The Impact of Clean Water Act Regulations on Small and Rural Wastewater Systems

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

BLM	Biotic Ligand Model
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
$CaCO_3$	Calcium Carbonate
CBOD	Carbonaceous Biochemical Oxygen Demand
CCC	Criterion Continuous Concentration
CFR	Code of Federal Regulations
CMC	Criterion Maximum Concentration
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DO	Dissolved Oxygen
ENR	Enhanced Nutrient Removal
EPA	Environmental Protection Agency
FR	Federal Register
FWPCA	Federal Water Pollution Control Act
FY	Fiscal Year
LA	Load Allocation
lb	Pound(s)
LC	Loading Capacity
MDE	Maryland Department of the Environment
MGD	Million Gallon(s) Per Day
mg/L	Milligram(s) Per Liter (parts per million)
MOS	Margin of Safety
NH_3-N	Ammonia-Nitrogen
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRWA	National Rural Water Association
PCBs	Polychlorinated Biphenyls
PEQ	Projected Effluent Quality
POTW	Publicly Owned Treatment Works
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RF	Reserve Factor

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

s.u.	Standard Unit(s)
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
µg/L	Microgram(s) Per Liter (parts per billion)
U.S.	United States
USGS	U.S. Geological Survey
WAU	Watershed Assessment Unit
WER	Water-Effect Ratio
WET	Whole Effluent Toxicity
WLA	Wasteload Allocation
WQBEL	Water Quality-Based Effluent Limit
WQC	Water quality Criteria
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

GLOSSARY

Antidegradation Policy. Part of a State's water quality standards that is designed to protect water quality that is better than that which is necessary to attain the designated use(s).

Designated Use. A use specified in water quality standards for each waterbody or segment whether are not it is being attained. (40 CFR 131.3)

Integrated Report. Report submitted by a State to EPA on a biennial basis that meets the reporting requirements of §305(b) (description of the water quality of all waters in the State) and §303(d) (list of impaired waters).

Load Allocation (LA). Portion of a receiving water's TMDL that is allocated to either to one of its existing or future non-point point sources of pollution or to natural background sources.

National Pollutant Discharge Elimination System (NPDES). A provision of the Clean Water Act which prohibits discharge of pollutants into waters of the U.S. unless a special permit is issued by EPA, a State, or, where delegated, a tribal government on an Indian reservation.

§**303(d) List. Clean Water Act required** list of water quality-limited (impaired and threatened) waters requiring a TMDL.

Technology-Based Limit. NPDES permit limit that represents a minimum level of treatment based on available treatment technologies for a particular category of dischargers.

Total Maximum Daily Load (TMDL). The highest pollutant load that will permit attainment of the designated use(s); the sum of the individual wasteload allocations and load allocations, plus a margin of safety.

Use Attainability Analysis. A structured scientific assessment of the factors affecting the attainment of the use which may include physical, chemical, biological, and economic factors as described in 40 CFR 131.10(g). (40 CFR 131.3)

Variance. Provision in a State's water quality standards that provides short-term relief from a water quality standard that is determined to be unattainable due to one or more of the factors outlined in 40 CFR 131.10(g).

Wasteload Allocation (WLA). Portion of a receiving water's TMDL that is allocated to one of its existing or future point sources of pollution.

Water Quality-Based Effluent Limit (WQBEL). NPDES permit limit based on a TMDL or otherwise derived with an intent to protect water quality standards.

Water Quality Criteria (WQC). Elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that

GLOSSARY (continued)

supports a particular use. When criteria are met, water quality will generally protect the designated use. (40 CFR 131.3)

Water Quality Standard (WQS). Provisions of State or Federal law which consist of a designated use or uses for waters of the U.S. and water quality criteria for such waters based upon such uses. (40 CFR 131.3)

EXECUTIVE SUMMARY

The regulation of wastewaters discharged to surface waters of the United States is a complex fusion of science and public policy. It has become increasingly difficult for an individual discharger to keep abreast of developments that may ultimately have profound impacts on its operations. The purpose of this document is to provide the National Rural Water Association (NRWA) and its members with an introduction to the important technical and policy issues that arise from the Clean Water Act and its implementing regulations. It demonstrates the significant impact that these regulations can have on small, rural wastewater dischargers, and the importance of being active participants in the process.

The scope of this document is summarized in Figure ES-1. The development of water quality control requirements (i.e., National Pollutant Discharge Elimination System [NPDES] permits) is traced from its basis in water quality standards (including use designations and water quality criteria), through the NPDES permitting process. The current programs for the assessment of water quality and development of §305(b) and §303(d) lists are addressed. Finally, the technical issues of Total Maximum Daily Load (TMDL) development and implementation are discussed.

The U.S. Environmental Protection Agency's (EPA's) current emphasis in its water program is on the listing of "impaired waters" and the development and implementation of TMDLs to bring those waterbodies into compliance with water quality standards. According to the §303(d) lists submitted by the states to EPA in 2004, nearly 39,000 waters in the U.S. are categorized as impaired. TMDLs must be developed and implemented for all of these waters. EPA has set ambitious goals for completing these TMDLs and attaining water quality standards in these waters.

The implications of these water quality-based compliance programs for NRWA members are enormous. It is expected that small, rural publicly owned treatment works (POTWs) will be included in many more TMDLs nationwide since many of the most significant remaining water quality issues in the U.S. are related to agricultural runoff and other rural non-point sources. As a result, thousands of TMDLs will be developed over the next few years to address waters impacted by these sources. Many of these TMDLs will address nutrients (nitrogen and phosphorus), sediments, and solids, and small, rural POTWs are known sources of these pollutants to these same waters. Because of the increasing emphasis on watershed-based TMDLs, even more facilities will be captured under the umbrella of large TMDLs. In some cases a small POTW may be the only point source discharger in a rural watershed. In addition, regional TMDLs, such as those for the entire Chesapeake Bay, will capture many small, rural POTWs and will set enforceable goals for reductions in discharge loadings of nutrients and other pollutants.

The attainment of EPA's program goals will not come cheaply. EPA estimated that more than 3,000 POTWs will be included in future TMDLs, at a cost of up to $697 million/year (EPA 2001b). The overall cost to point- and non-point sources of pollutants was estimated at up to $4.3 billion/year. Further, because these estimates are expressed in 2000 dollars and were based on 1998 information, when only 22,000 waters were listed as impaired, the actual costs are likely to be much higher. In addition, recent information from the State of Maryland shows that the estimated costs for necessary plant upgrades at small, rural POTWs range from $5.03 million to $14.2 million for nutrient treatment alone (Maryland Bay Restoration Fund Advisory Committee 2007).

It is critically important that the NRWA and its members remain informed of legislative and regulatory developments at all levels of government. Because EPA's greatest current water program emphasis is on listing of impaired waters and the development and implementation of TMDLs, activities related to these issues should receive significant attention. This document concludes with a list of suggested priorities for NRWA and its members at the national, state, and local levels. Through dedicated attention to regulatory developments, and involvement in water policy at the grass roots level, NRWA members can help to minimize the potential impact of Clean Water Act regulations on their operations, while still protecting the Nation's surface waters.

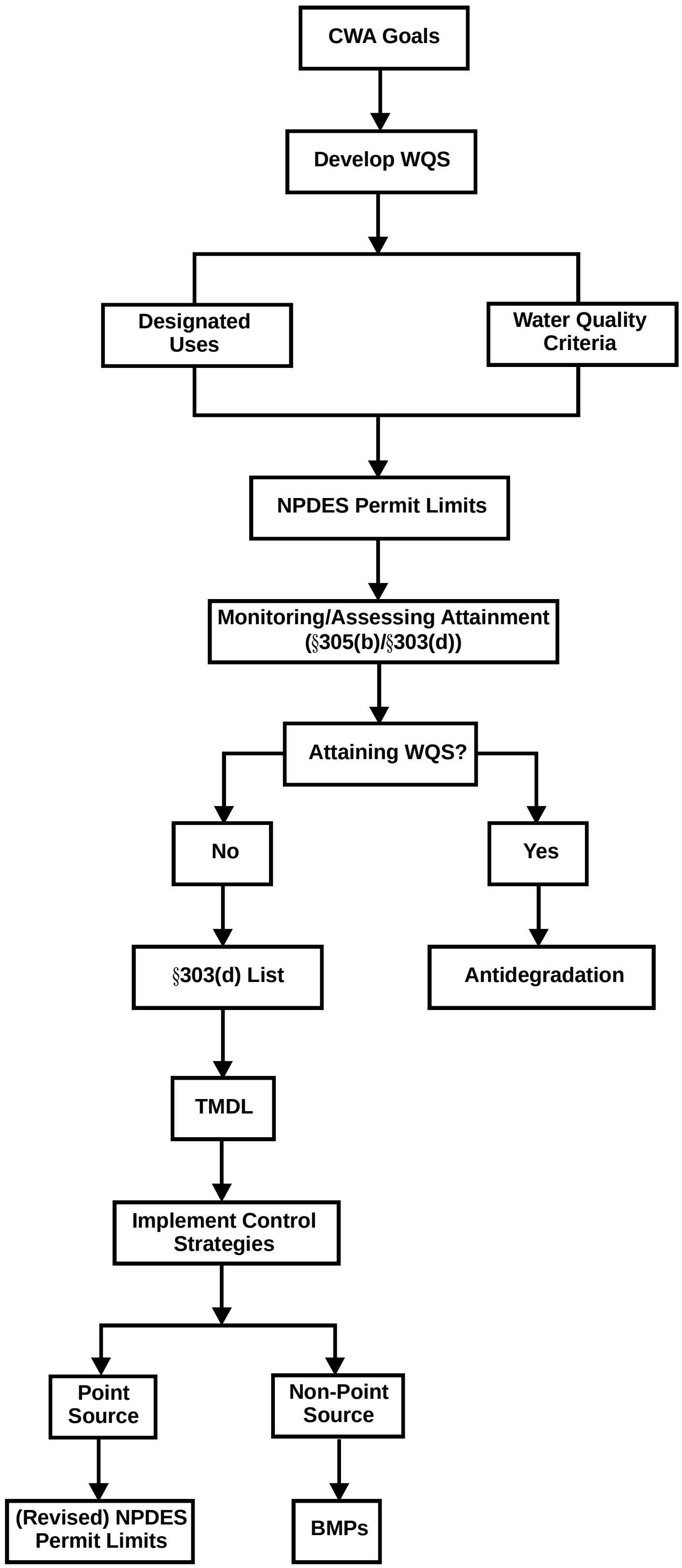

Figure ES-1. Overview of Clean Water Act Regulatory Process.

1. INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

The regulation of wastewater dischargers is a complex fusion of science and public policy. It has become increasingly difficult for an individual discharger to keep abreast of developments that may ultimately have profound impacts on its operations. The purpose of this document is to provide the National Rural Water Association (NRWA) and its members with an introduction to the important technical and policy issues that arise from the Clean Water Act and its implementing regulations. It demonstrates the significant impact that these regulations can have on wastewater dischargers. In addition, this document stresses the opportunities for the NRWA and its members to be active participants in the process, rather than passive observers.

1.2 HISTORY OF THE CLEAN WATER ACT

The first comprehensive legislation for water pollution control was the Water Pollution Control Act of 1948. This law established the roles of the Federal and State governments in resolving water pollution problems. The Federal Water Pollution Control Act (FWPCA) of 1956 and the Water Quality Act of 1965 made few changes to the original approach and had no discernible effect on the quality of the nation's waters.

In the FWPCA Amendments of 1972, known as the Clean Water Act (CWA) (Public Law 92-500), Congress established the framework of the current regulatory program for water pollution control. The foundation of that approach, described in Section 303(c) of the CWA, was the water quality standards program (Section 2 of this document). Designated uses (Section 3 of this document) and water quality criteria (Section 4 of this document) were also defined. The 1972 Amendments also established the National Pollutant Discharge Elimination System (NPDES) whereby each point source discharger to waters of the United States (U.S.) is required to obtain a discharge permit (Section 5 of this document). The 1972 Amendments also required the U.S. Environmental Protection Agency (EPA) to establish "technology-based" effluent limitations that were to be incorporated into NPDES permits. In addition, the amendments required NPDES permits to be consistent with applicable State water quality standards. Thus, the CWA established complementary technology-based and water quality-based approaches to water pollution control.

By the mid-1980s, it became clear that the approach established by the CWA was not sufficient to meet the national goals of water quality. The Water Quality Act of 1987 made substantial revisions to the CWA, particularly in addressing the impacts and control of toxic pollutants. As Senator Mitchell stated, Section 303(c)(2)(B) requires "States to identify waters that do not meet water quality standards due to the discharge of toxic substances, to adopt numerical criteria for the pollutants in such waters, and to establish effluent limitations for individual discharges to such water bodies." (From Senator Mitchell, 133 Cong. Rec. S733).

Since 1987, only minor amendments have been made to the CWA. Thus, today's CWA is the FWPCA and all its subsequent amendments, most notably those made in 1972 and 1987. Importantly, the objective and goals of the Act remain the same as declared in 1972:

> Sec. 101. (a) The objective of this Act is to **restore and maintain the chemical, physical, and biological integrity of the Nation's waters**. In order to achieve this objective it is hereby declared that, consistent with the provisions of this Act –
>
> > (1) it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985;
> > (2) it is the national goal that wherever attainable, an interim goal of **water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water** be achieved by July 1, 1983;
> > (3) it is the national policy that the **discharge of toxic pollutants in toxic amounts be prohibited**. (Emphasis added)

While the statutory deadlines were missed long ago, the highlighted objectives and goals form the foundation of today's approach to water quality protection and the regulation of point and non-point source discharges.

1.3 SCOPE OF THIS DOCUMENT

The scope of this document is summarized in Figure 1-1. The development of water quality control requirements (i.e., NPDES permits) is traced from its fundamentals in water quality standards (including use designations and water quality criteria), through the basics of NPDES permitting. The current programs for the assessment of water quality and development of §305(b) and §303(d) lists are addressed. The technical issues of Total Maximum Daily Load (TMDL) development and implementation are discussed. Examples of TMDLs and permit limit calculations are provided. Finally, implications for small, rural publicly owned treatment works (POTWs) and recommendations for action for NRWA and its members are presented.

For more information on the Clean Water Act see http://www.epa.gov/r5water/cwa.htm. A good overview of the process by which the CWA is implemented into regulatory programs is found at http://www.epa.gov/watertrain/cwa/.

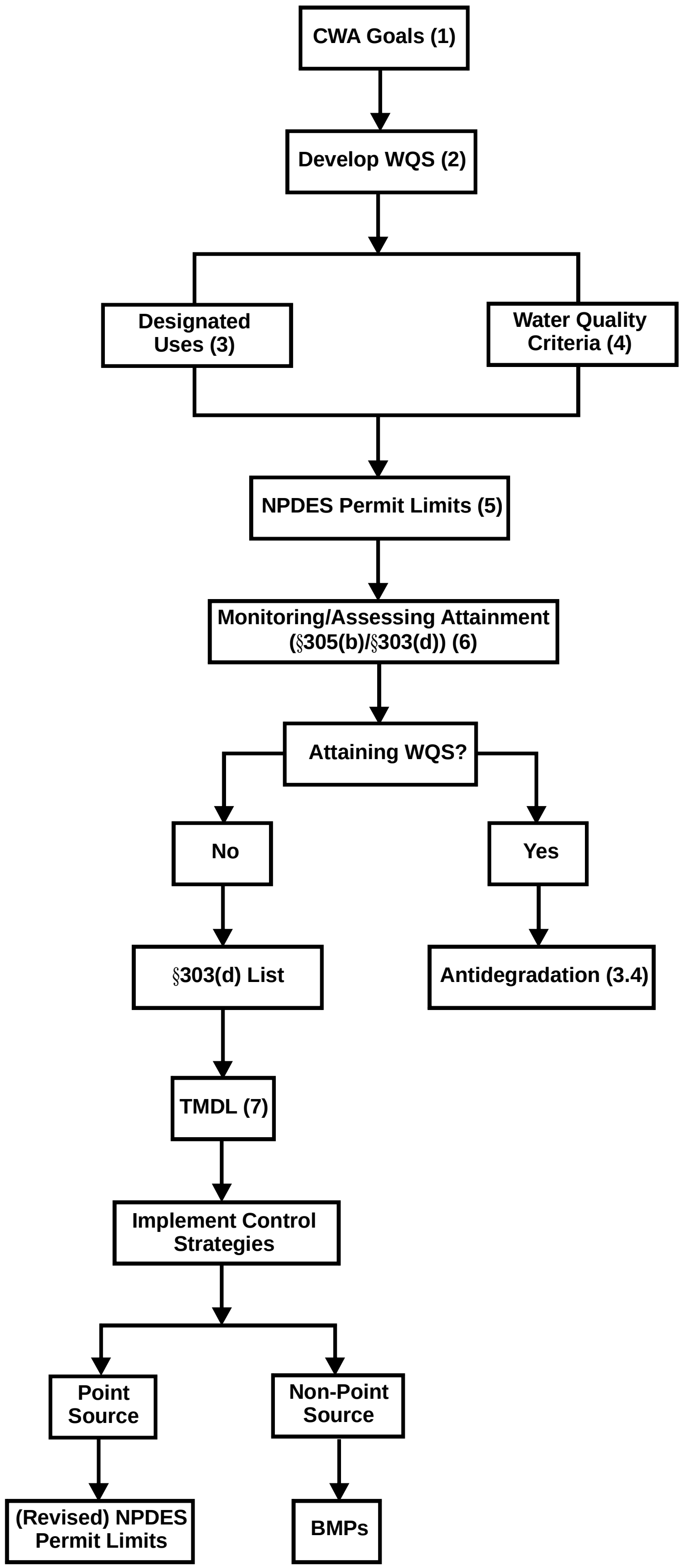

Figure 1-1. Overview of Clean Water Act Regulatory Process (Numbers in Parentheses Refer to Section Numbers of This Document).

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2. WATER QUALITY STANDARDS

2.1 OVERVIEW AND DEFINITIONS

The definition and purpose of water quality standards (WQS) are found in 40 CFR 131 (Water Quality Standards):

> A water quality standard defines the water quality goals of a water body, or portion thereof, by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses. States adopt water quality standards to protect public health or welfare, enhance the quality of water and serve the purposes of the Clean Water Act. (40 CFR 131.2)

Thus, WQS are intended to translate the broad goals of the CWA (see page 1-2) into measurable objectives that are specific to each waterbody. The statutory authority for WQS is established in Section 303(c) of the CWA, and the regulations for their implementation are found in 40 CFR 131.

As described in the reference above, a WQS is comprised of two components:

WQS = DESIGNATED USE + WATER QUALITY CRITERIA

These two components will be discussed in detail in Sections 3 and 4 of this document.

2.2 ROLE OF STATES AND EPA

The States are responsible for establishing, reviewing, and revising WQS (40 CFR 131.4). States are free to develop WQS that are <u>more</u> stringent than required by Federal regulations. At least every 3 years, States must review their WQS to determine whether any new information is available to revise either the designated uses or the water quality criteria (WQC). There are explicit requirements for public participation (including hearings) in this process. This “triennial review” is an extremely important process to wastewater dischargers, as changes can take place that might substantively influence individual facilities. As will be discussed in Sections 3 and 4, even seemingly minor changes to designated uses or WQC can have significant impact on NPDES permit limits and requirements. Most importantly, once these revisions are adopted by the State, the opportunity to challenge them is lost. Therefore, dischargers are strongly encouraged to follow the WQS revision process in their particular State. This can most easily be done by regularly visiting the appropriate State web site, or being placed on a State mailing list to be advised of proposed changes. The triennial review also provides an opportunity for dischargers to propose changes to the State. When dischargers are aware of technical information that would suggest beneficial changes to the designated uses or to specific WQC, they should share this information with the States and encourage them to formally pursue appropriate revisions to the WQS (e.g., EPA might have published a revised national water quality criterion for a particular chemical which is favorable).

Once the State has approved its revisions to the WQS, they are submitted to EPA for review. EPA has the authority to approve or disapprove the State WQS. In essence, EPA is to judge whether the revised WQS are consistent with the goals of the CWA (40 CFR 131.5). EPA has three options:

- approve the State WQS;
- conditionally approve the State WQS with a schedule for the State to make required changes within a specified time period; or
- disapprove the WQS and promulgate WQS for the State.

Note that EPA is *not* authorized to disapprove a State's WQS because EPA considers them to be overly stringent.

For more information on WQS see http://www.epa.gov/waterscience/standards/. More detail can be found in Water Quality Standards Handbook: Second Edition (EPA 1994).

3. DESIGNATED USES

Designated uses of a waterbody are those uses that society and its government determine should be attained. Thus, there are both technical and socio/economic components to these designations. The statutory authority for this process is established in Section 303(c)(2)(A) of the CWA. The regulations for establishing and evaluating designated uses are found in 40 CFR 131.10.

3.1 ESTABLISHMENT OF DESIGNATED USES

States have the authority and responsibility for specifying designated uses. States must follow these policies.

- States must designate all "existing uses," i.e., those that have been attained at some time since November 28, 1975, even if they are <u>not</u> currently being attained.

- All waters must be assigned a designation consistent with the "fishable/swimmable" goal of the CWA (Section 101(a)(2)) *unless* that use is removed as a result of a use attainability analysis (see Section 3.3).

- "Waste transport" is not an acceptable use.

- States may assign multiple uses to a single waterbody, but the most "sensitive" use drives the regulatory process.

- Designated uses of upstream waters must be protective of downstream uses.

- Social and economic factors *may* be considered.

It is very important to note the distinction between *designated* uses and *existing* uses. A designated use is assigned based on the *potential* for attaining that use, rather than whether it is actually being attained at the present time (see Section 3.3).

3.2 EXAMPLES OF DESIGNATED USES

There is a broad diversity of designated uses for waterbodies among the States. In addition, States are encouraged to assign subcategories of uses to more specifically describe the characteristics of a waterbody. The following are <u>examples</u> of categories and subcategories of uses common to many States:

- Aquatic life protection
  - warm water species/habitat
  - cold water species/habitat
- Human health protection
  - drinking water (public water supply)
  - fish consumption
- Recreation
  - primary contact (swimming)
  - secondary contact (boating/wading)
- Agricultural water supply (irrigation/livestock)
- Industrial water supply

Other uses assigned by some States include protection and consumption of shellfish, aquifer protection, and navigation. Seasonal uses (e.g., for trout fisheries or fish migration) are also designated in some States. Also recognize that numeric water quality criteria that apply to a waterbody may differ for the various use designations (e.g., ammonia criteria are typically more stringent for cold water than warm water aquatic life use designations).

3.3 REVISION OF DESIGNATED USES

As discussed in Section 2.2, States (with input from the public) review and may revise their WQS at any time. One type of revision is the revision in a designated use of a particular waterbody. The use might either be "upgraded" (i.e., changed to a more stringent use) or "downgraded" (i.e., changed to a less stringent use) based on the availability of new information.

States, often with the encouragement of environmental groups, may upgrade a use if it can be demonstrated that the waterbody is already attaining or is capable of attaining a use more stringent than that which is currently assigned. If such a change is made, the waterbody will receive an increased level of protection with the potential for more stringent water quality criteria, more stringent permit limits, and possible limitations on growth and development. It is very important for dischargers to keep abreast of any petitions or proposals to upgrade uses to their receiving stream (i.e., the waterbody to which they discharge) and to be active in the required public participation process as early as possible.

The downgrading or removal of an *existing* designated use is prohibited by Federal regulations (40 CFR 131.10(h)(1)). However, a use may be removed if it can be demonstrated that it is not attainable. A use is considered to be attainable if it can be achieved by the imposition of technology-based effluent limits for point source discharges and/or cost-effective and reasonable best management practices (BMPs) for non-point sources of pollution. Once these controls are considered, a use attainability analysis (UAA) may be performed. A UAA is a structured scientific assessment of the factors affecting the attainment of the designated use. Under 40 CFR 131.10(g), States may remove a designated use which is not an *existing* use if the State can demonstrate that attaining the designated use is not feasible because:

1. Naturally occurring pollutant concentrations prevent the attainment of the use; or

2. Natural, ephemeral, intermittent, or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the

discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or

3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

4. Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or

5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

6. Controls more stringent than those required by §301(b) and §306 of the Act would result in substantial and widespread economic and social impact.

Dischargers may petition the State to remove or downgrade a use based on any of these factors. However, it is important to recognize that States are usually reluctant to make such changes, and EPA strongly discourages removal of uses and may disapprove a WQS revision that includes a use removal.

For more information on use designations and UAAs see *http://www.epa.gov/waterscience/standards/about/uses.htm*.

3.4 ANTIDEGRADATION

In order to protect existing uses and to protect waters with water quality *better* than is necessary to maintain the designated uses, States are required by EPA to adopt and implement an antidegradation policy (40 CFR 131.12). Antidegradation is applied on a parameter-by-parameter basis. For example, if concentrations of one parameter (e.g., copper) are lower ("better") than the criteria while others are not, antidegradation could still be applied for that parameter. Antidegradation policies are normally applied in three "tiers":

- Tier 1. Existing uses, and the level of water quality necessary to protect them, must be attained. In other words, no deterioration of quality that contributes to non-attainment of an existing use is permitted.

- Tier 2. Where water quality exceeds that necessary to maintain a use, no activity that lowers water quality is permitted unless such an activity is "necessary to accommodate important economic or social development in the area in which the waters are located" (40 CFR 131.12(a)(2)). In some States, this may require a petition from any discharger that seeks to increase the discharge loading of a pollutant or to develop the property along the waterbody.

- Tier 3. Only very small or short-term decreases in water quality are allowed in waters designated as "Outstanding National Resource Waters."

Each State may have its own variations on these classifications and the procedures for implementing them. It is important for dischargers to be familiar with these antidegradation policies and procedures because they can severely limit the flexibility for future expansion. In some cases, dischargers may have to submit a formal request to increase the discharge loading of a pollutant, even if this is simply due to an increase in flow and not in concentration.

For more information on antidegradation see http://www.epa.gov/waterscience/standards/about/adeg.htm or EPA's Water Quality Standards Handbook: Second Edition (EPA 1994).

4. WATER QUALITY CRITERIA

Water quality criteria (WQC) are the second component of a WQS (see page 2-2). Criteria are the levels of individual pollutants or water quality characteristics, or descriptions of water quality conditions, that, if met, will generally protect the designated uses of a waterbody. The statutory authority for the development of WQC is established in Section 303(c)(2) of the CWA. The regulations for deriving WQC are found in 40 CFR 131.11.

4.1 TYPES OF WATER QUALITY CRITERIA

4.1.1 Narrative Criteria

Most States have developed narrative WQC that describe water quality goals, such as:

> All waters, including those within mixing zones, shall be free from substances attributable to wastewater discharges or other pollutant sources that:
>
> (1) settle to form objectionable deposits;
>
> (2) float as debris, scum, oil, or other matter forming nuisances;
>
> (3) produce objectionable color, odor, taste, or turbidity;
>
> (4) cause injury to, or are toxic to, or produce adverse physiological responses in humans, animals, or plants; or
>
> (5) produce undesirable or nuisance aquatic life. (54 FR 28627, July 6, 1989)

These narrative criteria form a "catch-all" to provide protection in cases where specific numeric criteria have not been derived or applied.

4.1.2 Numeric Criteria

States have also adopted numeric WQC for a long list of individual chemicals and conditions (e.g., copper, ammonia, dissolved oxygen). In most cases, these WQC have been developed by technical staff at EPA using large databases of scientific evidence, and have been published as guidance. The latest National Recommended Water Quality Criteria are included in Appendix A. States are encouraged to adopt these numeric criteria, or other equally protective values, as part of their WQS process. Specific numeric WQC can be derived for all of the types of designated uses described in Section 3 of this document. It is important to recognize that one type of criterion will not always be the most sensitive. For example, aquatic life WQC for copper are approximately 100 times lower (more restrictive) than human health WQC for copper, while aquatic life criteria for polychlorinated biphenyls (PCBs) are approximately 10,000 times higher (less restrictive) than human health WQC.

4.1.2.1 Aquatic Life

Aquatic life criteria are intended to protect the broad spectrum of animals and plants that may be present in a waterbody with a particular designated use. EPA's procedures to calculate aquatic life criteria apply a statistical approach to results of many toxicity tests on a variety of aquatic species to estimate the concentration of a pollutant that would protect 95 percent of the species that might be expected to be present in that type of waterbody (EPA 1985). Aquatic life WQC are typically expressed as two numbers:

- Acute WQC (or Criterion Maximum Concentration, CMC) for protection against short-term exposures and toxicological effects (e.g., lethality); and

- Chronic WQC (or Criterion Continuous Concentration, CCC) for protection against long-term exposures and effects (e.g., adverse effects on growth or reproduction).

For example, the CMC and CCC for arsenic are 340 and 150 µg/L (parts per billion), respectively (see Appendix A). The CCC is typically lower because it represents a more sensitive response that occurs from exposures over a longer period of time.

Many aquatic life WQC are expressed as formulas rather than as single values because the WQC are dependent on particular water quality characteristics. For example, the toxicity of several metals (e.g., copper, lead, and zinc) is dependent on the hardness of the water, with less toxicity (higher WQC) at higher hardness levels (see Appendix A). Ammonia toxicity and WQC are dependent on both pH and temperature, with increasing toxicity (more stringent WQC) as pH and/or temperature increase. Recognize that there is no inherent "safety factor" built into EPA's approach for calculating ambient water quality criteria for the protection of aquatic life.

Some States, particularly in the Great Lakes region, have recently adopted "short-cut" procedures for deriving aquatic life WQC for chemicals without sufficient data to calculate criteria using the standard EPA guidelines. These are often called "Tier 2" criteria or values. The procedures use very conservative statistical assumptions to compensate for scarcity of available data and can result in extremely stringent (and often unrealistic) WQC. These values can be calculated using data from as few as one or two species of aquatic life. Tier 2 criteria have a much weaker technical basis than "Tier 1" criteria, and need to be carefully evaluated before they are applied to evaluate use attainability or to calculate permit limits. In several cases, however, dischargers have sponsored testing programs to provide additional data that allow less conservative calculations and more reasonable WQC.

4.1.2.2 Human Health

Human health WQC are typically applied to two exposure routes:

- Drinking water criteria to protect public water supplies or incidental ingestion of water; and

- Fish/shellfish consumption criteria to protect humans eating organisms that have accumulated high levels of a pollutant from the water or the food chain.

Criteria can be developed to protect against either carcinogenic or non-carcinogenic effects. EPA recently revised its procedures for deriving human health WQC (U.S. EPA 2000) that reflect updates in cancer risk analysis, bioaccumulation measurements, and exposure assumptions (including the assumed levels of fish consumption by various categories of people).

4.1.2.3 Recreation

States have also adopted numeric criteria to protect the recreational uses described in Section 3.2 of this document. These are typically expressed as bacterial counts to protect swimmers and other recreational users. In the past, most bacterial WQC have been based on fecal coliforms. However, EPA is now recommending the use of *E. coli* and enterococci as indicators of bacterial contamination (U.S. EPA 1986). In some cases, WQC for other pathogens such as *Giardia* and *Cryptosporidium* have been adopted by the States.

4.1.2.4 Other

There are a wide variety of other types of numeric criteria that have been derived by EPA and adopted by some of the States, for example:

- Nutrient criteria (e.g., phosphorus and nitrogen) to protect against algal blooms (eutrophication), lowered dissolved oxygen (DO), and other water quality problems;

- Sediment criteria to protect organisms that live on or in bottom sediments;

- Organoleptic criteria to protect against objectionable odors and taste in fish for human consumption; and

- Biological criteria (biocriteria) that describe the types and diversity of aquatic life communities that should be present in waters of specified designated uses.

4.2 COMPONENTS OF A WATER QUALITY CRITERION

Water quality criteria are properly expressed not as a simple numerical value, but of a statement consisting of three related components:

- Magnitude – the concentration or level of the pollutant.

- Duration – the period of time over which the specified condition must be met. For example, EPA recommends that most acute and chronic aquatic life criteria (CMCs and CCCs) be expressed as 1-hour averages and 4-day averages, respectively.

- Frequency – how often it would be acceptable to exceed the WQC with no unacceptable adverse impact on the designated use. For example, EPA recommends a recurrence interval of once every 3 years for aquatic life WQC.

As an example, EPA's WQC for cadmium (U.S. EPA 2001a) is as follows:

> Freshwater aquatic life should be protected at a total hardness of 50 mg/L as $CaCO_3$ if the 4-day average concentration (in µg/L) of dissolved cadmium does not exceed the numeric value given by $0.938[e^{(0.7409[\ln(hardness)]-4.719)}]$ more than once every three years on the average, and if the 24-hour average dissolved concentration (in µg/L) does not exceed the numeric value given by $0.973[e^{(1.0166[\ln(hardness)]-3.924)}]$ more than once every three years on the average. For example, at hardnesses of 50, 100 and 200 mg/L as $CaCO_3$, the four-day average dissolved concentrations of cadmium are 0.15, 0.25 and 0.40 µg/L, respectively, and the 24-hour average dissolved concentrations are 1.0, 2.0 and 3.9 µg/L.

When all three components are expressed (magnitude, frequency, and duration), it is possible to interpret monitoring data to determine whether waters are meeting the chemical-specific water quality criteria. Unfortunately, States often neglect to include expressions of duration and especially frequency, particularly for WQC other than aquatic life. In such cases, it may not be possible to make a definitive statement about the attainment status of a waterbody based on a small number of samples collected over time. As a result, a State may conservatively assume that any exceedance of a criterion constitutes non-attainment, and dischargers may be faced with unnecessary, stringent permit limits.

The technical procedures used by EPA to derive WQC are rigorous and generally sound, but utilize some conservative assumptions. As a result, while one may say with confidence that, if WQC for a particular pollutant are met then adverse impacts from that pollutant are unlikely, it cannot be assumed that, if the WQC for a pollutant are occasionally exceeded that an adverse impact will likely result.

4.3 REVISIONS TO WATER QUALITY CRITERIA

4.3.1 Updates

EPA frequently issues updates to their recommended WQC for individual pollutants. Updates are primarily one of two types. The first is based on a review of newer toxicity test data that have been generated since the publication of the criteria. Most often, these new data include more sensitive species and/or life stages that were not previously included in the database. As a result, the general trend is toward more stringent criteria. For example, EPA has recently announced that it is reviewing data on ammonia toxicity to freshwater mussels that may lead to more stringent criteria. The other type of update is based on a revision in the methodology for criteria derivation. Often, these revisions are made to more accurately address the actual availability of the chemical to cause toxicity in the natural environment, which can sometimes lead to *less* stringent criteria. For example, EPA has very recently published the revised freshwater aquatic life criteria for copper (72 FR 7983-7985, February 22, 2007; http://www.epa.gov/waterscience/criteria/copper). The new copper criteria are based on the Biotic Ligand Model (BLM), which includes not only water hardness, but also temperature, pH, dissolved organic carbon, and several other key water quality parameters that influence the toxicity of copper. These BLM-based criteria will require site-specific data that are now largely unavailable. Therefore, dischargers may wish to collect data to determine whether these new WQC, when adopted by their State, may lead to lower (or higher) permit limits for copper.

4.3.2 Site-Specific Criteria

Because EPA criteria may not be applicable for every waterbody or aquatic community in the United States, the Agency has developed several procedures to adapt national aquatic life WQC to more closely reflect local biological communities and water characteristics (U.S. EPA 1994). For example, EPA's water-effect ratio (WER) accounts for the difference in toxicity of a chemical in laboratory water vs. site water, and the Recalculation Procedure accounts for differences in the species composition of the resident community. In some cases, these site-specific approaches can yield significantly less stringent criteria. However, the technical hurdles in these procedures are very high and quite conservative and the required studies can be expensive to negotiate and conduct. In addition, States are often reluctant to accept petitions for site-specific WQC. Finally, site-specific procedures are usually available only for aquatic life WQC, not for human health or other types of criteria.

4.3.3 Variances

Another potential means of relief from stringent WQC is the variance process. A variance is not a change to the numerical WQC, but rather a change to the WQS itself. The process is similar to that of removing of designated use (see Section 3.3 of this document) and is based on a demonstration that a WQS is not attainable due to one or more of the factors outlined in 40 CFR 131.10(g). However, a variance is temporary, and must be re-justified every 3 years. Also, because it requires a formal change to the State's WQS listing, extensive public participation and EPA review and approval are required. Variance petitions can provide substantial, albeit possibly *temporary* relief from stringent WQS. The demonstrations may be time-consuming and expensive, and there is no guarantee of a positive outcome. Further, because of the cumbersome administrative requirements, many States are reluctant to propose variances, and to support them in consultations with EPA.

For more information on all types of water quality criteria see http://www.epa.gov/waterscience/criteria/). This site provides very useful links to updated criteria tables, guidance documents, and other information.

5. NPDES PERMITS

As discussed in Section 1, the NPDES permit is the primary mechanism for the imposition of CWA-based regulatory requirements on point-source dischargers. Section 402 of the CWA created the NPDES program, and it is primarily implemented through the regulations contained in 40 CFR 122.

The NPDES program is administered by EPA, but the Agency has delegated permitting authority to almost all of the States. Therefore, most dischargers are issued discharge permits by the State. As a result, permitting procedures may vary from State to State. However, EPA has the authority to review and approve or reject any permit, and typically reviews every NPDES permit for "major" municipal and industrial dischargers. In general, a "major" POTW is defined as one that discharges $\geq$ 1 MGD. However, discharges with high concentrations of pollutants, discharge to sensitive waters, or discharges considered "high profile" may also be considered to be "majors" by EPA or the Director of the state agency.

Most point-source discharges are covered by an individual permit specifically tailored to that facility. In some cases, a "general permit," which covers multiple facilities within a specific category in the same geographical area, may be used.

A detailed discussion of the NPDES program is beyond the scope of this document. The focus of the present discussion will be on the derivation of the effluent limits contained in NPDES permits. As described in Section 1, the CWA established complementary programs of technology-based and water quality-based effluent limits. The permit limit for a given constituent (e.g., copper) will be the more stringent of the technology-based and the water quality-based limits.

5.1 TECHNOLOGY-BASED EFFLUENT LIMITS

Technology-based effluent limits apply to broad classes of dischargers based on the minimum level of treatment that is reasonably expected to be achieved by facilities of similar characteristics. For municipal wastewater treatment facilities (POTWs), the required performance level is secondary treatment. This requirement was established in Section 301(b)(1)(B) of the CWA. EPA's regulations for secondary treatment are found in 40 CFR 133. Secondary treatment standards are defined by the following limits:

Secondary Treatment Standards

Parameter	30-Day Average	7-Day Average
5-Day BOD	30 mg/L	45 mg/L
TSS	30 mg/L	45 mg/L
pH	6-9 s.u. (instantaneous)	
Removal	85% BOD_5 and TSS	

BOD – Biochemical Oxygen Demand
mg/L – Milligrams Per Liter (parts per million)
s.u. – Standard Units
TSS – Total Suspended Solids

According to 40 CFR 122.45(f), permit writers must apply these secondary treatment standards as mass-based limits using the design flow of the plant. Permits may also include concentration-based limits. For those facilities utilizing nitrification, limits for carbonaceous BOD_5 ($CBOD_5$) may be more appropriate than BOD_5 limits. EPA has concluded that $CBOD_5$ limits of 25 mg/L as a 30-day average, and 40 mg/L as a 7-day average are effectively equivalent to the BOD_5 standards.

Secondary treatment is required for all POTWs with limited exceptions (40 CFR 133.103). In addition, facilities using trickling filters and waste stabilization ponds may meet the requirements for "equivalent to secondary treatment" (40 CFR 133.105). The treatment standards for qualifying facilities include less stringent limits for BOD_5, TSS, and removal.

"Equivalent to Secondary Treatment" Standards

Parameter	30-Day Average	7-Day Average
5-Day BOD	45 mg/L	65 mg/L
TSS	45 mg/L	65 mg/L
pH	6-9 s.u. (instantaneous)	
Removal	65% BOD_5 and TSS	

BOD – Biochemical Oxygen Demand
mg/L – Milligrams Per Liter (parts per million)
s.u. – Standard Units
TSS – Total Suspended Solids

Many States also include limits for other "conventional" pollutants (e.g., bacteria, oil and grease) and "non-conventional" pollutants (e.g., ammonia, nitrogen, phosphorus) in regulations or guidance. These limits may be placed in all POTW permits of a particular size or treatment category.

Finally, it is important to note that technology-based limits form the "floor" for the NPDES permit. In some cases, substantially more stringent water quality-based limits for these same parameters may be applied. For example, water quality modeling may indicate the need for more stringent limits on BOD_5 or nutrients (nitrogen and phosphorus) than those required for secondary treatment.

5.2 WATER QUALITY-BASED EFFLUENT LIMITS (WQBELs)

A permit writer may determine that technology-based effluent limits are not sufficient to ensure that water quality standards will be attained in the receiving water. In such cases, the CWA (Section 301(b)(1)(C)) and NPDES regulations (40 CFR 122.44(d)) require that the permit writer develop more stringent, water quality-based effluent limits (WQBELs) designed to ensure that all applicable water quality standards are attained. The procedures for making such determinations are generally expressed in detail in a State's regulations or guidance. The analysis must also be included in a Fact Sheet that is required for every draft permit. Thus, the determination of permit conditions is objective rather than subjective, and is open to comment by the discharger and the public.

5.2.1 Integrated Approach to Water Quality-Based Toxics Control

EPA recommends the use of an "integrated approach" to implementing WQS in the NPDES permitting process (U.S. EPA 1991a). This approach consists of three individual approaches:

- Chemical-specific approach – limits the concentrations of individual pollutants to meet chemical-specific water quality standards. This is the most widely used approach in NPDES permits.

- Whole effluent toxicity (WET) approach – protects against aggregate toxic effects of a mixture of pollutants using acute (short term, lethal effects) and chronic (longer term, sublethal effects) toxicity tests. Many NPDES permits now include requirements for WET testing and, sometimes, enforceable limits for effluent toxicity as well.

- Biological assessment approach – uses surveys of the biological communities in the receiving water to assess their overall condition. While biological surveys are rarely required in permits, and the results are not directly transferable to permit limits, the biological condition of the stream may influence the permit writer's decision to include other permit limits and/or conditions.

EPA has long advocated the policy of "independent application" in interpreting the results of these three approaches. This policy says that the results of one approach should not be used to "overrule" the results of another. For example, the fact that a receiving stream has a healthy biological community does not mean that the permit need not include limits for individual toxic pollutants or requirements for WET testing. In practice, however, this policy is typically applied in only one direction – while one *positive* result may not overrule a negative one, one *negative* result may often lead to more stringent requirements even if the other two approaches yield positive results.

5.2.2 Mixing Zones

Most States include provisions for mixing zones in their WQS and NPDES permit regulations. A mixing zone is a limited spatial area downstream of a point-source discharge in which a designated use may not apply, and the WQC may be exceeded. Often two types of mixing zones are defined:

- Acute mixing zones, in which both acute and chronic aquatic life WQC may be exceeded, but lethal conditions are not allowed. These small areas are usually defined by discharge-induced mixing, frequently with a requirement for a high-velocity or multi-port diffuser on the discharge.

- Chronic mixing zones, in which acute WQC must be met but chronic WQC may be exceeded. These larger areas are usually characterized by ambient-induced mixing resulting from the physical and flow characteristics of the receiving water.

States often include limits on the areal dimensions of the mixing zones, as well as such provisions as requiring that a “zone of passage” for migrating fish be maintained, or that mixing zones not hug the bank. States may also prohibit mixing zones for particular types of pollutants (e.g., highly bioaccumulative chemicals). Mixing zone requirements vary substantially between the States, so it is important that dischargers understand what their particular requirements and size restrictions are.

States frequently require a modeling or field study before an acute mixing zone is allowed. On the other hand, States often assume that an effluent becomes completely mixed in the receiving water within the required physical dimensions of the chronic mixing zone because this assumption greatly simplifies the calculation of WQBELs. If there is evidence that an effluent does not mix well, the State may require a mixing zone study and the amount of dilution used in the WQBEL calculations described in Section 5.2.3 could be reduced if the results show incomplete mixing. There are numerous models that are available for the determination of site-specific dilution factors, but they must be used carefully to ensure that the model is appropriate for the location and regulatory application.

5.2.3 Calculation of Wasteload Allocation

A wasteload allocation (WLA) is the point-source component of a Total Maximum Daily Load (TMDL) (see Section 7.2 of this document). It is the amount of a pollutant that a facility may discharge while maintaining the applicable WQS of the receiving water. Prior to the expansion of the TMDL program, WLAs for individual dischargers or small groups of dischargers were the primary basis of WQBELs. Even today, this approach is frequently used in situations in which only one discharger is considered at a time.

There are many methods for the calculation of WQBELs. By far the most common is the steady-state, complete mix model. This is the simplest approach and requires the least site-specific information; however, this simplicity is achieved by the application of a number of conservative assumptions. The steady-state model is described by the following mass balance equation (U.S. EPA 1991a):

$$WLA = \frac{(WQC * Q_D) - (C_U * Q_U)}{Q_E}$$

where:

WQC	=	Applicable water quality criterion
Q_D	=	Downstream receiving water flow (usually $Q_U + Q_E$)
C_U	=	Upstream (background) concentration
Q_U	=	Upstream (stream design) flow
Q_E	=	Effluent discharge flow

The conservatism of this approach is largely determined by the values selected by the modeler or permit writer. Most States use the EPA-recommended stream design flows of 7Q10 (7-day low flow over a 10-year period) and 1Q10 (1-day low flow over a 10-year period) for chronic and acute aquatic life WQC, respectively. These flows are calculated statistically and are generally available from the U.S. Geological Survey (USGS) for major rivers and streams. The 7Q10 is approximately the 95^{th} percentile low flow while the 1Q10 is approximately the 99^{th} percentile low flow. Thus, these calculations often result in WLAs and permit limits that are more stringent than necessary much of the time in order to ensure adequate protection during relatively rare low flow events. In many small streams, these design stream flows will be zero, even though some level of flow is almost always observed. The upstream concentrations are often mean values or medians of monitoring data. However, some States use more conservative values, such as the 95^{th} percentile.

An alternative to this steady-state approach is an EPA-approved method called dynamic modeling that directly determines the probability that a WQC will be exceeded under a wide variety of conditions of effluent and upstream flows and concentrations. The result is a more realistic and less conservative approach; however, such modeling requires large amounts of site-specific data that are often not available for most discharges and receiving stream systems.

5.2.4 Reasonable Potential

EPA regulations (40 CFR 122.44(d)) require permit limits for any pollutant that is or may be "discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion" of numeric or narrative water quality criteria. To determine whether such "reasonable potential" exists, the WLA is compared to the "projected effluent quality" (PEQ) for that pollutant. Some States may very conservatively compare the WLA to the maximum observed effluent concentration. EPA recommends a statistical approach (U.S. EPA 1991a) for estimating the PEQ. Note that this method is very sensitive to sample size, and (when only one or very few data points are available) it may often be advantageous to the discharger to collect more data over a period of time to demonstrate that permit limits are not needed to comply with applicable water quality standards.

5.2.5 WQBELs in Permits

Some States apply WLAs directly as permit limits. The problem with this approach is that the aquatic life WQC are typically expressed as 1-hour or 4-day averages (see Section 4.2) while permit limits are typically expressed as daily maximums and monthly averages. EPA recommends a statistical approach to calculate these limits (U.S. EPA 1991a) that ensures that the most stringent WLA is met at a specified frequency and probability. In most cases, the final NPDES permit limits will be expressed both as concentration and mass loading (based on the design or average flow of the discharge).

5.3 INPUT TO NPDES PROCESS

Because the NPDES permit is the primary tool for imposing CWA-based regulatory requirements on point-source dischargers, it is important that dischargers be active throughout the permitting cycle. As described throughout this document, attention to regulatory developments that may impact permits are a key component to this. In addition, dischargers must be aware of changes in their own facility that might lead to changes in the permit. The permit application (typically required at least 6 months prior to expiration) is an opportunity to provide information to the permit writer. The application should be followed up with a phone call or meeting to determine whether the State may be considering significant changes. This gives time to provide additional information or new data before a draft permit is publicly noticed for comment. Often the State is willing to send a "pre-draft" permit to the discharger for review before publishing a draft permit. This allows issues to be negotiated and, hopefully, resolved, before the general public and EPA have an opportunity to review the draft. States are often more reluctant to make changes to the draft permit once the public notice has been issued. Finally, every effort should be made to resolve problems with the permit before the close of the 30-day comment period. Once the permit is issued as final, an appeal is necessary to make any changes. Filing an appeal can be a means of maintaining negotiations towards settling contentious issues. As long as the assigned judge is satisfied that both sides (the discharger and the State) are conscientiously working for resolution, then the appeal may last for several years (and the facility's current permit conditions are maintained). However, appeals can be very costly because they require legal counsel. They can also trigger public participation requirements, and are rarely as successful as proactive negotiations.

For more information on NPDES permits see http://cfpub.epa.gov/npdes/ or EPA's NPDES Permit Writers' Manual (1996). The Technical Support Document for Water Quality-based Toxics Control (EPA 1991a) contains detailed information on the calculation and application of WQBELs for individual chemicals and whole effluent toxicity.

6. MONITORING, ASSESSMENT, AND REPORTING

Once water quality standards have been established, the water bodies must be monitored to determine whether the WQS are being met – i.e., whether water quality criteria are exceeded and whether designated uses are being attained. The responsibility for this monitoring, and for reporting the results to EPA and the public, lies with the States. The CWA requires States to provide an overall assessment of the quality of their waters (§305(b)) and a list of those that are impaired or threatened (§303(d)) every two years.

In this section, the State of Ohio will be used as an example. Ohio has a diverse mixture of urban, small municipal, and rural areas, with waters ranging from intermittent agricultural drainage ditches to the Ohio River.

6.1 MONITORING

The task of monitoring the Nation's surface waters is a daunting one. In Ohio alone, there are 58,230 miles of streams or rivers, of which 5,750 miles are principal streams (draining 50 to 500 square miles) or large rivers (draining over 500 square miles) (Ohio EPA 2006). Each stream segment has several designated uses and many associated numeric water quality criteria. Obviously, neither Ohio nor any other State has the resources with which to monitor all of the necessary parameters in even a fraction of the streams, and ambient monitoring is often one of the first programs to be reduced when budgets are scrutinized. For this reason, U.S. EPA has encouraged the States to solicit data from volunteers (e.g., interested citizens, students, or dischargers). While such programs can increase the amount of available data, they can also introduce serious questions about data quality. Samples may be collected and analyses conducted by individuals or groups with little or no experience or training in quality assurance/quality control (QA/QC) procedures It is very important that NRWA members carefully review data sets that trigger the listing of "impaired" waters for inclusion on a State's §303(d) list, as well as any monitoring data used in the determination of TMDL-based permit conditions. States should not be using sub-standard data, or very small datasets, to support TMDL requirements. Some States have initiated programs to address data quality. Ohio and

Maryland, for example, specify a "tiered" data quality approach in which only data from the highest tier can be used in §303(d) listing and TMDL determinations. The requirements for these high-quality data include the submission of a detailed Quality Assurance Project Plan (QAPP) and the use of certified laboratories for analyses.

The size of the monitoring task also requires selectivity in the monitoring strategy. In theory, all waters of the State must be assessed; however, States usually select certain streams within a watershed to be representative of others of similar size and habitat. Watershed sampling is on a rotating schedule so that each area may be sampled only every few years. Priority is often placed on waters that are known or suspected to be impaired, or where there are significant point sources that require NPDES permits. States must also prioritize the parameters and indicators that should be measured. Ohio EPA has developed the following process to assess the major use designation categories:

- Human health – fish consumption use is evaluated with fish tissue contamination data;

- Recreation – primary and secondary recreation uses assessed with bacteria counts; and

- Aquatic life – primarily assessed with biological community assessments of streams and rivers.

Data for all three programs can be collected during the same sampling event. In addition, monitoring of specific chemical parameters is also conducted to provide additional information and to assist in the interpretation of the results of the other monitoring. These chemical-specific monitoring data can also come from studies required by NPDES permits, or from special studies conducted by Federal and State agencies, universities, and environmental groups. As discussed below, a great deal of data is generated when a watershed is identified as "impaired" and TMDL-based assessment activities are initiated.

6.2 ASSESSMENT OF MONITORING DATA

Once the data have been collected, they must be interpreted to determine whether the designated uses are being attained. Sometimes, this assessment may be made with very small data sets – in some cases, only a single sample. EPA has explicitly *discouraged* states from establishing minimum data base requirements (EPA 2005):

> EPA is particularly concerned with application of such thresholds state-wide…If employed, target sample set sizes should not be applied in an assessment methodology as absolute exclusionary rules, and even the smallest data sets should be evaluated and, in appropriate circumstances, used. (U.S. EPA 2005, p. 36)

It is important to recognize that it is much easier to demonstrate that a use is *not* being attained than to demonstrate that it is compliant. For example, a single exceedance of an acute water quality criterion (see Section 4.1.2.1 of this document) can indicate non-attainment of the aquatic life use at that particular time. However, how should that single data point be used to assess attainment with the chronic water quality criterion, which is expressed as a 4-day average exposure concentration? Further, how representative is that result of other locations in the watershed that were not sampled, or of that sampled location over time? Other "gray areas" include the interpretation and averaging of data below analytical detection levels. States must make policy judgments in such cases. They may use a statistical approach to evaluating the less-than detection data, but frequently simply make conservative assumptions (e.g., less-than values interpreted as one-half the detection limit, as equal to the detection limit, or as zero).

States must also make judgments about data that appear to be unrepresentative or statistical "outliers." EPA guidance urges States to be very cautious about rejecting such data, stating that, "One should never discard an outlier based solely on a statistical test." (U.S. EPA 2005, p. 36) However, *only* a statistical test can *define* an outlier, and a statistical test is the only objective means to make decisions about the inclusion or exclusion of data.

Once the State's data have been tabulated, each stream segment is assigned to one of the following categories (U.S. EPA 2005):

Category 1	All designated uses are met, none are threatened
Category 2	Some uses met, insufficient data to assess other uses
Category 3	Insufficient data to determine whether *any* uses are met
Category 4	Water is impaired or threatened but a TMDL is not needed because:
4A	a TMDL has been completed
4B	other required measures will result in attainment
4C	impairment is not caused by a pollutant
Category 5	Water is impaired or threatened and a TMDL is needed

The "other required measures" in Category 4B may include NPDES limits for point-source dischargers, or BMPs for non-point sources. The impairments in Category 4C are caused by "pollution" (e.g., stream channelization or habitat other alteration) rather than a chemical "pollutant." Waters in Category 5 comprise what is commonly referred to as the "§303(d) list."

6.3 REPORTING

Beginning in 2002, U.S. EPA requested that the States meet the §305(b) and §303(d) reporting requirements by submittal of a single "integrated report" by April 1 of every even-numbered year. For each reporting cycle, EPA has issued detailed guidance to the States regarding monitoring, assessment, and reporting (U.S. EPA 2005). The State's integrated report includes a description of all monitoring and assessment methodologies, and it is typically made available to the public on-line.

One of the features of the integrated report is a summary of the attainment status of the States' waters. In 2006, Ohio reported the following (Ohio EPA 2006):

Category	Number of Watersheds
1	1
2	13
3	54
4	19
5	244

Thus, more than 79 percent of Ohio's watersheds were reported as impaired, with 74 percent requiring one or more TMDLs. There are two primary causes of these observed impairments in Ohio. One is the nationwide issue of widespread contamination of fish with mercury and other bioaccumulative pollutants, much of which is due to "legacy" contamination rather than current contributions. The other is bacterial contamination from poorly-operated POTWs, combined sewer overflows (CSOs), septic systems, and agricultural practices.

Figure 1 of Appendix B is a summary of the §303(d) listed waters by State based on 2004 reports. Nearly 39,000 impaired waters were listed nationally. Figure 2 of Appendix B summarizes the causes of impairment as reported by the States.

For illustration, Appendix C includes several pages from Ohio's 2006 Integrated Report. One shows the assessment results from one segment of the Tiffin River watershed where a minor municipal point source is among the "high magnitude sources" and organic enrichment/DO is among the "high magnitude causes." Another is an excerpt from Ohio EPA's §303(d) list that shows the priority score and monitoring and TMDL schedule for this watershed assessment unit (WAU).

6.4 ROLE OF THE DISCHARGER

It is very important that dischargers be active in the monitoring, assessment, and reporting process. In this way, the discharger can be aware of issues that may lead to permit limits, to a future TMDL, or even prevent listing (or remove) a receiving water on the State's §303(d) impaired waters list. Facilities should monitor the appropriate State web site for developments regarding integrated reports and §303(d) lists, and where possible become an active participant in the watershed evaluation team (tributary strategy team) that many states have organized to assist them with the TMDL process. This can be a very significant help in shaping the monitoring, assessment, and TMDL processes from the earliest stages. States are required to make a draft of the integrated report available for public comment well before the final submission date. The document is typically available on-line. Dischargers should review the draft report to look for their watershed or specific receiving water. Most importantly, the discharger should examine the §303(d) list to see whether—and why—the water has been listed. One of the most important tasks is to review the quality and quantity of the data used in making the listing decision. The facility should provide any additional data or information to the State that might influence the assessment and listing. For example, a discharger may have monitored a stream for several parameters and not reported these data to the State previously. It may even be possible to collect and submit new data within the public comment period. Facilities also may have important information regarding the causes and sources of impairment because of their knowledge of the local area. More information on the discharger's role in the TMDL process once the integrated report is completed is presented in Section 7.6 of this document.

For more information on water quality monitoring, assessment, and reporting, including U.S. EPA's Integrated Report guidance, see http://www.epa.gov/owow/monitoring/. Ohio EPA's 2006 Integrated Report can be found at http://www.epa.state.oh.us/dsw/tmdl/2006IntReport/2006OhioIntegratedReport.html.

7. TOTAL MAXIMUM DAILY LOADS (TMDLs)

As discussed in Section 6.3 of this document, nearly 39,000 waters in the U.S. are currently listed as "impaired," despite that technology-based and/or water quality-based effluent limits have been imposed on nearly all point source discharges. EPA recognizes that the primary causes of these continued impairments are non-point sources of pollution. The 1998 §303(d) lists attributed impaired waters to the following categories of sources:

- 10 percent point sources only;
- 47 percent combination of point and non-point sources; and
- 43 percent non-point sources only.

TMDLs are intended to allocate the available stream loading capacity for a pollutant among the various point and non-point sources present such that the cumulative loading will not cause applicable water quality standards to be exceeded.

7.1 REGULATIONS AND LITIGATION

The regulatory basis of the TMDL program is found in 40 CFR 130.7. These regulations were last amended in 1992. A guidance document was published in 1991 (U.S. EPA 1991b), and clarifying guidance was issued in a 1997 memorandum (U.S. EPA 1997). In July 2000, EPA issued a final rule with significant amendments and clarifications to these TMDL regulations [65 FR 43585-43670]. However, the rule never took effect. Many stakeholders, and particularly agricultural interests, challenged the rule, arguing that the non-point source provisions of the new rule would be overly burdensome and costly. Finally, EPA withdrew the rule in April 2003. EPA therefore continues to operate the program based on the 1992 regulations.

Several years ago, environmental groups sued EPA over the slow pace of TMDL development across the country. To date, there have been 40 legal actions in 38 States. EPA has either been ordered by the courts or has entered into consent decrees in 22 States. In each of these, EPA has agreed to a schedule by which the backlog of TMDLs must be completed by either the State or

EPA. Figure 3 in Appendix B shows the number of TMDLs completed each fiscal year since 1996. The pace of TMDL development has increased dramatically in the past few years, with more than 4,500 TMDLs approved by EPA in each of the past two fiscal years. However, with nearly 39,000 listed waters, the pressure to develop TMDLs is expected to continue indefinitely. Further, even once a TMDL is completed, the process may not be over. In some cases, a new or revised TMDL for the same area may be needed later.

7.2 COMPONENTS OF A TMDL

A TMDL, as defined by EPA, is expressed in the form of the following equation:

$$TMDL = \Sigma\ WLA + \Sigma\ LA + MOS + RF$$

where:

TMDL	=	Total Maximum Daily Load
WLA	=	Wasteload Allocation for point source discharge(s)
LA	=	Loading Allocation for non-point sources
MOS	=	Margin of Safety
RF	=	Reserve Factor

Each of these components is discussed below.

7.2.1 Total Maximum Daily Load (TMDL)

The TMDL, or loading capacity (LC), is an *estimate* of the greatest amount of loading (mass/time) that a waterbody can receive without violating water quality standards. A TMDL is essentially a pollutant "budget," with the other components comprising the "line items" of the budget. The TMDL is sometimes conservatively calculated as simply the numeric water quality criterion times the design flow of the stream (i.e., 7Q10 or 1Q10), with the appropriate conversion factor to mass units. In more complex cases, computer modeling may be used to calculate the TMDL. Such modeling may include consideration of the fate of the pollutant (e.g., chemical degradation, loss from the system, or formation of less-toxic compounds). However, even the more complex models use assumptions to compensate for lack of adequate site-specific information. Further, all models have a considerable degree of uncertainty, particularly based on variability in stream flows. TMDLs are sometimes calculated seasonally, with different loadings for different times of year. This is appropriate for water quality criteria that vary with temperature, such as ammonia or dissolved oxygen. EPA recommends that, whenever possible, TMDLs be developed on a watershed basis—that is, grouping together all interconnected waters (impaired or unimpaired) in order to ensure attainment of WQS on a larger geographic scale.

7.2.2 Wasteload Allocation (WLA)

The WLA is the point-source component of the TMDL. Each point source discharge (i.e., NPDES permittee) is assigned an individual allocation. Note that the WLA should include stormwater conveyance systems in addition to municipal and industrial discharges.

7.2.3 Load Allocation (LA)

Load allocations are assigned to non-point sources of the pollutant. These non-point sources may be either natural or human-caused. Natural sources are accounted for based on the background concentration (absent any known point sources or human-caused non-point sources) of the stream. Load allocations can be assigned to individual non-point sources or to a group of sources (e.g., dairy farms or soybean fields).

7.2.4 Margin of Safety (MOS)

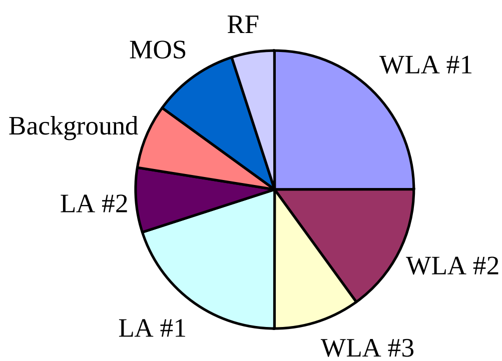
The MOS accounts for uncertainties in the relationship between pollutant loads and instream impacts and in the calculations themselves. The MOS may be either incorporated into conservative water quality modeling assumptions, or can be expressed explicitly (e.g., 10 percent of the TMDL). Because of the conservative assumptions often used in steady-state modeling, the use of an additional MOS may be unnecessary for TMDLs that use this modeling approach. It should also be noted that this MOS is an additional layer of conservatism beyond that used in the derivation of the water quality criteria.

7.2.5 Reserve Factor (RF)

TMDLs sometimes include a reserve factor to accommodate future growth and development within the watershed. In other cases, this RF may be assumed to be accounted for in the MOS. If a reserve factor is not included in the TMDL, it could preclude the expansion of a wastewater treatment plant (WWTP) (or the construction of a new WWTP) to accommodate population or industrial growth in a region. However, if significant future growth in the area is unlikely, or an area is completely built-out, then the use of a reserve factor would simply serve as another source of conservatism.

The components of the TMDL may be represented visually as a pie chart as shown in Figure 7-1.

Figure 7-1. Components of a TMDL



7.3 ALLOCATION METHODS

Once the size of the TMDL "pie" is determined ("X" lb/day) and the first slices are given to background, MOS, and reserve factor, the remaining pie is distributed among all of the point sources (WLAs) and non-point sources (LAs). States sometimes develop TMDLs assuming that the non-point loadings are "uncontrollable" and cannot be reduced, and therefore the Σ LA is fixed. In such cases, any necessary loading reduction will fall to the point source dischargers, and the WLAs will be reduced accordingly.

There are many different methods by which the WLAs and/or LAs may be allocated, including:

- Equal loads;
- Equal concentrations;
- Equal percent removal (load reduction);
- Equal cost per pound of pollutant removed;
- Seasonal limits based on cost-effectiveness; and
- Minimum total compliance cost.

The State weighs a number of issues when choosing the allocation scheme, such as:

- Economics;
- Political considerations;
- Feasibility;
- Equitability;
- Limits of technology; and
- Public involvement.

Obviously, these are not all technical considerations, and some factors may weigh more heavily in some TMDLs than in others. For example, in an area dominated by agriculture, there may be public pressure to shift load reductions towards point sources rather than non-point sources. EPA has developed models designed to "optimize" the allocation process based on cost functions, load models, and hydrologic models. Such models can represent a relatively objective means to find the most cost-effective and equitable allocation strategy. Note that the allocation approach selected for a particular TMDL can substantially influence the overall cost to a small, rural wastewater treatment plant, and should be considered early in the TMDL process.

EPA has endorsed the use of water quality trading as a means of achieving water quality and environmental benefits in a cost-effective manner (U.S. EPA 2003). Trading is particularly encouraged within TMDLs for nutrients (nitrogen and/or phosphorus) or sediment loads. Small, rural POTWs may find benefit in the trading concept either as a “buyer” or a “seller” of pollutant loads within a watershed.

7.4 TMDL IMPLEMENTATION

Once the final WLAs and LAs have been determined, the State is required to develop an implementation strategy to describe how the loading reductions will be achieved so that water quality standards will be attained. For point source dischargers, the implementation mechanism is usually the NPDES permit. If necessary, permit limits will be reduced to match the WLA for each discharger. This provides the State and EPA an enforceable mechanism for achieving load reductions.

There is, however, no parallel regulatory program for non-point sources. The CWA provides no Federal authority for requiring non-point sources to reduce loadings of pollutants. Instead, the State typically recommends one or more Best Management Practices (BMPs) that have been found to be effective in reducing loadings of the pollutant(s) of concern for that particular activity. For example, there are a number of BMPs for livestock waste management and growing of crops. There are also BMPs for construction areas, urban runoff, forestry practices, and mining. In addition, there are BMPs that apply to many categories of land use, such as buffer strips with vegetation on the banks of the stream. Section 319 of the CWA provides a source of funding to the States from which they can administer grants to address non-point source pollution.

The final TMDL report submitted to EPA by the State includes the assumptions used and the calculations to derive the TMDL and its components, a description of the allocation scheme, the implementation strategy, a monitoring program to assess progress towards meeting the water quality standards, and a description of the public participation process. As with NPDES permits, EPA has the final authority in approving TMDLs, and can develop its own TMDL if it is not satisfied with the approach taken by the State.

7.5 OTHER ISSUES

The National Research Council (NRC) identified 20 scientific research needs that would improve the technical approaches used in TMDL development (U.S. EPA 2002). Included among these needs were:

- increase quality and quantity of completed TMDLs;
- improve modeling and statistical techniques;
- improve guidance for allocation methods; and
- improve information on BMP effectiveness.

Of the defined needs, perhaps the most important for small, rural POTWs include: (1) the improvement of water quality modeling and statistical techniques and (2) further development of sound and equitable load allocation methods. The NRC report makes it clear that TMDL science is a "work in progress," and that much could be done to improve the program and the TMDLs that result from it. However, with the pressure of litigation, court-mandated deadlines, and staff limitations in the States, the pace of TMDL completion may continue to outrace the development of improved methodologies.

Another specific and critically important need identified in the NRC report is to improve the consideration of atmospheric deposition of certain pollutants. It has become increasingly apparent that some pollutants are transported through the air over very great distances, and can cause impairment in waters far from their sources. It is very difficult to track such pollutants back to their sources, and even more difficult to control those sources. If a TMDL is focused on sources within the watershed of concern, then point and non-point sources may receive reduced allocations at high cost without even the possibility of attaining the water quality standards. The most significant example is the nationwide problem of mercury transport and contamination.

Figure 2 of Appendix B shows that, in the §303(d) lists, mercury was the most commonly attributed cause of impairment, largely because of contamination of fish tissues. Some States (e.g., New Hampshire) listed every water in the State because of the ubiquitous nature of the contamination. While some States such as Ohio have exercised some regulatory flexibility in not overly penalizing small contributions from point and local non-point sources, the larger issue of unabated atmospheric transport continues to cause widespread impairment and frustrates the development of meaningful and effective TMDLs. EPA has recently announced a new category "5m" of the §303(d) lists that will allow deferment of TMDL development where States have implemented mercury reduction programs (U.S. EPA 2007a).

7.6 ROLE OF THE DISCHARGER

The most effective means of avoiding a TMDL is to avoid being included on the State's §303(d) list (see Section 6.4). Once the State's list is approved by EPA, there is a schedule in place by which the TMDL must be completed. Typically, the deadline is several years in the future. This timetable provides an opportunity for active involvement by the affected dischargers. Often there is ample time for additional monitoring that may provide information that could lead to delisting (see Section 6.4).

One of the most important features of the TMDL process is the extensive public participation process. Often, the stakeholders (potentially affected point and non-point sources) form a "task force" with or without involvement from the State. Some issues (e.g., filling in data gaps) are important to all stakeholders, and resources can be shared to maximize impact. All stakeholders have an interest in making the "pie" as large as possible. However, once the size of the pie is determined, then the battle over the slices begins. This is why it is vitally important that a discharger be actively involved in the process from the very start. Even before a water is listed as impaired and a TMDL scheduled, it may be wise for the discharger to have representation on local watershed associations, discharger groups, etc. It is also important to recognize that states often spend years modeling complex systems and developing a formal TMDL (with numeric LA and WLAs), and are often unwilling to make substantive changes at the end of the process.

As the State develops the TMDL, there are many opportunities for public participation. Citizen's groups and interests such as agriculture and developers will have active and vocal participation. It is important that the dischargers' voices be heard as well, particularly when the discharger provides a beneficial service to the community.

For more information on TMDLs, see http://www.epa.gov/owow/tmdl/. This site includes links to State Integrated Reports, § 303(d) lists, TMDL guidance, allocation methodologies, example TMDLs, and other important information. For more information on water quality trading, see http://www.epa.gov/owow/watershed/trading.htm .

8. CASE STUDY

In order to illustrate the calculation process for WQBELs and TMDLs and the potential impact on small WWTPs, a case study was developed. The study focuses on a hypothetical, "typical" NRWA member WWTP and the issues that may impact its NPDES permit limits.

8.1 FACILITY DESCRIPTION AND LOCATION

The Oak Creek WWTP is a small POTW (design flow 0.5 million gallons per day [MGD]) that uses lagoons for secondary treatment. It discharges to Oak Creek in a rural area near the town of Grove City (Figure 8-1). Oak Creek flows into the Shady River several miles downstream of the WWTP. Oak Creek is designated as:

- Warm-Water Habitat (aquatic life)
- Fish Consumption (human health)
- Secondary Contact (recreation)

The focus of the case study is on the aquatic life use (which typically has the most stringent criteria for the pollutants in this case study). The State's water quality criteria for aquatic life are identical to those recommend by EPA (Appendix A). For this case study, two pollutants were evaluated: ammonia-nitrogen (NH_3-N) and copper.

8.2 PERMITTING SCENARIOS

NPDES permit limits for the Oak Creek WWTP were calculated under three different scenarios:

- Single-discharger WQBELs (Section 8.2.1)
- TMDLs with load reductions for non-point sources (Section 8.2.2)
- TMDLs with no load reductions for non-point sources (Section 8.2.3)

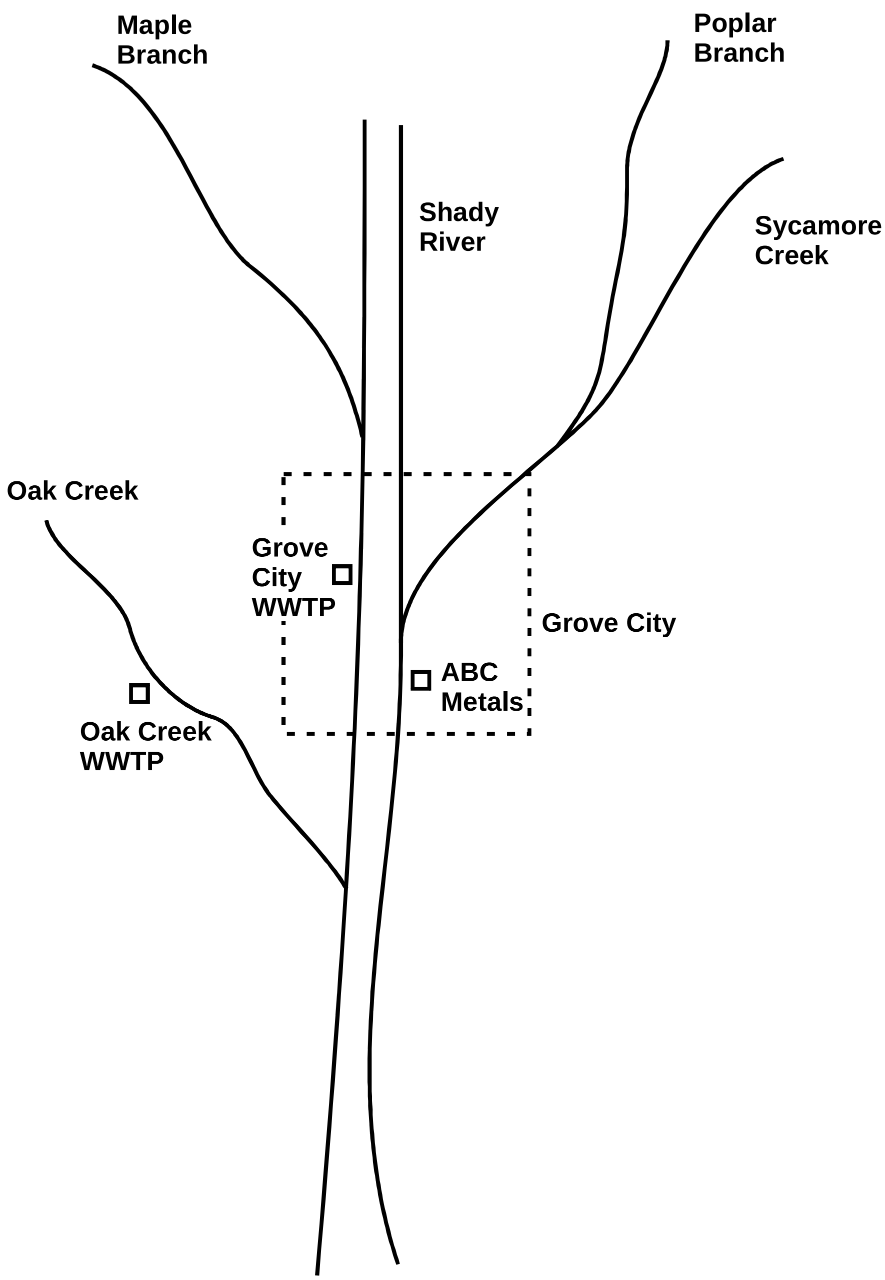


Figure 8-1. Study Area for Oak Creek WWTP Case Study.

All of the assumptions and calculations are included in spreadsheets in Appendix D. The following sections summarize the assumptions and results.

8.2.1 Scenario 1. Single-Discharger WQBELs

Scenario 1 focuses on the Oak Creek WWTP as a single discharger to Oak Creek. All criteria, flows, and background concentrations are included in Appendix D. WLAs are calculated by the equation in Section 5.2.3:

$$WLA = \frac{(WQC * Q_D) - (C_U * Q_U)}{Q_E}$$

where:

- WQC = Applicable water quality criterion
- Q_D = Downstream receiving water flow (usually $Q_U + Q_E$)
- C_U = Upstream (background) concentration
- Q_U = Upstream (stream design) flow
- Q_E = Effluent discharge flow

The State assumes complete, 100 percent mixing of the discharge in the receiving stream (see Section 5.2.2). The State also uses EPA's statistical approach (U.S. EPA 1991a) to calculate final daily maximum and monthly average NPDES permit limits (see Section 5.2.5).

The final WQBELs for Scenario 1 are as follows:

	Concentration		**Load (lb/day)**	
	Daily Max	**Monthly Avg**	**Daily Max**	**Monthly Avg**
NH_3-N – Summer (mg/L)	6.3	3.1	26	13
NH_3-N – Winter (mg/L)	27	13	111	55
Copper (µg/L)	37	19	0.16	0.078

8.2.2 Scenario 2. TMDLs With Load Reductions for Non-Point Sources

In Scenario 2, the State has included this portion of the Shady River watershed on the §303(d) impaired waters list for NH_3-N and copper. Therefore, TMDLs for these two pollutants are required. There are two other point source dischargers in the watershed, the Grove City WWTP and ABC Metals (Figure 8-1). Additionally, non-point source loadings from agricultural runoff and urban stormwater runoff have been measured. The State uses a margin of safety of 10 percent. No reserve factor is specified. An equal percent load reduction method (see Section 7.3) is used for both LAs (non-point sources) and WLAs (point sources) as necessary. BMPs will be implemented to reduce non-point source loadings, while facility-specific NPDES permit limits will reflect any necessary load reductions for point source dischargers.

The results of the TMDLs indicate that a 51 percent reduction in NH_3-N loadings is needed during the summer months (May-October) in order to attain water quality standards in the Shady River downstream of the confluence with Oak Creek (Appendix D). Similarly, 13 percent reductions in both winter (November-April) NH_3-N loadings and annual copper loadings are needed. Based on these TMDLs, new, more stringent monthly average NPDES permit limits are imposed on the Oak Creek WWTP:

	Pre-TMDL		**Post-TMDL**	
	Concentration	**Load (lb/day)**	**Concentration**	**Load (lb/day)**
NH_3-N – Summer (mg/L)	3.1	13	1.5	6.4
NH_3-N – Winter (mg/L)	13	55	12	48
Copper (µg/L)	19	0.078	16	0.068

8.2.3 Scenario 3. TMDLs With No Load Reductions for Non-Point Sources

Scenario 3 is identical to Scenario 2, except that the State has assumed that the non-point source loadings are "uncontrollable." As a result, the sum of the LAs is subtracted from the TMDL along with the margin of safety and background loadings. As a result, all necessary load reductions to attain water quality standards must be accomplished through adjustment of the WLAs for point source dischargers. (See Appendix D for details.)

The TMDLs for Scenario 3 require a much greater load reduction for summer NH_3-N (76 percent), while the load reductions for winter NH_3-N and copper are very similar to those in Scenario 2. The resulting monthly average NPDES permit limits for the Oak Creek WWTP are as follows:

	Pre-TMDL		**Post-TMDL**	
	Concentration	**Load (lb/day)**	**Concentration**	**Load (lb/day)**
NH_3-N – Summer (mg/L)	3.1	13	0.7	3.1
NH_3-N – Winter (mg/L)	13	55	12	48
Copper (µg/L)	19	0.078	16	0.068

8.3 CONCLUSIONS

The case study shows that water quality regulations and policies can have a dramatic impact on NPDES permit limits for small, rural POTWs. While this case study is intended to be representative of a "typical" NRWA member, it must be remembered that all of these calculations are highly site-specific and greatly dependent upon state-specific regulatory requirements. Therefore, it is impossible to compare the results to facilities in different discharge scenarios or to extrapolate the results to make sweeping, nationwide conclusions.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 IMPLICATIONS FOR SMALL, RURAL POTWs

It is impossible to estimate the overall impact of CWA regulations on small, rural POTWs as a group. Further, these impacts would vary from facility to facility, as the water quality-based approach is highly site-specific. Nevertheless, it can be stated with confidence that the impact on such facilities is significant, and will grow over the next few years. It is expected that small, rural POTWs will be included in many more TMDLs nationwide since many of the most significant remaining water quality issues in the U.S. are related to agricultural runoff and other rural non-point sources. As a result, thousands of TMDLs will be developed over the next few years to address waters impacted by these sources. Many of these TMDLs will address nutrients (nitrogen and phosphorus), sediments and solids, and small, rural POTWs are known sources of these pollutants to these same waters. Because of the increasing emphasis on watershed-based TMDLs, even more facilities will be captured under the umbrella of large TMDLs. In some cases a small POTW may be the only point source discharger in a rural watershed. In addition, regional TMDLs, such as those for the entire Chesapeake Bay, will capture many small, rural POTWs and will set enforceable goals for reductions in discharge loadings of nutrients and other pollutants.

9.2 POTENTIAL COSTS

In response to a request from Congress, EPA conducted a study to estimate the national costs of the TMDL program. The results were published in a draft report (EPA 2001b) that was never finalized. The study was based on estimates to develop and then implement TMDLs based on the 1998 §303(d) lists submitted by the states. In assessing the cost impact to point and non-point sources, EPA evaluated both basic TMDLs with little or no flexibility (i.e., pollutant loading reductions required of all sources) and more cost-effective TMDL approaches (i.e., requiring greater pollutant loading reductions from sources where such reductions would be more cost-effective.) Although the findings are somewhat dated, some of the results of the study are summarized in the following table.

Type of Source	Annual Costs ($ in millions)		Number of Affected Facilities
	Least Flexible TMDL Program	Moderately Cost-effective TMDL Program	
Point Sources	1,082 – 2,178	812 – 1,634	3,110 – 11,893
POTWs	396 - 697	297 – 523	821 – 3,335
Non-point Sources	783 – 2,162	234 – 1,791	-
Total	**1,865 – 4,340**	**1,046 – 3,425**	-

Some key observations can be made from these estimates and from other information included in the draft report:

- Nearly 12,000 point source dischargers, including over 3,000 POTWs, will be included in TMDLs.
- The estimated costs to implement controls based on these TMDLs will be up to $4.3 billion/year, with up to $ 2.18 billion/year for point source dischargers (including up to $697 million/year for POTWs.)
- Flexibility in TMDL allocation approaches can lead to significant cost savings. More creative approaches, including water quality trading, may yield even greater savings.

There are several reasons why these estimates are likely to be significantly underestimated. First, the costs of many TMDLs are impossible to estimate because the impairment listings are based on observed instream biological impacts where the actual causative chemical(s) and the necessary costs to treat the chemical(s) are unknown. Further, these estimates are based on 2000 dollars. Finally, these estimates are based on the approximately 22,000 waters that were listed as impaired in 1998, while EPA's 2004 §303(d) lists included approximately 39,000 waters and the 2006 total has not yet been reported. Therefore, it is reasonable to assume that the estimated annual costs for implementation of TMDLs are more than double what EPA estimated in the 2001 draft report.

A report from the Maryland Bay Restoration Fund Advisory Committee (2007) provides an additional perspective on the potential cost impact of TMDLs within a single state. The Maryland Department of the Environment (MDE) is implementing an Enhanced Nutrient Removal (ENR) program with requirements of 3 mg/L total nitrogen and 0.3 mg/L total phosphorus for all wastewater treatment plants with design flows of 0.5 MGD or greater. According to the 2007 Annual Status Report, there are five rural POTWs with design flows of 0.5 – 1.0 MGD that have been awarded State grant funding for ENR. For each of these five rural POTWs, the estimated costs for the necessary plant upgrades range from $5.03 million to $14.2 million for nutrient treatment alone. For the 66 “major” POTWs in Maryland which will be upgraded to ENR, the total estimated cost is $750 million to $1 billion.

9.3 OUTLOOK FOR THE FUTURE

EPA will continue its efforts to bring more and more of the Nation’s waters into attainment with water quality standards. The Agency has committed to a goal of an additional 242 impaired waters reaching attainment in fiscal year (FY) 2007, with a target of an additional 210 impaired waters in FY 2008 (U.S. EPA 2007b). By 2012, EPA intends that 2,250 waters that are currently included on States’ §303(d) lists will be in attainment. To accomplish these goals, EPA will maintain pressure on the States to develop and implement TMDLs in a timely fashion.

Independent of the TMDL program, the science behind water quality criteria, use designations, and other issues will continue to evolve. Changes in numerical water quality criteria, or guidance on implementation procedures, could have profound impacts on individual NRWA member dischargers.

9.4 RECOMMENDATIONS FOR NRWA ACTIVITIES

It is critically important that the NRWA and its members remain informed of legislative and regulatory developments at all levels of government. Because EPA's greatest current water program emphasis is on listing of impaired waters and the development and implementation of resulting TMDLs, activities related to these issues should receive significant attention. Among the most important issues identified in this document that have the most significant impact on small, rural POTWs are the following:

- increased stringency of water quality criteria for such critical parameters as ammonia and nutrients;
- conservatism in water quality modeling and TMDL/permitting calculations;
- data quality and quantity considerations in listing of impaired waters;
- equitability and cost-effectiveness in TMDL allocation methods;
- costs of compliance with permit limits based on large-scale TMDLs.

While most of the individual steps described in this document are technically sound, it is important that a "reality check" be done at the end of the process to determine whether the final outcome (i.e., stringent TMDL-based permit limits) represents the most cost-effective means of achieving the goals of the CWA – or whether the outcome will even lead to measurable progress towards those goals. EPA and the States do not typically make this final "does it make sense" assessment. NRWA and its members should challenge them to do so, providing information as early as possible to help in the assessment.

Finally, it should be stressed that the most important role of NRWA members is at the local level. Knowledge of their facility, their permit, their community, and their neighbors are vitally important towards achieving cost-effective compliance with CWA regulations. Among the ways of remaining informed and becoming actively involved are the following:

- View the NPDES permit as a "living document," always keeping a schedule of upcoming deadlines for compliance requirements, re-application submittal date, etc.

- Use the permit renewal process as an opportunity for providing desired information to the regulatory agency.

- Closely follow – and participate in – the State's Integrated Report process, including proposed §303(d) lists and TMDL schedules.

- Communicate with other nearby NRWA members and other dischargers with similar interests and concerns.

- Seek opportunities to become involved in TMDL process as early as possible (before major decisions are made).

- Join local watershed association or similar group if available, particularly if the receiving water is on the State's §303(d) list.

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Appendix A

National Recommended Water Criteria

United States Environmental Protection Agency
Office of Water
Office of Science and Technology
(4304T)
2006

National Recommended Water Quality Criteria

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
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 **8b**	Mercury Methylmercury	7439976 22967926	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 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

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
12	Thallium	7440280					0.24	0.47	68FR75510
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	140 jj	140 jj	EPA820/B-96-001 57FR60848 68FR75510
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					130 Z,U,	1,600 U	68FR75510
23	Chlorodibromomethane	124481					0.40 B,C	13 B,C	65FR66443
24	Chloroethane	75003							

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
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
28	1,1-Dichloroethane	75343							
29	1,2-Dichloroethane	107062					0.38 B,C	37 B,C	65FR66443
30	1,1-Dichloroethylene	75354					330	7,100	68FR75510
31	1,2-Dichloropropane	78875					0.50 B,C	15 B,C	65FR66443
32	1,3-Dichloropropene	542756					0.34 c	21 c	68FR75510
33	Ethylbenzene	100414					530	2,100	68FR75510
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					1,300 Z	15,000	68FR75510
40	1,2-Trans-Dichloroethylene	156605					140 Z	10,000	68FR75510

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
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					0.025 C,kk	2.4 C,kk	68FR75510
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

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
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
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							

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (Fg/L)	CCC (Fg/L)	CMC (Fg/L)	CCC (Fg/L)	Water + Organism (Fg/L)	Organism Only (Fg/L)	FR Cite/ Source
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					420	1,300	68FR75510
76	1,3-Dichlorobenzene	541731					320	960	65FR66443
77	1,4-Dichlorobenzene	106467					63	190	68FR75510
78	3,3'-Dichlorobenzidine	91941					0.021 B,C	0.028 B,C	65FR66443
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

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
89	Hexachlorobutadiene	87683					0.44 B,C	18 B,C	65FR66443
90	Hexachlorocyclopentadiene	77474					40 U	1,100 U	68FR75510
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
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					35	70	68FR75510
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

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
105	gamma-BHC (Lindane)	58899	0.95 K		0.16 G		0.98	1.8	65FR31682 68FR75510
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
111	Dieldrin	60571	0.24 K	0.056 K,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 K	0.036 K,O	0.037 G	0.0023 G,aa	0.059	0.060	65FR31682 68FR75510
116	Endrin Aldehyde	7421934					0.29 B	0.30 B,H	65FR66443

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

	Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/ Source
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	0.002 aa	0.21	0.002 aa	0.00028B,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(hardness)]+ b_A} (CF), or CCC (dissolved) = exp{m_C [ln (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(pH)-4.869); CCC = exp(1.005(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 Fg/l and 12.82 Fg/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 Fg 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-822-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 Fg/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 (60FR22228-222237, 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).

jj This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g., $Fe_4[Fe(CN)_6]_3$), this criterion may be over conservative.

kk This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

	Non Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/Source
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	860000 G	230000 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

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

	Non Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/Source
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
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		1000 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	Nonylphenol	1044051	28	6.6	7.0	1.7			71FR9337
29	Nitrosodibutylamine,N	924163					0.0063 A,H	0.22 A,H	65FR66443
30	Nitrosodiethylamine,N	55185					0.0008 A,H	1.24 A,H	Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

	Non Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/Source
31	Nitrosopyrrolidine,N	930552					0.016 H	34 H	65FR66443
32	Oil and Grease	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
33	Oxygen, Dissolved Freshwater	7782447	WARMWATER AND COLDWATER MATRIX -- SEE DOCUMENT N						Gold Book
	Oxygen, Dissolved Saltwater		SALTWATER – SEE DOCUMENT						EPA-822R-00-012
34	Diazinon	333415	0.17	0.17	0.82	0.82			71FR9336
35	Parathion	56382	0.065 J	0.013 J					Gold Book
36	Pentachlorobenzene	608935					1.4 E	1.5 E	65FR66443
37	pH	--		6.5 - 9 F		6.5 - 8.5 F,K	5 - 9		Gold Book
38	Phosphorus Elemental	7723140				0.1 F,K			Gold Book
39	Nutrients	--	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)						P
40	Solids Dissolved and Salinity	--					250,000 A		Gold Book
41	Solids Suspended and Turbidity	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
42	Sulfide-Hydrogen Sulfide	7783064		2.0 F		2.0 F			Gold Book
43	Tainting Substances	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
44	Temperature	--	SPECIES DEPENDENT CRITERIA -- SEE DOCUMENT M						Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

	Non Priority Pollutant	CAS Number	Freshwater CMC (Fg/L)	Freshwater CCC (Fg/L)	Saltwater CMC (Fg/L)	Saltwater CCC (Fg/L)	Human Health For Consumption of: Water + Organism (Fg/L)	Human Health For Consumption of: Organism Only (Fg/L)	FR Cite/Source
45	Tetrachlorobenzene,1,2,4,5-	95943					0.97 E	1.1 E	65FR66443
46	Tributyltin (TBT)	--	0.46 Q	0.072 Q	0.42 Q	0.0074 Q			EPA 822-F-00-008
47	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 Fg/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 Fg 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 (Fg/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-Trichloropehnol	88062	2	Gold Book
11	2,3,4,6-Tetrachlorophenol	--	1	Gold Book
12	2-Methyl-4-Chlorophenol	--	1800	Gold Book
13	3-Methyl-4-Chlorophenol	59507	3000	Gold Book
14	3-Methyl-6-Chlorophenol	--	20	Gold Book
15	2-Chlorophenol	95578	0.1	Gold Book
16	Copper	7440508	1000	Gold Book
17	2,4-Dichlorophenol	120832	0.3	Gold Book
18	2,4-Dimethylpehnol	105679	400	Gold Book

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR ORGANOLEPTIC EFFECTS

	Pollutant	CAS Number	Organoleptic Effect Criteria (Fg/L)	FR Cite/Source
19	Hexachlorocyclopentadiene	77474	1	Gold Book
20	Nitrobenzene	98953	30	Gold Book
21	Pentachlorophenol	87865	30	Gold Book
22	Phenol	108952	300	Gold Book
23	Zinc	7440666	5000	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 $CaCO_3$ 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-Chlorisoprpyl) 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 hardness)(0.041838)]	1.101672-[(ln 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 hardness)(0.145712)]	1.46203-[(ln 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 hardness)(0.041838)]	1.101672-[(ln 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 hardness)(0.145712)]	1.46203-[(ln 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:
CMC (dissolved) = exp{m_A [ln(hardness)]+ b_A} (CF)
CCC (dissolved) = exp{m_C [ln(hardness)]+ b_C} (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:

$$CMC = \frac{0.275}{\quad} + \frac{39.0}{\quad}$$

$$1 + 10^{7.204-pH} \qquad 1 + 10^{pH-7.204}$$

Or where salmonid fish are not present:

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

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:

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

When fish early life stages are absent:

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

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

Appendix B

EPA Figures for TMDL Program
(http://www.epa.gov/owow/tmdl/)

NOTE: Click on the underlined "State Name" value to see a State Report.

State Name	Current System (Electronic) Version	Waters on List
ALABAMA	2004	179
ALASKA	2004	35
AMERICAN SAMOA	1998	1
ARIZONA	2004	66
ARKANSAS	2004	187
CALIFORNIA	2002	686
COLORADO	1998	79
CONNECTICUT	2004	267
DELAWARE	2004	379
DISTRICT OF COLUMBIA	2004	17
FLORIDA	2002	827
GEORGIA	2002	447
GUAM	1998	3
HAWAII	2004	241
IDAHO	2002	1392
ILLINOIS	2004	952
INDIANA	2004	1320
IOWA	2004	213
KANSAS	2004	1366
KENTUCKY	2004	736
LOUISIANA	2004	234
MAINE	2002	201
MARYLAND	2004	473
MASSACHUSETTS	2002	775
MICHIGAN	2004	379
MINNESOTA	2004	1500
MISSISSIPPI	2002	490
MISSOURI	2002	197
MONTANA	2002	527
N. MARIANA ISLANDS	1998	2
NEBRASKA	2004	150
NEVADA	2004	118
NEW HAMPSHIRE	2004	5192
NEW JERSEY	2004	976
NEW MEXICO	2004	175
NEW YORK	2004	792
NORTH CAROLINA	2002	618
NORTH DAKOTA	2004	211
OHIO	2004	428
OKLAHOMA	2002	436
OREGON	2002	1177
PENNSYLVANIA	2004	6957
PUERTO RICO	2004	86
RHODE ISLAND	2004	148
SOUTH CAROLINA	2002	713
SOUTH DAKOTA	2004	165
TENNESSEE	2004	974
TEXAS	2004	307
UTAH	2002	166
VERMONT	2002	173
VIRGIN ISLANDS	2004	51
VIRGINIA	2004	1353
WASHINGTON	2004	1714
WEST VIRGINIA	2004	889
WISCONSIN	2004	613
WYOMING	2004	129

Total Number of Impaired Waters Reported: 38,882

NOTE: Click on the underlined "Causes of Impairment Reported" value to see a listing of those waters with that cause of impairment. Click on the underlined "General Impairment Name" to see the detailed state-reported impairment names.

General Impairment Name	Causes of Impairment Reported	Percent of Reported
MERCURY	8562	13.28
PATHOGENS	8522	13.21
SEDIMENT	6828	10.59
METALS (OTHER THAN MERCURY)	6479	10.05
NUTRIENTS	5650	8.76
OXYGEN DEPLETION	4497	6.97
PH	3476	5.39
CAUSE UNKNOWN - BIOLOGICAL INTEGRITY	2873	4.45
TEMPERATURE	2814	4.36
HABITAT ALTERATION	2382	3.69
PCBS	2083	3.23
TURBIDITY	2001	3.10
CAUSE UNKNOWN	1401	2.17
PESTICIDES	1246	1.93
SALINITY/TDS/ CHLORIDES	1113	1.73
FLOW ALTERATION	690	1.07
SULFATES	652	1.01
ALGAL GROWTH	506	.78
AMMONIA	404	.63
OTHER TOXIC ORGANICS	329	.51
TOTAL TOXICITY	298	.46
DIOXINS	288	.45
TOXIC INORGANICS	283	.44
FISH CONSUMPTION ADVISORY - POLLUTANT UNSPECIFIED	260	.40
NOXIOUS AQUATIC PLANTS	257	.40
OIL AND GREASE	130	.20
OTHER CAUSE	113	.18
TASTE, COLOR AND ODOR	83	.13
CHLORINE	78	.12
FLOATABLES	73	.11
NUISANCE EXOTIC SPECIES	44	.07
NUISANCE NATIVE SPECIES	30	.05
RADIATION	22	.03
CAUSE UNKNOWN - FISH KILLS	21	.03
HARMFUL ALGAL BLOOMS	4	.01
CAUSE UNKNOWN - BIOTOXINS	4	.01

Total Causes of Impairment Reported Nationwide: 64,496

Fiscal Year	Number of TMDLs Approved	Percent Approved
1996	117	.47
1997	497	2.01
1998	424	1.72
1999	415	1.68
2000	1504	6.09
2001	2646	10.71
2002	2869	11.61
2003	3309	13.39
2004	3279	13.27
2005	4552	18.42
2006	4520	18.29
2007	580	2.35

Appendix C

Excerpts From Ohio EPA's 2006 Integrated Report (Ohio EPA 2006)

Assessment Unit	Size (sq mi)	Impairment of Water Quality Standards: Aquatic Life Use	Impairment of Water Quality Standards: Recreation Use	Human Health (Fish Tissue)	AU Category	Priority Points	Next Field Monitoring	Projected TMDL
05030103 010	Mahoning River (headwaters to downstream Beech Creek)							
	129.2	Yes	Yes	Unknown	5	7	2006	2008
05030103 001	Mahoning River Mainstem (downstream Eagle Creek to Pennsylvania Border)							
	1075.0	Yes	Yes	Yes	5	7	2013	2015
04110004 050	Mill Creek							
	103.3	Yes	Yes	No	5	7	2019	2006
04110001 050	Black River; Lake Erie tributaries East of Black River to West of Porter Creek)							
	100.8	Yes	Yes	Yes	5	7	2021	2007
04100011 140	Lake Erie tributaries (West of Mills Creek to East of Sawmill Creek)							
	104.3	Yes	Yes	Unknown	5	7	2014	2016
04100011 130	Lake Erie tributaries (East of Green Creek to west of Mills Creek)							
	163.8	Yes	Yes	Unknown	5	7	2014	2016
04100009 050	Maumee River (downstream Bad Creek to downstream Beaver Creek); excluding Maumee R. mainstem							
	231.2	Yes	Yes	Unknown	5	7	2016	2018
04100007 110	Powell Creek							
	97.6	Yes	Yes	Unknown	5	7	2015	2017
04100006 040	Tiffin River (downstream Leatherwood Creek to upstream Lick Creek); excluding Tiffin River mainstem							
	166.2	Yes	Yes	Yes	5	7	2011	2013
24001 003	Lake Erie Islands Shoreline							
	0.0	Yes	No	Yes	5	6	2012	2014
05090203 010	Mill Creek							
	164.6	Yes	Yes	Yes	5	6	2020	2022
05090202 130	East Fork Little Miami River (upstream Stonelick Creek to mouth)							
	119.2	Yes	Yes	No	5	6	2012	2014
05090202 100	East Fork Little Miami River (headwaters to upstream Solomon Run)							
	140.8	Yes	Yes	No	5	6	2012	2014
05080003 070	East Fork Whitewater River							
	70.6	Unknown	Yes	Unknown	5	6	2015	2017
05080001 030	Great Miami River (upst. Cherokee Mans Run to downstream Bokengehalas Cr.); excluding Muchinippi							
	149.7	Yes	Unknown	Yes	5	6	2008	2010

E.1 Legend and Explanatory Notes

HUC11: The U.S. Geological Survey designated 11-digit Hydrologic Unit Code for Ohio's 331 Watershed Assessment Units (WAUs).

WAU/LRAU/Lake Erie AU Description: A geographic description of the Watershed, Large River, or Lake Erie Assessment Units.

WAU/LRAU Size (mi^2): The watershed drainage area of the Assessment Unit in square miles.

Integrated Report Assessment Category: U.S. EPA guidance requires each Assessment Unit to be assigned to one of five categories which reflects status of designated uses. The five categories and their definitions are as follows.

Category 1		All designated uses are met.
Category 2		Some of the designated uses are met but there is insufficient data to determine if remaining designated uses are met.
Category 3		Insufficient data to determine whether any designated uses are met.
Category 4		Water is impaired or threatened but a TMDL is not needed.
	4A	There are U.S. EPA approved TMDLs for all pollutants impairing designated uses.
	4B	Other pollution control practices required by local, State, or Federal authority are expected to address all water-pollutant combinations and attain all Water Quality Standards protecting designated uses in a reasonable period of time.
	4C	The impairment of designated use(s) is not caused by a pollutant.
Category 5		Water is impaired or threatened and a TMDL is needed.

Priority Points: A number between 1 and 13 if the Integrated Report Assessment Category is 5. Otherwise, blank. See Section 9 of the 2004 Integrated Report for an explanation of how the points are determined.

Next Scheduled Monitoring: The planned monitoring year when Ohio EPA expects to revisit the Assessment Unit for comprehensive monitoring.

Appendix E.1 (continued)

Aquatic Life Use Assessment (ALU)

Subcategories of ALU: The designated aquatic life uses as codified in the Ohio Water Quality Standards - EWH (Exceptional Warmwater Habitat), WWH (Warmwater Habitat), CWH (Coldwater Habitat), MWH-C (Modified Warmwater Habitat-Channelized), MWH-MD (Modified Warmwater Habitat-Mine Drainage), MWH-I (Modified Warmwater Habitat-Impounded), LRW/LRW-S (Limited Resource Water), LWH/WWH-L (Limited Warmwater Habitat), SSH (Seasonal Salmonid Habitat)

Sampling Years: Years with data available for specific streams and rivers within the Assessment Unit that were used to assess status of the designated aquatic life use(s).

Impairment: Yes, No, or Unknown depending on the assessment of the available sampling locations and their designated aquatic life use.

Data Assessment Summary (WAUs): Available site data from the Assessment Unit are grouped according to 4 stream size categories. Spatial category **Attainment** statistics are generated based on the proportion of sampling locations which are in full, partial, or non attainment. A weighting method is used to impart more significance to sites in larger drainage classes. Linear category **Attainment** statistics are generated based on extrapolation of full, partial, or non attaining miles to the total number of monitored stream miles. The **WAU Score** statistics are generated by averaging the spatial and linear **Attainment** statistics; these scores, weighted by stream size, reflect the relative proportion on a 0 to 100 scale of full, partial, and non attainment in the Assessment Unit. See Section 6.4.4 of the 2004 Integrated Report for a more detailed explanation of the assessment process.

Data Assessment Summary (LRAUs and Lake Erie AUs): **Attainment** statistics were generated based on extrapolation of full, partial, or non attaining miles to the total number of monitored river miles (LRAUs) or the proportion of shoreline sampling sites in full, partial, or non attainment for the Lake Erie AUs.

High Magnitude Causes: The listing of the most prominent “agents” deemed responsible for the observed aquatic life use impairment in the Assessment Unit and which will be the initial focus of restoration activities or TMDL development within the watershed. Blank if the Assessment Unit is unassessed (**Impairment: Unknown**), unless the AU was listed as impaired (**Integrated Report Assessment Category: 4 or 5**) in a previous Integrated Report and data are now considered historical, or the aquatic life uses are unimpaired (**Impairment: No**).

High Magnitude Sources: The listing of the most prominent origins of the “agents” (high magnitude causes) deemed responsible for the observed aquatic life use impairment.

Appendix E.1 (continued)

Recreation Use Assessment (WAUs and LRAUs)[1]

Subcategory of Use: "Primary Contact" refers to waters that are suitable for full-body contact recreation, such as swimming, canoeing and diving during the recreation season.

Impairment: Yes, No, or Unknown depending on the assessment of the available data from sampling locations within the Assessment Unit (AU). See Section 6.3 of the 2004 Integrated Report for a detailed explanation of the assessment process.

No. of Ambient Sites: The number of specific stream and river locations sampled by the Ohio EPA within the Assessment Unit where fecal coliform bacteria data were available for the period of record.

No. of NPDES MOR Sites: The number of permit holders within the Assessment Unit that collected fecal coliform bacteria data at one or more stream, river or lake locations and reported it to Ohio EPA via the Surface Water Information Management System (SWIMS) database during the period of record. Sites were generally a paired set of upstream and downstream locations far field from the point of discharge.

No. of Ambient Sampling Records: The number of fecal coliform bacteria values available from ambient sites within the Assessment Unit for the period of record.

No. of NPDES MOR Records: The number of fecal coliform bacteria values available from NPDES MOR sites within the AU for the period of record.

Geometric Mean: The geometric mean of all available fecal coliform bacteria data collected within the Assessment Unit for the period of record computed as the arithmetic mean of the log-transformed data.

75th %ile: A fecal coliform bacteria level at which 75% of all the results collected within the Assessment Unit were below that value and 25% were above.

90th %ile: A fecal coliform bacteria level at which 90% of all the results collected within the Assessment Unit were below that value, and 10% were above.

Other: Descriptive information about related issues such as the presence and location of dermal contact advisories for water bodies located within the Assessment Unit, if any exist.

[1]The Bathing Water recreation use was evaluated for the three Lake Erie Assessment Units using *E. coli* bacteria sample results (Appendix E.4) . See Section 4.5.2 for specific method details.

Fish Consumption Advisory (FCA) Assessment

Results of comparing FCA information to the single route exposure human health water quality criteria in Ohio's Water Quality Standards. See Section 6.2 of the 2004 Integrated Report for a more detailed explanation of the assessment process.

Waters Within the WAU/LRAU/Lake Erie AU Sampled and Assessed: Yes indicates data were available to assess; blank when no data exists or unknown.

FCA Issued: Yes indicates that a water body specific advisory regarding the human consumption of sport fish has been issued by the Ohio Department of Health for at least one water body within the Assessment Unit. Left blank when no advisory issued for waters within the Assessment Unit.

Impairment Due to FCA: Yes indicates that the level of chemical contamination associated with the issuance of the FCA was sufficiently high enough that exceedence of the single route human health water quality criterion is indicated.

Pollutant(s) (Waterbody): The specific chemical pollutant or pollutants responsible for the FCA are identified along with the specific waters within the Assessment Unit for which the advisory was issued.

HUC11	**WAU Description**	**WAU Size (mi^2):** 166.2
04100006 040	Tiffin River (downstream Leatherwood Creek to upstream Lick Creek); excluding Tiffin River mainstem	

Integrated Report Assessment Category: 5 **Priority Points: 7**

Next Scheduled Monitoring: 2011

Aquatic Life Use Assessment

Subcategories of ALU: WWH Sampling Year(s): 1997

Impairment: Yes (5)

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	% Attainment: Full	% Attainment: Partial	% Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Secondary Tributaries < 5 mi^2	Sites	Sites						
Primary Tributaries			25.0	16.5	58.5			
5-20 mi^2	2 Sites	1 Sites						
20-50 mi^2	6 Sites	0 Sites				24	29	47
Principal Streams	3 Sites							
50-500 mi^2	9.9 Miles	2.2 Miles	22.3	42.5	35.2			

High Magnitude Causes

Cause Unknown
Siltation
Organic Enrichment/DO
Direct Habitat Alterations

High Magnitude Sources

Major Industrial Point Source
Minor Municipal Point Source
Nonirrigated Crop Production
Flow Regulation/Modification - Ag.
Removal of Riparian Vegetation - Ag.
Source Unknown

Recreation Use Assessment

Subcategory of Use: Primary Contact

Impairment: Yes (5)

No. Ambient Sites: 1
No. Ambient Sampling Records: 3
No. of NPDES MOR Sites: 3
No. of NPDES MOR Records: 91
Other:

Geometric Mean: 1231
75^{th} %ile: 2575
90^{th} %ile: 12100

Fish Tissue Assessment

Waters Sampled: Yes Impairment: Yes (5)

Stream Miles Monitored: 16.67 Stream Miles Impaired: 16.67 Pollutants (Waterbody): Mercury, PCBs (Tiffin River)

Lake Acres Monitored: 49.0 Lake Acres Impaired: 0.0

WAU Comments

The 2006 Integrated Report assessment of available fish tissue data from the Tiffin River documented body burdens of one or more pollutants at levels exceeding the threshold level upon which Ohio Water Quality Standards human health criteria are based which resulted in listing as impaired for fish consumption.

Appendix D

Case Study:
Permitting Scenarios

APPENDIX D: SCENARIO 1. WQBELs FOR OAK CREEK WWTP

STREAM CONDITIONS
Oak Creek

	ANNUAL	SUMMER	WINTER
pH		7.8	7.6
Temperature (C)		24	12
Hardness (mg/l CaCO3)	150		
7Q10 Flow (cfs)	1	1	2
1Q10 Flow (cfs)	0.75	0.75	1.5
NH3-N Background (mg/l)		0.1	0.2
Copper Background (ugl)	3		

FACILITY
Oak Creek WWTP

	MGD	cfs
Design Flow	0.5	0.77

WATER QUALITY CRITERIA

	ANNUAL		SUMMER		WINTER	
	CMC	CCC	CMC	CCC	CMC	CCC
NH3-N (mg/l)			12.1	1.73	17.0	4.68
Copper (ug/l)	20.5	13.2				

WLAs

	Acute	Chronic
NH3 - Summer	24	3.8
NH3 - Winter	50	16
Copper	37	26

LTAs

	Acute	Chronic
NH3 - Summer	8	2.0
NH3 - Winter	16	9
Copper	12	14

WQBELs

	Concentration		Load (lb/day)	
	Daily Max	Monthly Ave	Daily Max	Monthly Ave
NH3-N - Summer (mg/l)	6.3	3.1	26	13
NH3-N - Winter (mg/l)	27	13	111	55
Copper (ug/l)	37	19	0.16	0.078

APPENDIX D: SCENARIO 2. TMDL FOR OAK CREEK WWTP (INCLUDES NON-POINT SOURCE REDUCTIONS)

STREAM CONDITIONS

	Oak Creek			Sycamore Creek			Upstream Shady River			Downstream Shady River		
	ANNUAL	SUMMER	WINTER	ANNUAL	SUMMER	WINTER	ANNUAL	SUMMER	WINTER	ANNUAL	SUMMER	WINTER
pH		7.8	7.6		7.7	7.6		7.9	7.7		8	7.7
Temperature (C)		24	12		24	12		25	13		27	14
Hardness (mg/l CaCO3)	150			120			110			120		
7Q10 Flow (cfs)	1	1	2	1	1	2	8	8	12	22	22	30
1Q10 Flow (cfs)	0.75	0.75	1.5	0.75	0.75	1.5	6	6	8	20	20	27
NH3-N Background (mg/l)		0.1	0.2		0.1	0.2		0.4	0.8			
Copper Background (mg/l)	3			3			3					

POINT SOURCES

	Oak Creek WWTP		Grove City WWTP		ABC Metals	
	MGD	cfs	MGD	cfs	MGD	cfs
Design Flow	0.5	0.77	5	7.7	3	4.6

	Oak Creek WWTP	Grove City WWTP	ABC Metals	Sum of Point Sources
NH3-N - Summer Load (lb/day)	13	120	0	133
NH3-N - Winter Load (lb/day)	55	480	0	535
Copper Load (lb/day)	0.078	0.67	0.37	1.12

NON-POINT SOURCES

	Agricultural	Storm Water	Sum of NPS
NH3-N - Summer Load (lb/day)	60	6	66
NH3-N - Winter Load (lb/day)	15	2	17
Copper Load (lb/day)	0	0.03	0.03

ALL SOURCES

NH3-N - Summer Load (lb/day)	199
NH3-N - Winter Load (lb/day)	552
Copper Load (lb/day)	1.15

BACKGROUND LOAD

NH3-N - Summer Load (lb/day)	18
NH3-N - Winter Load (lb/day)	56
Copper Load (lb/day)	0.16

WATER QUALITY CRITERIA

Downstream Shady River

	ANNUAL		SUMMER		WINTER	
	CMC	CCC	CMC	CCC	CMC	CCC
NH3-N (mg/l)			8.4	1.09	14.4	3.70
Copper (ug/l)	16.6	10.9				

TMDLs - Downstream Shady River

	TMDL	MOS	Background	Available	Reduction Needed	Reduction Needed (%)
NH3-N - Summer Load (lb/day)	129	13	18	98	101	51
NH3-N - Winter Load (lb/day)	599	60	56	483	70	13
Copper Load (lb/day)	1.29	0.13	0.16	1.00	0.15	13

OAK CREEK WWTP MONTHLY AVERAGE LIMITS

	Pre-TMDL		Post-TMDL	
	Conc	Load (lb/day)	Conc	Load (lb/day)
NH3-N - Summer (mg/l)	3.1	13	1.5	6.4
NH3-N - Winter (mg/l)	13	55	12	48
Copper (ug/l)	19	0.078	16	0.068

APPENDIX D: SCENARIO 3. TMDL FOR OAK CREEK WWTP (NO NON-POINT SOURCE REDUCTIONS)

STREAM CONDITIONS

	Oak Creek			Sycamore Creek			Upstream Shady River			Downstream Shady River		
	ANNUAL	SUMMER	WINTER	ANNUAL	SUMMER	WINTER	ANNUAL	SUMMER	WINTER	ANNUAL	SUMMER	WINTER
pH		7.8	7.6		7.7	7.6		7.9	7.7		8	7.7
Temperature (C)		24	12		24	12		25	13		27	14
Hardness (mg/l CaCO3)	150			120			110			120		
7Q10 Flow (cfs)	1	1	2	1	1	2	8	8	12	22	22	30
1Q10 Flow (cfs)	0.75	0.75	1.5	0.75	0.75	1.5	6	6	8	20	20	27
NH3-N Background (mg/l)		0.1	0.2		0.1	0.2		0.4	0.8			
Copper Background (mg/l)	3			3			3					

POINT SOURCES

	Oak Creek WWTP		Grove City WWTP		ABC Metals	
	MGD	cfs	MGD	cfs	MGD	cfs
Design Flow	0.5	0.77	5	7.7	3	4.6

	Oak Creek WWTP	Grove City WWTP	ABC Metals	Sum of Point Sources
NH3-N - Summer Load (lb/day)	13	120	0	133
NH3-N - Winter Load (lb/day)	55	480	0	535
Copper Load (lb/day)	0.078	0.67	0.37	1.12

NON-POINT SOURCES

	Agricultural	Storm Water	Sum of NPS
NH3-N - Summer Load (lb/day)	60	6	66
NH3-N - Winter Load (lb/day)	15	2	17
Copper Load (lb/day)	0	0.03	0.03

ALL SOURCES

NH3-N - Summer Load (lb/day)	199
NH3-N - Winter Load (lb/day)	552
Copper Load (lb/day)	1.15

BACKGROUND LOAD

NH3-N - Summer Load (lb/day)	18
NH3-N - Winter Load (lb/day)	56
Copper Load (lb/day)	0.16

WATER QUALITY CRITERIA

Downstream Shady River

	ANNUAL		SUMMER		WINTER	
	CMC	CCC	CMC	CCC	CMC	CCC
NH3-N (mg/l)			8.4	1.09	14.4	3.70
Copper (ug/l)	16.6	10.9				

TMDLs - Downstream Shady River

	TMDL	MOS	Background	Non-Point Sources	Available	Reduction Needed	Reduction Needed (%)
NH3-N - Summer Load (lb/day)	129	13	18	66	32	101	76
NH3-N - Winter Load (lb/day)	599	60	56	17	466	70	13
Copper Load (lb/day)	1.29	0.13	0.16	0.03	0.97	0.15	13

OAK CREEK WWTP MONTHLY AVERAGE LIMITS

	Pre-TMDL		Post-TMDL	
	Conc	Load (lb/day)	Conc	Load (lb/day)
NH3-N - Summer (mg/l)	3.1	13	0.7	3.1
NH3-N - Winter (mg/l)	13	55	12	48
Copper (ug/l)	19	0.078	16	0.068