



National Recommended Water Quality Criteria: 2002

NOTICE

This document has been reviewed by the Health and Ecological Criteria Division, Office of Science and Technology, U.S. Environmental Protection Agency, and approved for publication.

CONTENTS

NOTICE	i
CONTENTS	ii
I Introduction	1
II What is in this Updated Compilation?	1
III What is the Relationship Between These Criteria and Your State or Tribal Water Quality Standards?	2
IV What is the Status of Existing Recommended Criteria While They Are Under Revision? ..	3
V What's New in the Compilation?	3
Human Health Criteria	3
Revised Human Health Criteria	3
Methylmercury	5
Dioxin	5
Aquatic Life Criteria	6
Revised Definition of Total PCBs for Aquatic Life Criteria	6
Saltwater Dissolved Oxygen (Cape Cod to Cape Hatteras)	6
Freshwater Aquatic Life Criteria for Ammonia	7
Cadmium	7
Guidance on the Calculation of Hardness-Dependent Metals Criteria	7
National Guidance on the Applicability of Freshwater and Saltwater Criteria ...	9
Nutrient Criteria	9
VI Comments on the December 10, 1998 National Recommended Water Quality Criteria Compilation	10
VII Where Can I Find More Information About Water Quality Criteria and Water Quality Standards?	10
VIII What Are the National Recommended Water Quality Criteria?	11
General Notes:	29
Appendices:	31
Appendix A - Conversion Factors for Dissolved Metals	31
Appendix B - Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent	32
Appendix C - Calculation of Freshwater Ammonia Criterion	33

I Introduction

The U.S. Environmental Protection Agency (EPA) is publishing an updated compilation of its national recommended water quality criteria for 158 pollutants, developed pursuant to section 304(a) of the Clean Water Act (CWA or the Act). Section 304(a)(1) of the Act requires EPA to develop and publish, and from time to time revise, criteria for water quality accurately reflecting the latest scientific knowledge. Water quality criteria developed under section 304(a) are based solely on data and scientific judgments on the relationship between pollutant concentrations and environmental and human health effects. Section 304(a) criteria do not reflect consideration of economic impacts or the technological feasibility of meeting the chemical concentrations in ambient water.

The recommended water quality criteria contained in this document provide guidance for states and tribes authorized to establish water quality standards under the CWA to protect human health and aquatic life. Under the CWA, states and authorized tribes are to establish water quality standards to protect designated uses. Such standards are used in implementing a number of environmental programs, including setting discharge limits in National Pollutant Discharge Elimination System (NPDES) permits. While this document constitutes the EPA's guidance regarding ambient concentrations for various pollutants, this document does not substitute for the CWA or EPA's regulations; nor is it a regulation itself. Thus, it cannot impose legally binding requirements on the EPA, states, authorized tribes or the regulated community, and might not apply to a particular situation based upon the circumstances. State and tribal decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate. The EPA may change this guidance in the future.

II What is in this Updated Compilation?

EPA developed an updated compilation of its national recommended water quality criteria (NRWQC) for pollutants. The criteria in this document supercede any Clean Water Act (CWA) section 304(a) water quality criteria published in EPA's previous criteria compilations including: the "*Blue Book*," "*Red Book*," "*Gold Book*" and EPA's last compilation of national recommended water quality criteria published on December 10, 1998 (63 FR 68354 or *National Recommended Water Quality Criteria—Correction*, April 1999, EPA 822-Z-99-001). Many of the human health criteria in this compilation have been revised based on EPA's new methodology for deriving human health criteria (*See: Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000), EPA-822-B-00-004, October 2000). Water quality criteria contained in this document may be superceded by the publication of section 304(a) water quality criteria subsequent to the publication of this document.

This compilation is presented as a summary table containing EPA's water quality criteria for 158 pollutants. For each set of criteria, EPA lists a **Federal Register** citation, EPA document number or Integrated Risk Information System (IRIS) entry (www.epa.gov/iris/index.html). Information pertinent to the derivation of individual criteria may be found in the cited references or footnotes. Still, these references may not be a single complete source of information for the

criteria derivation. You may need to refer to more than one document for complete information. A calculation matrix that contains all of the components (e.g., cancer potency factors (q1*s), reference doses (RfDs) and bioconcentration factors (BCFs)) and formulas used to derive the human health criteria in the compilation is available at <http://www.epa.gov/waterscience/criteria/>. EPA does not have national recommended water quality criteria for pollutants with no criteria listed.

The national recommended water quality criteria include: previously published criteria that are unchanged, criteria that have been recalculated from earlier criteria (63 FR68354, 12/10/1998) and newly calculated criteria based on peer-reviewed assessments and data.

The Agency intends to revise this compilation of national recommended water quality criteria from time to time to keep states and authorized tribes informed as to the most current recommended section 304(a) water quality criteria.

III What is the Relationship Between These Criteria and Your State or Tribal Water Quality Standards?

As part of the water quality standards triennial review process defined in Section 303(c)(1) of the CWA, the states and authorized tribes are responsible for maintaining and revising water quality standards. Water quality standards consist of designated uses, water quality criteria to protect those uses, a policy for antidegradation, and general policies for application and implementation. Section 303(c)(1) requires States and Tribes to review, and modify if appropriate, their water quality standards at least once every three years.

States and authorized tribes must adopt water quality criteria that protect designated uses. Protective criteria are based on a sound scientific rationale and contain sufficient parameters or constituents to protect the designated uses. Criteria may be expressed in either narrative or numeric form. States and authorized tribes have four options when adopting water quality criteria for which EPA has published section 304(a) criteria. They can: (1) establish numerical values based on recommended section 304(a) criteria; (2) adopt section 304(a) criteria modified to reflect site-specific conditions; (3) adopt criteria derived using other scientifically defensible methods; or (4) establish narrative criteria where numeric criteria cannot be determined (40 CFR 131.11).

Consistent with 40 CFR131.21 (See: *EPA Review and Approval of State and Tribal Water Quality Standards* (65 FR 24641, April 27, 2000)), water quality criteria adopted by law or regulation by States and Tribes prior to May 30, 2000, are in effect for CWA purposes unless superseded by federal regulations (see, for example, the *National Toxics Rule*, 40 CFR 131.36; *Water Quality Standards for Idaho*, 40 CFR 131.33). New or revised water quality criteria adopted into law or regulation by States and Tribes on or after May 30, 2000 are in effect for CWA purposes only after EPA approval.

IV What is the Status of Existing Recommended Criteria While They Are Under Revision?

Water quality criteria published by EPA remain the Agency's recommended water quality criteria until EPA revises or withdraws the criteria. For example, while undertaking recent reassessments of certain chemicals, EPA has consistently supported the use of the existing section 304(a) criteria for these chemicals and considers them to be scientifically sound until the Agency reevaluates the 304(a) criteria, subjects the criteria to appropriate peer review, and subsequently publishes revised 304(a) criteria.

V What's New in the Compilation?

Human Health Criteria

Revised Human Health Criteria

EPA revised the methodology it uses to develop water quality criteria for protection of human health. The revised methodology entitled, *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000) (EPA-822-B-00-004, October 2000) and a **Federal Register** notice (65 FR 66443, 11/3/2000) both describe the Agency's current approach for deriving national recommended water quality criteria to protect human health.

EPA has revised many of the human health criteria in the compilation based on this new methodology. By and large, these represent partial updates of the 304(a) criteria as described in both the draft Methodology revisions and the **Federal Register** notice that accompanied the final Methodology (65 FR 66443). EPA received much support for revising criteria based on partially updated components of the criteria equations as a way of increasing the frequency of scientific improvements to the nationally recommended criteria that currently available information would allow. For a water quality criterion revision based on a partial update to be considered acceptable to EPA, a component of the criterion (e.g., the toxicological risk assessment) would need to be comprehensive (e.g., a new or revised RfD or cancer dose-response assessment, as opposed to simply a new scaling factor), should stand alone and be based on new national or local data. These recalculations of water quality criteria integrate an updated national default freshwater/estuarine fish consumption rate (17.5 g/day) and, in some cases, previously determined relative source contribution (RSC) values obtained from primary drinking water standards as well as new cancer potency information from the Agency's Integrated Risk Information System (IRIS).

EPA has not revised the human health criteria in today's compilation to include bioaccumulation factors (BAFs) based on the 2000 Methodology. The BAF component of criteria development is comparatively time- and resource-intensive. As previously indicated, EPA received support for partial updates rather than waiting a substantially longer period of time for BAFs to be developed. EPA also received support for the idea of not automatically developing BAFs for all of the currently published criteria, but rather revising criteria for

pollutants of high priority and national importance. EPA intends to focus its limited resources on developing BAFs for pollutants that the Agency considers highest priority in terms of toxicological concern, frequency of occurrence and bioaccumulation potential. EPA is in the process of determining candidate pollutants for BAF derivations. The human health criteria were developed with BCFs or field-measured BAFs previously developed using the 1980 Methodology. The BCFs used in deriving these criteria are consistent with BCFs used in promulgating human health criteria for priority toxic pollutants in rules such as the 1992 *National Toxics Rule* and the 2000 *California Toxics Rule*.

Not all of EPA's national recommended water quality criteria for protection of human health were revised in this compilation. Criteria currently undergoing major reassessments, such as arsenic, chloroform and nickel, were not revised at this time. Water quality criteria that predate EPA's 1980 human health methodology were not revised for this effort. EPA believes revisions for these criteria, which include barium, 2,4-D and 2,4,5-TP, iron, manganese, methoxychlor, nitrates and solids (dissolved) and salinity may warrant major reassessments. Updated IRIS information and/or RSC values are available for vinyl chloride, 1,1-dichloroethylene, 1,3-dichloropropene, thallium, chlorobenzene, cyanide, ethylbenzene, toluene, 1,2-trans-dichloroethylene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, hexachlorocyclopentadiene, 1,2,4-trichlorobenzene, Lindane and Endrin. Yet, EPA did not update the criteria for the preceding 15 chemicals in this document. EPA intends to publish revisions for the aforementioned chemicals in a separate **Federal Register** notice, soliciting scientific views regarding these revisions.

New IRIS information was available and incorporated for benzene. EPA revised the criteria for benzene based on the new cancer slope factors, which are presented in IRIS as a range. The set of risk estimates falling within this interval reflects both the inherent uncertainties in the risk assessment of benzene and the limitations of the epidemiological studies in determining dose-response and exposure data. EPA modeled the unit risk values for the carcinogenicity of benzene from epidemiological data on occupationally exposed humans. The unit risk is expressed as a range rather than a single value because in the case of this particular pollutant there is no scientific basis for choosing a single result from various model estimates. (See IRIS Benzene CASRN 71-43-2 (01/19/2000) at: www.epa.gov/iris/subst/0276.htm). The resulting ranges of criteria for protection of human health from consumption of water and organisms and consumption of organisms only are 0.61- 2.2 ug/L and 14- 51 ug/L, respectively. The Agency calculated the criteria as ranges, but is recommending the use of the upper limits in the criteria table. EPA considers any criterion in each range scientifically defensible, yet only the upper limit of each range is presented to establish the upper bound of the average ambient concentration that should not be exceeded.

For copper and asbestos, the Agency chose to base the section 304(a) water quality criteria on the Agency's drinking water maximum contaminant levels (MCLs) or action levels which are established on drinking water regulation methodologies.

A notice of intent to revise or develop human health criteria for arsenic, methylmercury and carbofuran was published in the **Federal Register** on October 12, 2000 (65 FR 60664). This

notice informed the public that EPA was in the process of revising or developing criteria for these pollutants and solicited any significant scientific information the public may be aware of that was not identified in EPA's literature search. A human health criterion for methylmercury is now available. Work is ongoing for arsenic and carbofuran.

Methylmercury

On January 8, 2001, EPA announced the availability of a recommended water quality criterion for methylmercury (66 FR 1344). In the January 8, 2001 notice, EPA withdrew its previous ambient human health water quality criteria for mercury (see 63 FR 68354, December 10, 1998; correction in 64 FR 19781, April 22, 1999) as the recommended section 304(a) water quality criteria. This updated compilation contains the new methylmercury criterion. This new water quality criterion describes the concentration of methylmercury in freshwater and estuarine fish and shellfish tissue that should not be exceeded to protect consumers of fish and shellfish among the general population. EPA expects the criterion recommendation to be used as guidance by states, tribes, and EPA in establishing or updating water quality standards for waters of the United States and in issuing fish and shellfish consumption advisories. This is the first time EPA has issued a water quality criterion expressed as a fish and shellfish tissue value rather than as a water column value. This approach is a direct consequence of the scientific consensus that consumption of contaminated fish and shellfish is the primary human route of exposure to methylmercury. EPA recognizes that this approach differs from traditional water column criteria, and will pose implementation challenges. In the January 8, 2001 notice EPA provided suggested approaches for relating the fish and shellfish tissue criterion to concentrations of methylmercury in the water column. EPA also plans to develop more detailed guidance to assist states and authorized tribes with implementation of the methylmercury criterion in water quality standards and related programs.

Dioxin

The section 304(a) water quality criteria for dioxin contained in this compilation is expressed in terms of 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) and should be used in conjunction with the national/international convention of toxicity equivalence factors (TEF/TEQs) to account for the additive effects of other dioxin-like compounds (dioxins). EPA supports the use of either the 1989 interim procedures or the 1998 World Health Organization (WHO) TEF scheme, but prefers the 1998 WHO TEF scheme because it is based on more recent data and is internationally accepted. (See: *Update to the Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and -dibenzofurans*, EPA/625/3-89/016, March 1989 and Van den Berg M., 1998). By applying the TEF/TEQ approach, the other highly toxic dioxins will be properly taken into account.

Aquatic Life Criteria

Revised Definition of Total PCBs for Aquatic Life Criteria

The aquatic life criteria for Polychlorinated Biphenyls (PCBs) in this compilation apply to total PCBs. The definition of total PCBs is the sum of all homolog, all isomer, all congener, or all Aroclor analyses. The aquatic life criteria contained in the previous publication of the NRWQC (63 FR 68354, 12/10/1998) were based on total PCB concentrations, but the definition of total PCBs only applied to the sum of seven particular Aroclors (1242, 1254, 1221, 1232, 1248, 1260 and 1016, CAS numbers 53469219, 11097691, 11104282, 11141165, 12672296, 11096825, and 12674112, respectively). This revision of the aquatic life criteria harmonizes the total PCB definition with that used for EPA's human health criteria for PCBs.

Saltwater Dissolved Oxygen (Cape Cod to Cape Hatteras)

This new compilation of NRWQC contains saltwater criteria for dissolved oxygen (D.O.). EPA's new water quality criteria are the result of a 10-year research effort to produce sufficient information to support their development. The water quality criteria presented today represent EPA's best estimates, based on the data available, of D.O. concentrations necessary to protect aquatic life and uses associated with aquatic life.

EPA published saltwater criteria for dissolved oxygen because hypoxia (low dissolved oxygen) is a significant problem for certain coastal waters that receive runoff containing nutrients (e.g., nitrogen, phosphorous) and other oxygen demanding biological wastes. Excessive amounts of nutrients in aquatic systems stimulate algal growth which can deplete available dissolved oxygen required to maintain healthy fish and shellfish populations. EPA's Environmental Monitoring and Assessment Program (EMAP) for the estuaries in the Virginian Province (defined as Cape Cod to Cape Hatteras) has shown that 25% of the area of the Virginian Province exhibits dissolved oxygen concentrations of less than 5 mg/L. For many fish and shellfish, extended periods of D.O. below 5 mg/L can cause adverse effects to larval life stages. EMAP also has generated field observations that correlate many of the biologically degraded benthic areas with low dissolved oxygen in the lower water column. These two reports emphasize that hypoxia is a major concern within the Virginian Province, among other coastal locations of the United States.

The geographic scope of the saltwater dissolved oxygen water quality criteria are limited to coastal saltwaters of the Virginian Province of the Atlantic coast of the United States (i.e., southern Cape Cod, MA, to Cape Hatteras, NC). However, the saltwater dissolved oxygen criteria can be applied elsewhere if the species and data used to derive the criteria for the Virginia Province are applicable to location-specific biological, physical, and water quality conditions. EPA believes that the overall approach for deriving marine water quality criteria for D.O. contained in *Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras* is applicable to regions outside the Virginian Province.

For additional information see: *Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras* (EPA-822R-00-012).

Freshwater Aquatic Life Criteria for Ammonia

This compilation includes EPA's latest revision (1999) of the freshwater aquatic life criteria for ammonia. The new water quality criteria reflect research and data since 1984, including the pH and temperature relationship of the acute and chronic criteria and the averaging period of the chronic criterion. The revised acute criterion for ammonia is now dependent on pH and fish species, and the chronic criterion is dependent on pH and temperature. At lower temperatures, the chronic criterion incorporates the presence or absence of early life stages of fish. The temperature dependency results in a gradual increase in the criterion as temperature decreases. At temperatures below 15 °C the criterion is more stringent, when early life stages of fish are expected to be present. EPA's recommendations in the 1999 criteria represent a change from both the 1984 chronic ammonia criterion, which was dependent mainly on pH, and from the 1998 ammonia criteria, in which the chronic criterion was dependent on pH and the presence of early life stages of fish.

For additional information see: *1999 Update of Ambient Water Quality Criteria for Ammonia* (EPA-822-R-99-014).

Cadmium

EPA revised its aquatic life criteria for cadmium. A notice was published in the **Federal Register** (65 FR 50201, 8/17/2000) announcing the availability of the peer review draft and soliciting any significant scientific input from the public. EPA has addressed the peer review comments and significant issues raised by the public. A notice of availability for the completed document, entitled *2001 Update of Ambient Water Quality Criteria for Cadmium* (EPA-822-R-01-001) was published in the **Federal Register** on April 12, 2001 (66 FR18935).

Guidance on the Calculation of Hardness-Dependent Metals Criteria

Freshwater aquatic life criteria for certain metals are expressed as a function of hardness because hardness can affect the toxicities of these metals. Hardness is used as a surrogate for a number of water quality characteristics which affect the toxicity of metals. Increasing hardness has the effect of decreasing the toxicity of metals. Water quality criteria to protect aquatic life may be calculated at different concentrations of hardness measured in milligrams per liter (mg/L) as calcium carbonate (CaCO₃).

Appendix B of this document presents the hardness-dependent equations for freshwater metals criteria. The specific values in the table are calculated at a hardness of 100 mg/L (CaCO₃) for illustrative purposes only. The hardness equations included in this compilation were developed based on results from laboratory toxicity tests that were conducted in fresh waters encompassing a range of hardness values. Although the amount of data and the strength of the

relationship vary for different metals, almost all data for hardness and toxicity are in the 20 to 400 mg/L hardness range.

In the past, EPA recommended that when the hardness of fresh surface water is less than 25 mg/L, 304(a) criteria concentrations be calculated as if the hardness is 25 mg/L. Available toxicity data in this range for copper, zinc and cadmium (EPA 440/5-84-031, EPA 440/5-87-003, and EPA-822-R-01-001) are somewhat limited, and are quite limited for silver, lead, chromium III and nickel (EPA 440/5-80-071, EPA 440/5-84-027, EPA 440/5-84-029 and EPA 440/5-86-004). Even fewer data are available below 20 mg/L hardness for copper, zinc and cadmium and none are available for silver, lead, chromium III and nickel. EPA evaluated these limited data, available in the current metals' criteria documents, and determined that they are inconclusive. Capping hardness at 25 mg/L without additional data or justification may result in criteria that provide less protection than that intended by EPA's *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (EPA 822/R-85-100) or "the Guidelines." Therefore, EPA now recommends that hardness not be capped at 25 mg/L, or any other hardness on the low end. If there is a state or tribal regulatory requirement that hardness be capped at 25 mg/L, or if there are any situation-specific questions about the applicability of the hardness-toxicity relationship, a Water Effect Ratio (WER) procedure should be used to provide the level of protection intended by the Guidelines. When an ambient hardness of less than 25 mg/L is used to establish criteria for lead or cadmium, the hardness dependent Conversion Factor (CF) should not exceed one.

For hardness over 400 mg/L, EPA recommends two options: (1) calculate the criterion using a default WER of 1.0 and using a hardness of 400 mg/L in the hardness equation; or (2) calculate the criterion using a WER and the actual ambient hardness of the surface water in the equation. The second option is expected to result in the level of protection intended in the Guidelines whereas the first option is thought to result in an even more protective aquatic life criterion. At high hardness there is an indication that hardness and related inorganic water quality characteristics do not have as much of an effect on toxicity of metals as they do at lower hardnesses. Related water quality characteristics do not correlate as well at higher hardnesses as they do at lower hardnesses. There is also increased uncertainty in this range because very limited data are available to clearly quantify the relationship between hardness and toxicity. Therefore, if hardness is over 400 mg/L as CaCO₃, EPA continues to recommend that a hardness of 400 mg/L be used with a default WER of 1.0; alternatively, the WER and actual hardness of the surface water may be used.

Where applicable water quality standards require the use of a default hardness (e.g., 25 mg/L) to calculate a criterion, states and authorized tribes should use the WER procedure to adjust that criterion so that it provides the level of protection intended by the Guidelines. As the WER is inherently a site-specific procedure, any WER developed for a given site would be applicable only for that site unless its applicability at other sites is demonstrated. In any case, states and authorized tribes electing to use the WER Guidance should ensure that their water quality standards provide for them. Consistent with the "Performance-Based Approach" discussed in detail in EPA's recent modification of its implementing regulations at 40 CFR

131.21 (See 65 FR 24641, April 27, 2000), EPA encourages states and authorized tribes to identify all opportunities for adoption, and EPA approval of, such site-specific criteria. A performance-based approach relies on the adoption of a standard method or process (e.g., WER procedures) into state or tribal water quality standards, rather than adoption of a specific outcome (e.g., a site-specific criterion). When such an approach is sufficiently detailed and has suitable safeguards to ensure predictable, repeatable outcomes, EPA approval of the approach can serve as approval of the outcomes as well.

National Guidance on the Applicability of Freshwater and Saltwater Criteria

EPA recommends that the aquatic life criteria in this compilation apply as follows:

- (1) For water in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the applicable criteria are the freshwater criteria.
- (2) For water in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, the applicable criteria are the saltwater criteria in Column C; and
- (3) For water in which the salinity is between 1 and 10 parts per thousand the applicable criteria are the more stringent of the freshwater or saltwater criteria, as described in items (1) and (2) of this section. However, an alternative freshwater or saltwater criteria may be used if scientifically defensible information and data demonstrate that on a site-specific basis the biology of the water body is dominated by freshwater aquatic life and that freshwater criteria are more appropriate; or conversely, the biology of the water body is dominated by saltwater aquatic life and that saltwater criteria are more appropriate.

Nutrient Criteria

EPA recently developed section 304(a) water quality criteria for nutrients because excessive levels of nutrients are a major cause of the nonattainment of designated uses and more scientific information is needed to evaluate and address these conditions. Availability of these nutrient criteria recommendations was announced in the **Federal Register** on January 9, 2001 (66 FR1671). EPA's nutrient criteria will cover four major types of waterbodies: lakes and reservoirs, rivers and streams, estuarine and coastal areas, and wetlands across 14 major ecoregions of the United States. EPA's section 304(a) criteria are intended to provide for the protection and propagation of aquatic life and recreation. To support the development of the nutrient criteria, EPA published Technical Guidance Manuals that describe a process for assessing nutrient conditions in the four waterbody types. (For example See: *Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs*, April 2000; *Nutrient Criteria Technical Guidance Manual: Rivers and Streams*, July 2000; *Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters*, October 2001). This information is intended to serve as a starting point for the states, authorized tribes and others to develop more refined

nutrient criteria, as appropriate, using EPA waterbody-specific technical guidance manuals and other scientifically defensible approaches.

In cases where no new ecoregional nutrient criteria are available, the phosphate phosphorus information presented in the Gold Book (*Quality Criteria for Water: 1986*, EPA 440/5-86-001) may still be applicable. The phosphate phosphorus information in the Gold Book address eutrophication in freshwater systems on a national basis without any consideration of regional differences that may occur. The new ecoregional nutrient criteria recommendations reflect regional differences in eutrophication for different water body types and ecological conditions. The criteria in the compilation for elemental phosphorus is based on the toxic effects of phosphorus to aquatic organisms and is not intended to prevent eutrophication.

VI Comments on the December 10, 1998 National Recommended Water Quality Criteria Compilation

When the national recommended water quality criteria compilation was published in 1998, the Agency requested comment and observations on the compilation format and on the revised criteria development process. No comments were received on the format or process. Comments were, however, received on specific criteria and errors in formulas. The comments stated that certain criteria did not reflect the latest scientific knowledge and also that some criteria were derived based on data where an improper form of chemical was tested because of bioavailability issues. The errors in the formulas have been corrected. EPA does not agree that an improper form of the specified chemicals was tested.

VII Where Can I Find More Information About Water Quality Criteria and Water Quality Standards?

For more information about water quality criteria and Water Quality Standards refer to the following: *Water Quality Standards Handbook* (EPA 823-B94-005a); *Advanced Notice of Proposed Rule Making (ANPRM)*, (63FR36742); *Draft Strategy for Water Quality Standards and Criteria: Strengthening the Foundation of Programs to Protect and Restore the Nation's Water* (EPA-823-R-02-001, May 2002); *Water Quality Criteria and Standards Plan -- Priorities for the Future* (EPA 822-R-98-003); *Guidelines and Methodologies Used in the Preparation of Health Effects Assessment Chapters of the Consent Decree Water Criteria Documents* (45FR79347); *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (2000), EPA-822-B-00-004, October 2000); *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (EPA 822/R-85-100); *National Strategy for the Development of Regional Nutrient Criteria* (EPA 822-R-98-002); and *EPA Review and Approval of State and Tribal Water Quality Standards* (65FR24641).

These publications may also be accessed through EPA's National Service Center for Environmental Publications (NSCEP, previously NCEPI) or on the Office of Science and Technology's Homepage (www.epa.gov/OST).

VIII What Are the National Recommended Water Quality Criteria?

The following compilation and its associated footnotes and notes presents the EPA's latest national recommended water quality criteria.

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of: Water + Organism		FR Cite/ Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)		
1	Antimony	7440360					5.6 B	640 B	65FR66443
2	Arsenic	7440382	340 A,D,K	150 A,D,K	69 A,D,bb	36 A,D,bb	0.018 C,M,S	0.14 C,M,S	65FR31682 57FR60848
3	Beryllium	7440417					Z		65FR31682
4	Cadmium	7440439	2.0 D,E,K,bb	0.25 D,E,K,bb	40 D,bb	8.8 D,bb	Z		EPA-822-R-01-001 65FR31682
5a	Chromium (III)	16065831	570 D,E,K	74 D,E,K			Z Total		EPA820/B-96-001 65FR31682
5b	Chromium (VI)	18540299	16 D,K	11 D,K	1,100 D,bb	50 D,bb	Z Total		65FR31682
6	Copper	7440508	13 D,E,K,cc	9.0 D,E,K,cc	4.8 D,cc,ff	3.1 D,cc,ff	1,300 U		65FR31682
7	Lead	7439921	65 D,E,bb,gg	2.5 D,E,bb,gg	210 D,bb	8.1 D,bb			65FR31682
8a	Mercury	7439976	1.4 D,K,hh	0.77 D,K,hh	1.8 D,ee,hh	0.94 D,ee,hh		0.3 mg/kg J	62FR42160
8b	Methylmercury	22967926							EPA823-R-01-001
9	Nickel	7440020	470 D,E,K	52 D,E,K	74 D,bb	8.2 D,bb	610 B	4,600 B	65FR31682
10	Selenium	7782492	L,R,T	5.0 T	290 D,bb,dd	71 D,bb,dd	170 Z	4200	62FR42160 65FR31682 65FR66443
11	Silver	7440224	3.2 D,E,G		1.9 D,G				65FR31682
12	Thallium	7440280					1.7 B	6.3 B	65FR31682

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of: Water + Organism Only		FR Cite/Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Organism (µg/L)	Organism (µg/L)		
13	Zinc	7440666	120 D,E,K	120 D,E,K	90 D,bb	81 D,bb	7,400 U	26,000 U	65FR31682 65FR66443
14	Cyanide	57125	22 K,Q	5.2 K,Q	1 Q,bb	1 Q,bb	700 B	220,000 B,H	EPA820/B-96-001 57FR60848
15	Asbestos	1332214					7 million fibers/L I		57FR60848
16	2,3,7,8-TCDD (Dioxin)	1746016					5.0E-9 C	5.1E-9 C	65FR66443
17	Acrolein	107028					190	290	65FR66443
18	Acrylonitrile	107131					0.051 B,C	0.25 B,C	65FR66443
19	Benzene	71432					2.2 B,C	51 B,C	IRIS 01/19/00 &65FR66443
20	Bromoform	75252					4.3 B,C	140 B,C	65FR66443
21	Carbon Tetrachloride	56235					0.23 B,C	1.6 B,C	65FR66443
22	Chlorobenzene	108907					680 B,Z,U,	21,000 B,H,U	65FR31682
23	Chlorodibromomethane	124481					0.40 B,C	13 B,C	65FR66443
24	Chloroethane	75003							
25	2-Chloroethylvinyl Ether	110758							
26	Chloroform	67663					5.7 C,P	470 C,P	62FR42160
27	Dichlorobromomethane	75274					0.55 B,C	17 B,C	65FR66443

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/Source
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
28	1,1-Dichloroethane	75343						
29	1,2-Dichloroethane	107062				0.38 B,C	37 B,C	65FR66443
30	1,1-Dichloroethylene	75354				0.057 C	3.2 C	65FR66443
31	1,2-Dichloropropane	78875				0.50 B,C	15 B,C	65FR66443
32	1,3-Dichloropropene	542756				10	1,700	57FR60848
33	Ethylbenzene	100414				3,100 B	29,000 B	65FR31682
34	Methyl Bromide	74839				47 B	1,500 B	65FR66443
35	Methyl Chloride	74873						65FR31682
36	Methylene Chloride	75092				4.6 B,C	590 B,C	65FR66443
37	1,1,2,2-Tetrachloroethane	79345				0.17 B,C	4.0 B,C	65FR66443
38	Tetrachloroethylene	127184				0.69 C	3.3 C	65FR66443
39	Toluene	108883				6,800 B,Z	200,000 B	65FR31682
40	1,2-Trans-Dichloroethylene	156605				700 B,Z	140,000 B	65FR31682
41	1,1,1-Trichloroethane	71556				Z		65FR31682
42	1,1,2-Trichloroethane	79005				0.59 B,C	16 B,C	65FR66443
43	Trichloroethylene	79016				2.5 C	30 C	65FR66443
44	Vinyl Chloride	75014				2.0 C	530 C	57FR60848

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of: Water + Organism		FR Cite/ Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Organism (µg/L)	Organism (µg/L)		
45	2-Chlorophenol	95578					81 B,U	150 B,U	65FR66443
46	2,4-Dichlorophenol	120832					77 B,U	290 B,U	65FR66443
47	2,4-Dimethylphenol	105679					380 B	850 B,U	65FR66443
48	2-Methyl-4,6-Dinitrophenol	534521					13	280	65FR66443
49	2,4-Dinitrophenol	51285					69 B	5,300 B	65FR66443
50	2-Nitrophenol	88755							
51	4-Nitrophenol	100027							
52	3-Methyl-4-Chlorophenol	59507					U	U	
53	Pentachlorophenol	87865	19 F,K	15 F,K	13 bb	7.9 bb	0.27 B,C	3.0 B,C,H	65FR31682 65FR66443
54	Phenol	108952					21,000 B,U	1,700,000 B,U	65FR66443
55	2,4,6-Trichlorophenol	88062					1.4 B,C	2.4 B,C,U	65FR66443
56	Acenaphthene	83329					670 B,U	990 B,U	65FR66443
57	Acenaphthylene	208968							
58	Anthracene	120127					8,300 B	40,000 B	65FR66443
59	Benzidine	92875					0.000086 B,C	0.00020 B,C	65FR66443
60	Benzo(a)Anthracene	56553					0.0038 B,C	0.018 B,C	65FR66443
61	Benzo(a)Pyrene	50328					0.0038 B,C	0.018 B,C	65FR66443

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/ Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)		
62	Benzo(b)Fluoranthene	205992					0.0038 B,C	0.018 B,C	65FR66443
63	Benzo(ghi)Perylene	191242							
64	Benzo(k)Fluoranthene	207089					0.0038 B,C	0.018 B,C	65FR66443
65	Bis(2-Chloroethoxy)Methane	111911							
66	Bis(2-Chloroethyl)Ether	111444					0.030 B,C	0.53 B,C	65FR66443
67	Bis(2-Chloroisopropyl)Ether	108601					1,400 B	65,000 B	65FR66443
68	Bis(2-Ethylhexyl)Phthalate ^x	117817					1.2 B,C	2.2 B,C	65FR66443
69	4-Bromophenyl Phenyl Ether	101553							
70	Butylbenzyl Phthalate ^w	85687					1,500 B	1,900 B	65FR66443
71	2-Chloronaphthalene	91587					1,000 B	1,600 B	65FR66443
72	4-Chlorophenyl Phenyl Ether	7005723							
73	Chrysene	218019					0.0038 B,C	0.018 B,C	65FR66443
74	Dibenzo(a,h)Anthracene	53703					0.0038 B,C	0.018 B,C	65FR66443
75	1,2-Dichlorobenzene	95501					2,700 B	17,000 B	65FR31682
76	1,3-Dichlorobenzene	541731					320	960	65FR66443
77	1,4-Dichlorobenzene	106467					400 z	2,600	65FR31682
78	3,3'-Dichlorobenzidine	91941					0.021 B,C	0.028 B,C	65FR66443

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/Source
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
79	Diethyl Phthalate ^W	84662				17,000 _B	44,000 _B	65FR66443
80	Dimethyl Phthalate ^W	131113				270,000	1,100,000	65FR66443
81	Di-n-Butyl Phthalate ^W	84742				2,000 _B	4,500 _B	65FR66443
82	2,4-Dinitrotoluene	121142				0.11 _C	3.4 _C	65FR66443
83	2,6-Dinitrotoluene	606202						
84	Di-n-Octyl Phthalate	117840						
85	1,2-Diphenylhydrazine	122667				0.036 _{B,C}	0.20 _{B,C}	65FR66443
86	Fluoranthene	206440				130 _B	140 _B	65FR66443
87	Fluorene	86737				1,100 _B	5,300 _B	65FR66443
88	Hexachlorobenzene	118741				0.00028 _{B,C}	0.00029 _{B,C}	65FR66443
89	Hexachlorobutadiene	87683				0.44 _{B,C}	18 _{B,C}	65FR66443
90	Hexachlorocyclopentadiene	77474				240 _{U,Z}	17,000 _{H,U}	57FR60848
91	Hexachloroethane	67721				1.4 _{B,C}	3.3 _{B,C}	65FR66443
92	Ideno(1,2,3-cd)Pyrene	193395				0.0038 _{B,C}	0.018 _{B,C}	65FR66443
93	Isophorone	78591				35 _{B,C}	960 _{B,C}	65FR66443
94	Naphthalene	91203						
95	Nitrobenzene	98953				17 _B	690 _{B,H,U}	65FR66443

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)		
96	N-Nitrosodimethylamine	62759					0.00069 _{B,C}	3.0 _{B,C}	65FR66443
97	N-Nitrosodi-n-Propylamine	621647					0.0050 _{B,C}	0.51 _{B,C}	65FR66443
98	N-Nitrosodiphenylamine	86306					3.3 _{B,C}	6.0 _{B,C}	65FR66443
99	Phenanthrene	85018							
100	Pyrene	129000					830 _B	4,000 _B	65FR66443
101	1,2,4-Trichlorobenzene	120821					260	940	IRIS11/01/96
102	Aldrin	309002	3.0 _G		1.3 _G		0.000049 _{B,C}	0.000050 _{B,C}	65FR31682 65FR66443
103	alpha-BHC	319846					0.0026 _{B,C}	0.0049 _{B,C}	65FR66443
104	beta-BHC	319857					0.0091 _{B,C}	0.017 _{B,C}	65FR66443
105	gamma-BHC (Lindane)	58899	0.95 _K		0.16 _G		0.019 _C	0.063 _C	65FR31682 65FR66443
106	delta-BHC	319868							
107	Chlordane	57749	2.4 _G	0.0043 _{G,aa}	0.09 _G	0.004 _{G,aa}	0.00080 _{B,C}	0.00081 _{B,C}	65FR31682 65FR66443
108	4,4'-DDT	50293	1.1 _{G,ii}	0.001 _{G,aa,ii}	0.13 _{G,ii}	0.001 _{G,aa,ii}	0.00022 _{B,C}	0.00022 _{B,C}	65FR31682 65FR66443
109	4,4'-DDE	72559					0.00022 _{B,C}	0.00022 _{B,C}	65FR66443
110	4,4'-DDD	72548					0.00031 _{B,C}	0.00031 _{B,C}	65FR66443

Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of: Water + Organism		FR Cite/Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Organism (µg/L)	Only (µg/L)		
111	Dieldrin	60571	0.24 κ	0.056 κ,O	0.71 G	0.0019 G,aa	0.000052 B,C	0.000054 B,C	65FR31682 65FR66443
112	alpha-Endosulfan	959988	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	65FR31682 65FR66443
113	beta-Endosulfan	33213659	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	65FR31682 65FR66443
114	Endosulfan Sulfate	1031078					62 B	89 B	65FR66443
115	Endrin	72208	0.086 κ	0.036 κ,O	0.037 G	0.0023 G,aa	0.76 B	0.81 B,H	65FR31682
116	Endrin Aldehyde	7421934					0.29 B	0.30 B,H	65FR66443
117	Heptachlor	76448	0.52 G	0.0038 G,aa	0.053 G	0.0036 G,aa	0.000079 B,C	0.000079 B,C	65FR31682 65FR66443
118	Heptachlor Epoxide	1024573	0.52 G,V	0.0038 G,V,aa	0.053 G,V	0.0036 G,V,aa	0.000039 B,C	0.000039 B,C	65FR31682 65FR66443
119	Polychlorinated Biphenyls PCBs:			0.014 N,aa		0.03 N,aa	0.000064 B,C,N	0.000064 B,C,N	65FR31682 65FR66443
120	Toxaphene	8001352	0.73	0.0002 aa	0.21	0.0002 aa	0.00028 B,C	0.00028 B,C	65FR31682 65FR66443

Footnotes:

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440/5-84-033, January 1985), Species Mean Acute Values are given for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to 1.7.

- Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.
- B This criterion has been revised to reflect The Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.
- C This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5} , move the decimal point in the recommended criterion one place to the right).
- D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria," October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the Water Resource center, USEPA, 401 M St., SW, mail code RC4100, Washington, DC 20460; and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.
- E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = $\exp\{m_A [\ln(\text{hardness})] + b_A\}$ (CF), or CCC (dissolved) = $\exp\{m_C [\ln(\text{hardness})] + b_C\}$ (CF) and the parameters specified in Appendix B- Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent.
- F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows: CMC = $\exp(1.005(\text{pH}) - 4.869)$; CCC = $\exp(1.005(\text{pH}) - 5.134)$. Values displayed in table correspond to a pH of 7.8.
- G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.
- H No criterion for protection of human health from consumption of aquatic organisms excluding water was presented in the 1980 criteria document or in the *1986 Quality Criteria for Water*. Nevertheless, sufficient information was presented in the 1980 document to allow the calculation of a criterion, even though the results of such a calculation were not shown in the document.
- I This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).
- J This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.
- K This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water*, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

- L The CMC = $1/[(f1/CMC1) + (f2/CMC2)]$ where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/l and 12.82 µg/l, respectively.
- M EPA is currently reassessing the criteria for arsenic.
- N This criterion applies to total pcbs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)
- O The derivation of the CCC for this pollutant (Endrin) did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.
- P Although a new RfD is available in IRIS, the surface water criteria will not be revised until the National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) is completed, since public comment on the relative source contribution (RSC) for chloroform is anticipated.
- Q This recommended water quality criterion is expressed as µg free cyanide (as CN)/L.
- R This value for selenium was announced (61FR58444-58449, November 14, 1996) as a proposed GLI 303(c) aquatic life criterion. EPA is currently working on this criterion and so this value might change substantially in the near future.
- S This recommended water quality criterion for arsenic refers to the inorganic form only.
- T This recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996- CMC or 0.922- CCC) that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.
- U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.
- V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.
- W Although EPA has not published a completed criteria document for butylbenzyl phthalate it is EPA's understanding that sufficient data exist to allow calculation of aquatic criteria. It is anticipated that industry intends to publish in the peer reviewed literature draft aquatic life criteria generated in accordance with EPA Guidelines. EPA will review such criteria for possible issuance as national WQC.
- X There is a full set of aquatic life toxicity data that show that DEHP is not toxic to aquatic organisms at or below its solubility limit.
- Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.
- Z A more stringent MCL has been issued by EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.
- aa This criterion is based on a 304(a) aquatic life criterion issued in 1980 or 1986, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Polychlorinated biphenyls (EPA 440/5-80-068), Toxaphene (EPA 440/5-86-006). This CCC is currently based on the Final Residue Value (FRV) procedure. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria. Therefore, the Agency anticipates that future revisions of this CCC will not be based on the FRV procedure.
- bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA 882-R-01-001), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5-84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87-003).

- cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.
- dd The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 µg/L in salt water because the saltwater CCC does not take into account uptake via the food chain.
- ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.
- ff This recommended water quality criterion was derived in *Ambient Water Quality Criteria Saltwater Copper Addendum* (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60FR22228-22237, May 4, 1995).
- gg EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.
- hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.
- ii This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

Non Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/Source
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)	
1	Alkalinity	--	20000 F					Gold Book
2	Aluminum pH 6.5 - 9.0	7429905	750 G,I	87 G,I,L				53FR33178
3	Ammonia	7664417	FRESHWATER CRITERIA ARE pH, Temperature and Life-stage DEPENDENT -- SEE DOCUMENT D SALTWATER CRITERIA ARE pH AND TEMPERATURE DEPENDENT					EPA822-R-99-014 EPA440/5-88-004
4	Aesthetic Qualities	--	NARRATIVE STATEMENT-- SEE DOCUMENT					Gold Book
5	Bacteria	--	FOR PRIMARY RECREATION AND SHELLFISH USES -- SEE DOCUMENT					Gold Book
6	Barium	7440393				1,000 A		Gold Book
7	Boron	--	NARRATIVE STATEMENT-- SEE DOCUMENT					Gold Book
8	Chloride	16887006	860,000 G	230,000 G				53FR19028
9	Chlorine	7782505	19	11	13	7.5	C	Gold Book
10	Chlorophenoxy Herbicide (2,4,5,-TP)	93721				10 A		Gold Book
11	Chlorophenoxy Herbicide (2,4-D)	94757				100 A,C		Gold Book
12	Chloropyrifos	2921882	0.083 G	0.041 G	0.011 G	0.0056 G		Gold Book
13	Color	--	NARRATIVE STATEMENT-- SEE DOCUMENT F					Gold Book
14	Demeton	8065483		0.1 F		0.1 F		Gold Book
15	Ether, Bis(Chloromethyl)	542881				0.00010 E, H	0.00029 E,H	65FR66443

Non Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)		
16	Gases, Total Dissolved	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
17	Guthion	86500		0.01 F		0.01 F		Gold Book	
18	Hardness	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
19	Hexachlorocyclo-hexane-Technical	319868					0.0123	0.0414	Gold Book
20	Iron	7439896		1,000 F			300 A		Gold Book
21	Malathion	121755		0.1 F		0.1 F			Gold Book
22	Manganese	7439965					50 A,O	100 A	Gold Book
23	Methoxychlor	72435		0.03 F		0.03 F	100 A,C		Gold Book
24	Mirex	2385855		0.001 F		0.001 F			Gold Book
25	Nitrates	14797558					10,000 A		Gold Book
26	Nitrosamines	--					0.0008	1.24	Gold Book
27	Dinitrophenols	25550587					69	5300	65FR66443
28	Nitrosodibutylamine,N	924163					0.0063 A,H	0.22 A,H	65FR66443
29	Nitrosodiethylamine,N	55185					0.0008 A,H	1.24 A,H	Gold Book
30	Nitrosopyrrolidine,N	930552					0.016 H	34 H	65FR66443
31	Oil and Grease	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book

Non Priority Pollutant	CAS Number	Freshwater		Saltwater		Human Health For Consumption of:		FR Cite/Source	
		CMC (µg/L)	CCC (µg/L)	CMC (µg/L)	CCC (µg/L)	Water + Organism (µg/L)	Organism Only (µg/L)		
32	Oxygen, Dissolved Freshwater Oxygen, Dissolved Saltwater	7782447	WARMWATER AND COLDWATER MATRIX -- SEE DOCUMENT N						Gold Book
			SALTWATER -- SEE DOCUMENT						EPA-822R-00-012
33	Parathion	56382	0.065 J	0.013 J				Gold Book	
34	Pentachlorobenzene	608935				1.4 E	1.5 E	65FR66443	
35	pH	--		6.5 - 9 F		6.5 - 8.5 F,K	5 - 9	Gold Book	
36	Phosphorus Elemental	7723140				0.1 F,K		Gold Book	
37	Nutrients	--	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll <i>a</i> and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)						P
38	Solids Dissolved and Salinity	--				250,000 A		Gold Book	
39	Solids Suspended and Turbidity	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
40	Sulfide-Hydrogen Sulfide	7783064		2.0 F		2.0 F		Gold Book	
41	Tainting Substances	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
42	Temperature	--	SPECIES DEPENDENT CRITERIA -- SEE DOCUMENT M						Gold Book
43	Tetrachlorobenzene,1,2,4,5-	95943				0.97 E	1.1 E	65FR66443	
44	Tributyltin (TBT)	--	0.46 Q	0.063 Q	0.37 Q	0.010 Q		EPA 822-F-00-008	
45	Trichlorophenol,2,4,5-	95954				1,800 B,E	3,600 B,E	65FR66443	

Footnotes:

- A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.
- B The organoleptic effect criterion is more stringent than the value presented in the non priority pollutants table.
- C A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.
- D According to the procedures described in the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, except possibly where a very sensitive species is important at a site, freshwater aquatic life should be protected if both conditions specified in Appendix C to the Preamble- Calculation of Freshwater Ammonia Criterion are satisfied.
- E This criterion has been revised to reflect EPA's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) used to derive the original criterion was retained in each case.
- F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).
- G This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Aluminum (EPA 440/5-86-008); Chloride (EPA 440/5-88-001); Chloropyrifos (EPA 440/5-86-005).
- H This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5} , move the decimal point in the recommended criterion one place to the right).
- I This value for aluminum is expressed in terms of total recoverable metal in the water column.
- J This value is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-B-96-001). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the differences between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. No decision concerning this criterion was affected by any considerations that are specific to the Great Lakes.
- K According to page 181 of the Red Book:
For open ocean waters where the depth is substantially greater than the euphotic zone, the pH should not be changed more than 0.2 units from the naturally occurring variation or any case outside the range of 6.5 to 8.5. For shallow, highly productive coastal and estuarine areas where naturally occurring pH variations approach the lethal limits of some species, changes in pH should be avoided but in any case should not exceed the limits established for fresh water, i.e., 6.5-9.0.
- L There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 µg/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 µg aluminum/L, when either total recoverable or dissolved is measured.
- M U.S. EPA. 1973. *Water Quality Criteria 1972*. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. *Temperature Criteria for Freshwater Fish: Protocol and Procedures*. EPA-600/3-77-061. National Technical Information Service, Springfield, VA.

- N U.S. EPA. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003. National Technical Information Service, Springfield, VA.
- O This criterion for manganese is not based on toxic effects, but rather is intended to minimize objectionable qualities such as laundry stains and objectionable tastes in beverages.
- P Lakes and Reservoirs in Nutrient Ecoregion: II EPA 822-B-00-007, III EPA 822-B-01-008, IV EPA 822-B-01-009, V EPA 822-B-01-010, VI EPA 822-B-00-008 , VII EPA 822-B-00-009, VIII EPA 822-B-01-015, IX EPA 822-B-00-011, XI EPA 822-B-00-012, XII EPA 822-B-00-013, XIII EPA 822-B-00-014, XIV EPA 822-B-01-011; Rivers and Streams in Nutrient Ecoregion: I EPA 822-B-01-012, II EPA 822-B-00-015, III EPA 822-B-00-016, IV EPA 822-B-01-013, V EPA 822-B-01-014, VI EPA 822-B-00-017, VII EPA 822-B-00-018, VIII EPA 822-B-01-015, IX EPA 822-B-00-019, X EPA 822-B-01-016, XI EPA 822-B-00-020, XII EPA 822-B-00-021, XIV EPA 822-B-00-022; and Wetlands in Nutrient Ecoregion XIII EPA 822-B-00-023.
- Q EPA announced the availability of a draft updated tributyltin (TBT) document on August 7, 1997 (62FR42554). The Agency has reevaluated this document and anticipates releasing an updated document for public comment in the near future.

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR ORGANOLEPTIC EFFECTS

	Pollutant	CAS Number	Organoleptic Effect Criteria (µg/L)	FR Cite/Source
1	Acenaphthene	83329	20	Gold Book
2	Monochlorobenzene	108907	20	Gold Book
3	3-Chlorophenol	--	0.1	Gold Book
4	4-Chlorophenol	106489	0.1	Gold Book
5	2,3-Dichlorophenol	--	0.04	Gold Book
6	2,5-Dichlorophenol	--	0.5	Gold Book
7	2,6-Dichlorophenol	--	0.2	Gold Book
8	3,4-Dichlorophenol	--	0.3	Gold Book
9	2,4,5-Trichlorophenol	95954	1	Gold Book
10	2,4,6-Trichlorophenol	88062	2	Gold Book
11	2,3,4,6-Tetrachlorophenol	--	1	Gold Book
12	2-Methyl-4-Chlorophenol	--	1,800	Gold Book
13	3-Methyl-4-Chlorophenol	59507	3,000	Gold Book
14	3-Methyl-6-Chlorophenol	--	20	Gold Book
15	2-Chlorophenol	95578	0.1	Gold Book
16	Copper	7440508	1,000	Gold Book
17	2,4-Dichlorophenol	120832	0.3	Gold Book
18	2,4-Dimethylphenol	105679	400	Gold Book
19	Hexachlorocyclopentadiene	77474	1	Gold Book
20	Nitrobenzene	98953	30	Gold Book

	Pollutant	CAS Number	Organoleptic Effect Criteria (µg/L)	FR Cite/Source
21	Pentachlorophenol	87865	30	Gold Book
22	Phenol	108952	300	Gold Book
23	Zinc	7440666	5,000	45 FR79341

General Notes:

1. These criteria are based on organoleptic (taste and odor) effects. Because of variations in chemical nomenclature systems, this listing of pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service (CAS) registry numbers, which provide a unique identification for each chemical.

NATIONAL RECOMMENDED WATER QUALITY CRITERIA

Additional Notes:

1. Criteria Maximum Concentration and Criterion Continuous Concentration

The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two of the six parts of an aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States.

2. Criteria Recommendations for Priority Pollutants, Non Priority Pollutants and Organoleptic Effects

This compilation lists all priority toxic pollutants and some non priority toxic pollutants, and both human health effect and organoleptic effect criteria issued pursuant to CWA §304(a). Blank spaces indicate that EPA has no CWA §304(a) criteria recommendations. For a number of non-priority toxic pollutants not listed, CWA §304(a) “water + organism” human health criteria are not available, but EPA has published MCLs under the SDWA that may be used in establishing water quality standards to protect water supply designated uses. Because of variations in chemical nomenclature systems, this listing of toxic pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service CAS registry numbers, which provide a unique identification for each chemical.

3. Human Health Risk

The human health criteria for the priority and non priority pollutants are based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5} , move the decimal point in the recommended criterion one place to the right).

4. Water Quality Criteria published pursuant to Section 304(a) or Section 303(c) of the CWA

Many of the values in the compilation were published in the California Toxics Rule. Although such values were published pursuant to Section 303(c) of the CWA, they represent the Agency’s most recent calculation of water quality criteria and are thus the Agency’s 304(a) criteria.

5. Calculation of Dissolved Metals Criteria

The 304(a) criteria for metals, shown as dissolved metals, are calculated in one of two ways. For freshwater metals criteria that are hardness-dependent, the dissolved metal criteria were calculated using a hardness of 100 mg/l as CaCO₃ for illustrative purposes only. Saltwater and freshwater metals' criteria that are not hardness-dependent are calculated by multiplying the total recoverable criteria before rounding by the appropriate conversion factors. The final dissolved metals' criteria in the table are rounded to two significant figures. Information regarding the calculation of hardness dependent conversion factors are included in the footnotes.

6. Maximum Contaminant Levels

The compilation includes footnotes for pollutants with Maximum Contaminant Levels (MCLs) more stringent than the recommended water quality criteria in the compilation. MCLs for these pollutants are not included in the compilation, but can be found in the appropriate drinking water regulations (40 CFR 141.11-16 and 141.60-63), or can be accessed through the Safe Drinking Water Hotline (800-426-4791) or the Internet (<http://www.epa.gov/waterscience/drinking/standards/dwstandards.pdf>).

7. Organoleptic Effects

The compilation contains 304(a) criteria for pollutants with toxicity-based criteria as well as non-toxicity based criteria. The basis for the non-toxicity based criteria are organoleptic effects (e.g., taste and odor) which would make water and edible aquatic life unpalatable but not toxic to humans. The table includes criteria for organoleptic effects for 23 pollutants. Pollutants with organoleptic effect criteria more stringent than the criteria based on toxicity (e.g., included in both the priority and non-priority pollutant tables) are footnoted as such.

8. Gold Book

The "Gold Book" is Quality Criteria for Water: 1986. EPA 440/5-86-001.

9. Correction of Chemical Abstract Services Number

The Chemical Abstract Services number (CAS) for Bis(2-Chlorisopropyl) Ether, has been revised in IRIS and in the table. The correct CAS number for this chemical is 108-60-1. The previous CAS number for this pollutant was 39638-32-9.

10. Contaminants with Blanks

EPA has not calculated criteria for contaminants with blanks. However, permit authorities should address these contaminants in NPDES permit actions using the States' existing narrative criteria for toxics.

11. Specific Chemical Calculations

A. Selenium

Aquatic Life

This compilation contains aquatic life criteria for selenium that are the same as those published in the proposed CTR. In the CTR, EPA proposed an acute criterion for selenium based on the criterion proposed for selenium in the Water Quality Guidance for the Great Lakes System (61 FR 58444). The GLI and CTR proposals take into account data showing that selenium's two prevalent oxidation states in water, selenite and selenate, present differing potentials for aquatic toxicity, as well as new data indicating that various forms of selenium are additive. The new approach produces a different selenium acute criterion concentration, or CMC, depending upon the relative proportions of selenite, selenate, and other forms of selenium that are present.

EPA is currently undertaking a reassessment of selenium, and expects the 304(a) criteria for selenium will be revised based on the final reassessment (63FR26186). However, until such time as revised water quality criteria for selenium are published by the Agency, the recommended water quality criteria in this compilation are EPA's current 304(a) criteria.

Appendices:

Appendix A - Conversion Factors for Dissolved Metals

Metal	Conversion Factor freshwater CMC	Conversion Factor freshwater CCC	Conversion Factor saltwater CMC	Conversion Factor saltwater CCC ¹
Arsenic	1.000	1.000	1.000	1.000
Cadmium	$1.136672 - [(\ln \text{hardness})(0.041838)]$	$1.101672 - [(\ln \text{hardness})(0.041838)]$	0.994	0.994
Chromium III	0.316	0.860	--	--
Chromium VI	0.982	0.962	0.993	0.993
Copper	0.960	0.960	0.83	0.83
Lead	$1.46203 - [(\ln \text{hardness})(0.145712)]$	$1.46203 - [(\ln \text{hardness})(0.145712)]$	0.951	0.951
Mercury	0.85	0.85	0.85	0.85
Nickel	0.998	0.997	0.990	0.990
Selenium	--	--	0.998	0.998
Silver	0.85	--	0.85	--
Zinc	0.978	0.986	0.946	0.946

Appendix B - Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent

Chemical	m_A	b_A	m_C	b_C	Freshwater Conversion Factors (CF)	
					CMC	CCC
Cadmium	1.0166	-3.924	0.7409	-4.719	$1.136672 - [(\ln \text{hardness})(0.041838)]$	$1.101672 - [(\ln \text{hardness})(0.041838)]$
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	$1.46203 - [(\ln \text{hardness})(0.145712)]$	$1.46203 - [(\ln \text{hardness})(0.145712)]$
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.59	--	--	0.85	--
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependant metals' criteria may be calculated from the following:

$$\text{CMC (dissolved)} = \exp \{m_A [\ln(\text{hardness})] + b_A\} \text{ (CF)}$$

$$\text{CCC (dissolved)} = \exp \{m_C [\ln(\text{hardness})] + b_C\} \text{ (CF)}$$

Appendix C - Calculation of Freshwater Ammonia Criterion

1. The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equations.

Where salmonid fish are present:

$$\text{CMC} = \frac{0.275}{1 + 10^{7.204-\text{pH}}} + \frac{39.0}{1 + 10^{\text{pH}-7.204}}$$

Or where salmonid fish are not present:

$$\text{CMC} = \frac{0.411}{1 + 10^{7.204-\text{pH}}} + \frac{58.4}{1 + 10^{\text{pH}-7.204}}$$

2A The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CCC (chronic criterion) calculated using the following equations.

When fish early life stages are present:

$$\text{CCC} = \left(\frac{0.0577}{1 + 10^{7.688-\text{pH}}} + \frac{2.487}{1 + 10^{\text{pH}-7.688}} \right) \cdot \text{MIN} (2.85, 1.45 \cdot 10^{0.028 \cdot (25-T)})$$

When fish early life stages are absent:

$$\text{CCC} = \left(\frac{0.0577}{1 + 10^{7.688-\text{pH}}} + \frac{2.487}{1 + 10^{\text{pH}-7.688}} \right) \cdot 1.45 \cdot 10^{0.028 \cdot (25-\text{MAX}(T,7))}$$

2B. In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the CCC.