressed in mg/L.

** True Colour Units.

*** Total kjeldahl nitrogen minus ammonia nitrogen.

The establishment of a limit should not be regarded as implying approval of the degradation of a high quality supply to the specified level. The limits described herein have been derived from the best information currently available; however, the development of drinking water objectives is an on-going process. Scientific knowledge of the complex interrelationships that determine water quality continues to increase as does the understanding of the physiological effects of the substances present in water. Also, man continues to introduce new chemical substances into the environment, many of which may contaminate drinking water supplies. It, therefore, may be necessary to revise the established limits as new and more significant data become available.

APPLICATION OF LIMITS

A water supply system is defined as including the works and auxiliaries for collection, treatment, storage and distribution of the water from the source of supply to the free-flowing outlet of the ultimate consumer.

The limits outlined in this document apply to all water supply systems which provide water for domestic purposes and serve more than five private residences or are capable of supplying water ata rate greater than 50,000 litres per day (OWR Act, R.S.O. 1980 Section 23, Subsection 9). Although a water supply serving five or fewer private residences is excluded from the application of the limits, it is desirable that the quality of water from these supplies should not be inferior to that supplied to the public in general.

Table 4D: Microbiological Characteristics — Health

The microbiological quality of drinking water has traditionally been viewed as the most important aspect of drinking water quality because of its association with waterborne disease. Typhoid fever, cholera, enterovirus disease, bacillary and amoebic dysenteries, and many varieties of gastro-intestinal disease can all be transmitted by water. The introduction of water treatment with disinfection and the implementation of bacteriological surveillance programs to ensure the delivery of safe drinking water have resulted in a dramatic decrease in the incidence of water-related illness. Occasional outbreaks of waterborne disease underline the continuing importance of strict supervision and control over the microbiological quality of drinking water supplies.

MICROBIOLOGICAL CHARACTERISTICS — HEALTH

Unsafe Water Quality — Definition and Corrective Action

Total Coliform bacteria, when determined by the MF or MPN method, should not he present in densities of 5 or more organisms per 100 mL or, when determined by the P-A method, should not give positive results within 48 hours.
Fecal coliforms should not be detected in any sample by any of these methods.

If these limits are exceeded, the water quality is judged unsafe. The regional staff of the Ministry will be notified immediately by telephone by the laboratory for collection of *special samples.* Further information is available in the publication "Ontario Drinking Water Objectives".

Poor Water Quality — Definition

a) **Total Coliform and Aeromonas Organisms**

When total coliform bacteria are present at levels below 5 organisms per 100 mL by MF or MPN tests, or when positive P-A results for total coliform bacteria occur after 48 hours incubation, *and/or when Aeromonas organisms are detected they should not occur in more than 25% of the samples of a single submission, nor in successive submissions from the same sampling site.*
Total coliforms at levels below 5 organisms per 100 mL by MF or MPN tests, or producing positive P-A results for total coliform bacteria after 48 hours incubation *should not occur in more than 10% of the samples submitted in any one month. Aeromonas organisms should not occur in more than 15% of the samples submitted in any one month.*

b) ***Pseudomonas aeruginosa, Staphylococcus aureus* and Members of the Fecal Streptococcus Group**
These organisms should not be detected in am sample.

c) **Standard Plate Counts**
The routine analysis for coliform bacteria should periodically he supplemented by standard plate counts (SPC). This should be done by either testing some of the samples from each submission or by testing all the samples in a given submission on a quarterly basis. *The limit for SPC (35° C, 48 hours) is 500 organisms per mL (based on a geometric mean of 5 or more samples).* Samples for SPC analysis should preferably be kept refrigerated and transported on ice, and be received and analyzed within 24 hours of collection.

When the above limits are exceeded, the Ministry may require more intensive monitoring of the distribution system. The extent of such additional monitoring is at the discretion of the Regional Director of the Ministry of the Environment. An outline of the sampling procedures and corrective measures which could be requested is given in Appendix A.2.1.4 of the publication "Ontario Drinking Water Objectives".

Table 4E: Radioactivity — Health

Man's exposure to radiation results from external sources such as cosmic and terrestrial radiation and internal sources such as radionuclides taken into the body with food, water, inhaled air and particulate matter. With respect to internal sources, the important factors to be considered from the health viewpoint are the radiation doses delivered to the organs and tissues of the body resulting from intakes of radionuclides. The radionuclides currently of greatest interest from a health viewpoint are tritium, strontium-90, iodine-131, cesium-137, and radium-226. The guidelines for these radionuclides are set out in Table 4E.

The guidelines for the radiological characteristics of water are based on dose-response relationships as recommended by the International Commission on Radiological Protection (ICRP) in publication 26. Maximum acceptable concentrations in drinking water have been derived which correspond to one per cent of the ICRP recommended annual occupational dose equivalent limits for continuous exposure. Target concentrations have been derived which correspond to one tenth the maximum acceptable concentration. The guidelines can be calculated using ICRP recommended annual limits of intake in publication 30. An average daily intake of 2 litres of drinking water is assumed.

Table 4E: Guidelines for Radionuclides

Radionuclide*	Maximum Acceptable Concentration** (Becquerels/Litre)	Target Concentration*** (Becquerels/Litre)
Cesium-137	50	5.0
Iodine-131	10	1.0
Radium-226	1	0.1
Strontium-90	10	1.0
Tritium	40,000	4,000.0

The above limits refer to the sum of all forms present.

* If two or more radionuclides affecting the same organ or tissue are found to be present, the following relationship based on ICRP Publication 26 should be satisfied:

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

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.

** Radionuclide concentrations exceeding the maximum acceptable concentrations may be tolerated provided that the duration of the increase is short and that the annual average concentrations remain below this level and meet the restriction for multiple radionuclides.

*** *The target concentration is intended to be a guideline for lifelong continuous consumption.* Radionuclide concentrations exceeding this level on a continuous basis are acceptable provided the situation is reviewed by the health authorities, taking into account factors such as magnitude and duration of population exposure.

Table 5: Water Quality Criteria for Agricultural Uses

Introduction

Ontario's agriculture increasingly depends upon high quality water to achieve the fullest production of domestic plants and animals and satisfy general farmstead needs. The quality of water is also important to the health and welfare of the human farm population.

Criteria for major agricultural uses of water are given in three headings: general farmstead uses of water, livestock watering and irrigation. It should be recognized that the following criteria are not precise requirements. They are developed from the best available information as safe guidelines to be used in concert with expert and considered judgement. The rationale for criteria establishment can be found in "Water Quality Criteria 1972." (EPA-R3- 73-033, March 1973).

General Farmstead Uses of Water

For general farmstead uses of water. including drinking, other household uses, and handling of produce and milk, it is recommended that water of a quality meeting the "Drinking Water Objectives be used. Raw water supplies not meeting this requirement should be treated to yield finished water of a quality comparable to drinking water. In general, raw waters should be free of impurities that are offensive to sight, smell, and taste. At point of use, they should be free of significant concentrations of substances and organisms harmful to public health and detrimental to the market value of agricultural products.

Livestock Watering

The health and productivity of livestock are affected by the quantities of various substances ingested as feed and as water. Accordingly, the amount of certain substances that can be present without harm in water consumed by livestock will depend in part on the amount of the same substances that are present in the feed in addition to a number of other factors which include the daily water requirements and the species, age and the physiological condition of the animals, and the nature and the quantities of other constituents of the feed and water.

Animals may be able to tolerate a fairly high level of total dissolved solids or bacteria if they are accustomed to such levels, but may be unable to tolerate a sudden change from waters with low dissolved solids or bacteria to waters with high dissolved solids or bacteria. In addition to direct effects on the animals, certain substances may contaminate animal products to the point where they will not be acceptable for human consumption.

The variability of the factors that influence the acceptability of water for livestock watering purposes must be considered when using the following water quality criteria. Although the criteria provide a general guide to the quality of water that will be acceptable for most livestock, there may be cases where water of different quality than that indicated by the criteria will be required or acceptable because of the nature, age or condition of species being raised or because of special rearing conditions or feed components. In such cases, or where the quality of an individual supply is in doubt, the quality should be assessed in relation to the specific uses.

Table 5A: Water Quality Criteria for Livestock Watering

	mg/L
Aluminum	5.0
Arsenic	0.2
Boron	5.0
Cadmium	0.05
Chromium	1.0
Cobalt	1.0
Copper	0.5
Fluoride	2.0
Lead	0.1
Mercury	0.01
Nickel	1.0
NO_3-N+NO_2-N	100.0
NO_2-N	10.0
Radionuclides	meeting drinking water objectives
Selenium	0.05
Vanadium	0.1
Zinc	25.0
Salinity (total soluble salts)	3000.0
Toxic Algae	no heavy growth
PESTICIDES:	
Aldrin	0.001
Chlordane	0.003
DDT	0.05
Dieldrin	0.001
Endrin	0.0005
Heptachlor	0.0001
Heptachlor Epoxide	0.0001
Lindane	0.005
Methoxychlor	1.0
Toxaphene	0.005
Carbamate & Organo-Phosphorus pesticides	0.1

Irrigation

The suitability of water for irrigation cannot be defined precisely because effects of the water on the crop being irrigated depend on many factors. These include soil types, climatic conditions, irrigation practices, variation in the relation between the concentration and composition of the irrigation water and the soil solution, variations in the tolerance of different plants through the combined or individual constituents in irrigation water or the soil solution, and modifying effects of interrelations between and among the constituents in irrigation water or the soil solution, and modifying effects of interrelations between and among the constituents. In general, for satisfactory irrigations, soils with poor drain-age characteristics require water of higher quality than better drained soils.

In assessing irrigation water quality, the following parameters should be considered.

I. The *total salt content* is the single most important criterion for evaluating irrigation water quality, However. all crop tolerance data are based on the salinity of the soil solution in the root zone, and these data are applicable to specific crops. Although criteria are not included here, waters with salt content of less than 700 to 800 mg/L are not expected to create serious problems. An indication of total salt content can also be obtained by measuring the Electrical Conductivity (EC) of the water. Generally, waters with EC values of less than 1 mmhos/cm can be considered safe for all conditions. Water with EC values of 1-2 mmhos/cm could cause problems, and decisions about irrigation should be based on the advice of irrigation specialists.

2. Sodium in irrigation water may be a problem in the soil solution as a component of total salinity. The *sodium adsorption ratio* (SAR) is an expression of the amount of sodium adsorbed on the soil:

$$SAR = Na^{+} \sqrt{(Ca^{++} + Mg^{++})/2}$$

where the cations are expressed in meq/L. SAR values of less than 4 will not create toxicity problems for foliar absorption. For the less sensitive crops, values of up to 6 or 7 can be used. However, higher SAR values may cause a reduction in soil permeability and should be avoided.

3. Chlorides in irrigation waters are not generally toxic to crops. Certain fruit crops are, however, sensitive to chlorides; and foliar absorption of chlorides can he of importance in sprinkler irrigation. Permissible chloride concentrations depend upon type of crop. environmental conditions and management practices. A single value cannot be recommended because detrimental effects from salinity, *per se* ordinarily deter crop growth first.

4. High bicarbonate water may induce chlorosis by making iron unavailable to plants. Although concentrations of 10 to 20 meq/L of bicarbonate can cause chlorosis in some plants, it is of little concern in the field where precipitation of calcium carbonate minimizes this hazard. Specific recommendations for bicarbonates cannot be given without considerations of other soil and water constituents.

5. The temperature of irrigation water has a direct and indirect effect on plant growth. Each occurs when physiological functions are impaired by excessively high or excessively low temperatures. The exact water temperature at which growth is severely restricted depends on method of water application, atmospheric conditions at the time of application, frequency of application, and plant species. All plant species have a temperature range in which they develop best. These temperature limits vary with plant species. Present literature does not provide adequate data to establish specific temperature recommendations for irrigation waters.

6. In general, the effect of acidity and alkalinity in irrigation water on soils and plant growth are indirect and no specific pH values can be recommended. However, water with pH values in the range of 4.5 to 9.0 should be usable provided that care is taken to detect the development of harmful indirect effects.

7. There is a lack of experimental evidence concerning the longterm accumulation and availability of radionuclides in irrigated soils and to provide an adequate margin of safety. It is recommended that "Drinking Water Objectives" be used for irrigation water.

8. Irrigation water used on crops which may be eaten raw or with little processing and which are irrigated by a spray or sprinkler mechanism must be of the best microbiological quality possible, in order to protect the user of the crop from the transmission of disease by this route. Irrigation water should be of such quality

as to meet the Objectives for swimming and bathing uses (pages 40-44). Such waters should be protected against untreated inputs of barn yard wastes and other sources of human and/or animal fecal material.

9. *Pesticides:* When present in irrigation water, pesticides can leave unacceptable residues on crops or be injurious to crop growth. Of the various pesticide residues that might be injurious to crop growth, herbicides are the most important. Insecticides, fungicides, nematocides and others excluding herbicides are generally not phytotoxic to field-grown crops in concentrations as low as the drinking water criteria. However, they could leave undesirable residues on harvested crops. Some fungicides such as chlorinated phenols and dithiocarbamate, if present in water, can damage indoor-grown mushrooms.

When assessing irrigation water for possible effects of herbicide residues on crops, one must take into account the following factors:

- toxicity of the herbicide and its concentration;
- the susceptibility of the crop irrigated and the stage of growth being watered;
- the frequency and the volume of irrigating water used;
- the weather conditions; and the soil type and pH.

Experience shows that at the present time, two major types of herbicides are of primary concern: the "hormone-type" herbicides and the nitrogen containing triazines. Injury has been observed to seedling crops at concentration of 0.5 µg/L with both types of herbicides. Therefore, irrigation water should have residues of these pesticides below this threshold limit to avoid crop damage.

The hormone-type herbicides include:

2,4-D	fenoprop	
2,4,5-T	MCPB	
MCPA picloram	dicamba	
2,4-DB	dichlorprop	
	mecoprop	

The triazines include:

atrazine
simazine
cyanazine
metribuzin

In addition to the above important parameters, trace elements (in concentrations less than a few mg/L or usually less than 100 µg/L) may cause

plant growth reductions. Recommended maximum concentrations of trace elements in irrigation water are shown below.

Table 5B: Recommended Maximum Concentrations of Trace Elements in Irrigation Waters [a]

	For waters used continuously on all soil mg/L	For use up to 20 years on fine textured soils of pH 6.0 to 8.5 mg/L
Aluminium	5.0	20.0
Arsenic	0.10	2.0
Beryllium	0.10	0.50
Boron	0.75	2.0
Cadmium	0.010	0.050
Chromium	0.10	1.0
Cobalt	0.050	5.0
Copper	0.20	5.0
Fluoride	1.0	15.0
Iron	5.0	20.0
Lead	5.0	10.0
Lithium	2.5	2.5
Manganese	0.20	10.0
Molybdenum	0.010	0.050 [c]
Nickel	0.20	2.0
Selenium	0.020	0.020
Tin [b]		
Titanium [b]		
Tungsten [b]		
Vanadium	0.10	1.0
Zinc	2.0	10.0

a These levels will normally not adversely affect plants or soils.

b See a discussion of these elements in "Water Quality Criteria 1972"

c For only acid fine textured soils or acid soils with relatively high iron oxide contents.

Glossary of Terms

Antagonism - the power of one toxic substance to diminish or eliminate the toxic effect of another; it also may refer to interactions of microorganisms growing in close association, to the detriment of at least one of them.

Application Factor - the ratio of the maximum concentration having no negative affect on the test organisms, to the 96-hour LC_{50} concentration.

Artificial Aeration - a lake management technique used in water bodies with low concentrations of dissolved oxygen to increase dissolved oxygen levels and to improve fish and fish food organism productivity and to reduce anoxic odours.

Assimilative Capacity - the ability of a waterbody to transform and/or incorporate substances (e.g. nutrients) by the ecosystem, such that the water quality does not degrade below a predetermined level.

Best Practicable Treatment (BPT) - is a waste treatment technology or process technology that has been demonstrated on a full scale basis, is generally accepted by the industrial sector and is economically viable in the particular application.

Biota - the combined fauna and flora of any geographical area or geological period.

Bioaccumulation - the uptake and retention of contaminants by an organism from its environment.

Bioassay - a determination of a concentration or dose of a given material necessary to affect a test organism under stated conditions.

Cold Water Fishery - a fresh water, mixed fish population, including some salmonids.

Conservative Pollutant - a pollutant that is relatively persistent and resistant to degradation, such as PCB and most chlorinated hydrocarbon insecticides.

Criterion, Water Quality - a designated concentration of a constituent. based on scientific judgements. that. when not exceeded will protect an organism, a community of organisms, or a prescribed water use with an adequate degree of safety.

Cumulative - brought about or increased in strength by successive additions.

Effluent - the wastewater discharged to a receiving water body following sewage treatment and/or industrial processing.

Fauna - the animals living within a given area or environment or during a stated period.

Flowing Well - a well in which the static water level is above ground level.

Flora - the aggregate of plants growing in and usually peculiar to a particular region or period.

Geometric Mean - the antilog of the mean of the log transformed data.

Guideline - any suggestion, rule, etc., that guides or directs.

Goal - an aim or objective towards which to strive; it may represent an ideal condition that is difficult. if not impossible to attain economically.

Hazardous Substances - chemicals considered to be a threat to man in the environment. including substances which (individually or in combination with other substances) can cause death, disease including cancer, behavioral abnormalities, genetic mutations. physiological malfunctions or physical deformities.

Hypolimnion - the region of a body of water extending below the thermocline to the bottom of the lake and thus removed from - much of the surface influence.

Lethal - involving a stimulus or effect causing death directly.

Micrograms per litre (µg/L) and milligrams per litre (mg/L) - units or measure expressing the concentration of a substance in a solution.

Mixing Zone - an area of water contiguous to a point source where exceptions to water quality objectives and conditions otherwise applicable to the receiving water may be granted.

Medium Lethal Concentration (LC_{50}) - the concentration of test material that causes death to 50 per cent of a population within a given time period.

Non-Conservative Pollutant - a pollutant that is quickly degraded and lacks persistence, such as most organophosphate insecticides.

Non-point Source - an area from which pollutants are exported in a manner not compatible with practical means of pollutant removal (e.g. crop lands).

Nutrient Inactivation - the addition to a water body of some type of material that will hind with, adsorb, or otherwise immobilize necessary algal nutrients, thus preventing them from being utilized by these organisms for their growth.

Regulation - a specific law that legally applies in all relevant situations.

Reserve Capacity - a portion of the assimilative capacity of a stream, which is set aside to provide an adequate margin of protection. including consideration for future water uses.

Sub-Lethal - involving a stimulus below the level that causes death.

Synergistic - interactions of two or more substances or organisms producing a result such that the total effect is greater than the sum of the individual effects.

Warm Water Fishery - a fresh water, mixed fish population with no salmonids.

Waste - for the purposes of this publication, waste means any solid, liquid, gas. odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from the activities of man which may: impair the quality of the natural environment for any use that can he made of it: cause injury or damage to property or to plant or animal life; cause harm or material discomfort to any person; adversely affect the health or impair the safety of any person; or render any property or plant or animal life unfit for use by man.

Weed Harvesting - the mechanical cutting of aquatic macrophytes and subsequent removal of the detritus from the water body.

Zone of Passage - in river systems, reservoirs, lakes, estuaries and coastal waters, zones of passage arc continuous water routes of sufficient volume. area, and quality to allow passage of free-swimming and drifting organisms so that no significant effects are produced on the populations.

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ENVIRONMENT ONTARIO SETS WATER QUALITY OBJECTIVES FOR CHLORINATED BENZENES AND CHLORINATED PHENOLS

The Ontario Ministry of the Environment has released two reports establishing water quality criteria for chlorinated benzenes and chlorinated phenols, Environment minister Jim Bradley announced today.

Chlorinated benzenes are man-made chemicals used in solvents, pesticides, deodorants and dielectric fluids. They enter the environment primarily through wastewater discharges.

Chlorinated phenols are used commercially in disinfectants, herbicides, insecticides and wood and glue preservatives. They enter the environment through various means, including agricultural drainage discharges, pulp and paper operations and sewage treatment plants.

These widely used groups of compounds are found in many parts of Ontario. The recommended criteria are levels that will protect aquatic life and ensure that surface waters are safe for recreation.

The criteria are now included in the Ministry of the Environment's Provincial Water Quality Objectives. The objectives are used to assess the quality of surface waters in Ontario, identify areas with degraded conditions and provide a basis for establishing industrial and municipal wastewater discharge limits.

.../2

The Provincial Water Quality Objectives for chlorinated benzenes are:

COMPOUND	ISOMER	OBJECTIVE(µg/L)
Monochlorobenzene	-	15.
Dichlorobenzene	1,2	2.5
	1,3	2.5
	1,4	4.0
Trichlorobenzene	1,2,3	0.90
	1,2,4	0.50
	1,3,5	0.65
Tetrachlorobenzene	1,2,3,4	0.10
	1,2,3,5	0.10
	1,2,4,5	0.15
Pentachlorobenzene	-	0.030
Hexachlorobenzene	-	0.0065

The Provincial Water Quality Objectives for chlorinated phenols (criteria are applicable to each isomer within each class) are:

Monochlorophenols	7.
Dichlorophenols	0.2
Trichlorophenols	18.
Tetrachlorophenols	1.
Pentachlorophenol	0.5

The two reports are entitled Scientific Criteria Document No. 3-84 - Chlorinated Benzenes in the Aquatic Environment and Scientific Criteria Document No. 2-84 - Chlorinated Phenols in the Aquatic Environment. Copies of the documents are available upon written request to:

Ontario Ministry of the Environment
Water Resources Branch
135 St. Clair Ave. W.
Toronto, Ontario
M4V 1P5

PROVINCIAL WATER QUALITY GUIDELINE FOR RESIN ACIDS

Receiving Water pH	Concentration (µg/L) DMA	Total Resin Acids_
5.0 **	1.0	1.0
5.5 **	2.0	3.0
6.0 **	2.0	4.0
6.5	4.0	9.0
7.0	8.0	25.0
7.5	12.0	45.0
8.0	13.0	52.0
8.5	14.0	60.0
9.0	14.0	62.0

** Lower than PWQO for pH

Note: PWQGs summarized from the publication: Scientific Criteria Document for Development of Provincial Water Quality Objectives and Guidelines - Resin Acids. Ontario Ministry of the Environment. 1988.

PROVINCIAL WATER QUALITY GUIDELINE FOR ALUMINUM

*1. For pH 4.5 to 5.5, the Guideline for Aluminum is 0.015 mg/L based on inorganic monomeric aluminum measured in clay-free samples.

2. For pH >5.5 to 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than ten percent (10%) above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs.

* 3. For pH >6.5 to 9.0, the Guideline is 0.075 mg/L based on total aluminum measured in clay-free samples.

* If natural background aluminum concentrations in water bodies unaffected by man-made inputs are greater than the numerical Guidelines in 1. and 3. above, then no condition is permitted that would increase the aluminum concentration in clay-free samples by more than ten percent (10%) of the natural background level.

Note: PWQGs summarized from the publication: Scientific Criteria Document for Development of Provincial Water Quality Objectives and Guidelines - Aluminum. Ontario Ministry of the Environment. 1988.