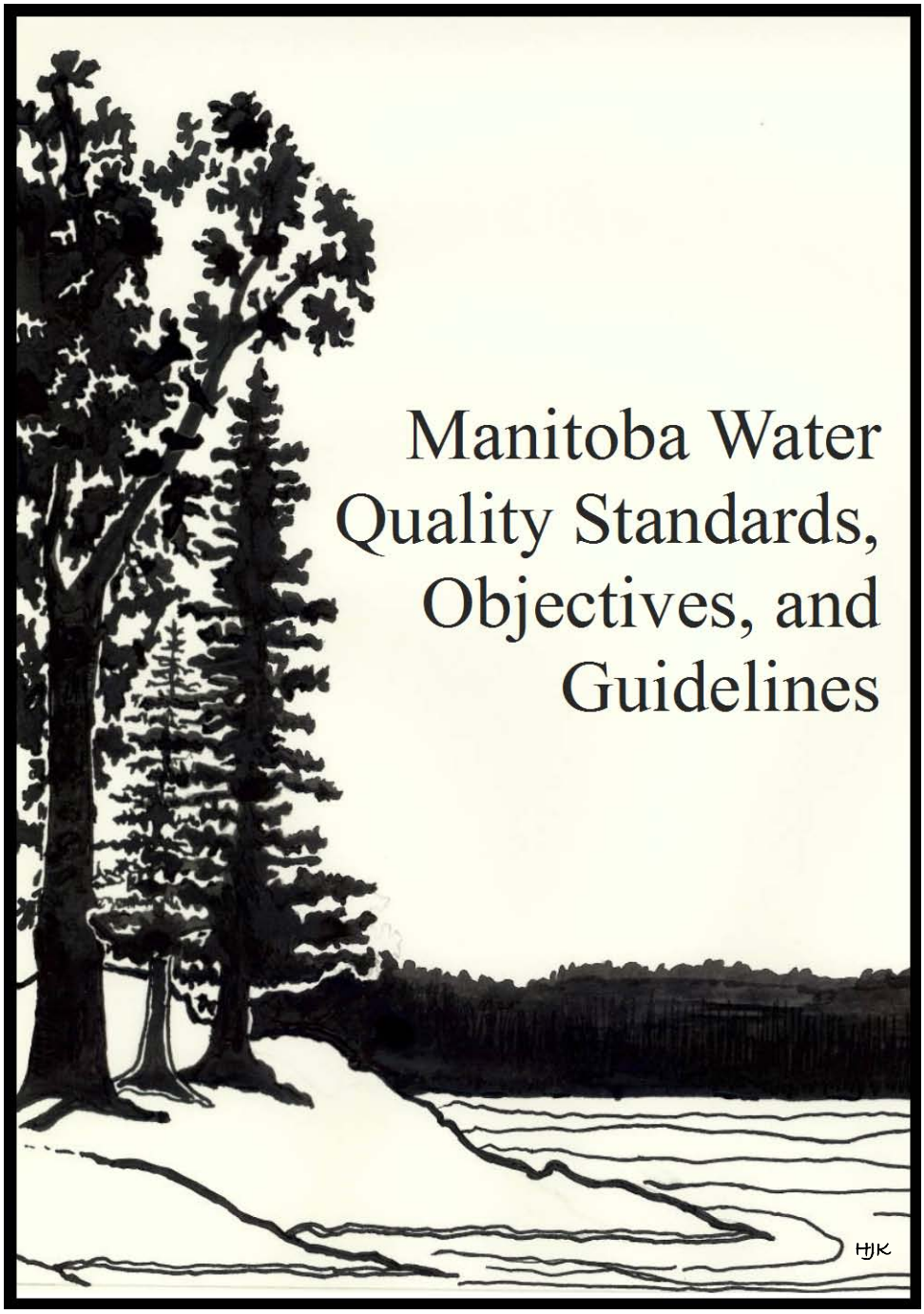

Manitoba Water Stewardship
November 28, 2011

Manitoba

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MANITOBA WATER QUALITY STANDARDS, OBJECTIVES, AND GUIDELINES

Water Science and Management Branch
Manitoba Water Stewardship

Manitoba

A GUIDE TO THIS DOCUMENT

General Approach to Environmental Protection

Manitoba Water Stewardship ensures a high level of environmental quality by identifying, evaluating, and managing existing and potential future risks to the environment and human health. A variety of scientific tools and management strategies are used in a proactive manner to protect, maintain, and rehabilitate water quality to meet this mission. Similar to many other jurisdictions, two general water quality management strategies are simultaneously used. First, all activities and waste discharges are controlled to the extent that is reasonably practical and economically achievable using a consistent technology-based approach for each development sector. This is consistent with pollution prevention principles that have been historically applied in Manitoba on a routine basis and, more recently, described in the Canadian Council of Ministers of the Environment's (CCME) Canada-Wide Accord on Environmental Harmonization. Second, when more stringent environmental controls are required to protect important water uses, a water quality-based approach is then used. Additional environmental limits are derived using the water quality-based approach to ensure that applicable ambient water quality standards, objectives, or guidelines are not exceeded.

This document formally supersedes the "Manitoba Water Quality Standards, Objectives, and Guidelines" (Williamson 2002 draft).

Future Revisions

The Manitoba Water Quality Standards, Objectives, and Guidelines will be revised periodically in the future as new scientific information emerges and as further experience is gained in the administrative application of these principles, policies, and guidance. A number of activities are presently underway both in Manitoba and elsewhere in Canada that may result in significant new information arising within the near future. Manitoba Water Stewardship, along with other agencies in the Canadian prairies, is developing an overall strategy to better manage plant nutrients in prairie streams. As well, new principles relating to environmental protection in Canada continue to be developed through national processes, such as the CCME. As results emerge and are evaluated, modifications will be made to the Manitoba Water Quality Standards, Objectives, and Guidelines wherever appropriate.

For Further Information

For further information on the Manitoba Water Quality Standards, Objectives, and Guidelines or to obtain copies of this document, please contact:

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Tier I - Water Quality Standards contain two general types of guidance. First, minimum standards are identified for common classes of discharges in Manitoba. These standards form the basis of the *technology-based approach* to the prevention of pollution, consistent with the general historical practice in Manitoba, and ensure that best available, economically achievable treatment technologies for each sector are utilized to treat all wastes that are amenable to treatment, regardless of location. In a number of cases, these technology-based standards are already contained in existing provincial and federal regulations and are merely referenced here for completeness. There is little or no opportunity to modify the technology-based standards at any site except where specifically indicated.

Second, in the future, *Tier I - Water Quality Standards* may contain Canada-Wide Standards developed and negotiated by the CCME under the Canada-Wide Accord on Environmental Harmonization. Information on the Canada-Wide Accord on Environmental Harmonization and Canada-Wide Standards is available from the CCME's website at http://www.ccme.ca/.

TIER I - WATER QUALITY STANDARDS

Variable	Standard	Implementation
Industrial and Municipal Wastewater Effluents Discharged to a Water Body	• 1 mg/L total phosphorus	• All facilities discharging more than 820 kg total phosphorus per year (that is, communities with a population greater than 2,000 or equivalent due to industrial contributions)
	• 1 mg/L total phosphorus or demonstrated nutrient reduction strategy	• New or expanding facilities discharging less than 820 kg total phosphorus per year (that is, communities with a population less than 2,000 or equivalent due to industrial contributions)
	• Total ammonia limits shall not exceed a site-specific limit derived from the Manitoba Water Quality Objectives	• All continuously discharging facilities
	• 15 mg/L total nitrogen	• Site specific requirements based on the receiving environment for new and expanding industrial facilities serving the food processing industry and new and expanding wastewater treatment facilities discharging more than 33,000 kg of total nitrogen per year (that is, serving more than 10,000 people or equivalent due to industrial loading).
	• Best practical technology for beneficial use of valuable resources such as nutrients, organic matter and energy contained within municipal biosolids and sludge.	• All new or expanding facilities

Variable	Standard	Implementation
Municipal Wastewater Effluents Discharged to a Water Body	Effluent quality must achieve the following minimum secondary treatment technology standards: • 200 fecal coliform organisms / 100 mL or 200 *Escherichia coli* organisms / 100 mL • 25 mg/L Carbonaceous Biochemical Oxygen Demand • 25 mg/L Biochemical Oxygen Demand • 25 mg/L Total Suspended Sediments (excluding growing algae)	 • All facilities • All facilities with ammonia and/or total nitrogen limits • All facilities without ammonia and/or total nitrogen limits • All facilities

Carbonaceous biochemical oxygen demand and biochemical oxygen demand standards are intended to be applied as not to exceed maximum concentrations. However, some flexibility on a site-specific basis can be added to provide an allowance for minimal variability at continuously discharging facilities. For facilities that discharge intermittently, carbonaceous biochemical oxygen demand and biochemical oxygen demand standards must be met before facilities are discharged and must be maintained throughout the discharge period.

For facilities that discharge continuously, total phosphorus standards would be based on a 30-day rolling average. For facilities that discharge intermittently, total phosphorus standards would be calculated as an average per discharge period (for discharge periods less than 30 day) or as a 30-day rolling average (for discharge periods more than 30 days).

While the total phosphorus standard depends on the size of the nutrient load, the intent is not to provide a disincentive to the development of larger, regional facilities that may be able to provide advanced wastewater treatment more economically than several smaller facilities. Therefore, the load of phosphorus discharged per year will be measured as the cumulative load (including multiple treatment facilities and combined sewer overflows) from each community (or collection of communities considering regional wastewater treatment) per water body.

Demonstrated nutrient reduction strategies are those strategies that have been demonstrated to be effective in reducing nutrient loads to surface waters including, but not limited to, effluent irrigation, trickle discharge or constructed wetlands and have been approved by the Director under *The Water Protection Act*.

Variable	Standard	Implementation
Other Effluents or Activities Governed by Provincial or Federal Regulation: • Metal Mining Liquid Effluents	• Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Metal Mining Effluent Regulations (http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/index.html) of the federal Fisheries Act.	In accordance with the Metal Mining Effluent Regulations of the Federal Fisheries Act, or any future amendment thereof including production of non-acutely lethal effluents, pH ≥ 6.0 and ≤ 9.5, and authorized limits of deleterious substances described in Schedule 4.
• Pulp and Paper Mill Effluents	• Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Pulp and Paper Effluent Regulations ((http://laws-lois.justice.gc.ca/eng/regulations/SOR-92-269/index.html) of the federal Fisheries Act	As defined by the Pulp and Paper Effluent Regulations of the federal Fisheries Act , or any future amendment thereof, including: • limits on the discharge of Biochemical Oxygen Demand based upon reference production rates • limits on the discharge of Total Suspended Solids based upon reference production rates • discharges not to be acutely lethal
• Storage and Handling of Gasoline	• Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Storage and Handling of Petroleum Products and Allied Products Regulation (Manitoba Regulation 188/2001 R) under The Dangerous Goods Handling and Transportation Act (C.C.S.M. c. D12) (http://web2.gov.mb.ca/laws/regs/index.php)	As defined by the Storage and Handling of Petroleum Products and Allied Products Regulation (Manitoba Regulation 188/2001 R) under The Dangerous Goods Handling and Transportation Act (C.C.S.M. c. D12), or any future amendment thereof.

Variable	Standard	Implementation
• Livestock Manure	• Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Livestock Manure and Mortalities Management Regulation (Manitoba Regulation 42/98) under The Manitoba Environment Act (C.C.S.M. c. E125) (http://web2.gov.mb.ca/laws/regs/index.php)	As defined by the Livestock Manure and Mortalities Management Regulation (Manitoba Regulation 42/98) under The Manitoba Environment Act (C.C.S.M. c. E125) , or any future amendment thereof, including: • application of manure at agronomic rates to prevent contamination of ground and surface waters • application of manure in such a manner to avoid loss beyond the boundaries of the agricultural property
• Municipal wastewater sludge, biosolids, inorganic fertilizer, and livestock manure	• Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Nutrient Management Regulation (Manitoba Regulation 62/2008) under The Water Protection Act (C.C.S.M. c. W65)http://web2.gov.mb.ca/laws/regs/index.php)	Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Nutrient Management Regulation (Manitoba Regulation 62/2008) under The Water Protection Act (C.C.S.M. c. W65) , or any future amendment thereof.
• Protection of Ground Water Quality	• Best Practical Technology, to prevent contamination of ground water, as defined by The Ground Water and Water Well Act (C.C.S.M. c. G110) and the Well Drilling Regulation (Manitoba Regulation 28/88 R) http://web2.gov.mb.ca/laws/regs/index.php	As defined by The Ground Water and Water Well Act (C.C.S.M. c. G110) and the Well Drilling Regulation (Manitoba Regulation 28/88 R), or any future amendment thereof.
• Onsite Wastewater Systems	• Best Practical Technology, to prevent contamination of surface and ground water, as defined by the Onsite Wastewater Management Systems Regulation (Manitoba Regulation 83/2003 R) http://web2.gov.mb.ca/laws/regs/index.php	As defined by the Onsite Wastewater Management Systems Regulation (Manitoba Regulation 83/2003 R) , or any future amendment thereof.

Variable	Standard	Implementation
• Other Discharges or Activities	• As defined by applicable provincial or federal regulation to prevent contamination of surface and ground water.	As defined by applicable provincial or federal regulation.

TIER II - WATER QUALITY OBJECTIVES

IMPLEMENTATION POLICIES

General Application

Tier II - Water Quality Objectives are defined for a limited number of common pollutants in Manitoba that are routinely controlled through licencing under The Manitoba Environment Act (http://web2.gov.mb.ca/laws/regs/index.php). These objectives form the basis for the water quality-based approach when additional restrictions need to be developed to protect important uses of ground or surface waters beyond those defined under *Tier I - Water Quality Standards* or other controls to which dischargers are subject.

These objectives provide the fundamental link between environmental management regulatory activities, ambient water quality monitoring data, scientific toxicological information, water uses, and public expectations concerning environmental quality.

These objectives, in conjunction with other information such as downstream waters uses, existing water quality characteristics, and stream discharge volumes, can also be used by developers and project planners to determine the wastewater treatment requirements likely associated with any specific location. To be most effective, this information should be used early in project planning to accurately estimate the environmental control costs associated with any proposed location.

At some sites, further modification of *Tier II - Water Quality Objectives* may be required to better account for site-specific or regional-specific factors such as the greater or lesser sensitivity of resident species, unique influence of the receiving water on toxicity, or other factors. Scientific protocols have been developed by a number of agencies (*e.g.*, US EPA 1994, MacDonald 1997, CCME 2003) to guide the modification of water quality objectives at specific sites. These or other scientifically rigorous methods should be followed when site-specific or regional-specific modifications are made.

Exceedance of Objectives due to Natural Conditions

Waters may have natural characteristics which exceed a number of water quality objectives. These naturally occurring situations are normal where, for example, productivity of aquatic life communities may be constrained or limited by natural conditions. In these cases, water quality objectives may be unattainable. Naturally occurring conditions that exceed the objectives should not be considered as violations and additional impairment by man-made activities should not occur unless it can be demonstrated that important water uses will not be further impaired.

Levels of Protection

Waterbodies in Manitoba can be protected to one of three different and successively higher levels of quality:

- Routine Protection of Water Uses

Water quality will be managed in most ground and surface waters in Manitoba through application of the Routine Protection of Water Uses. This routine level of protection is achieved by simultaneously using a consistent, technology-based approach, as defined by *Tier I - Water Quality Standards*, and when required, deriving additional, more stringent requirements using the

water quality-based approach, as defined by *Tier II - Water Quality Objectives*.

The routine level of protection of water uses will ensure that all pollutants are reduced or eliminated with the use of standard treatment technologies commonly available to each unique sector. This approach also recognizes that in some cases, the sole use of common, technology-based treatment systems may not provide adequate protection to a specific body of water (*e.g.*, in situations involving a large volume of effluent discharge to a small stream, a large number of industries discharging to a single body of water, or other similar situations). In these cases, water quality objectives are used to develop effluent limitations that will provide the required protection.

This level will provide reasonable protection from unacceptable impacts to all but a small percentage of aquatic taxa for most of the time and, therefore, reflects the principle advanced by the US EPA that healthy communities can tolerate some stress and can recover. Similarly, other water uses are provided reasonable protection from most, but not all impacts.

- High Quality Waters

Some surface or ground waters in Manitoba that have (1) biological, chemical and physical quality better than the standards, objectives, and guidelines and (2) support a high quality water use may be designated as "High Quality". Waters suitable for inclusion may include:

(a) Waters that flow through or that are bounded by Provincial or National Parks;

(b) Waters within relatively undisturbed aquifers or watersheds;

(c) Waters possessing outstanding quality characteristics;

(d) Waters that support a diverse or unique flora and fauna which are sensitive to man-induced water quality alterations;

(e) Waters designated as Canadian Heritage Rivers.

Measurable or calculable degradation that will jeopardize the designated high quality use should not occur as a result of human activity unless:

(a) The proposed new, additional or increased discharge or discharges of pollutants is justified;

(b) Such proposed discharges will not preclude any use presently possible in such waters and downstream from such waters, and will not result in exceedances of the water quality standards, objectives, and guidelines. Should the High Quality use involve the protection of aquatic life and wildlife, all life stages of all resident organisms likely to be affected will be protected at all times. Consequently, the specific numerical standards, objectives, and guidelines may be adjusted to reflect this additional degree of protection; and

(c) Such proposed projects or developments which will result in new, additional or increased discharges of pollutants into such waters should be required to use the best available combination of treatment, land disposal,

re-use and discharge technologies to control such wastes, including the use of best management practices to curb soil erosion.

This level will provide protection to all species in all places at all times. When development is justified, risk of unanticipated impacts will be minimized by requiring the use of best available treatment technologies.

At the present time, the Upper Burntwood, Upper Grass River, and Clearwater Lake watersheds have been designated as High Quality Waters.

- Exceptional Value Waters

Some surface waters that have (1) biological, chemical, and physical quality better than the established standards, objectives, and guidelines and (2) support a combination of aquatic life and wildlife and recreational uses of exceptional recreational and ecological value will be given an "Exceptional Value" designation. Waters suitable for inclusion are as follows:

(a) Ecological Reserves;

(b) Wild and scenic rivers or lakes;

(c) Waters or watersheds providing habitat for rare or endangered flora and fauna;

(d) Waters considered sensitive such that irreversible harm will result following human impact;

(e) Waters whose exceptional quality and value as a future resource precludes the assignment of present uses;

(f) Waters designated as Canadian Heritage Rivers.

Water courses designated as Exceptional Value should not receive any alterations that result in measurable, calculable, or perceived water quality degradation or degradation of other values deemed exceptional.

This level will provide a near zero risk of unanticipated impacts since water bodies designated as Exceptional Value will be virtually removed from the opportunity for development.

No water bodies have yet been designated as Exceptional Value.

Minimum Design Flows and Levels

Ideally, *Tier II - Water Quality Objectives* should apply at all times. However, this is generally viewed as being unreasonable since it would require the construction of costly treatment facilities capable of meeting *Tier II - Water Quality Objectives* even during periods of infrequent and extreme low stream flows. Thus, specific low flow levels have been chosen below which *Tier II - Water Quality Objectives* do not apply:

- Rivers and Streams

Specific guidance is provided with each *Tier II - Water Quality Objective*. In general, however, most aquatic life communities will be reasonably protected from unacceptable effects if *Tier II - Water Quality Objectives* are not exceeded more than once in each three year period. The US EPA (1994)

reported that exceedance frequencies greater than once each three years would result in aquatic communities constantly being in a state of recovery. They also advised that this exceedance frequency may be too great for some sensitive communities, while others may be able to recover more quickly, particularly those with numerous refugia. For those *Tier II - Water Quality Objectives* intended to prevent unacceptable chronic effects, the minimum design flow that corresponds to this return frequency is either the 4-Day, 3-Year Biological Flow or the 7Q10 Hydrological Flow, and in the case of ammonia, an additional 30-Day, 3-Year Biological Flow or 30Q10 Hydrological Flow is specified. For those *Tier II - Water Quality Objectives* intended to prevent acute effects, the minimum design flow that corresponds to this return frequency is either the 1-Day, 3-Year Biological Flow or the 1Q10 Hydrological Flow. Comparative analyses has shown that the 4-Day, 3-Year Biological Flow is approximately 10 % less than the 7Q10 Hydrological Flow. In cases where minimum design flows are desired to be expressed on a seasonal or monthly basis, 7Q10s may be calculated using applicable flow data for the desired seasons or months.

For water uses other than aquatic life, reasonable protection should be provided if *Tier II - Water Quality Objectives* apply for all flows 7Q10.

In cases where the minimum design flow calculated by either the biological or hydrological method is 0.003 m^3/s or less, the guidance for Intermittent Streams, provided in the following section, should apply.

Actual, reconstructed, or predicted future hydrological data used to derive minimum design flows should be verified by professional hydrologists within Manitoba Water Stewardship, and should consider present or likely future stream management policies.

Tier II - Water Quality Objectives should apply at all times if important uses are supported because of pooling of water during periods of low natural flows.

The applicable narrative *Tier III - Water Quality Guidelines* should apply at all times regardless of the amount of flow.

- Intermittent Streams

Intermittent streams and natural or man-made drainage channels receive water from precipitation from small watersheds (usually less than 1 km^2 in area) and from ground water sources and, therefore, usually flow during short periods. Such streams however, are an integral part of the surface water resources of Manitoba. *Tier II - Water Quality Objectives* should apply to all such streams when the flow is 0.003 m^3/s or greater. When discharge within intermittent streams is less than this flow, minimum levels of quality should be maintained in order to not exceed *Tier II - Water Quality Objectives* within downstream water bodies to which the intermittent stream is tributary.

Similar to other larger streams, *Tier II - Water Quality Objectives* should apply at all times if important uses are supported because of pooling during periods of low natural flows.

The applicable narrative *Tier III - Water Quality Guidelines* should apply at all times regardless of the amount of flow.

- Lakes, Bays, Marshes, Sloughs, Impoundments, and Other Wetlands

Tier II - Water Quality Objectives apply at all times to lakes, bays, marshes, sloughs, impoundments, and other wetlands unless they are a defined part of an effluent system prior to the final discharge point.

- Ground Water

Tier II - Water Quality Objectives apply at all times to ground water.

Mixing Zones

Mixing zones should be determined on a case-by-case basis using a thorough knowledge of local conditions. Normally, geometric size constraints will not be assigned due to the complex nature of the mixing properties of liquids. The following guidelines should apply to mixing zones, where applicable, to minimize the loss of value such that water uses are not unacceptably impaired (US EPA 1994, US EPA 1995a):

(a) The mixing zone should be as small as practicable and should not be of such size or shape as to cause or contribute to the impairment of water uses outside the zone;

(b) The mixing zone should be designed to allow an adequate zone of passage for the movement or drift of all stages of aquatic life:

(i) For those materials that elicit an avoidance response from aquatic life, the mixing zone should contain not more than 25 % of the cross-sectional area or volume of flow at any transect in the receiving water. Should a proportion of the stream width greater than 25 % be selected for these materials, the mixing zone could act similar to a physical barrier and could effectively preclude the passage of aquatic life;

(ii) The mixing zone should not be acutely lethal to aquatic life passing through the mixing zone. Thus, for toxic materials, acute lethality within the mixing zone is a function of concentration and the duration of exposure. Whole effluents should not be acutely lethal to aquatic life, as demonstrated by 96 hour LC_{50} tests done on appropriate species, unless it can be shown either through mixing zone modelling that mixing of the effluent with the receiving water will be achieved in a relatively rapid and complete manner (*e.g.,* no more than a 10 % difference in bank-to-bank concentrations within a longitudinal distance of not more than two stream or river widths) or through other scientifically rigorous methods that acute lethality will not occur within the mixing zone;

(iii) Mixing zones should not interfere with the migratory routes essential to the reproduction, growth, or survival of aquatic species;

(iv) Mixing zones should not cause an irreversible organism response, or increase the vulnerability to predation;

(v) When two or more mixing zones are in close proximity, they should

be so defined that a continuous passageway for aquatic life is available;

(vi) Mixing zones should not intersect the mouths' of rivers.

(c) Mixing zones should not interfere with spawning and nursery areas;

(d) In lakes and other surface impoundments, the volume of mixing zones should not exceed 10 % of the volume of those portions of the receiving waters available for mixing or 100 m in radius, whichever is less;

(e) Mixing zones should not contaminate natural sediments so as to cause or contribute to exceedances of the water quality standards, objectives, and guidelines outside the mixing zone;

(f) Mixing zones should not intersect domestic water supply intakes or bathing areas;

(g) Mixing zones generally do not apply to ground water;

(h) The applicable narrative *Tier III - Water Quality Guidelines* should apply at all points within mixing zones to avoid objectionable nuisance conditions and to protect uses outside mixing zones from unacceptable effects.

TIER II - WATER QUALITY OBJECTIVES

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Ammonia	mg/L Total Ammonia as N	Surface Water: Cool Water Aquatic Life and Wildlife	$= \left[\left(\left[\frac{0.0577}{1+10^{7.688-\text{pH}}}\right]+\left[\frac{2.487}{1+10^{\text{pH}-7.688}}\right]\right)\times a\right]$ (Eq. 1) where a = 2.85 or $= 1.45\times 10^{0.028\times(25\text{-Temperature})}$, whichever is less and pH ≥6.5 and ≤ 9.0; and $= 2.5\times\left[\left(\left[\frac{0.0577}{1+10^{7.688-\text{pH}}}\right]+\left[\frac{2.487}{1+10^{\text{pH}-7.688}}\right]\right)\times a\right]$ (Eq. 2) where a = 2.85 or $= 1.45\times 10^{0.028\times(25\text{-Temperature})}$, whichever is less and pH ≥6.5 and ≤ 9.0; and $= \left[\frac{0.411}{1+10^{7.204-\text{pH}}}\right]+\left[\frac{58.4}{1+10^{\text{pH}-7.204}}\right]$ (Eq. 3) and Eq. 2 ≤ Eq. 3 **or**	Water Temperature >5°C or Early Life Stages are Present	30 Days[c]	Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10	US EPA (1999a)
				Water Temperature >5°C or Early Life Stages are Present	4 Days[c]	Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10	
				All Periods	1 Hour[d]	Not More Than Once Each 3 Years, On Average	1-Day, 3-Year or 1Q10	

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Ammonia	mg/L Total Ammonia as N	Surface Water: Cool Water Aquatic Life and Wildlife (continued)	$= \left[\left(\left[\frac{0.0577}{1+10^{7.688-\text{pH}}}\right]+\left[\frac{2.487}{1+10^{\text{pH}-7.688}}\right]\right)\times b\right]$ (Eq. 4) where $b = 1.45\times10^{0.028\times(25-c)}$ and c = Maximum Temperature or 7°C whichever is greater and pH ≥6.5 and ≤ 9.0;	Water Temperature ≤5°C or Early Life Stages are Absent	30 Days[c]	Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10	
			and $= 2.5\times\left[\left(\left[\frac{0.0577}{1+10^{7.688-\text{pH}}}\right]+\left[\frac{2.487}{1+10^{\text{pH}-7.688}}\right]\right)\times b\right]$ (Eq. 5) where $b = 1.45\times10^{0.028\times(25-c)}$ and c = Maximum Temperature or 7°C whichever is greater and pH ≥6.5 and ≤ 9.0;	Water Temperature ≤5°C or Early Life Stages are Absent	4 Days[c]	Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10	
			and $= \left[\frac{0.411}{1+10^{7.204-\text{pH}}}\right]+\left[\frac{58.4}{1+10^{\text{pH}-7.204}}\right]$ (Eq. 6) and Eq. 5 ≤ Eq. 6	All Periods	1 Hour[d]	Not More Than Once Each 3 Years, On Average	1-Day, 3-Year or 1Q10	

Water Quality Variable	**Units and Form**	**Water Use**	**Tier II - Water Quality Objectives**[a]	**Applicable Period**	**Averaging Duration**	**Allowable Exceedance Frequency**	**Design Flow**[b]	**References**
Ammonia	mg/L Total Ammonia as N	Surface Water: Cold Water Aquatic Life and Wildlife	$=\left[\left(\left[\frac{0.0577}{1+10^{7.688-\mathrm{pH}}}\right]+\left[\frac{2.487}{1+10^{\mathrm{pH}-7.688}}\right]\right)\times a\right]$ (Eq. 7) where a = 2.85 or $=1.45\times10^{0.028\times(25-\mathrm{Temperature})}$ whichever is less and pH ≥6.5 and ≤ 9.0; and	Early Life Stages are Present	30 Days[c]	Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10	US EPA (1999a)
			$=2.5\times\left[\left(\left[\frac{0.0577}{1+10^{7.688-\mathrm{pH}}}\right]+\left[\frac{2.487}{1+10^{\mathrm{pH}-7.688}}\right]\right)\times a\right]$ (Eq. 8) where a = 2.85 or $=1.45\times10^{0.028\times(25-\mathrm{Temperature})}$ whichever is less and pH ≥6.5 and ≤ 9.0; and	Early Life Stages are Present	4 Days[c]	Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10	
			$=\left[\frac{0.275}{1+10^{7.204-\mathrm{pH}}}\right]+\left[\frac{39.0}{1+10^{\mathrm{pH}-7.204}}\right]$ (Eq. 9) and Eq. 8 ≤ Eq. 9 **or**	All Periods	1 Hour[d]	Not More Than Once Each 3 Years, On Average	1-Day, 3-Year or 1Q10	

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Ammonia	mg/L Total Ammonia as N	Surface Water: Cold Water Aquatic Life and Wildlife (continued)	$= \left[\left(\left[\frac{0.0577}{1+10^{7.688-\mathrm{pH}}}\right]+\left[\frac{2.487}{1+10^{\mathrm{pH}-7.688}}\right]\right)\times b\right]$ (Eq. 10) where $b = 1.45\times 10^{0.028\times(25-c)}$ and c = Maximum Temperature or 7°C whichever is greater and pH ≥6.5 and ≤ 9.0;	Early Life Stages are Absent	30 Days[c]	Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10	
			and $= 2.5\times\left[\left(\left[\frac{0.0577}{1+10^{7.688-\mathrm{pH}}}\right]+\left[\frac{2.487}{1+10^{\mathrm{pH}-7.688}}\right]\right)\times b\right]$ (Eq. 11) where $b = 1.45\times 10^{0.028\times(25-c)}$ and c = Maximum Temperature or 7°C whichever is greater and pH ≥6.5 and ≤ 9.0;	Early Life Stages are Absent	4 Days[c]	Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10	
			and $= \left[\frac{0.275}{1+10^{7.204-\mathrm{pH}}}\right]+\left[\frac{39.0}{1+10^{\mathrm{pH}-7.204}}\right]$ (Eq. 12) and Eq. 11 ≤ Eq. 12	All Periods	1 Hour[d]	Not More Than Once Each 3 Years, On Average	1-Day, 3-Year or 1Q10	

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Arsenic	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	150 and 340	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985a), US EPA (1995b), US EPA (1999b)
Cadmium[e]	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	$= \left[e^{\{0.7409[\ln(Hardness)]-4.719\}}\right] \times \left[1.101672 - \{\ln(Hardness)(0.041838)\}\right]$ (Eq. 13) where Hardness is expressed in mg/L as $CaCO_3$ and $= \left[e^{\{1.0166[\ln(Hardness)]-3.924\}}\right] \times \left[1.136672 - \{\ln(Hardness)(0.041838)\}\right]$ (Eq. 14) where Hardness is expressed in mg/L as $CaCO_3$	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985b), US EPA (1995b), US EPA (1999b), US EPA (2001)
Chlorine	µg/L as Total Residual	Surface Water: Aquatic Life and Wildlife	11 and 19	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985c), US EPA (1995b), US EPA (1999b)
Chromium III[e]	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	$= \left[e^{\{0.8190[\ln(Hardness)]+0.6848\}}\right] \times \left[0.860\right]$ (Eq. 15) where Hardness is expressed in mg/L as $CaCO_3$ and $= \left[e^{\{0.8190[\ln(Hardness)]+3.7256\}}\right] \times \left[0.316\right]$ (Eq. 16) where Hardness is expressed in mg/L as $CaCO_3$	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985d), US EPA (1995b), US EPA (1999b)

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Chromium VI	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	11 and 16	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985d), US EPA (1995b), US EPA (1999b)
Copper[e]	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	$= \left[e^{\{0.8545[\ln(Hardness)]-1.702\}}\right] \times [0.960]$ (Eq. 17) where Hardness is expressed in mg/L as $CaCO_3$ and $= \left[e^{\{0.9422[\ln(Hardness)]-1.700\}}\right] \times [0.960]$ (Eq. 18) where Hardness is expressed in mg/L as $CaCO_3$	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985e), US EPA (1995b), US EPA (1999b)
Cyanide	µg/L as Free Cyanide (as CN)	Surface Water: Aquatic Life and Wildlife	5.2 and 22	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985f), US EPA (1995b), US EPA (1999b)
Cyanobacteria (total)	cells per 1 mL	Surface Water: Primary Recreation	100,000	Recreational Season	1 Day	Not Applicable	Not Applicable	Health Canada (2009b)

Water Quality Variable	**Units and Form**	**Water Use**	**Tier II - Water Quality Objectives**[a]	**Applicable Period**	**Averaging Duration**	**Allowable Exceedance Frequency**	**Design Flow**[b]	**References**
Dissolved Oxygen	mg/L	Surface Water: Cool Water Aquatic Life and Wildlife	5.5 and 6.0 and 4.0 and 5.0 and 3.0	Mature Life Stages[f] (*e.g.*, Water Temperature ≤5°C) Early Life Stages[g] (*e.g.*, Water Temperature >5°C) Mature Life Stages (*e.g.*, Water Temperature ≤5°C) Early Life Stages (*e.g.*, Water Temperature >5°C) Mature Life Stages (*e.g.*, Water Temperature ≤5°C)	30 Days 7 Days 7 Day Minimum Instantaneous Minimum Instantaneous Minimum	Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10 7-Day, 3-Year or 7Q10 7-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10 1-Day, 3-Year or 1Q10	US EPA (1986), US EPA (1999b)

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Dissolved Oxygen	mg/L	Surface Water: Cold Water Aquatic Life and Wildlife	6.5 and 9.5 (to achieve 6.5 in intergravel) and 5.0 and 8.0 (to achieve 5.0 in intergravel) and 4.0	Mature Life Stages (*e.g.*, Water Temperature >5°C) Early Life Stages (*e.g.*, Water Temperature ≤5°C) Mature Life Stages (*e.g.*, Water Temperature >5°C) Early Life Stages (*e.g.*, Water Temperature ≤5°C) Mature Life Stages (*e.g.*, Water Temperature >5°C)	30 Days 7 Days 7 Day Minimum Instantaneous Minimum Instantaneous Minimum	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10 7-Day, 3-Year or 7Q10 7-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10 1-Day, 3-Year or 1Q10	US EPA (1986), US EPA (1999b)
Fecal Coliform Bacteria or *Escherichia coli*	Colony Forming Units / 100 mL	Surface Water: Primary Recreation	200	Recreational Season	1 Day	Not Applicable[h]	7Q10	Williamson (1988b), Health and Welfare Canada (1992)

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Fecal Coliform Bacteria or *Escherichia coli*	Colony Forming Units / 100 mL	Surface and Ground Water: Greenhouse Irrigation	200	All Periods When Greenhouse Irrigation is Likely to Occur and When Workers or the Public May Come in Contact With Irrigation Water [i]	1 Day	Not Applicable[h]	7Q10	Williamson (1988b), Health and Welfare Canada (1992)
Fecal Coliform Bacteria or *Escherichia coli*	Colony Forming Units / 100 mL	Surface and Ground Water: Field, Park, and Garden Irrigation	200	All Periods When Irrigation is Likely to Occur and When Workers or the Public May Come in Contact With Irrigation Water [i]	1 Day	Not Applicable[h]	7Q10	Williamson (1988b), Health and Welfare Canada (1992)
Fecal Coliform Bacteria or *Escherichia coli*	Colony Forming Units / 100 mL	Surface and Ground Water: Drinking Water	0	All Periods	Not To Be Exceeded	Not To Be Exceeded	Not Applicable	Health and Welfare Canada (1996) and Health Canada (2010)

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Lead[e]	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	$= \left[e^{\{1.273[\ln(Hardness)]-4.705\}}\right] \times \left[1.46203 - \{\ln(Hardness)(0.145712)\}\right]$ (Eq. 19) where Hardness is expressed in mg/L as $CaCO_3$ and $= \left[e^{\{1.273[\ln(Hardness)]-1.460\}}\right] \times \left[1.46203 - \{\ln(Hardness)(0.145712)\}\right]$ (Eq. 20) where Hardness is expressed in mg/L as $CaCO_3$	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985g), US EPA (1995b), US EPA (1999b)
Microcystin (Total)	µg/L (as microcystin-LR)	Surface Water: Primary Recreation	20 µg/L	Recreational Season	1 Day	Not Applicable	Not Applicable	Health Canada (2009b)
Nickel[e]	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	$= \left[e^{\{0.8460[\ln(Hardness)]+0.0584\}}\right] \times \left[0.997\right]$ (Eq. 21) where Hardness is expressed in mg/L as $CaCO_3$ and $= \left[e^{\{0.8460[\ln(Hardness)]+2.255\}}\right] \times \left[0.998\right]$ (Eq. 22) where Hardness is expressed in mg/L as $CaCO_3$	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985h), US EPA (1995b), US EPA (1999b)
Nitrate - Nitrite Nitrogen	mg/L as N	Surface and Ground Water: Drinking Water	10	All Periods	Not To Be Exceeded	Not To Be Exceeded	Not Applicable	Health and Welfare Canada (1996) and Health Canada (2010)

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Sodium Adsorption Ratio	SAR	Surface and Ground Water: Greenhouse Irrigation	4.0	All Periods When Greenhouse Irrigation is Likely to Occur	Not Applicable[h]	Not Applicable[h]	7Q10	National Academy of Sciences / National Academy of Engineering (1973), CCREM (1987)
Sodium Adsorption Ratio	SAR	Surface and Ground Water: Field, Park, and Garden Irrigation	6.0	All Periods When Field, Park, and Garden Irrigation is Likely to Occur	7 Days	Not Applicable[h]	7Q10	National Academy of Sciences / National Academy of Engineering (1973), CCREM (1987)

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Temperature	°C	Surface Water: Aquatic Life and Wildlife	Site specific objectives will be developed considering the following:					US EPA (1976), US EPA (1999b)
			(1) Thermal additions should be such that thermal stratification and subsequent turnover dates are not altered from those existing prior to the addition of heat from artificial origin.	All Periods				
			(2) One limit which consists of a maximum weekly average temperature (MWAT) that:		7 Days	Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10	
			(a) In the warmer months is determined by adding to the physiological optimum temperature (usually for growth) a factor calculated as one-third of the difference between the ultimate upper incipient lethal temperature and the optimum temperature for the most sensitive important species (and appropriate life stages) that normally is found at that location and time; and	Warmer Months				
			(b) In the colder months is an elevated temperature that would still ensure that important species would survive if the temperature suddenly dropped to the normal ambient temperature; or	Colder Months				
			(c) During reproduction seasons meets specific site requirements for successful migration, spawning, egg incubation, and other reproductive functions of important species; or	Reproduction Season				
			(d) At a specific site is found necessary to preserve normal species diversity or prevent undesirable growths of nuisance organisms.	All Periods				
			(3) A second limit which is the time-dependent maximum temperature for short exposures.	All Periods	Site-Specific or Regional-Specific		1-Day, 3-Year or 1Q10	
			(4) Maximum limits may be specified for incremental temperature fluctuations necessary to protect aquatic life from sudden temperature changes.	All Periods	Site-Specific or Regional-Specific			

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Total Dissolved Solids or Conductivity	mg/L µS/cm	Surface and Ground Water: Greenhouse Irrigation	700 1000	All Periods When Greenhouse Irrigation is Likely to Occur	7 Days	Not Applicable[h]	7Q10	CCREM (1987), Williamson (1988)
Total Dissolved Solids or Conductivity	mg/L µS/cm	Surface and Ground Water: Field, Park, and Garden Irrigation	500 to 3500 (crop dependent) 1500	All Periods When Field, Park, and Garden Irrigation is Likely to Occur	7 Days	Not Applicable[h]	7Q10	CCREM (1987), CCME (2011), Williamson (1988)
Total Suspended Sediment	mg/L	Surface Water: Aquatic Life and Wildlife	5 mg/L Induced Change from Background[j] and	Background Total Suspended Sediment ≤25 mg/L	30 Days	Not More Than Once Each 3 Years, On Average	30-Day, 3-Year or 30Q10	CCME (2011)
			25 mg/L Induced Change from Background and	Background Total Suspended Sediment ≤250mg/L	1 Day	Not More Than Once Each 3 Years, On Average	1-Day, 3-Year or 1Q10	
or			10 % Induced Change from Background	Background Total Suspended Sediment >250 mg/L	1 Day	Not More Than Once Each 3 Years, On Average	1-Day, 3-Year or 1Q10	
Turbidity	NTU		Equivalent Induced Levels of Change as Calculated From Site-Specific or Regional-Specific Correlation Between Total Suspended Sediment and Turbidity					

Water Quality Variable	Units and Form	Water Use	Tier II - Water Quality Objectives[a]	Applicable Period	Averaging Duration	Allowable Exceedance Frequency	Design Flow[b]	References
Zinc[e]	µg/L as Dissolved	Surface Water: Aquatic Life and Wildlife	$= \left[e^{\{0.8473[\ln(Hardness)]+0.884\}}\right] \times [0.986]$ (Eq. 23) where Hardness is expressed in mg/L as $CaCO_3$ and $= \left[e^{\{0.8473[\ln(Hardness)]+0.884\}}\right] \times [0.978]$ (Eq. 24) where Hardness is expressed in mg/L as $CaCO_3$	All Periods All Periods	4 Days[c] 1 Hour[d]	Not More Than Once Each 3 Years, On Average Not More Than Once Each 3 Years, On Average	4-Day, 3-Year or 7Q10 1-Day, 3-Year or 1Q10	US EPA (1985i), US EPA (1995b), US EPA (1999b)

Notes:

a All calculations are available in the linked Excel spreadsheet MWQSOG 2011 CALCULATIONS.XLS and example output is shown for ammonia in Table 1 and for metals in Table 2.

b See Minimum Design Flows and Levels for additional guidance.

c This is analogous to US EPA's Criterion Continuous Concentration (CCC) to prevent chronic effects.

d This is analogous to US EPA's Criterion Maximum Concentration (CMC) to prevent acute effects.

e *Tier II - Water Quality Objectives* for most metals are comprised of two factors - the first represents the toxicity of the total recoverable form of the metal and, when necessary, expressed as a relationship with hardness. This is then multiplied by a second factor to convert the final *Tier II - Water Quality Objective* to a dissolved metal fraction.

f Includes all other life stages other than those defined as "Early Life Stages".

g Includes all embryonic and larval stages and all juvenile forms within 30 days of hatching.

h There is no defined allowable exceedance frequency. Exceedance frequency, however, is governed by the design flow.

i This is analogous to exposure during primary recreation and, therefore, similar *Tier II - Water Quality Objectives* should apply.

j Historical, pre-development concentrations, the upstream concentration existing at any given time, or when necessary, the concentration in an adjacent, undisturbed water body with similar hydrological and geological properties.

Table 1. Matrix showing *Tier II - Water Quality Objectives* for ammonia at pH increments of 0.1 units between 6.50 and 9.00 and at temperature increments of 5°C between 0°C and 30°C.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	0.0	6.67	16.67	48.83	10.82	27.06	48.83	6.67	16.67	32.61	10.82	27.06	32.61
6.60	0.0	6.57	16.41	46.84	10.66	26.65	46.84	6.57	16.41	31.28	10.66	26.65	31.28
6.70	0.0	6.44	16.11	44.57	10.46	26.15	44.57	6.44	16.11	29.76	10.46	26.15	29.76
6.80	0.0	6.29	15.74	42.00	10.22	25.55	42.00	6.29	15.74	28.05	10.22	25.55	28.05
6.90	0.0	6.12	15.29	39.16	9.93	24.84	39.16	6.12	15.29	26.15	9.93	24.84	26.15
7.00	0.0	5.91	14.77	36.09	9.60	23.99	36.09	5.91	14.77	24.10	9.60	23.99	24.10
7.10	0.0	5.67	14.17	32.86	9.20	23.00	32.86	5.67	14.17	21.94	9.20	21.94	21.94
7.20	0.0	5.39	13.47	29.54	8.75	21.88	29.54	5.39	13.47	19.73	8.75	19.73	19.73
7.30	0.0	5.08	12.69	26.21	8.24	20.61	26.21	5.08	12.69	17.51	8.24	17.51	17.51
7.40	0.0	4.73	11.83	22.97	7.69	19.22	22.97	4.73	11.83	15.34	7.69	15.34	15.34
7.50	0.0	4.36	10.91	19.89	7.09	17.72	19.89	4.36	10.91	13.28	7.09	13.28	13.28
7.60	0.0	3.98	9.94	17.03	6.46	16.14	17.03	3.98	9.94	11.37	6.46	11.37	11.37
7.70	0.0	3.58	8.95	14.44	5.81	14.44	14.44	3.58	8.95	9.64	5.81	9.64	9.64
7.80	0.0	3.18	7.96	12.14	5.17	12.14	12.14	3.18	7.96	8.11	5.17	8.11	8.11
7.90	0.0	2.80	6.99	10.13	4.54	10.13	10.13	2.80	6.77	6.77	4.54	6.77	6.77
8.00	0.0	2.43	6.08	8.41	3.95	8.41	8.41	2.43	5.62	5.62	3.95	5.62	5.62
8.10	0.0	2.10	5.24	6.95	3.41	6.95	6.95	2.10	4.64	4.64	3.41	4.64	4.64
8.20	0.0	1.79	4.48	5.73	2.91	5.73	5.73	1.79	3.83	3.83	2.91	3.83	3.83
8.30	0.0	1.52	3.81	4.71	2.47	4.71	4.71	1.52	3.15	3.15	2.47	3.15	3.15
8.40	0.0	1.29	3.22	3.88	2.09	3.88	3.88	1.29	2.59	2.59	2.09	2.59	2.59
8.50	0.0	1.09	2.72	3.20	1.77	3.20	3.20	1.09	2.14	2.14	1.77	2.14	2.14
8.60	0.0	0.92	2.30	2.65	1.49	2.65	2.65	0.92	1.77	1.77	1.49	1.77	1.77
8.70	0.0	0.78	1.95	2.20	1.26	2.20	2.20	0.78	1.47	1.47	1.26	1.47	1.47
8.80	0.0	0.66	1.65	1.84	1.07	1.84	1.84	0.66	1.23	1.23	1.07	1.23	1.23
8.90	0.0	0.56	1.41	1.56	0.92	1.56	1.56	0.56	1.04	1.04	0.92	1.04	1.04
9.00	0.0	0.49	1.22	1.32	0.79	1.32	1.32	0.49	0.88	0.88	0.79	0.88	0.88

Table 1. Continued.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	5.0	6.67	16.67	48.83	10.82	27.06	48.83	6.67	16.67	32.61	10.82	27.06	32.61
6.60	5.0	6.57	16.41	46.84	10.66	26.65	46.84	6.57	16.41	31.28	10.66	26.65	31.28
6.70	5.0	6.44	16.11	44.57	10.46	26.15	44.57	6.44	16.11	29.76	10.46	26.15	29.76
6.80	5.0	6.29	15.74	42.00	10.22	25.55	42.00	6.29	15.74	28.05	10.22	25.55	28.05
6.90	5.0	6.12	15.29	39.16	9.93	24.84	39.16	6.12	15.29	26.15	9.93	24.84	26.15
7.00	5.0	5.91	14.77	36.09	9.60	23.99	36.09	5.91	14.77	24.10	9.60	23.99	24.10
7.10	5.0	5.67	14.17	32.86	9.20	23.00	32.86	5.67	14.17	21.94	9.20	21.94	21.94
7.20	5.0	5.39	13.47	29.54	8.75	21.88	29.54	5.39	13.47	19.73	8.75	19.73	19.73
7.30	5.0	5.08	12.69	26.21	8.24	20.61	26.21	5.08	12.69	17.51	8.24	17.51	17.51
7.40	5.0	4.73	11.83	22.97	7.69	19.22	22.97	4.73	11.83	15.34	7.69	15.34	15.34
7.50	5.0	4.36	10.91	19.89	7.09	17.72	19.89	4.36	10.91	13.28	7.09	13.28	13.28
7.60	5.0	3.98	9.94	17.03	6.46	16.14	17.03	3.98	9.94	11.37	6.46	11.37	11.37
7.70	5.0	3.58	8.95	14.44	5.81	14.44	14.44	3.58	8.95	9.64	5.81	9.64	9.64
7.80	5.0	3.18	7.96	12.14	5.17	12.14	12.14	3.18	7.96	8.11	5.17	8.11	8.11
7.90	5.0	2.80	6.99	10.13	4.54	10.13	10.13	2.80	6.77	6.77	4.54	6.77	6.77
8.00	5.0	2.43	6.08	8.41	3.95	8.41	8.41	2.43	5.62	5.62	3.95	5.62	5.62
8.10	5.0	2.10	5.24	6.95	3.41	6.95	6.95	2.10	4.64	4.64	3.41	4.64	4.64
8.20	5.0	1.79	4.48	5.73	2.91	5.73	5.73	1.79	3.83	3.83	2.91	3.83	3.83
8.30	5.0	1.52	3.81	4.71	2.47	4.71	4.71	1.52	3.15	3.15	2.47	3.15	3.15
8.40	5.0	1.29	3.22	3.88	2.09	3.88	3.88	1.29	2.59	2.59	2.09	2.59	2.59
8.50	5.0	1.09	2.72	3.20	1.77	3.20	3.20	1.09	2.14	2.14	1.77	2.14	2.14
8.60	5.0	0.92	2.30	2.65	1.49	2.65	2.65	0.92	1.77	1.77	1.49	1.77	1.77
8.70	5.0	0.78	1.95	2.20	1.26	2.20	2.20	0.78	1.47	1.47	1.26	1.47	1.47
8.80	5.0	0.66	1.65	1.84	1.07	1.84	1.84	0.66	1.23	1.23	1.07	1.23	1.23
8.90	5.0	0.56	1.41	1.56	0.92	1.56	1.56	0.56	1.04	1.04	0.92	1.04	1.04
9.00	5.0	0.49	1.22	1.32	0.79	1.32	1.32	0.49	0.88	0.88	0.79	0.88	0.88

Table 1. Continued.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	10.0	6.67	16.67	48.83	8.92	22.30	48.83	6.67	16.67	32.61	8.92	22.30	32.61
6.60	10.0	6.57	16.41	46.84	8.79	21.96	46.84	6.57	16.41	31.28	8.79	21.96	31.28
6.70	10.0	6.44	16.11	44.57	8.62	21.55	44.57	6.44	16.11	29.76	8.62	21.55	29.76
6.80	10.0	6.29	15.74	42.00	8.42	21.06	42.00	6.29	15.74	28.05	8.42	21.06	28.05
6.90	10.0	6.12	15.29	39.16	8.19	20.47	39.16	6.12	15.29	26.15	8.19	20.47	26.15
7.00	10.0	5.91	14.77	36.09	7.91	19.77	36.09	5.91	14.77	24.10	7.91	19.77	24.10
7.10	10.0	5.67	14.17	32.86	7.58	18.96	32.86	5.67	14.17	21.94	7.58	18.96	21.94
7.20	10.0	5.39	13.47	29.54	7.21	18.03	29.54	5.39	13.47	19.73	7.21	18.03	19.73
7.30	10.0	5.08	12.69	26.21	6.79	16.99	26.21	5.08	12.69	17.51	6.79	16.99	17.51
7.40	10.0	4.73	11.83	22.97	6.33	15.84	22.97	4.73	11.83	15.34	6.33	15.34	15.34
7.50	10.0	4.36	10.91	19.89	5.84	14.60	19.89	4.36	10.91	13.28	5.84	13.28	13.28
7.60	10.0	3.98	9.94	17.03	5.32	13.30	17.03	3.98	9.94	11.37	5.32	11.37	11.37
7.70	10.0	3.58	8.95	14.44	4.79	11.97	14.44	3.58	8.95	9.64	4.79	9.64	9.64
7.80	10.0	3.18	7.96	12.14	4.26	10.65	12.14	3.18	7.96	8.11	4.26	8.11	8.11
7.90	10.0	2.80	6.99	10.13	3.74	9.36	10.13	2.80	6.77	6.77	3.74	6.77	6.77
8.00	10.0	2.43	6.08	8.41	3.26	8.14	8.41	2.43	5.62	5.62	3.26	5.62	5.62
8.10	10.0	2.10	5.24	6.95	2.81	6.95	6.95	2.10	4.64	4.64	2.81	4.64	4.64
8.20	10.0	1.79	4.48	5.73	2.40	5.73	5.73	1.79	3.83	3.83	2.40	3.83	3.83
8.30	10.0	1.52	3.81	4.71	2.04	4.71	4.71	1.52	3.15	3.15	2.04	3.15	3.15
8.40	10.0	1.29	3.22	3.88	1.73	3.88	3.88	1.29	2.59	2.59	1.73	2.59	2.59
8.50	10.0	1.09	2.72	3.20	1.46	3.20	3.20	1.09	2.14	2.14	1.46	2.14	2.14
8.60	10.0	0.92	2.30	2.65	1.23	2.65	2.65	0.92	1.77	1.77	1.23	1.77	1.77
8.70	10.0	0.78	1.95	2.20	1.04	2.20	2.20	0.78	1.47	1.47	1.04	1.47	1.47
8.80	10.0	0.66	1.65	1.84	0.88	1.84	1.84	0.66	1.23	1.23	0.88	1.23	1.23
8.90	10.0	0.56	1.41	1.56	0.76	1.56	1.56	0.56	1.04	1.04	0.76	1.04	1.04
9.00	10.0	0.49	1.22	1.32	0.65	1.32	1.32	0.49	0.88	0.88	0.65	0.88	0.88

Table 1. Continued.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	15.0	6.46	16.16	48.83	6.46	16.16	48.83	6.46	16.16	32.61	6.46	16.16	32.61
6.60	15.0	6.36	15.91	46.84	6.36	15.91	46.84	6.36	15.91	31.28	6.36	15.91	31.28
6.70	15.0	6.25	15.61	44.57	6.25	15.61	44.57	6.25	15.61	29.76	6.25	15.61	29.76
6.80	15.0	6.10	15.26	42.00	6.10	15.26	42.00	6.10	15.26	28.05	6.10	15.26	28.05
6.90	15.0	5.93	14.83	39.16	5.93	14.83	39.16	5.93	14.83	26.15	5.93	14.83	26.15
7.00	15.0	5.73	14.32	36.09	5.73	14.32	36.09	5.73	14.32	24.10	5.73	14.32	24.10
7.10	15.0	5.49	13.73	32.86	5.49	13.73	32.86	5.49	13.73	21.94	5.49	13.73	21.94
7.20	15.0	5.22	13.06	29.54	5.22	13.06	29.54	5.22	13.06	19.73	5.22	13.06	19.73
7.30	15.0	4.92	12.31	26.21	4.92	12.31	26.21	4.92	12.31	17.51	4.92	12.31	17.51
7.40	15.0	4.59	11.47	22.97	4.59	11.47	22.97	4.59	11.47	15.34	4.59	11.47	15.34
7.50	15.0	4.23	10.58	19.89	4.23	10.58	19.89	4.23	10.58	13.28	4.23	10.58	13.28
7.60	15.0	3.85	9.64	17.03	3.85	9.64	17.03	3.85	9.64	11.37	3.85	9.64	11.37
7.70	15.0	3.47	8.67	14.44	3.47	8.67	14.44	3.47	8.67	9.64	3.47	8.67	9.64
7.80	15.0	3.09	7.71	12.14	3.09	7.71	12.14	3.09	7.71	8.11	3.09	7.71	8.11
7.90	15.0	2.71	6.78	10.13	2.71	6.78	10.13	2.71	6.77	6.77	2.71	6.77	6.77
8.00	15.0	2.36	5.90	8.41	2.36	5.90	8.41	2.36	5.62	5.62	2.36	5.62	5.62
8.10	15.0	2.03	5.08	6.95	2.03	5.08	6.95	2.03	4.64	4.64	2.03	4.64	4.64
8.20	15.0	1.74	4.35	5.73	1.74	4.35	5.73	1.74	3.83	3.83	1.74	3.83	3.83
8.30	15.0	1.48	3.69	4.71	1.48	3.69	4.71	1.48	3.15	3.15	1.48	3.15	3.15
8.40	15.0	1.25	3.13	3.88	1.25	3.13	3.88	1.25	2.59	2.59	1.25	2.59	2.59
8.50	15.0	1.06	2.64	3.20	1.06	2.64	3.20	1.06	2.14	2.14	1.06	2.14	2.14
8.60	15.0	0.89	2.23	2.65	0.89	2.23	2.65	0.89	1.77	1.77	0.89	1.77	1.77
8.70	15.0	0.75	1.89	2.20	0.75	1.89	2.20	0.75	1.47	1.47	0.75	1.47	1.47
8.80	15.0	0.64	1.60	1.84	0.64	1.60	1.84	0.64	1.23	1.23	0.64	1.23	1.23
8.90	15.0	0.55	1.37	1.56	0.55	1.37	1.56	0.55	1.04	1.04	0.55	1.04	1.04
9.00	15.0	0.47	1.18	1.32	0.47	1.18	1.32	0.47	0.88	0.88	0.47	0.88	0.88

Table 1. Continued.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	20.0	4.68	11.70	48.83	4.68	11.70	48.83	4.68	11.70	32.61	4.68	11.70	32.61
6.60	20.0	4.61	11.53	46.84	4.61	11.53	46.84	4.61	11.53	31.28	4.61	11.53	31.28
6.70	20.0	4.52	11.31	44.57	4.52	11.31	44.57	4.52	11.31	29.76	4.52	11.31	29.76
6.80	20.0	4.42	11.05	42.00	4.42	11.05	42.00	4.42	11.05	28.05	4.42	11.05	28.05
6.90	20.0	4.30	10.74	39.16	4.30	10.74	39.16	4.30	10.74	26.15	4.30	10.74	26.15
7.00	20.0	4.15	10.38	36.09	4.15	10.38	36.09	4.15	10.38	24.10	4.15	10.38	24.10
7.10	20.0	3.98	9.95	32.86	3.98	9.95	32.86	3.98	9.95	21.94	3.98	9.95	21.94
7.20	20.0	3.78	9.46	29.54	3.78	9.46	29.54	3.78	9.46	19.73	3.78	9.46	19.73
7.30	20.0	3.57	8.91	26.21	3.57	8.91	26.21	3.57	8.91	17.51	3.57	8.91	17.51
7.40	20.0	3.32	8.31	22.97	3.32	8.31	22.97	3.32	8.31	15.34	3.32	8.31	15.34
7.50	20.0	3.06	7.66	19.89	3.06	7.66	19.89	3.06	7.66	13.28	3.06	7.66	13.28
7.60	20.0	2.79	6.98	17.03	2.79	6.98	17.03	2.79	6.98	11.37	2.79	6.98	11.37
7.70	20.0	2.51	6.28	14.44	2.51	6.28	14.44	2.51	6.28	9.64	2.51	6.28	9.64
7.80	20.0	2.23	5.59	12.14	2.23	5.59	12.14	2.23	5.59	8.11	2.23	5.59	8.11
7.90	20.0	1.96	4.91	10.13	1.96	4.91	10.13	1.96	4.91	6.77	1.96	4.91	6.77
8.00	20.0	1.71	4.27	8.41	1.71	4.27	8.41	1.71	4.27	5.62	1.71	4.27	5.62
8.10	20.0	1.47	3.68	6.95	1.47	3.68	6.95	1.47	3.68	4.64	1.47	3.68	4.64
8.20	20.0	1.26	3.15	5.73	1.26	3.15	5.73	1.26	3.15	3.83	1.26	3.15	3.83
8.30	20.0	1.07	2.68	4.71	1.07	2.68	4.71	1.07	2.68	3.15	1.07	2.68	3.15
8.40	20.0	0.91	2.26	3.88	0.91	2.26	3.88	0.91	2.26	2.59	0.91	2.26	2.59
8.50	20.0	0.76	1.91	3.20	0.76	1.91	3.20	0.76	1.91	2.14	0.76	1.91	2.14
8.60	20.0	0.65	1.61	2.65	0.65	1.61	2.65	0.65	1.61	1.77	0.65	1.61	1.77
8.70	20.0	0.55	1.37	2.20	0.55	1.37	2.20	0.55	1.37	1.47	0.55	1.37	1.47
8.80	20.0	0.46	1.16	1.84	0.46	1.16	1.84	0.46	1.16	1.23	0.46	1.16	1.23
8.90	20.0	0.40	0.99	1.56	0.40	0.99	1.56	0.40	0.99	1.04	0.40	0.99	1.04
9.00	20.0	0.34	0.85	1.32	0.34	0.85	1.32	0.34	0.85	0.88	0.34	0.85	0.88

Table 1. Continued.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	25.0	3.39	8.48	48.83	3.39	8.48	48.83	3.39	8.48	32.61	3.39	8.48	32.61
6.60	25.0	3.34	8.35	46.84	3.34	8.35	46.84	3.34	8.35	31.28	3.34	8.35	31.28
6.70	25.0	3.28	8.19	44.57	3.28	8.19	44.57	3.28	8.19	29.76	3.28	8.19	29.76
6.80	25.0	3.20	8.01	42.00	3.20	8.01	42.00	3.20	8.01	28.05	3.20	8.01	28.05
6.90	25.0	3.11	7.78	39.16	3.11	7.78	39.16	3.11	7.78	26.15	3.11	7.78	26.15
7.00	25.0	3.01	7.52	36.09	3.01	7.52	36.09	3.01	7.52	24.10	3.01	7.52	24.10
7.10	25.0	2.88	7.21	32.86	2.88	7.21	32.86	2.88	7.21	21.94	2.88	7.21	21.94
7.20	25.0	2.74	6.85	29.54	2.74	6.85	29.54	2.74	6.85	19.73	2.74	6.85	19.73
7.30	25.0	2.58	6.46	26.21	2.58	6.46	26.21	2.58	6.46	17.51	2.58	6.46	17.51
7.40	25.0	2.41	6.02	22.97	2.41	6.02	22.97	2.41	6.02	15.34	2.41	6.02	15.34
7.50	25.0	2.22	5.55	19.89	2.22	5.55	19.89	2.22	5.55	13.28	2.22	5.55	13.28
7.60	25.0	2.02	5.06	17.03	2.02	5.06	17.03	2.02	5.06	11.37	2.02	5.06	11.37
7.70	25.0	1.82	4.55	14.44	1.82	4.55	14.44	1.82	4.55	9.64	1.82	4.55	9.64
7.80	25.0	1.62	4.05	12.14	1.62	4.05	12.14	1.62	4.05	8.11	1.62	4.05	8.11
7.90	25.0	1.42	3.56	10.13	1.42	3.56	10.13	1.42	3.56	6.77	1.42	3.56	6.77
8.00	25.0	1.24	3.10	8.41	1.24	3.10	8.41	1.24	3.10	5.62	1.24	3.10	5.62
8.10	25.0	1.07	2.67	6.95	1.07	2.67	6.95	1.07	2.67	4.64	1.07	2.67	4.64
8.20	25.0	0.91	2.28	5.73	0.91	2.28	5.73	0.91	2.28	3.83	0.91	2.28	3.83
8.30	25.0	0.78	1.94	4.71	0.78	1.94	4.71	0.78	1.94	3.15	0.78	1.94	3.15
8.40	25.0	0.66	1.64	3.88	0.66	1.64	3.88	0.66	1.64	2.59	0.66	1.64	2.59
8.50	25.0	0.55	1.39	3.20	0.55	1.39	3.20	0.55	1.39	2.14	0.55	1.39	2.14
8.60	25.0	0.47	1.17	2.65	0.47	1.17	2.65	0.47	1.17	1.77	0.47	1.17	1.77
8.70	25.0	0.40	0.99	2.20	0.40	0.99	2.20	0.40	0.99	1.47	0.40	0.99	1.47
8.80	25.0	0.34	0.84	1.84	0.34	0.84	1.84	0.34	0.84	1.23	0.34	0.84	1.23
8.90	25.0	0.29	0.72	1.56	0.29	0.72	1.56	0.29	0.72	1.04	0.29	0.72	1.04
9.00	25.0	0.25	0.62	1.32	0.25	0.62	1.32	0.25	0.62	0.88	0.25	0.62	0.88

Table 1. Continued.

pH	Temperature	Equation 1 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 2 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 3 (Ammonia - Acute; All Periods) mg/L	Equation 4 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 5 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 6 (Ammonia - Acute; All Periods) mg/L	Equation 7 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 8 (Ammonia - Chronic; Early Life Stages Present) mg/L	Equation 9 (Ammonia - Acute; All Periods) mg/L	Equation 10 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 11 (Ammonia - Chronic; Early Life Stages Absent) mg/L	Equation 12 (Ammonia - Acute; All Periods) mg/L
6.50	30.0	2.46	6.14	48.83	2.46	6.14	48.83	2.46	6.14	32.61	2.46	6.14	32.61
6.60	30.0	2.42	6.05	46.84	2.42	6.05	46.84	2.42	6.05	31.28	2.42	6.05	31.28
6.70	30.0	2.37	5.94	44.57	2.37	5.94	44.57	2.37	5.94	29.76	2.37	5.94	29.76
6.80	30.0	2.32	5.80	42.00	2.32	5.80	42.00	2.32	5.80	28.05	2.32	5.80	28.05
6.90	30.0	2.25	5.64	39.16	2.25	5.64	39.16	2.25	5.64	26.15	2.25	5.64	26.15
7.00	30.0	2.18	5.45	36.09	2.18	5.45	36.09	2.18	5.45	24.10	2.18	5.45	24.10
7.10	30.0	2.09	5.22	32.86	2.09	5.22	32.86	2.09	5.22	21.94	2.09	5.22	21.94
7.20	30.0	1.99	4.97	29.54	1.99	4.97	29.54	1.99	4.97	19.73	1.99	4.97	19.73
7.30	30.0	1.87	4.68	26.21	1.87	4.68	26.21	1.87	4.68	17.51	1.87	4.68	17.51
7.40	30.0	1.74	4.36	22.97	1.74	4.36	22.97	1.74	4.36	15.34	1.74	4.36	15.34
7.50	30.0	1.61	4.02	19.89	1.61	4.02	19.89	1.61	4.02	13.28	1.61	4.02	13.28
7.60	30.0	1.47	3.66	17.03	1.47	3.66	17.03	1.47	3.66	11.37	1.47	3.66	11.37
7.70	30.0	1.32	3.30	14.44	1.32	3.30	14.44	1.32	3.30	9.64	1.32	3.30	9.64
7.80	30.0	1.17	2.93	12.14	1.17	2.93	12.14	1.17	2.93	8.11	1.17	2.93	8.11
7.90	30.0	1.03	2.58	10.13	1.03	2.58	10.13	1.03	2.58	6.77	1.03	2.58	6.77
8.00	30.0	0.90	2.24	8.41	0.90	2.24	8.41	0.90	2.24	5.62	0.90	2.24	5.62
8.10	30.0	0.77	1.93	6.95	0.77	1.93	6.95	0.77	1.93	4.64	0.77	1.93	4.64
8.20	30.0	0.66	1.65	5.73	0.66	1.65	5.73	0.66	1.65	3.83	0.66	1.65	3.83
8.30	30.0	0.56	1.40	4.71	0.56	1.40	4.71	0.56	1.40	3.15	0.56	1.40	3.15
8.40	30.0	0.48	1.19	3.88	0.48	1.19	3.88	0.48	1.19	2.59	0.48	1.19	2.59
8.50	30.0	0.40	1.00	3.20	0.40	1.00	3.20	0.40	1.00	2.14	0.40	1.00	2.14
8.60	30.0	0.34	0.85	2.65	0.34	0.85	2.65	0.34	0.85	1.77	0.34	0.85	1.77
8.70	30.0	0.29	0.72	2.20	0.29	0.72	2.20	0.29	0.72	1.47	0.29	0.72	1.47
8.80	30.0	0.24	0.61	1.84	0.24	0.61	1.84	0.24	0.61	1.23	0.24	0.61	1.23
8.90	30.0	0.21	0.52	1.56	0.21	0.52	1.56	0.21	0.52	1.04	0.21	0.52	1.04
9.00	30.0	0.18	0.45	1.32	0.18	0.45	1.32	0.18	0.45	0.88	0.18	0.45	0.88

Table 2. Matrix showing *Tier II - Water Quality Objectives* for various metals at hardness increments of 5 mg/L between 5 and 400 mg/L.

Hardness mg/L $CaC0_3$	Equation 13 (Cadmium - Chronic) µg/L	Equation 14 (Cadmium - Acute) µg/L	Equation 15 (Chromium III - Chronic) µg/L	Equation 16 (Chromium III - Acute) µg/L	Equation 17 (Copper - Chronic) µg/L	Equation 18 (Copper - Acute) µg/L	Equation 19 (Lead - Chronic) µg/L	Equation 20 (Lead - Acute) µg/L	Equation 21 (Nickel - Chronic) µg/L	Equation 22 (Nickel - Acute) µg/L	Equation 23 (Zinc - Chronic) µg/L	Equation 24 (Zinc - Acute) µg/L
5.00	0.03	0.11	6.37	48.99	0.69	0.80	0.09	2.21	4.12	37.14	9.33	9.26
10.00	0.05	0.21	11.24	86.44	1.25	1.54	0.19	4.91	7.41	66.75	16.79	16.66
15.00	0.07	0.32	15.67	120.48	1.77	2.25	0.30	7.79	10.45	94.07	23.68	23.48
20.00	0.08	0.42	19.84	152.49	2.26	2.95	0.42	10.79	13.33	119.99	30.21	29.97
25.00	0.09	0.52	23.81	183.07	2.74	3.64	0.54	13.88	16.10	144.92	36.50	36.20
30.00	0.11	0.62	27.65	212.55	3.20	4.32	0.66	17.04	18.78	169.09	42.59	42.25
35.00	0.12	0.72	31.37	241.15	3.65	5.00	0.79	20.25	21.40	192.64	48.54	48.14
40.00	0.13	0.83	34.99	269.02	4.09	5.67	0.92	23.51	23.96	215.68	54.35	53.91
45.00	0.14	0.93	38.54	296.26	4.53	6.33	1.04	26.81	26.47	238.28	60.06	59.57
50.00	0.15	1.03	42.01	322.96	4.95	6.99	1.17	30.14	28.93	260.49	65.66	65.13
55.00	0.16	1.13	45.42	349.18	5.37	7.65	1.31	33.49	31.36	282.37	71.19	70.61
60.00	0.17	1.23	48.78	374.97	5.79	8.31	1.44	36.88	33.76	303.93	76.63	76.01
65.00	0.18	1.32	52.08	400.38	6.20	8.96	1.57	40.28	36.12	325.23	82.01	81.35
70.00	0.19	1.42	55.34	425.43	6.60	9.60	1.70	43.71	38.46	346.27	87.33	86.62
75.00	0.20	1.52	58.56	450.16	7.00	10.25	1.84	47.15	40.77	367.08	92.58	91.83
80.00	0.21	1.62	61.74	474.60	7.40	10.89	1.97	50.61	43.06	387.68	97.79	96.99
85.00	0.22	1.72	64.88	498.76	7.79	11.53	2.11	54.08	45.33	408.09	102.94	102.11
90.00	0.23	1.82	67.99	522.66	8.18	12.17	2.24	57.57	47.57	428.31	108.05	107.17
95.00	0.24	1.92	71.07	546.32	8.57	12.81	2.38	61.07	49.80	448.35	113.11	112.20
100.00	0.25	2.01	74.11	569.76	8.96	13.44	2.52	64.58	52.01	468.24	118.14	117.18
105.00	0.25	2.11	77.14	592.99	9.34	14.07	2.65	68.10	54.20	487.97	123.13	122.13
110.00	0.26	2.21	80.13	616.02	9.72	14.70	2.79	71.63	56.37	507.55	128.08	127.04
115.00	0.27	2.31	83.10	638.86	10.09	15.33	2.93	75.17	58.53	527.01	132.99	131.91
120.00	0.28	2.40	86.05	661.52	10.47	15.96	3.07	78.72	60.68	546.33	137.87	136.76
125.00	0.29	2.50	88.98	684.01	10.84	16.58	3.21	82.27	62.81	565.52	142.73	141.57
130.00	0.30	2.60	91.88	706.34	11.21	17.21	3.34	85.83	64.93	584.60	147.55	146.35
135.00	0.30	2.70	94.76	728.51	11.57	17.83	3.48	89.40	67.04	603.57	152.34	151.11
140.00	0.31	2.79	97.63	750.54	11.94	18.45	3.62	92.97	69.13	622.43	157.11	155.84
145.00	0.32	2.89	100.48	772.42	12.30	19.07	3.76	96.55	71.22	641.18	161.85	160.54
150.00	0.33	2.99	103.31	794.17	12.66	19.69	3.90	100.13	73.29	659.84	166.57	165.22
155.00	0.33	3.08	106.12	815.79	13.02	20.31	4.04	103.72	75.35	678.40	171.26	169.87

Table 2. Continued.

Hardness mg/L $CaC0_3$	Equation 13 (Cadmium - Chronic) µg/L	Equation 14 (Cadmium - Acute) µg/L	Equation 15 (Chromium III - Chronic) µg/L	Equation 16 (Chromium III - Acute) µg/L	Equation 17 (Copper - Chronic) µg/L	Equation 18 (Copper - Acute) µg/L	Equation 19 (Lead - Chronic) µg/L	Equation 20 (Lead - Acute) µg/L	Equation 21 (Nickel - Chronic) µg/L	Equation 22 (Nickel - Acute) µg/L	Equation 23 (Zinc - Chronic) µg/L	Equation 24 (Zinc - Acute) µg/L
160.00	0.34	3.18	108.91	837.28	13.38	20.93	4.18	107.31	77.40	696.87	175.93	174.50
165.00	0.35	3.28	111.69	858.65	13.74	21.54	4.32	110.90	79.44	715.25	180.58	179.11
170.00	0.36	3.37	114.46	879.90	14.09	22.16	4.46	114.50	81.47	733.54	185.20	183.70
175.00	0.36	3.47	117.21	901.04	14.45	22.77	4.60	118.10	83.50	751.75	189.81	188.27
180.00	0.37	3.56	119.94	922.07	14.80	23.38	4.74	121.70	85.51	769.88	194.40	192.82
185.00	0.38	3.66	122.66	942.99	15.15	23.99	4.88	125.31	87.52	787.94	198.96	197.35
190.00	0.38	3.76	125.37	963.82	15.50	24.60	5.02	128.92	89.51	805.92	203.51	201.86
195.00	0.39	3.85	128.07	984.54	15.85	25.21	5.16	132.53	91.50	823.82	208.04	206.35
200.00	0.40	3.95	130.75	1005.17	16.19	25.82	5.31	136.14	93.48	841.66	212.55	210.82
205.00	0.40	4.04	133.42	1025.70	16.54	26.43	5.45	139.76	95.46	859.43	217.04	215.28
210.00	0.41	4.14	136.08	1046.15	16.88	27.04	5.59	143.37	97.42	877.13	221.52	219.72
215.00	0.42	4.24	138.73	1066.50	17.23	27.64	5.73	146.99	99.38	894.76	225.98	224.15
220.00	0.43	4.33	141.37	1086.77	17.57	28.25	5.87	150.61	101.33	912.33	230.42	228.55
225.00	0.43	4.43	143.99	1106.96	17.91	28.85	6.01	154.23	103.28	929.85	234.85	232.95
230.00	0.44	4.52	146.61	1127.07	18.25	29.46	6.15	157.85	105.22	947.30	239.27	237.33
235.00	0.45	4.62	149.21	1147.09	18.59	30.06	6.29	161.47	107.15	964.69	243.67	241.69
240.00	0.45	4.71	151.81	1167.05	18.92	30.66	6.43	165.10	109.07	982.03	248.05	246.04
245.00	0.46	4.81	154.39	1186.92	19.26	31.26	6.57	168.72	110.99	999.31	252.43	250.38
250.00	0.46	4.90	156.97	1206.72	19.59	31.86	6.72	172.34	112.91	1016.53	256.78	254.70
255.00	0.47	5.00	159.54	1226.45	19.93	32.46	6.86	175.97	114.81	1033.71	261.13	259.01
260.00	0.48	5.09	162.09	1246.11	20.26	33.06	7.00	179.59	116.71	1050.83	265.46	263.31
265.00	0.48	5.19	164.64	1265.71	20.60	33.66	7.14	183.22	118.61	1067.90	269.78	267.59
270.00	0.49	5.28	167.18	1285.23	20.93	34.26	7.28	186.84	120.50	1084.92	274.09	271.86
275.00	0.50	5.38	169.71	1304.69	21.26	34.86	7.42	190.47	122.39	1101.89	278.38	276.12
280.00	0.50	5.47	172.24	1324.09	21.59	35.46	7.56	194.09	124.27	1118.82	282.66	280.37
285.00	0.51	5.57	174.75	1343.42	21.92	36.05	7.70	197.71	126.14	1135.70	286.93	284.61
290.00	0.51	5.66	177.26	1362.69	22.24	36.65	7.85	201.34	128.01	1152.53	291.19	288.83
295.00	0.52	5.76	179.76	1381.91	22.57	37.24	7.99	204.96	129.88	1169.32	295.44	293.05
300.00	0.53	5.85	182.25	1401.06	22.90	37.84	8.13	208.58	131.74	1186.07	299.68	297.25
305.00	0.53	5.95	184.73	1420.16	23.22	38.43	8.27	212.21	133.59	1202.77	303.91	301.44
310.00	0.54	6.04	187.21	1439.20	23.55	39.02	8.41	215.83	135.44	1219.43	308.12	305.62
315.00	0.55	6.14	189.68	1458.18	23.87	39.62	8.55	219.45	137.29	1236.05	312.33	309.79

Table 2. Continued.

Hardness mg/L $CaC0_3$	Equation 13 (Cadmium - Chronic) µg/L	Equation 14 (Cadmium - Acute) µg/L	Equation 15 (Chromium III - Chronic) µg/L	Equation 16 (Chromium III - Acute) µg/L	Equation 17 (Copper - Chronic) µg/L	Equation 18 (Copper - Acute) µg/L	Equation 19 (Lead - Chronic) µg/L	Equation 20 (Lead - Acute) µg/L	Equation 21 (Nickel - Chronic) µg/L	Equation 22 (Nickel - Acute) µg/L	Equation 23 (Zinc - Chronic) µg/L	Equation 24 (Zinc - Acute) µg/L
320.00	0.55	6.23	192.14	1477.11	24.20	40.21	8.69	223.07	139.13	1252.63	316.52	313.96
325.00	0.56	6.33	194.60	1495.98	24.52	40.80	8.83	226.69	140.96	1269.16	320.71	318.11
330.00	0.56	6.42	197.05	1514.81	24.84	41.39	8.97	230.31	142.80	1285.66	324.89	322.25
335.00	0.57	6.51	199.49	1533.58	25.16	41.98	9.12	233.92	144.63	1302.12	329.05	326.38
340.00	0.57	6.61	201.92	1552.30	25.48	42.57	9.26	237.54	146.45	1318.55	333.21	330.50
345.00	0.58	6.70	204.35	1570.97	25.80	43.16	9.40	241.16	148.27	1334.93	337.36	334.62
350.00	0.59	6.80	206.77	1589.59	26.12	43.75	9.54	244.77	150.09	1351.28	341.49	338.72
355.00	0.59	6.89	209.19	1608.17	26.44	44.34	9.68	248.38	151.90	1367.60	345.62	342.82
360.00	0.60	6.98	211.60	1626.70	26.76	44.93	9.82	252.00	153.71	1383.87	349.74	346.90
365.00	0.60	7.08	214.00	1645.18	27.08	45.52	9.96	255.61	155.51	1400.12	353.85	350.98
370.00	0.61	7.17	216.40	1663.61	27.39	46.10	10.10	259.22	157.31	1416.33	357.96	355.05
375.00	0.62	7.27	218.79	1682.00	27.71	46.69	10.24	262.83	159.11	1432.50	362.05	359.11
380.00	0.62	7.36	221.18	1700.35	28.02	47.28	10.38	266.43	160.90	1448.64	366.14	363.17
385.00	0.63	7.45	223.56	1718.65	28.34	47.86	10.52	270.04	162.69	1464.75	370.22	367.21
390.00	0.63	7.55	225.94	1736.91	28.65	48.45	10.66	273.64	164.47	1480.83	374.28	371.25
395.00	0.64	7.64	228.31	1755.12	28.97	49.03	10.80	277.25	166.26	1496.88	378.35	375.28
400.00	0.64	7.74	230.67	1773.30	29.28	49.62	10.94	280.85	168.04	1512.89	382.40	379.30

TIER III - WATER QUALITY GUIDELINES

IMPLEMENTATION POLICIES

General Application

Tier III - Water Quality Guidelines include three general types of guidance. First, *Tier III - Water Quality Guidelines* include a large number of variables derived by the CCME for general application across Canada. Environmental quality guidelines are included for water, lake and river bottom sediments, and residues in fish or other aquatic life tissues for protection of wildlife consumers. Second, *Tier III - Water Quality Guidelines* contain tissue residue guidelines derived by Health Canada to protect human consumers of fish or other aquatic life tissues. Third, *Tier III - Water Quality Guidelines* contain narrative water quality guidelines since numerical guidelines cannot reasonably be developed for every possible chemical, physical, or biological variable.

Tier III - Water Quality Guidelines should be used as follows:

(a) The *Tier III - Numerical Water Quality Guidelines* should be used to assist in the interpretation of ambient water quality data. Ambient water quality data can be compared directly to the water quality guidelines to identify exceedances or long-term trends that may lead to exceedances in the future. If management intervention appears necessary, *Tier III - Water Quality Guidelines* can be advanced to *Tier II - Water Quality Objectives* for application in pollution control activities;

(b) The *Tier III - Numerical Water Quality Guidelines* should be used to assist in identifying if ambient water can sustain specific uses. The water quality guidelines can be used in combination with ambient monitoring data to initially determine whether or not specific bodies of water are suitable for certain proposed uses or activities;

(c) The *Tier III - Narrative Water Quality Guidelines* should be met as minimum conditions at all times and in all places to ensure that all surface and ground water of Manitoba are free of constituents attributable to sewage, industrial, agricultural, and other land-use practices, or other man-induced point or non-point source discharges that may unacceptably impair water quality.

Advancement to Tier II - Water Quality Objectives

Occasionally, *Tier III - Water Quality Guidelines* may need to be advanced to *Tier II - Water Quality Objectives* for direct use in pollution control initiatives. The following general guidance should be followed:

(a) When the minimum toxicological data base requirements of the US EPA (Stephan *et al.* 1985) or subsequent similar methods are met for the protection of aquatic life, modifications may be made to provide a similar level of protection as envisaged for other *Tier II - Water Quality Objectives*.

(b) When the minimum toxicological data base requirements of the US EPA (Stephan *et al.* 1985) or subsequent similar methods are not satisfied to prevent the occurrence of unacceptable adverse effects to aquatic life, *Tier III - Water Quality Guidelines* should be used as *Tier II - Water Quality*

Objectives without modification unless site-specific or regional-specific modifications can be made following CCME guidance (CCME 2003).

(c) For protection of water uses other than aquatic life, *Tier III - Water Quality Guidelines* should be advanced to *Tier II - Water Quality Objectives* using the best available scientific information on exposure-response data, ingestion rates, risk extrapolation techniques, exposure from sources other than surface water, and appropriate safety factors dependent upon the quantity and quality of data or should be used without modification.

Protection of Surface Water Drinking Sources

All surface waters and some shallow, surficial aquifers, including those in remote locations, are susceptible to uncontrolled microbiological contamination. It is therefore assumed that all raw surface water supplies will be disinfected as the minimum level of treatment prior to consumption. The *Tier III - Water Quality Guidelines* contained here apply to finished drinking water, but can be extrapolated to provide protection to raw drinking water sources using the following principles:

(a) It is intended that man-induced water quality alterations not cause an unacceptable increased risk to public health or an unacceptable increased treatment cost to the water user or supplier;

(b) *Tier III - Water Quality Guidelines* should be used, on a site-specific basis, to assist in determining when increased health risks or increased treatment costs may be expected, in conjunction with information concerning:

(i) The chemical, physical or biological quality of the proposed discharge or alteration being considered;

(ii) Ambient or background surface water quality;

(iii) Design of downstream water treatment facilities;

(iv) Other pertinent information.

Drinking water quality standards for public and semi-public water suppliers can be found in the Drinking Water Quality Standards Regulation under *The Drinking Water Safety Act* (http://web2.gov.mb.ca/laws/regs/pdf/d101-041.07.pdf).

TIER III - NARRATIVE WATER QUALITY GUIDELINES

Biological Integrity

The biological communities within Manitoba's aquatic ecosystems should not be altered beyond that which would naturally exist such that:

(1) In waters designated as High Quality or Exceptional Value, there should be no change in the species composition, community structure, or community function, and rare or endangered species should be preserved.

(2) In other waters, community composition should not be altered by more than 5 % of genera, community structure should not be altered by more

than 20 %, there should be no change in community function, important recreational, commercial, or ecological species should be protected, and rare or endangered species should be preserved.

Numerical biological guidelines for specific water bodies may be developed, where possible, and may replace or augment the above narrative guidelines.

Colour, Odour, Taste, Turbidity — Free from materials that produce colour, odour, taste, turbidity, or other conditions in such a degree as to be objectionable or to impair any beneficial use.

Deposits — None that will cause the formation of putrescent or otherwise objectionable sludge deposits.

Floating Materials — Free from floating debris, scum, and other floating materials in sufficient amounts to be unsightly or deleterious.

Flow — Water quantities (flows and lake levels) should not be altered to a degree which will cause exceedances of the water quality standards, objectives, or guidelines such that important uses may be unacceptably impaired. In addition, where practicable, sufficient minimum flows should be maintained to protect aquatic life.

Litter — Free from materials such as garbage, rubbish, trash, cans, bottles, or any unwanted or discarded solid material.

Non-Indigenous Aquatic Species — All reasonable measures should be taken to prevent the accidental introduction of non-native aquatic species into Manitoba or into waters that flow into Manitoba. The Manitoba Fishery Regulations (SOR/87-509) under the federal Fisheries Act, makes it illegal in Manitoba to possess and transport a number of fish and invertebrates including, but not limited to, rusty crayfish, zebra and quagga mussels, spiny water flea, and round goby (http://laws-lois.justice.gc.ca/eng/regulations/SOR-87-509/index.html). Intentional introductions of non-indigenous aquatic species must receive approval by Manitoba Water Stewardship, Fisheries Branch.

Nutrients, Nuisance Aquatic Plants, and Toxic Algae — Nitrogen, phosphorus, carbon, and contributing trace elements should be limited to the extent necessary to prevent the nuisance growth and reproduction of aquatic rooted, attached and floating plants, fungi, or bacteria, or to otherwise render the water unsuitable for other beneficial uses. For general guidance, unless it can be demonstrated that total phosphorus is not a limiting factor, considering the morphological, physical, chemical, or other characteristics of the water body, total phosphorus should not exceed 0.025 mg/L in any reservoir, lake, or pond, or in a tributary at the point where it enters such bodies of water. In other streams, total phosphorus should not exceed 0.05 mg/L. It should be noted that maintenance of such concentrations may not guarantee that eutrophication problems will not develop.

Oil and Grease — Free from oil and grease residues which causes a visible film or sheen upon the waters or any discolouration of the surface of adjoining shorelines or

causes a sludge or emulsion to be deposited beneath the surface of the water or upon the adjoining shorelines.

Toxic Substances Free from substances in concentrations or in combinations that injure, be toxic to, or produce unacceptable adverse physiological or behavioural responses in humans, aquatic, semi-aquatic, and terrestrial life.

TIER III - NUMERICAL WATER QUALITY GUIDELINES

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
Acenaphthene [See Polycyclic aromatic hydrocarbons]									
Acenaphthylene [See Polycyclic aromatic hydrocarbons]									
Acridine [See Polycyclic aromatic hydrocarbons]									
Aldicarb	9 µg/L		1 µg/L	54.9 µg/L	11 µg/L				
Aldrin + Dieldrin	0.7 µg/L								
Aluminum			5 µg/L if pH < 6.5 or 100 µg/L if pH ≥ 6.5	5000 µg/L	5000 µg/L				
Ammonia			See *Tier II - Water Quality Objectives*						
Aniline			2.2 µg/L						
Anthracene [See Polycyclic aromatic hydrocarbons]									
Antimony	6 µg/L								
Aroclor 1254 [See Polychlorinated biphenyls (PCBs)]									
Arsenic	10 µg/L		See *Tier II - Water Quality Objectives*	100 µg/L	25 µg/L		5900 µg/kg [PEL: 17,000 µg/kg]		3500 µg/kg[c]
Atrazine and metabolites	5 µg/L		1.8 µg/L	10 µg/L	5 µg/L				
Azinphos-methyl	20 µg/L								
Barium	1000 µg/L								
Bendiocarb	40 µg/L								
Benz*(a)*anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]									

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Benzo[a]pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]	0.01		0.15						
Benzene	5 µg/L		370 µg/L						
Beryllium				100 µg/L	100 µg/L				
2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethane [See DDD]									
1,1-Dichloro-2,2-bis(*p*-chlorophenyl)-ethene [See DDE]									
2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane [See DDT]									
Boron	5000 µg/L		29,000 µg/L short term exposure; 1,500 µg//L long term exposure	500-6000 µg/L (crop dependent)	5000 µg/L				
Bromacil			5 µg/L	0.2 µg/L	1100 µg/L				
Bromate	10 µg/L								
Bromoxynil	5 µg/L		5 µg/L	0.33 µg/L	11 µg/L				
Cadmium	5 µg/L		See *Tier II - Water Quality Objectives*	5.1 µg/L	80 µg/L		600 µg/kg ISQG [PEL: 3,500 µg/kg]		
Calcium					1,000,000 µg/L				
Captan			1.3 µg/L		13 µg/L				
Carbaryl	90 µg/L		3.3 µg/L short term exposure; 0.2 µg/L long term exposure		1100 µg/L				
Carbofuran	90 µg/L		1.8 µg/L		45 µg/L				
Carbon tetrachloride [See Halogenated methanes; Tetrachloromethane]									

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Cesium-137 (^{137}Cs)	10 Bq/L								
Chloramines [See Reactive Chlorine]									
Chlordane							4.5 µg/kg [PEL: 8.87 µg/kg]		
Chloride		≤250,000 µg/L		100,000-900,000 µg/L					
Chlorinated benzenes									
Monochlorobenzene	80 µg/L	≤30 µg/L	1.3 µg/L						
1,2-Dichlorobenzene	200 µg/L	≤3 µg/L	0.70 µg/L						
1,3-Dichlorobenzene			150 µg/L						
1,4-Dichlorobenzene	5 µg/L	≤1 µg/L	26 µg/L						
1,2,3-Trichlorobenzene			8.0 µg/L						
1,2,4-Trichlorobenzene			24 µg/L						
1,2,3,4-Tetrachlorobenzene			1.8 µg/L						
Pentachlorobenzene			6.0 µg/L						
Hexachlorobenzene					0.52 µg/L				
Chlorinated ethanes									
1,2-Dichloroethane	5 µg/L		100 µg/L		5 µg/L				
1,1,1-Trichloroethane [see DDT]									
Chlorinated ethenes									
Monochloroethane (Vinyl Chloride)	2 µg/L								
1,1-Dichloroethene (Dichloroethylene)	14 µg/L								
1,1,2-Trichloroethene [Trichloroethylene, TCE]	5 µg/L		21 µg/L		50 µg/L				
1,1,2,2-Tetrachloroethene [Tetrachloroethylene, PCE]	30 µg/L		110 µg/L						
Chlorinated methanes [See Halogenated methanes]									
Chlorinated phenols									

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Monochlorophenol			7 µg/L						
Dichlorophenol			0.2 µg/L						
2,4-Dichlorophenol	900 µg/L	≤0.3 µg/L							
Trichlorophenol			18 µg/L						
2,4,6-Trichlorophenol	5 µg/L	≤2 µg/L							
Tetrachlorophenol			1 µg/L						
2,3,4,6-Tetrachlorophenol	100 µg/L	≤1 µg/L							
Pentachlorophenol [PCP]	60 µg/L	≤30 µg/L	0.5 µg/L						
Chlorine, Reactive [See Reactive Chlorine]									
Chloroform [See Halogenated methanes; Trichloromethane]									
4-Chloro-2-methyl phenoxy acetic acid [See MCPA]									
Chlorothalonil			0.18 µg/L	5.8 µg/L	170 µg/L				
Chlorpyrifos	90 µg/L		0.02 µg/L short term exposure; 0.0002 µg/L long term exposure		24 µg/L				
Chromium	50 µg/L						37,300 µg/kg [PEL: 90,000 µg/kg]		
Chromium (III)			See *Tier II - Water Quality Objectives*	4.9 µg/L	50 µg/L				
Chromium (VI)			See *Tier II - Water Quality Objectives*	8 µg/L	50 µg/L				
Chrysene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Cobalt				50 µg/L	1000 µg/L				

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
Coliforms, Fecal	See *Tier II - Water Quality Objectives*			See *Tier II - Water Quality Objectives*		See *Tier II - Water Quality Objectives*			
Coliforms, Total	0 per 100 mL			1000 per 100 mL					
Colour		≤15 TCU							
Copper		≤1000 µg/L	See *Tier II - Water Quality Objectives*	200-1000 µg/L (crop dependent)	500-5000 µg/L (species dependent)		35,700 µg/kg [PEL: 197,000 µg/kg]		
Cyanazine	10 µg/L		2.0	0.5 µg/L	10 µg/L				
Cyanide	200 µg/L		See *Tier II - Water Quality Objectives*						
2,4-D [See 2,4-Dichlorophenoxyacetic acid]									
DDAC [Didecyl dimethyl ammonium chloride]			1.5 µg/L						
DDD [2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethane; Dichloro diphenyl dichloroethane]							3.54 µg/kg [PEL: 8.51 µg/kg]		
DDE [1,1-Dichloro-2,2-bis(*p*-chlorophenyl)-ethene; Diphenyl dichloro ethylene]							1.42 µg/kg [PEL: 6.75 µg/kg]		
DDT [2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethan; Dichloro diphenyl trichloroethane]							1.19 µg/kg [PEL: 4.77 µg/kg]		
DDT, Total (sum of DDE, DDD, DDT)								14.0 µg/kg (wet weight)	5000 µg/kg[d]
Deltamethrin			0.0004 µg/L		2.5 µg/L				
Diazinon	20 µg/L								
Dibenz*(a,h)*anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Dibromochloromethane [See Halogenated methanes]									

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
Di-*n*-butyl phthalate [See Phthalate esters]									
Dicamba	120 µg/L		10 µg/L	0.006 µg/L	122 µg/L				
Dichlorobenzene [See Chlorinated benzenes]									
Dichlorobromomethane [See Halogenated methanes]									
1,1-Dichloro-2,2-bis(*p*-chlorophenyl)-ethane [See DDE]									
Dichloro diphenyl dichloroethane[2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethane; See DDD]									
Dichloro diphenyl trichloroethane[2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane; See DDT]									
Dichloroethane [See Chlorinated ethanes]									
Dichloroethylene [See Chlorinated ethenes; 1,1-Dichloroethene]									
Dichloromethane [See Halogenated methanes]									
Dichlorophenol [See Chlorinated phenols]									
2,4-Dichlorophenoxyacetic acid [2,4-D]	100 µg/L								
Diclofop-methyl	9 µg/L		6.1 µg/L	0.18 µg/L	9 µg/L				
Didecyl dimethyl ammonium chloride [See DDAC]									
Dieldrin							2.85 µg/kg [PEL: 6.67 µg/kg]		
Dieldrin + Aldrin [See Aldrin + Dieldrin]									

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
Di(2-ethylhexyl) phthalate [See Phthalate esters]									
Diisopropanolamine			1,600 µg/L	2000 µg/L					
Dimethoate	20 µg/L		6.2 µg/L		3 µg/L				
Di-*n*-butyl phthalate [See Phthalate esters]									
Dinoseb	10 µg/L		0.05 µg/L	16 µg/L	150 µg/L				
Dioxins and furans (2,3,7,8-TCDD) (see also Polychlorinated dibenzo-*p*-dioxins/dibenzo furans (PCDD/Fs)]									
Diphenyl dichloro ethylene [See DDE]									
Diquat	70 µg/L								
Dissolved oxygen [See Oxygen, Dissolved]									
Dissolved solids [See Total dissolved solids]									
Diuron	150 µg/L								
Endosulfan			0.06 µg/L short term exposure; 0.003 µg/L long-term exposure						
Endrin							2.67 µg/kg [PEL: 62.4 µg/kg]		
Ethylbenzene		≤2.4 µg/L	90 µg/L		2.4 µg/L				
Ethylene glycol [See Glycols]									
Fecal coliforms [See Coliforms, fecal]									
Fluoranthene [See Polycyclic aromatic hydrocarbons (PAHs)]									

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Fluorene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Fluoride	1500 µg/L			1000 µg/L	1000-2000 µg/L				150,000 µg/kg(c)
Inorganic fluorides			120 µg/L						
Glycols									
Ethylene glycol			192,000 µg/L						
Propylene glycol			500,000 µg/L						
Glyphosate	280 µg/L		65 µg/L		280 µg/L				
Halogenated methanes									
Dichloromethane [Methylene chloride]	50 µg/L		98.1 µg/L		50 µg/L				
Trichloromethane [Chloroform]			1.8 µg/L						
Tetrachloromethane [Carbon tetrachloride]	5 µg/L		13.3 µg/L		5 µg/L				
Tribromomethane (Bromoform)					100 µg/L				
Dichlorobromomethane					100 µg/L				
Dibromochloromethane					100 µg/L				
Trihalomethanes-total (THMs)	100 µg/L								
HCBD [See Hexachlorobutadiene]									
Heptachlor (Heptachlor epoxide)							0.60 µg/kg [PEL: 2.74 µg/kg]		
Hexachlorobenzene [See Chlorinated benzenes]									
Hexachlorobutadiene [HCBD]			1.3 µg/L						
Hexachlorocyclohexane [See Lindane]									
Hypochlorous acid [See Reactive chlorine species]									
Imidacloprid			0.23 µg/L						
Iodine-131 (^{131}I)	6 Bq/L								

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
3-Iodo-2-propynyl butyl carbamate [See IPBC]									
IPBC [3-Iodo-2-propynyl butyl carbamate]			1.9 µg/L						
Iron		≤300 µg/L	300 µg/L	5000 µg/L					
Lead	10 µg/L		See *Tier II - Water Quality Objectives*	200 µg/L	100 µg/L		35,000 µg/kg [PEL: 91,300 µg/kg]		500 µg/kg[c]
Lead-210 (^{210}Pb)	0.2 Bq/L								
Lindane [Hexachlorocyclohexane]			0.01 µg/L		4 µg/L		0.94 µg/kg [PEL: 1.38 µg/kg]		
Linuron			7.0 µg/L	0.071 µg/L					
Lithium				2500 µg/L					
Malathion	190 µg/L								
Manganese		≤50 µg/L		200 µg/L					
MCPA [4-Chloro-2-methyl phenoxy acetic acid; 2-Methyl-4chloro phenoxy acetic acid]			2.6 µg/L	0.025 µg/L	25 µg/L				
Mercury	1 µg/L				3 µg/L		170 µg/kg [PEL: 486 µg/kg]		500 µg/kg[d]
Inorganic Mercury			0.026 µg/L						
Methoprene			0.09 µg/L, (Target Organism Management guideline value: 0.53 µg/L)						
Methylmercury			0.004 µg/L					33.0 µg/kg	
Methoxychlor	900 µg/L								
Methylene chloride [See Halogenated methanes, Dichloromethane]									
2-Methyl-4-chloro phenoxy acetic acid [See MCPA]									

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Methyl tertiary-butyl ether (MTBE)		15 µg/L	10,000 ug/L						
2-Methylnaphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Metolachlor	50 µg/L		7.8 µg/L	28 µg/L	50 µg/L				
Metribuzin	80 µg/L		1.0 µg/L	0.5 µg/L	80 µg/L				
Microcystin LR	1.5 µg/L					See *Tier II - Water Quality Objectives*			
Molybdenum			73 µg/L	10-50 µg/L	500 µg/L				
Monochloramine [See Reactive chlorine species]									
Monochlorobenzene [See Chlorinated benzenes]									
Monochlorophenol [See Chlorinated phenols]									
Naphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Nickel			See *Tier II - Water Quality Objectives*	200 µg/L	1000 µg/L				
Nitrate (as N)	10,000 µg/L		13,000 µg/L						
Nitrate + Nitrite	See *Tier II - Water Quality Objectives*				100,000 µg/L				
Nitrilotriacetic acid [NTA]	400 µg/L								
Nitrite (as N)	3,200 µg/L		60 µg/L		10,000 µg/L				
Nitrite + Nitrate [See Nitrate + Nitrite]									
Nonylphenol and its ethoxylates			1.0 µg/L				1400 µg/kg (dry weight)		
NTA [See Nitrilotriacetic acid]									
Organotins									
Tributyltin			0.008 µg/L		250 µg/L				
Tricyclohexyltin					250 µg/L				

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Triphenyltin			0.022 µg/L		820 µg/L				
Oxygen, Dissolved			See *Tier II - Water Quality Objectives*						
PAHs [See Polycyclic aromatic hydrocarbons]									
Paraquat (as dichloride)	10 µg/L								
Parathion	50 µg/L								
PCBs [See Polychlorinated biphenyls (PCBs)]									
PCE [See Chlorinated ethenes, Tetrachloroethylene; 1,1,2,2-Tetrachloroethene]									
PCP [See Chlorinated phenols, Pentachlorophenol]									
Pentachlorobenzene [See Chlorinated benzenes]									
Pentachlorophenol;[See Chlorinated phenols (PCP)]									
Permithrin			0.004 µg/L						
pH		6.5-8.5	6.5-9.0			5.0-9.0			
Phenanthrene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Phenols			4 µg/L		2 µg/L				
Phenoxy herbicides			4 µg/L		100 µg/L				
Phorate	2 µg/L								
Phthalate esters									
Di-*n*-butyl phthalate			19 µg/L						
Di(2-ethylhexyl) phthalate			16 µg/L						
Di-*n*-octyl phthalate									
Picloram			29 µg/L		190 µg/L				

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Polychlorinated biphenyls [PCBs]							34.1 µg/kg [PEL: 277 µg/kg]	Mammalian: 0.79 ng TEQ/kg diet (wet weight) Avian: 2.4 ng TEQ/kg diet (wet weight)	
Aroclor 1254							60 µg/kg [PEL: 340 µg/kg]		
Polychlorinated dibenzo-*p*-dioxins/dibenzo furans (PCDD/Fs) [see also Dioxins and furans]							0.85 ng TEQ/kg (dry weight) [PEL: 21.5 ng TEQ/kg (dry weight)]	Mammalian: 0.71 ng TEQ/kg diet (wet weight) Avian: 4.75 ng TEQ/kg diet (wet weight)	
Polycyclic aromatic hydrocarbons [PAHs]									
Acenaphthene			5.8 µg/L				6.71 µg/kg [PEL: 88.9 µg/kg]		
Acenaphthylene							5.87 µg/kg [PEL: 128 µg/kg]		
Acridine			4.4 µg/L						
Anthracene			0.012 µg/L				46.9 µg/kg [PEL: 245 µg/kg]		
Benz*(a)*anthracene			0.018 µg/L				31.7 µg/kg [PEL: 385 µg/kg]		
Benzo*(a)*pyrene Benz(*b)*fluoranthene	0.01 µg/L		0.015 µg/L				31.9 µg/kg [PEL: 782 µg/kg]		
Chrysene							57.1 µg/kg [PEL: 862 µg/kg]		

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Dibenz*(a,h)*anthracene							6.22 µg/kg [PEL: 135 µg/kg]		
Fluoranthene			0.04 µg/L				111 µg/kg [PEL: 2,355 µg/kg]		
Fluorene			3.0 µg/L				21.2 µg/kg [PEL: 144 µg/kg]		
2-Methylnaphthalene							20.2 µg/kg [PEL: 201 µg/kg]		
Naphthalene			1.1 µg/L				34.6 µg/kg [PEL: 391 µg/kg]		
Phenanthrene			0.4 µg/L				41.9 µg/kg [PEL: 515 µg/kg]		
Pyrene			0.025 µg/L				53.0 µg/kg [PEL: 875 µg/kg]		
Quinoline			3.4 µg/L						
Propylene glycol [See Glycols]									
Pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]									
Quinoline [See Polycyclic aromatic hydrocarbons (PAHs)]									
Radium-226	0.5 Bq/L								
Reactive chlorine species			See *Tier II - Water Quality Objectives*						
Chloramines, total	3000 µg/L								
Selenium	10 µg/L		1.0 µg/L	20-50 µg/L	50 µg/L				
Silver			0.1 µg/L						
Simazine			10 µg/L	0.5 µg/L	10 µg/L				

Variable	**Surface or Ground Water: Drinking**(a) (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**(a) (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**(b)	**Surface or Ground Water: Irrigation**(b)	**Surface or Ground Water: Livestock**(b)	**Surface Water: Recreation**(b)	**Surface Water: Sediment**(b)	**Aquatic Life Tissue Residue: Wildlife Consumers**(b)	**Aquatic Life Tissue Residue: Human Consumers**
Sodium		≤200,000 µg/L							
Streambed substrate [See Total particulate matter]									
Strontium-90 (^{90}Sr)	5 Bq/L								
Styrene			72 µg/L						
Sulfolane			50,000 ug/L	500 ug/L					
Sulphate		≤500,000 µg/L			1,000,000 µg/L				
Sulphide (as H_2S)		≤50 µg/L							
Suspended particulates [See Total particulate matter]									
Suspended sediments [See Total particulate matter]									
TCE [See Chlorinated ethenes, 1,1,2-Trichloroethene]									
Tebuthiuron			1.6 µg/L	0.27 µg/L	130 µg/L				
Temperature		≤15ºC	See *Tier II - Water Quality Objectives*						
Terbufos	1 µg/L								
Tetrachlorobenzene [See Chlorinated benzenes]									
Tetrachloroethylene [See Chlorinated ethenes, 1,1,2,2-Tetrachloroethene]									
Tetrachloromethane [See Halogenated methanes]									
Tetrachlorophenol [See Chlorinated phenols]									
Thallium			0.8 µg/L						
Toluene		≤24 µg/L	2.0 µg/L		24 µg/L				
Total dissolved solids		≤500,000 µg/L		See *Tier II - Water Quality Objectives*	3,000,000 µg/L				
Total particulate matter									

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
Suspended sediments			See *Tier II - Water Quality Objectives*						
Turbidity	0.3/1.0/0.1 NTU[e]		See *Tier II - Water Quality Objectives*						
Toxaphene							0.1 µg/kg	6.3 µg/kg (wet weight)	
Triallate			0.24 µg/L		230 µg/L				
Tribromomethane [See Halogenated methanes]									
Tributyltin [See Organotins]									
Trichlorobenzene [See Chlorinated benzenes]									
Trichloroethane [See Chlorinated ethanes]									
Trichloroethene [See Chlorinated ethenes]									
Trichloroethylene [See Chlorinated ethenes, 1,1,2-Trichloroethene]									
Trichloromethane [See Halogenated methanes]									
Trichlorophenol [See Chlorinated phenols]									
Tricyclohexyltin [See Organotins]									
Trifluralin			0.20 µg/L		45 µg/L				
Trihalomethanes [See Halogenated methanes]									
Triphenyltin [See Organotins]									
Tritium (^{3}H)	7000 Bq/L								
Turbidity [See Total particulate matter]									

Variable	**Surface or Ground Water: Drinking**[a] (Maximum Acceptable Concentration)	**Surface or Ground Water: Drinking**[a] (Aesthetic Objectives)	**Surface Water: Freshwater Aquatic Life**[b]	**Surface or Ground Water: Irrigation**[b]	**Surface or Ground Water: Livestock**[b]	**Surface Water: Recreation**[b]	**Surface Water: Sediment**[b]	**Aquatic Life Tissue Residue: Wildlife Consumers**[b]	**Aquatic Life Tissue Residue: Human Consumers**
Uranium	20 µg/L		33 µg/L short term exposure; 15 µg/L long term exposure	10 µg/L	200 µg/L				
Vanadium				100 µg/L	100 µg/L				
Vinyl chloride [See Chlorinated ethenes, Monochloroethene]									
Xylene		≤300 µg/L							
Zinc		≤5000 µg/L	See *Tier II - Water Quality Objectives*	1000-5000 µg/L	50,000 µg/L		123,000 µg/kg [PEL: 315,000 µg/kg]		

Notes:

a Further information on Guidelines for Canadian Drinking Water Quality is available from Health Canada's website at http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index_e.html

b Canadian Council of Ministers of the Environment (CCME) (2011). Further information on CCME's Canadian Environmental Quality Guidelines is available from their website at http://www.ccme.ca/.

c Health Canada's regulations for residues in fish tissue (Division 15, Food and Drugs Act). Further information is available on the Food and Drugs Act from Health Canada's website at http://www.hc-sc.gc.ca/.

d Health Canada's Canadian Standards ("Maximum Levels") for Various Chemical Contaminants in Foods. Further information is available on Health Canada's web site at http://www.hc-sc.gc.ca/fn-an/securit/chem-chim/contaminants-guidelines-directives-eng.php

e The treated water turbidity target is less than 0.1 NTU at all times. Where this is not achievable, the maximum treated water turbidity level depends on the method of treatment used. Based on chemically assisted filtration/slow sand or diatomaceous earth filtration/membrane filtration.

f Ontario Ministry of Environment (1999), derived from Health Canada's Provisional Tolerable Daily Intake of 0.2 µg/kg·bw/day (pers. comm., Dr. John Salminen). Further information on Ontario's consumption guide for sport fish is available from their website at http://www.ene.gov.on.ca/.

g Additional information maximum acceptable concentrations of radiological parameters in drinking water can be found in the "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Radiological Parameters" available from Health Canada at http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/radiological_para-radiologiques/radiological_para-radiologiques-eng.pdf.

DEFINITIONS AND REFERENCES

DEFINITIONS

Water Uses Water uses in Manitoba requiring protection include the following:

- Drinking Water — Waters which are or may be used for human consumption, culinary, food processing purposes, and other household purposes.

- Cool Water Aquatic Life and Wildlife — Fish species and additional flora and fauna which are indigenous to a cool water habitat (*e.g.*, mooneye, goldeye, pike, perch, walleye, sauger) including those forms of wildlife that rely upon surface waters for habitat and for food supplies. Additional flora and fauna include other aquatic organisms such as bacteria, fungi, algae, aquatic insects, other aquatic invertebrates, reptiles, amphibians, and fish.

- Cold Water Aquatic Life and Wildlife — Fish species in the family Salmonidae (*e.g.*, char, trout, whitefish, grayling) and additional flora and fauna which are indigenous to a cold water habitat including those forms of wildlife that rely upon surface waters for habitat and for food supplies. Additional flora and fauna include other aquatic organisms such as bacteria, fungi, algae, aquatic insects, other aquatic invertebrates, reptiles, amphibians, and fish.

- Industrial and Cooling Water Supplies — Waters which are or may be used as a source of supply for industrial processes or cooling water, or any other industrial, commercial purposes, or private purpose and for which quality control is or may be necessary.

- Greenhouse Irrigation — Waters which are or may be used for intensive horticultural crop production, where irrigation is used as the only source of water. Long-term protection is afforded (1) fine, medium, and coarse textured soils from the accumulation of substances that may be harmful or cause a reduction in fertility; (2) sensitive, semi-tolerant, and tolerant species of plants; and (3) humans from the harmful effects caused by the accumulation of substances on marketable produce that may not be processed prior to consumption.

- Field, Park, and Garden Irrigation — Waters which are or may be used for field crop production, park lands, golf courses, gardens, and other areas where irrigation water is used to supplement natural precipitation. Long-term protection is afforded (1) fine, medium, and coarse textured soils from the accumulation of substances that may be harmful or cause a reduction in fertility; (2) sensitive, semi-tolerant and tolerant species of plants; and (3) humans from harmful effects caused by the accumulation of substances on marketable produce that may not be processed prior to consumption.

- Livestock Watering — Waters which are or may be used by livestock and poultry. Protection is afforded all classes and ages of livestock and poultry from unacceptable effects following water consumption. Disinfection may be required for waters heavily contaminated with wastes of fecal origin in order to provide a suitable supply for ingestion by monogastric animals (poultry, swine, horses).

- Primary Recreation

Waters which are or may be used for primary recreational uses where the human body may come in direct contact with the water, to the point that water may be ingested accidentally or water may contact certain sensitive organs such as the eyes, ears, and nose. Examples could include wading and dabbling, swimming, diving, water skiing, surfing, and contact with water directly associated with shoreline activities.

4-Day, 3-Year Biological-Based Minimum Design Flow

The 4-day, 3-year biological-based design flow is calculated by an iterative convergence procedure in five steps (Rossman 1990) and estimates the flow which occurs, on average, once each 3 years from 4-day running harmonic averages during the period of record. Biologically-based minimum design flows of other duration and frequency (*e.g.*, 1-day, 3-year; 30-day, 3-year; or others) can be calculated in the same manner.

5-Day Biochemical Oxygen Demand (BOD)

The 5-day Biochemical Oxygen Demand means that part of the oxygen demand usually associated with biochemical oxidation of organic matter within 5 days at a temperature of 20° C.

7Q10 Hydrological-Based Minimum Design Flow

The 7Q10 hydrological-based design flow is the minimum 7-day average flow which occurs with a return frequency of once in each 10 years. It is an extreme value design flow estimated in three steps by calculating 7-day running arithmetic averages for the period of record, fitting the annual minima to a log Pearson III probability distribution, then selecting the value from the distribution with a probability of not being exceeded of 1/10 years or 0.10. Other hydrological extreme value design flows such as 1Q10, 30Q10, or others can be calculated in the same manner. The method is described by Rossman (1990).

96 hour LC_{50}

The concentration of a material that results in the death of 50 % of the test organisms over a period of 96 hours.

Acute Lethality

A toxic effect resulting in death produced in an organism by a substance or mixture of substances within a short exposure period (usually 96 hours or less).

Canada-Wide Standards

The following has been excerpted from the CCME website at http://www.ccme.ca/: "Canada-Wide Standards (CWSs) can include qualitative or quantitative standards, guidelines, objectives, and criteria for protecting the environment and reducing the risk to human health. CWSs will include a numeric limit (*e.g.*, ambient, discharge, or product standard), a commitment and timetable for attainment, a list of preliminary actions to attain the standard, and a framework for reporting to the public.

CWSs are intended to be achievable targets and will be based on sound science. CWSs will consider other factors such as social aspects (*e.g.*, effects on jobs), economic impacts (*e.g.*, costs associated with solving the problem), and technical feasibility (for example, availability of technology). Public input will be a key feature in the development of CWSs. Governments are responsible for implementing the CWS and are accountable to the public for doing so. CWSs do not themselves have any legal force. In implementing the standards, governments may choose to use their existing legal authorities, or create new ones where necessary.

Several features of the emerging CWS process differ from those used for traditional guideline development. First, socio-economic and technical factors must be duly considered in the development of CWSs. CCME guidelines for the ambient environment focus principally on prevention of adverse environmental effects. Socio-economic factors are not generally accommodated in guidelines, although such factors can be used to develop site-specific or regional-specific objectives from guidelines. Second, greater public participation is planned for the development of CWSs. It is expected that public participation in some form will occur at various stages in the process. Third, through preparation of implementation workplans, governments will demonstrate a commitment to attain the CWS. In the case of guidelines, implementation has been very much at the discretion of the individual jurisdiction. Jurisdictional powers are not altered under the CWS exercise; however, jurisdictions commit to stating their course of action. Finally, in implementing a CWS, jurisdictions agree to report publicly on the results achieved."

Mixing Zones

Mixing zones are areas adjacent to a discharge or to an activity that may affect water quality where, in particular, not all *Tier II - Water Quality Objectives* are met but acutely toxic conditions are prevented. Mixing zones are usually comprised of a zone of initial dilution and a secondary zone of mixing. Mixing zones are allowed for practical reasons since, for most pollutants, it would be unreasonable to require the objectives to be met at the end of the discharge pipe.

Sodium Adsorption Ratio (SAR)

$$= \frac{0.044 \times [\text{Sodium}]}{\sqrt{(0.025 \times [\text{Calcium}]) + (0.041 \times [\text{Magnesium}])}}$$

where sodium, calcium, and magnesium are concentrations expressed in mg/L.

Units

µg/L	micrograms per litre (approximately equivalent to parts per billion).
Bq/L	Becquerels per litre.
pBq/L	picoBecquerels per litre
mg/kg	milligrams per kilogram (equivalent to parts per million).
µg/kg	micrograms per kilogram (equivalent to parts per billion).
mg/L	milligrams per litre (approximately equivalent to parts per million).
ng/kg	nanograms per kilogram (equivalent to parts per trillion).
NTU	Nephelometric Turbidity Units
TCU	True Colour Units.
TEQ	Toxic Equivalents (to relate toxicity to standard units derived for dioxin).
PEL	Probable Effects Level.

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