Index to Exhibits

Volume I

Exhibit A. U.S. Envtl. Prot. Agency, *Clarifications Regarding Certain Aspects of EPA's Surface Water Toxics Control Regulations* (1992).

Exhibit B. U.S. Envtl, Prot. Agency, *Permit Writers' Manual* (September 2010) (excerpts including Introduction, Chapter 6, and Chapter 9).

Exhibit C. U.S. Envtl. Prot. Agency, *Technical Support Document For Water Quality-based Toxics Control* (EPA/505/2-90-001) (March 1991) (excerpt includes Chapter 3).

Exhibit D. Dave Serdar et. al, *Spokane River PCB Source Assessment, 2003-2007* (Wash. Dep't of Ecology 2011).

Exhibit E. U.S. Geological Survey, *Ecological Indicators of Water Quality in the Spokane River, Idaho and Washington, 1998 and 1999* (September 2003).

Exhibit F. Patti Sandvik, Memorandum, *Baseline Summary of Long-Term Monitoring Effort in the Spokane River for PCBs, PBDEs, and Metals* (Wash. Dep't of Ecology 2011).

Exhibit G. Randy Coots and Casey Deligeannis, *PCBs, Dioxins and Furans in Fish, Sediment, and Wastewater Treatment Plant Effluent from West Medical Lake* (Washington Dep't of Ecology 2010).

Exhibit H. U.S. Envtl. Prot. Agency, *Decision on Petition for Rulemaking to Publish Water Quality Standards on the Mississippi and Missouri Rivers Within Arkansas, Illinois, Iowa, Kansas, Kentucky, Missouri, Nebraska and Tennessee* (June 25, 2004).

Exhibit I. Wash. Dep't of Ecology, *Fact Sheet for Spokane Cnty. Reg'l Water Reclamation Facility* (Nov. 28, 2011).

Exhibit J. Penn. Dep't of Envtl. Prot., *Total Maximum Daily Load, PCB and Chlordane, Ohio River* (March 2001).

Volume II

Exhibit K. Wash. Dep't of Ecology, *Fact Sheet for Liberty Lake Sewer & Water Dist.* (May 24, 2011).

Exhibit L. Wash. Dep't of Ecology, *Fact Sheet for Inland Empire Paper Co.* (Sept. 29, 2011).

Exhibit M. *Memorandum of Agreement Regarding Spokane River Regional Toxics Task Force* (January 23, 2012).

Exhibit N. Wash. Dep't of Ecology, *Final Permit for Kaiser Aluminum Fabricated Products, LLC* (June 23, 2011).

Exhibit O. Wash. Dep't of Ecology, *Final Permit for City of Spokane Riverside Park Water Reclamation Facility and Combined Sewer Overflows* (June 16, 2011).

Exhibit P. Wash. Dep't of Ecology, *Final Permit for Inland Empire Paper Co.* (Sept. 29, 2011).

Exhibit Q. Findings of Fact, Conclusions of Law and Order, *Sierra Club, et al. v. Washington Dep't of Ecology, et al.*, PCHB No. 110184 (Wash. Pollution Control Hearings Bd. July 19, 2013).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 14 1992

OFFICE OF WATER

MEMORANDUM

SUBJECT: Clarifications Regarding Certain Aspects of EPA's Surface Water Toxics Control Regulations

FROM: for Michael B. Cook, Director
Office of Wastewater Enforcement And Compliance

Robert H. Wayland, III, Director
Office of Wetlands, Oceans and Watersheds

TO: Water Management Division Directors, Regions I-X

Attached is a set of clarifications relating to five issues associated with EPA's Surface Water Toxics Control Regulations. Each clarification concerns aspects of EPA's regulations relating to section 304(l) and water quality-based effluent limitations.

These clarifications are being issued by EPA in connection with negotiations between EPA and petitioners in the case of American Paper Institute v. EPA (No. 89-1499), which is pending in the U.S. Court of Appeals for the D.C. Circuit. In return, petitioners have agreed not to brief the issues that are subject to these clarifications in the aforementioned case.

Your offices should refer to these clarifications when applying the regulations to which they correspond. We also ask that you distribute these clarifications to the States within your respective regions.

cc: Regional Counsel Water Branch Chiefs, Regions I-X

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CLARIFICATIONS

1. ISSUE: The definition of whole effluent toxicity in 40 C.F.R. § 122.2.

CLARIFICATION:

EPA defined whole effluent toxicity in 40 C.F.R. § 122.2 as the "aggregate toxic effect of an effluent measured directly by a toxicity test." The petitioners were concerned that this definition, in conjunction with the requirement in 40 C.F.R. § 122.44(d)(1)(iv) and (v) that states implement narrative criteria by imposing limits on whole effluent toxicity, could be read expansively to require states to impose whole effluent toxicity limits prohibiting discharges which evoke any response in test organisms, no matter how slight, as measured by toxicity tests. The petitioners stated that such an interpretation could deprive a state of the authority to define what it considers to be acceptable levels of toxicity in a discharger's effluent consistent with applicable water quality standards. EPA does not interpret the definition of whole effluent toxicity in section 122.2, or the requirements of section 122.44(d)(1)(iv) and (v), as imposing any substantive water quality standard for what constitutes an acceptable level of whole effluent toxicity. Rather, these sections indicate when the permitting authority must establish permit limits on whole effluent toxicity for purposes of achieving water quality standards (either numeric or narrative water quality criteria).

2. ISSUE: The enforceability of limitations based upon single toxicity test results, as discussed at 54 Fed. Reg. 23,871.

CLARIFICATION:

In the preamble to the final rule, at 54 Fed. Reg. 23,871, EPA stated that:

> A limit on whole effluent toxicity refers to a numeric effluent limitation expressed in terms such as toxic units, no observed effect level (NOEL), LC 50, or percent mortality. Effluent limitations may be expressed as chronic toxicity or acute toxicity (or both). Regardless of how the numeric limitations for whole effluent toxicity are expressed, any single violation of an effluent limit is a violation of the NPDES permit and is subject to the full range of state and Federal enforcement actions.

EPA interprets this paragraph and existing regulations to provide that violation of an effluent limit for whole effluent toxicity is enforceable, whether that limit is expressed in terms of a numeric effluent limit or, where setting a numeric effluent

limit is infeasible, best management practices. (For example, some storm water discharges have volumes and pollutant concentrations that fluctuate wildly with storm events, making it difficult to document resulting water quality impacts.) The preamble statement does not address the issue of how permit limits may be derived. For example, when used appropriately, permit limits may include averages (e.g., monthly averages) which may be exceeded by an individual measurement so long as the average of the individual measurements is not above the limit and any applicable daily maximum is complied with. Permit limits, however expressed, must be designed to protect water quality standards.

3. ISSUE: The requirement for limitations on all pollutants and the use of indicators, as set forth at 40 C.F.R. § 122.44(d)(1)(i).

CLARIFICATION:

40 C.F.R. § 122.44(d)(1)(i) requires that permits contain effluent limitations to control pollutants that "are or may be" discharged at levels having the "reasonable potential to cause, or contribute to an excursion above any State water quality standard, including State narrative criteria for water quality."

EPA did not intend to require water quality-based permit limitations on all pollutants contained in a discharge through the promulgation of the June 2, 1989 regulation; nor do we believe that the regulation has that effect. The proper interpretation of the regulations is that developing water quality-based limitations is a step-by-step process. First, the permitting authority must evaluate all available information to determine at what level pollutants are expected to exist in the current discharge. This determination is governed by 40 C.F.R. § 122.44(d)(1)(ii). The goal of this step is to estimate the levels of pollutants in the effluent as discharged at the time of permit application, or with any projected increases in the discharge.

Under 40 C.F.R. § 122.44(d)(1)(ii), the permitting authority must take into account the likely variability of the pollutant in the effluent, other current discharges (from both point and non-point sources as well as natural background), and (where appropriate) dilution. At the end of this step the permitting authority will have estimated an in-stream level of the pollutant (or pollutant parameter) of concern that has the reasonable potential to occur as a result of the discharge. (Most of this

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[1] The technological or economic feasibility of a discharger meeting numeric limitations is not relevant to this determination.

step may have already been completed as a part of the total maximum daily load and wasteload allocation calculation.) If the estimated in-stream levels (which may occur, but will not necessarily occur) would exceed any applicable water quality criterion, including the narrative criteria, then the permitting authority must go to the next step and establish a water quality-based limit in accordance with paragraphs 122.44(d)(1)(iii)-(vi).

EPA does not interpret section 122.44(d)(1)(i) as requiring that permits contain water quality-based limitations on every pollutant that may be present in a given effluent. Rather, water quality-based limits are established where the permitting authority reasonably anticipates the discharge of pollutants by the permittee at levels that have the reasonable potential to cause or contribute to an excursion above any state water quality criterion, including state narrative criteria for water quality. 40 C.F.R. § 122.44(d)(1)(i). The permitting authority should evaluate the reasonable potential for an excursion above a water quality criterion in light of the character of the effluent as discharged.

4. <u>ISSUE</u>: The use of a state policy or regulation interpreting state narrative water quality criteria, as set forth at 40 C.F.R. § 122.44(d)(1)(vi)(A).

<u>CLARIFICATION</u>:

The final rule provides that a permitting authority must establish permit limits using one or more of several options whenever a specific chemical for which the state has not established a water quality criterion is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above a state narrative criterion. 40 C.F.R. § 122.44(d)(1)(vi). The rule then prescribes several options for establishing permit limitations, including "explicit State policy or regulation interpreting [the State's] narrative water quality criterion . . . ." 54 Fed. Reg. at 23,896, codified at 40 C.F.R. § 122.44(d)(1)(vi)(A).

EPA interprets section 122.44(d)(1)(vi) as requiring permit writers to use a formally adopted state regulation or policy (including any state waste load allocation approved by EPA or established by EPA using formally-adopted state regulations or polices, where available) for deriving a chemical-specific numeric water quality-based effluent limitation from an applicable narrative standard in lieu of the other options for interpreting a narrative standard set forth in that section, if such a formally-adopted state regulation or policy exists. Such a regulation or policy would typically be part of either a state's water quality standards or total maximum daily load for the water body in question, and would be subject to EPA approval or disapproval in accordance with 40 C.F.R. Parts 130 or 131. If

the state had not formally adopted a state regulation or policy pursuant to 40 C.F.R. Parts 130 or 131, or if it has not been approved as part of the state NPDES program, the permit writer must develop limits, using any one of the options set forth in section 122.44(d)(1)(vi). Some of the industry petitioners in American Paper Institute v. U.S. EPA (D.C. Cir. No. 89-1499) and consolidated cases do not agree that a formally adopted state regulation or policy must be subject to EPA approval or disapproval before permit writers would be required to use the policy in developing limits. EPA expects this issue to be litigated in the permit context.

When a permit writer interprets a narrative standard, the method of interpretation used will be available for public comment as a part of the permit and typically may be appealed through administrative and judicial procedures available for review of NPDES permit conditions.

5. ISSUE: The standards for listing waters on the list of Clean Water Act ("CWA") section 304(l)(1)(B), 33 U.S.C. § 1314(l)(1)(B), as set out at 40 C.F.R. § 130.10(d)(5.

CLARIFICATION:

Section 304(l)(1)(B) of the CWA, 33 U.S.C. § 1314(l)(1)(B), provides that the state should list waters where an applicable water quality standard is exceeded "due entirely or substantially" to point sources. EPA's final rule requires listing of a water under section 304(l)(1)(B) where (1) water quality-based limits on one or more point sources would result in the water quality standard for a toxic pollutant being achieved, or (2) discharges from one or more point sources would be sufficient to cause or are expected to cause an exceedence of the water quality standard for a toxic pollutant, regardless of any contribution of the same pollutant from nonpoint sources. 54 Fed. Reg. at 23,897, codified at 40 C.F.R. § 130.10(d)(5).

The conditions in 40 C.F.R. § 130.10(d)(5) govern only the determination of whether or not a given water should be listed under section 304(l)(1)(B). Section 130.10 (d)(5) does not dictate the limitations to be included in an individual control strategy ("ICS"). ICSs may be developed in light of permit limits and nonpoint source requirements established through the total maximum daily load ("TMDL") process. The TMDL is a quantification of the capacity of a waterbody to assimilate pollutants based on the applicable water quality standard. The TMDL consists of the sum of wasteload allocations for point sources, load allocations for nonpoint sources, and natural background, with a margin of safety to account for uncertainty. Subject to EPA approval, if a state determines that reductions in the discharge of pollutants from a point source would be inequitable or prohibitively expensive, the state may adopt a

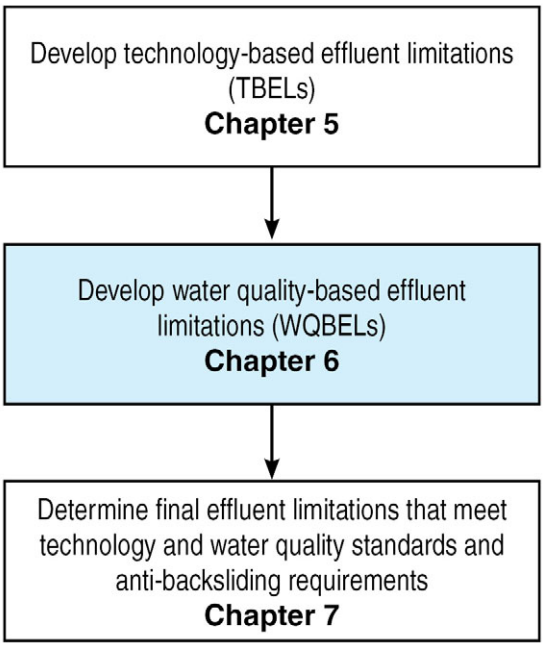
TMDL for achieving the water quality standards which relies in whole or in part upon control requirements on nonpoint sources. See 40 C.F.R. Section 130.7

CHAPTER 6. Water Quality-Based Effluent Limitations

When drafting a National Pollutant Discharge Elimination System (NPDES) permit, a permit writer must consider the impact of the proposed discharge on the quality of the receiving water. Water quality goals for a waterbody are defined by state water quality standards. By analyzing the effect of a discharge on the receiving water, a permit writer could find that technology-based effluent limitations (TBELs) alone will not achieve the applicable water quality standards. In such cases, the Clean Water Act (CWA) and its implementing regulations require development of water quality-based effluent limitations (WQBELs). WQBELs help meet the CWA objective of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters and the goal of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water (*fishable/swimmable*).

WQBELs are designed to protect water quality by ensuring that water quality standards are met in the receiving water. On the basis of the requirements of 40 CFR 125.3(a), additional or more stringent effluent limitations and conditions, such as WQBELs, are imposed when TBELs are not sufficient to protect water quality. Exhibit 6-1 illustrates the relationship between TBELs and WQBELs in an NPDES permit, as well as the determination of final effluent limitations.

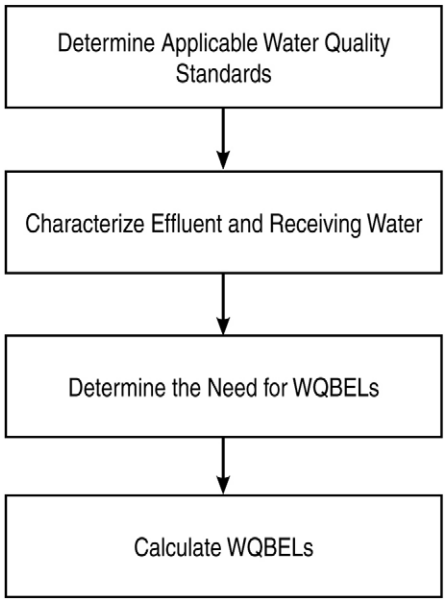
Exhibit 6-1 Developing effluent limitations



CWA section 301(b)(1)(C) requires that permits include any effluent limitations necessary to meet water quality standards. As illustrated above, to satisfy that requirement, permit writers implement a process to determine when existing effluent limitations (e.g., TBELs) and existing effluent quality are not sufficient to comply with water quality standards and to, where necessary, develop WQBELs. Exhibit 6-2 illustrates the four basic parts of the *standards-to-permits* process used to assess the need for and develop WQBELs.

After completing that process, the permit writer determines the final effluent limitations, includes any compliance schedules and interim effluent limitations, as appropriate, and documents all his or her decisions and calculations.

Exhibit 6-2 Standards-to-permits process



This chapter provides basic information on the standards-to-permits process. For more detailed information on water quality standards and water quality-based permitting, and some of the specific topics discussed in this chapter, refer to the NPDES Website <www.epa.gov/npdes> and Water Quality Standards Website <www.epa.gov/waterscience/standards>.

6.1 Determine Applicable Water Quality Standards

CWA section 303(c) and Title 40 of the *Code of Federal Regulations* (CFR) Part 131 establish the framework for water quality standards. The CWA and implementing regulations require states to develop and, from time to time, revise water quality standards applicable to waters of the United States, or segments of such waterbodies, that are in the jurisdiction of the state. States must review their water quality standards at least once every 3 years and revise them as appropriate. Wherever attainable, water quality standards should protect water quality that provides for the protection and propagation of fish, shellfish and wildlife, and recreation in and on the water (i.e., the CWA section 101(a)(2) *fishable/swimmable* goal). In establishing standards, states must consider the use and value of their waters for public water supplies, propagation of fish and wildlife, recreation, agriculture and industrial purposes, and navigation. The U.S. Environmental Protection Agency (EPA) has provided information regarding procedures for developing water quality standards in the Water Quality Standards Regulation at Part 131 and EPA's *Water Quality Standards Handbook: Second Edition*[1] <www.epa.gov/waterscience/library/wqstandards/handbook.pdf.> (hereafter *WQS Handbook*). Under CWA section 510, states may develop water quality standards that are more stringent than those required by the CWA.

EPA Regions review and approve or disapprove new and revised water quality standards adopted by states. The purpose of EPA's review is to ensure that the new and revised water quality standards meet the requirements of the CWA and the Water Quality Standards Regulation. Water quality standards adopted and submitted to EPA after May 30, 2000, must be approved by EPA before they may be used to implement the CWA (e.g., used in NPDES permitting). If an EPA Region disapproves a submitted new or revised state water quality standard, and the state does not adopt the necessary changes within 90 days of notification of the disapproval, EPA must promptly propose and promulgate a replacement standard [see § 131.22(a)].

When writing an NPDES permit, the permit writer must identify and use the state water quality standards in effect for CWA purposes. EPA maintains a compilation of current state water quality standards on the Water Quality Standards: State, Tribal, & Territorial Standards Website <www.epa.gov/waterscience/standards/wqslibrary/>. In addition, EPA's Water Quality Standards: Laws and Regulations Website <http://www.epa.gov/waterscience/standards/rules/> provides federally promulgated standards applicable to specific states. The remainder of this section provides permit writers with a general overview of water quality standards and how they are implemented in NPDES permits.

6.1.1 Components of Water Quality Standards

Water quality standards comprise three parts:

- Designated uses.
- Numeric and/or narrative water quality criteria.
- Antidegradation policy.

Each of those three components, along with general policies that also may be included in state water quality standards, is described below.

6.1.1.1 Designated Uses (§ 131.10)

The first part of a state's water quality standards is a classification system for waterbodies based on the expected uses of those waterbodies. The uses in this system are called *designated uses*. The regulations at § 131.10(a) describe various uses of waters that are considered desirable and that must be considered when establishing water quality standards. Those uses include public water supplies, propagation of fish, shellfish, and wildlife, recreation in and on the water, agricultural, industrial, and other purposes including navigation. The regulations allow states to designate more specific uses (e.g., cold water aquatic life) [see § 131.10(c)] or uses not specifically mentioned in the CWA, with the exception of waste transport and assimilation, which are not acceptable designated uses [see § 131.10(a)]. States must also consider and ensure the attainment and maintenance of the water quality standards of downstream waters when establishing designated uses [see § 131.10(b)].

The regulations in § 131.10(j) effectively establish a *rebuttable presumption* that the uses in CWA section 101(a)(2) (fishable/swimmable) are attainable. If a state fails to designate a given waterbody for such uses, or wishes to remove such uses, it must provide appropriate documentation demonstrating why such uses are not attainable. This analysis is commonly called a *Use Attainability Analysis* (UAA) (see § 131.3(g) and section 6.1.2.1 below.

6.1.1.2 Water Quality Criteria (§ 131.11)

The second part of a state's water quality standards is the set of water quality criteria sufficient to support the designated uses of each waterbody. EPA's Water Quality Standards Regulation at § 131.11(a) requires states to adopt water quality criteria using sound scientific rationale and to include sufficient parameters or constituents to protect the designated use. If a waterbody has multiple use designations, the criteria must support the most sensitive use. The regulation at § 131.11(b) allows states to adopt both numeric and narrative water quality criteria. Numeric water quality criteria are developed for specific parameters to protect aquatic life and human health and, in some cases, wildlife from the deleterious effects of pollutants. States establish narrative criteria where numeric criteria cannot be established, or to supplement numeric criteria. Criteria newly adopted or revised on or after May 30, 2000, do not become effective for purposes of the CWA until approved by EPA (see § 131.21(c)).

CWA section 304(a) directs EPA to develop, publish, and, from time to time, revise criteria for water quality accurately reflecting the latest scientific knowledge on the following:

- The kind and extent of all identifiable effects on health and welfare, including effects on aquatic life and recreational uses, that may be expected from the presence of pollutants in any body of water.
- The concentration and dispersal of pollutants or their byproducts through biological, physical, and chemical processes.
- The effects of pollutants on biological community diversity, productivity, and stability.

EPA's recommended criteria developed under CWA section 304(a) assist states in developing their water quality standards. EPA's numeric criteria are ambient levels of individual pollutants or parameters or they describe conditions of a waterbody that, if met, generally will protect the CWA section 101(a)(2) fishable and swimmable uses. EPA's recommended criteria developed under CWA section 304(a) do not reflect consideration of economic impacts or the technological feasibility of meeting the chemical concentrations in ambient water. EPA provides a table of the nationally recommended CWA section 304(a) criteria on the National Recommended Water Quality Criteria Website <www.epa.gov/waterscience/criteria/wqctable/>. The regulation at § 131.11(b)(1) indicates that, in establishing numeric criteria, states may (1) adopt EPA's recommended criteria published under CWA section 304(a), (2) adopt those criteria modified to reflect site-specific conditions, or (3) adopt criteria based on other scientifically defensible methods.

CWA section 303(c)(2)(B) specifically requires states to adopt numeric criteria for CWA section 307(a) toxic (priority) pollutants for which EPA has published recommended criteria if the discharge or presence of the pollutant can reasonably be expected to interfere with designated uses. Furthermore, § 131.11(a)(2) requires states to review water quality data and information on discharges to identify specific water bodies where toxic pollutants might be adversely affecting water quality or attainment of designated uses or where levels of toxic pollutants would warrant concern and to adopt criteria for such toxic pollutants applicable to the waterbody that are sufficient to protect the designated use. As discussed in section 1.2 and presented in Exhibit C-1 in Appendix C of this manual, the CWA section 307(a) list contains 65 compounds and families of compounds, which EPA has interpreted to include 126 toxic (priority) pollutants.

Numeric Criteria—Aquatic Life

Numeric criteria for the protection of aquatic life are designed to protect aquatic organisms, including both plants and animals. EPA's aquatic life criteria address both short-term (acute) and long-term (chronic) effects on both freshwater and saltwater species. Each of those criteria generally consists of three components:

- **Magnitude:** The level of pollutant (or pollutant parameter), usually expressed as a concentration, that is allowable.
- **Duration:** The period (averaging period) over which the in-stream concentration is averaged for comparison with criteria concentrations.
- **Frequency:** How often criteria may be exceeded.

Are criteria and effluent limitations expressed in the same terms?

Generally, criteria and effluent limitations are not expressed in the same terms. As discussed above, criteria are generally expressed as a magnitude, duration and frequency. Effluent limitations in NPDES permits are generally expressed as a magnitude (e.g., milligrams per liter, micrograms per liter) and an averaging period (e.g., maximum daily, average weekly, average monthly). A permit writer should be aware of the procedures used by his or her permitting authority to appropriately reflect the magnitude, duration, and frequency components of aquatic life criteria when determining the need for and calculating effluent limitations for NPDES permits. Typically, the components of the criteria are addressed in water quality models through the use of statistically derived receiving water and effluent flow values that ensure that criteria are met under *critical conditions* (see section 6.2 below).

Exhibit 6-3 is an example of freshwater aquatic life criteria for cadmium from the National Recommended Water Quality Criteria Website <www.epa.gov/waterscience/criteria/wqctable/> and at 66 FR 18935, April 12, 2001, Notice of Availability of 2001 Update: Aquatic Life Criteria Document for Cadmium <www.epa.gov/EPA-WATER/2001/April/Day-12/w9056.htm>.

Exhibit 6-3 Aquatic life criteria example: Cadmium (dissolved)

Except possibly where a locally important species is unusually sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if

Chronic criterion:
The 4-day average concentration (in micrograms per liter [µg/L]) does not exceed the numerical value given by $e^{(0.7409[\ln(\text{hardness})]-4.719)}$ (1.101672 – [(ln hardness)(0.041838)]) more than once every 3 years on average.

Acute criterion:
The 24-hour average concentration (in µg/L) does not exceed the numerical value given by $e^{(1.0166[\ln(\text{hardness})]-3.924)}$ (1.136672 – [(ln hardness)(0.041838)]) more than once every 3 years on average.

It is apparent that the acute and chronic aquatic life criteria for cadmium are not simply single numbers. Rather, they are expressed as a magnitude, a duration (4-day average or 24-hour average), and a frequency (not more than once every 3 years). Furthermore, the magnitude is expressed by a formula that is hardness-dependent, as is the case for most criteria for metals.

The magnitude of other aquatic life criteria can vary according to other conditions in the water or even based on the presence or absence of certain aquatic life. For example, EPA's 1999 recommended ammonia criteria vary according to pH, temperature, the presence or absence of salmonid species, and the presence or absence of early life stages of fish. A permit writer must be aware of the applicable criteria and any state regulations, policies, and procedures for interpreting numeric criteria and for implementing the criteria in NPDES permits. The durations of aquatic life criteria vary as well. For example, EPA's criteria recommendations for ammonia include a 30-day average chronic criterion. Also, many acute criteria for toxic pollutants are expressed as a 1-hour average. The frequency component of most aquatic life criteria specifies that they should be exceeded no more than once every three years.

Some states have adopted numeric criteria for nutrients as part of their water quality standards. EPA has developed nutrient criteria recommendations that are numeric values for both causative (phosphorus and nitrogen) and response (chlorophyll *a* and turbidity) variables associated with the prevention and assessment of eutrophic conditions. EPA's recommended nutrient criteria are different from most of its other recommended criteria, such as the criteria for cadmium and ammonia. First, EPA's recommended nutrient criteria are *ecoregional* rather than nationally applicable criteria, and they can be refined and localized using nutrient criteria technical guidance manuals. Second, the recommended nutrient criteria represent conditions of surface waters that have minimal impacts caused by human activities rather than values derived from laboratory toxicity testing. Third, the recommended nutrient criteria are do not include specific duration or frequency components; however, the ecoregional nutrient criteria documents indicate that states may adopt seasonal or annual averaging periods for nutrient criteria instead of the 1-hour, 24-hour, or 4-day average durations typical of aquatic life criteria for toxic pollutants. The ecoregional nutrient criteria documents, technical guidance manuals, and other information on EPA's nutrient criteria recommendations, are available on the Water Quality Criteria for Nitrogen and Phosphorus Pollution Website <www.epa.gov/waterscience/criteria/nutrient/>.

Water quality standards also typically include aquatic life criteria for parameters such as temperature and pH that are not chemical constituents. Criteria for pH generally are expressed as an acceptable pH range in the waterbody. Temperature criteria might be expressed as both *absolute temperature values* (e.g., temperature may not exceed 18 degrees Celsius [°C]) and restrictions on causing *changes in temperature* in the waterbody (e.g., discharges may not warm receiving waters by more than 0.5 °C).

In addition to criteria for individual pollutants or pollutant parameters, many states include in their water quality standards criteria for dissolved oxygen. Often, criteria for dissolved oxygen are addressed by modeling and limiting discharges of oxygen-demanding pollutants such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), and nutrients (phosphorus and nitrogen).

Finally, states could also include in their water quality standards numeric criteria to address the effect of mixtures of pollutants. For example, whole effluent toxicity (WET) criteria protect the waterbody from the aggregate and synergistic toxic effects of a mixture of pollutants. WET is discussed in detail later in this chapter.

Numeric Criteria—Human Health

Human health criteria for toxic pollutants are designed to protect people from exposure resulting from consumption of fish or other aquatic organisms (e.g., mussels, crayfish) or from consumption of both water and aquatic organisms. These criteria express the highest concentrations of a pollutant that are not

expected to pose significant long-term risk to human health. Exhibit 6-4 is an example of human health criteria for dichlorobromomethane.

Exhibit 6-4 Human health criteria example: Dichlorobromomethane

For the protection of human health from the potential carcinogenic effects of dichlorobromomethane through ingestion of water and contaminated aquatic organisms, the ambient water criterion is determined to be 0.55 µg/L.

For the protection of human health from the potential carcinogenic effects of dichlorobromomethane through ingestion contaminated aquatic organisms alone, the ambient water criterion is determined to be 17 µg/L.

These values were calculated based on a national default freshwater/estuarine fish consumption rate of 17.5 grams per day.

Other criteria for protection of human health (e.g., bacteria criteria) consider a shorter-term exposure through uses of the waterbody such as contact recreation. EPA's current bacteria criteria recommendations use enterococci and *Escherichia coli* bacteria as indicators and include two components: a geometric mean value and a single sample maximum value. EPA has developed information on implementing those criteria in water quality standards on the Microbial (Pathogen) Water Quality Criteria Website <www.epa.gov/waterscience/criteria/humanhealth/microbial/>.

Other Numeric Criteria

In addition to aquatic life and human health criteria, some state water quality standards include other forms of numeric criteria, such as wildlife, sediment, and biocriteria.

Wildlife criteria are derived to establish ambient concentrations of chemicals that, if not exceeded, will protect mammals and birds from adverse impacts resulting from exposure to those chemicals through consumption of aquatic organisms and water. EPA established four numeric criteria to protect wildlife in the Great Lakes system in its *Final Water Quality Guidance for the Great Lakes System* <www.epa.gov/EPA-WATER/1995/March/Day-23/pr-82.html> (60 FR 15387, March 23, 1995).

In a healthy aquatic community, sediments provide a habitat for many living organisms. Controlling the concentration of pollutants in the sediment helps to protect bottom-dwelling species and prevents harmful toxins from moving up the food chain and accumulating in the tissue of animals at progressively higher levels. For more information on this topic, see EPA's Suspended and Bedded Sediments Website <http://www.epa.gov/waterscience/criteria/sediment/>.

The presence, condition and numbers of types of fish, insects, algae, plants, and other organisms are data that, together, provide direct, accurate information about the health of specific bodies of water. Biological criteria (biocriteria) are narrative or numeric expressions that describe the reference biological integrity (structure and function) of aquatic communities inhabiting waters of a given designated aquatic life use. Biocriteria are based on the numbers and kinds of organisms present and are regulatory-based biological measurements. They are used as a way of describing the qualities that must be present to support a desired condition in a waterbody, and they serve as the standard against which biological assessment results are compared. EPA's Biocriteria: Uses of Data in NPDES Permits Website <http://www.epa.gov/waterscience/biocriteria/watershed/npdes.html> provides more information on the use of bioassessment information.

Narrative Criteria

All states have adopted narrative water quality criteria to supplement numeric criteria. Narrative criteria are statements that describe the desired water quality goal for a waterbody. Narrative criteria, for example, might require that discharges be "free from toxics in toxic amounts" or be "free of objectionable color, odor, taste, and turbidity." Narrative criteria can be the basis for limiting specific pollutants for which the state does not have numeric criteria [§ 122.44(d)(1)(vi)] or they can be used as the basis for limiting toxicity using WET requirements where the toxicity has not yet been traced to a specific pollutant or pollutants [§ 122.44(d)(1)(v)]. For toxic pollutants, EPA's Water Quality Standards Regulation at § 131.11(a)(2) requires states to develop implementation procedures for toxics narrative criteria that address how the state intends to regulate point source discharges of toxic pollutants to water quality limited segments.

6.1.1.3 Antidegradation Policy (§ 131.12)

The third part of a state's water quality standards is its antidegradation policy. Each state is required to adopt an antidegradation policy consistent with EPA's antidegradation regulations at § 131.12 A state's antidegradation policy specifies the framework to be used in making decisions about proposed activities that will result in changes in water quality. Antidegradation policies can play a critical role in helping states protect the public resource of water whose quality is better than established criteria levels and ensure that decisions to allow reductions in water quality are made in a public manner and serve the public good. Along with developing an antidegradation policy, each state must identify the method it will use to implement the policy. It is important for permit writers to be familiar with their state's antidegradation policy and how that policy is to be implemented in NPDES permits.

A state's antidegradation policy provides three levels of protection from degradation of existing water quality:

- **Tier 1:** This tier requires that existing uses, and the level of water quality necessary to protect the existing uses, be maintained and protected.
- **Tier 2:** Where the quality of waters exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water (sometimes referred to as *high-quality waters*), Tier 2 requires that this level of water quality be maintained and protected unless the state finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area where the waters are located. In allowing any such degradation or lower water quality, the state must assure water quality adequate to protect existing uses fully and must assure that there will be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control.
- **Tier 3:** This tier requires that the water quality of outstanding national resources waters (ONRWs) be maintained and protected.

States take a variety of approaches to implementing antidegradation policies. Some states designate their waters as Tier 1, Tier 2 (high-quality water) or Tier 3 waters in their antidegradation implementation methods, while others designate a waterbody as a Tier 2 or high-quality water only when activities that would degrade water quality are proposed. In some cases, states may have classified the waterbody as

receiving a tier of protection for all pollutant-related parameters, whereas in other cases, tiers of protection have been determined on a parameter-by-parameter basis.

6.1.1.4 General Policies (§ 131.13)

In addition to the three required components of water quality standards, states may, at their discretion, include in their standards policies that generally affect how the standards are applied or implemented. Examples of such policies include mixing zone policies, critical low flows at which criteria must be achieved, and the availability of variances. Some general policies are discussed in more detail later in this chapter. As with the other components of water quality standards, general policies are subject to EPA review and approval if they are deemed to be new or revised water quality standards (i.e., if they constitute a change to designated use(s), water quality criteria, antidegradation requirements, or any combination).

Additional and more detailed information on water quality standards is available in the WQS Handbook.

6.1.2 Water Quality Standards Modifications

Permit writers should be aware of several types of modifications to water quality standards that could permanently or temporarily change the standards and, thus, change the fundamental basis of WQBELs. Those modifications, described below, are as follows:

- Designated use reclassification.
- Site-specific water quality criteria modification.
- Water quality standard variance.

6.1.2.1 Designated Use Reclassification

Once a use has been designated for a particular waterbody or segment, that use may not be removed from the water quality standards except under specific conditions. To remove a designated use, the state demonstrates that attaining that use is not feasible because of any one of the six factors listed in § 131.10(g). The regulations at § 131.10(j) specifically require a state to conduct a UAA if the designated uses for a waterbody do not include the uses in CWA section 101(a)(2) (i.e., fishable/swimmable uses); if the state wishes to remove designated uses included in CWA section 101(a)(2) from its water quality standards; or if the state wishes to adopt subcategories of CWA section 101(a)(2) uses with less stringent criteria. The WQS Handbook discusses UAAs and removing designated uses in detail. Reclassifying a waterbody's designated uses, as supported by a UAA, is a permanent change to both the designated use(s) and the water quality criteria associated with that (those) use(s).

States may conduct a UAA and remove a designated use but not if it is an existing use. Existing uses are defined in § 131.3 as those uses actually attained in the waterbody on or after November 28, 1975 (the date of EPA's initial water quality standards regulation at 40 *Federal Register* 55334, November 28, 1975). At a minimum, uses are deemed attainable if they can be achieved by the implementing effluent limits required under CWA sections 301(b) and 306 and by implementing cost effective and reasonable best management practices (BMPs) for nonpoint source control. EPA's Water Quality Standards: UAA Website <http://www.epa.gov/waterscience/standards/uses/uaa/index.htm> provides additional information and some example UAAs.

6.1.2.2 Site-Specific Water Quality Criteria Modification

As noted above, CWA sections 303(a)–(c) require states to adopt water quality criteria sufficient to protect applicable designated uses. In some cases, a state might find that the criteria it has adopted to protect a waterbody or segment of a waterbody do not adequately account for site-specific conditions. In such cases, states have the option of modifying water quality criteria on a site-specific basis. Setting site-specific criteria might be appropriate where, for example, a state has adopted EPA's CWA section 304(a) criteria recommendations and finds that physical or chemical properties of the water at a site affect the bioavailability or toxicity of a chemical, or the types of local aquatic organisms differ significantly from those actually tested in developing the EPA-recommended criteria. Site-specific criteria modifications change water quality criteria permanently while continuing to support the current designated uses.

Development of site-specific criteria for aquatic life is discussed in section 3.7 of the WQS Handbook for cases when (1) there might be relevant differences in the toxicity of the chemical in the water at the site and laboratory dilution water (Water-Effect Ratio Procedure) and (2). the species at the site are more or less sensitive than those used in developing the natural criteria (Species Recalculation Procedure). EPA's Office of Science and Technology (OST) has developed the Interim Guidance on Determination and Use of Water-Effect Ratios for Metals <www.epa.gov/waterscience/standards/handbook/handbookappxL.pdf> in Appendix L of the WQS Handbook and the *Streamlined Water-Effect Ratio Procedure for Discharges of Copper*[2] <www.epa.gov/waterscience/criteria/copper/copper.pdf>. In addition, pages 90-97 of Appendix L provide guidance for using the Species Recalculation Procedure. States may also consider establishing aquatic life criteria based on *natural background* conditions. Further information can be found in the memo *Establishing Site Specific Aquatic Life Criteria Equal to Natural Background*[3] <www.epa.gov/waterscience/library/wqcriteria/naturalback.pdf>.

6.1.2.3 Water Quality Standard Variance

Water quality standard variances are changes to water quality standards and have similar substantive and procedural requirements and what is required to remove a designated use. Unlike use removal, variances are time-limited and do not permanently remove the current designated use of a waterbody. Variances are usually discharger- and pollutant-specific, though some states have adopted *general variances*. Where a state has adopted a general variance, the analyses necessary for the variance have been completed on a watershed-wide or statewide basis and, therefore, the process of obtaining a variance is simplified for individual dischargers in that watershed or state.

A variance might be appropriate where the state believes that the existing standards are ultimately attainable and that, by retaining the existing standards rather than changing them, the state would ensure that further progress is made in improving the water quality toward attaining the designated uses while the variance is in effect. State-adopted variances have been approved by EPA where, among other things, the state's standards allow variances and the state demonstrates that meeting the applicable criteria is not feasible on the basis of one or more of the factors outlined in § 131.10(g). A variance typically is granted for a specified period and must be reevaluated at least once every 3 years as reasonable progress is made toward meeting the standards [see section 5.3 of the WQS Handbook and § 131.20(a)].

Modifications of water quality standards could affect effluent limitations in permits in several ways. Specifically, the modifications can change the fundamental basis for WQBELs, potentially affecting an assessment of the need for WQBELs and possibly resulting in either more or less stringent WQBELs than

would otherwise be required. It is the permit writer's responsibility to ensure that any EPA-approved modification of water quality standards is properly reflected in an affected NPDES permit.

6.1.3 Water Quality Standards Implementation

As previously noted, CWA section 301(b)(1)(C) requires NPDES permits to establish effluent limitations as necessary to meet water quality standards. Effluent limitations and other conditions in NPDES permits may be based on a parameter-specific approach or a WET testing approach to implementing water quality standards. A third approach to implementing water quality standards, using biocriteria or bioassessment, is not directly accomplished through NPDES permit effluent limitations but can lead to effluent limitations for specific parameters or for WET. Each of those approaches to implementing water quality standards is discussed briefly below.

What procedures should permit writers use to implement water quality standards?

The terminology used and procedures described in this manual when discussing both assessing the need for and calculating WQBELs are based on the procedures in EPA's *Technical Support Document for Water Quality-Based Toxics Control*[4] <www.epa.gov/npdes/pubs/owm0264.pdf> (hereafter *TSD*). Those procedures were developed specifically to address toxic pollutants but have been appropriately used to address a number of conventional and nonconventional pollutants as well. Permit writers should be aware that most permitting authorities have developed their own terminology and procedures for water quality-based permitting, often derived from, but with variations on, EPA's guidance. For example, EPA itself promulgated *Final Water Quality Guidance for the Great Lakes System* (60 FR 15387, March 23, 1995) with minimum water quality criteria, antidegradation policies, and implementation procedures, including permitting procedures based on the TSD. Under the CWA, Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin were required to adopt procedures for the Great Lakes system that are consistent with that guidance. Permit writers should always consult the applicable permitting regulations, policy, and guidance for the approved water quality-based permitting procedures in their state.

6.1.3.1 Parameter-Specific Approach

The parameter-specific approach uses parameter-specific criteria for protection of aquatic life, human health, wildlife, and sediments, as well as any other parameter-specific criteria adopted into a state's water quality standards. The criteria are the basis for analyzing an effluent, deciding which parameters need controls, and deriving effluent limitations that will control those parameters to the extent necessary to achieve water quality standards in the receiving water. Parameter-specific WQBELs in NPDES permits involve a site-specific evaluation of the discharge (or proposed discharge) and its potential effect on the receiving water or an evaluation of the effects of multiple sources of a pollutant on the receiving water (e.g., through a total maximum daily load [TMDL] analysis). The parameter-specific approach allows for controlling individual parameters, (e.g., copper, BOD, total phosphorus) before a water quality impact has occurred or for helping return water quality to a level that will meet designated uses.

6.1.3.2 Whole Effluent Toxicity (WET) Approach

WET requirements in NPDES permits protect aquatic life from the aggregate toxic effect of a mixture of pollutants in the effluent. WET tests measure the degree of response of exposed aquatic test organisms to an effluent. The WET approach is useful for complex effluents where it might be infeasible to identify

and regulate all toxic pollutants in the effluent or where parameter-specific effluent limitations are set, but the combined effects of multiple pollutants are suspected to be problematic. The WET approach allows a permit writer to implement numeric criteria for toxicity included in a state's water quality standards or to be protective of a narrative "no toxics in toxic amounts" criterion. Like the parameter-specific approach, the WET approach allows permitting authorities to control toxicity in effluents before toxic impacts occur or may be used to help return water quality to a level that will meet designated uses.

6.1.3.3 Bioassessment Approach

The biocriteria approach is used to assess the overall biological integrity of an aquatic community. As discussed in section 6.1.1 above, biocriteria are numeric values or narrative statements that describe the biological integrity of aquatic communities inhabiting waters of a given designated aquatic life use. When incorporated into state water quality standards, biocriteria and aquatic life use designations serve as direct endpoints for determining aquatic life use attainment. Once biocriteria are developed, the biological condition of a waterbody can be measured through a biological assessment, or bioassessment.

A bioassessment is an evaluation of the biological condition of a waterbody using biological surveys and other direct measurements of resident biota in surface waters. A biological survey, or biosurvey, consists of collecting, processing, and analyzing representative portions of a resident aquatic community to determine the community structure and function. The results of biosurveys can be compared to the reference waterbody to determine if the biocriteria for the designated use of the waterbody are being met. EPA issued guidance on this approach in *Biological Criteria: National Program Guidance for Surface Waters*[5] <www.epa.gov/bioindicators/html/biolcont.html>. As previously discussed, biocriteria generally are not directly implemented through NPDES permits but could be used in assessing whether a waterbody is attaining water quality standards. Nonattainment of biocriteria could lead to parameter-specific effluent limitations where the permitting authority is able to identify specific pollutant(s) and source(s) contributing to that nonattainment (see EPA's Biocriteria: Uses of Data – Identify Stressors to a Waterbody Website <http://www.epa.gov/waterscience/biocriteria/uses/stressors.html> or could lead to WET limitations where the permitting authority identifies sources of toxicity to aquatic life. EPA's Biocriteria: Uses of Data - NPDES <http://www.epa.gov/waterscience/biocriteria/watershed/npdes.html> provides examples on the use of bioassessment information in the NPDES permitting process.

Sections 6.2–6.4 below discuss, in detail, implementing water quality standards using the parameter-specific approach to assess the need for and develop effluent limitations in NPDES permits. Section 6.5 below provides additional detail on WET requirements in NPDES permits.

6.2 Characterize the Effluent and the Receiving Water

After identifying the most current, approved, water quality standards that apply to a waterbody, a permit writer should characterize both the effluent discharged by the facility being permitted and the receiving water for that discharge. The permit writer uses the information from those characterizations to determine whether WQBELs are required (section 6.3 below) and, if so, to calculate WQBELs (section 6.4 below). Characterizing the effluent and receiving water can be divided into five steps as shown in Exhibit 6-5 and discussed in detail below.

Exhibit 6-5 Steps for characterizing the effluent and receiving water

Step 1.	Identify pollutants of concern in the effluent
Step 2.	Determine whether water quality standards provide for consideration of a dilution allowance or mixing zone
Step 3.	Select an approach to model effluent and receiving water interactions
Step 4.	Identify effluent and receiving water critical conditions
Step 5.	Establish an appropriate dilution allowance or mixing zone

6.2.1 Step 1: Identify Pollutants of Concern in the Effluent

There are several sources of information for and methods of identifying pollutants of concern for WQBEL development. For some pollutants of concern, the permit writer might not need to conduct any further analysis and could, after characterizing the effluent and receiving water, proceed directly to developing WQBELs (section 6.4 below). For other pollutants of concern, the permit writer uses the information from the effluent and receiving water characterization to assess the need for WQBELs (section 6.3 below). The following subsections identify five categories of pollutants of concern for WQBEL development.

6.2.1.1 Pollutants with Applicable TBELs

One category of pollutants of concern includes those pollutants for which the permit writer has developed TBELs based on national or state technology standards or on a case-by-case basis using best professional judgment. By developing TBELs for a pollutant, the permit writer has already determined that there will be some type of final limitations for that pollutant in the permit and must then determine whether more stringent limitations than the applicable TBELs are needed to prevent an excursion above water quality standards in the receiving water (see Exhibit 6-1 above). A permit writer can determine whether the TBELs are sufficiently protective by either proceeding to calculate WQBELs as described in section 6.4 below and comparing them to the TBELs or by assuming that the maximum daily TBEL calculated is the maximum discharge concentration in the water quality assessments described in section 6.3 below.

6.2.1.2 Pollutants with a Wasteload Allocation from a TMDL

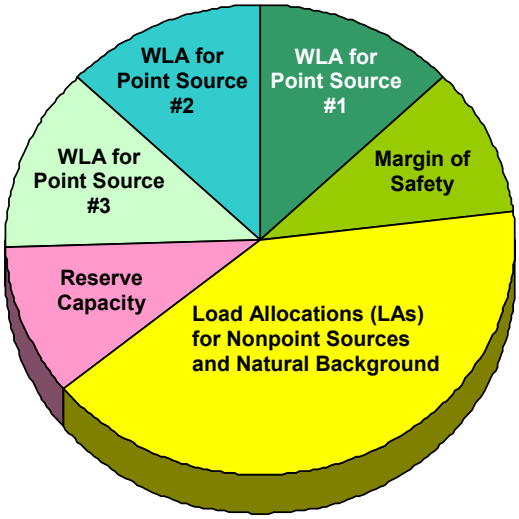
Pollutants of concern include those pollutants for which a *wasteload allocation* (WLA) has been assigned to the discharge through a TMDL. Under CWA section 303(d), states are required to develop lists of impaired waters. Impaired waters are those that do not meet the water quality standards set for them, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that those jurisdictions establish priority rankings for waters on their CWA section 303(d) list and develop TMDLs for those waters.

What is a WLA?

The term WLA refers to the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution [see § 130.2(h)]. The WLA could be allocated through an EPA-approved TMDL, an EPA or state watershed loading analysis, or a facility-specific water quality modeling analysis.

A TMDL is a calculation of the maximum amount of a single pollutant that a waterbody can receive and still meet water quality standards and an allocation of that amount to the pollutant's sources. The portions of the TMDL assigned to point sources are WLAs, and the portions assigned to nonpoint sources and background concentrations of the pollutant are called *load allocations* (LAs). The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes designated in the water quality standards, to provide for the uncertainty in predicting how well pollutant reduction will result in meeting water quality standards, and to account for seasonal variations. A TMDL might also include a reserve capacity to accommodate expanded or new discharges in the future. Exhibit 6-6 depicts the parts of a TMDL.

Exhibit 6-6 Parts of a TMDL



TMDL = ΣWLA + ΣLA + Margin of Safety + Reserve Capacity

The NPDES regulations at § 122.44(d)(1)(vii)(B) require that NPDES permits include effluent limitations developed consistent with the assumptions and requirements of any WLA that has been assigned to the discharge as part of an approved TMDL. Thus, any pollutant for which a WLA has been assigned to the permitted facility through a TMDL is a pollutant of concern.

Permit writers might also choose to consider any pollutant associated with an impairment of the receiving water a pollutant of concern, regardless of whether an approved TMDL has been developed for that pollutant, a WLA has been assigned to the permitted facility, or the permitted facility has demonstrated that the pollutant is present in its effluent. Permitting authorities might consider monitoring requirements to collect additional data related to the presence or absence of the impairing pollutant in a specific discharge to provide information for further analyses.

6.2.1.3 Pollutants Identified as Needing WQBELs in the Previous Permit

Another category of pollutants of concern includes those pollutants that were identified as needing WQBELs in the discharger's previous permit. Permit writers must determine whether the conditions leading to a decision to include WQBELs for the pollutant in the previous permit continue to apply. Where those conditions no longer apply, the permit writer would need to complete an anti-backsliding

analysis to determine whether to remove the WQBELs from the reissued permit. Chapter 7 of this manual provides additional information on anti-backsliding requirements of the CWA and NPDES regulations. In addition, the permit writer might need to conduct an antidegradation analysis if the revised limitation would allow degradation of the quality of the receiving water.

6.2.1.4 Pollutants Identified as Present in the Effluent through Monitoring

Pollutants of concern also include any pollutants identified as present in the effluent through effluent monitoring. Effluent monitoring data are reported in the discharger's NPDES permit application, discharge monitoring reports and special studies. In addition, the permitting authority might collect data itself through compliance inspection monitoring or other special study. Permit writers can match information on which pollutants are present in the effluent to the applicable water quality standards to identify parameters that are candidates for WQBELs.

6.2.1.5 Pollutants Otherwise Expected to be Present in the Discharge

A final category of pollutants of concern includes those pollutants that are not in one of the other categories but are otherwise expected to be present in the discharge. There might be pollutants for which neither the discharger nor the permitting authority have monitoring data but, because of the raw materials stored or used, products or by-products of the facility operation, or available data and information on similar facilities, the permit writer has a strong basis for expecting that the pollutant could be present in the discharge. Because there are no analytical data to verify the concentrations of these pollutants in the effluent, the permit writer must either postpone a quantitative analysis of the need for WQBELs and generate, or require the discharger to generate, effluent monitoring data, or base a determination of the need for WQBELs on other information, such as the effluent characteristics of a similar discharge. A discussion on determining the need for WQBELs without effluent monitoring data is provided in section 6.3.3 below.

6.2.2 Step 2: Determine Whether Water Quality Standards Provide for Consideration of a Dilution Allowance or Mixing Zone

Many state water quality standards have general provisions allowing some consideration of mixing of effluent and receiving water when determining the need for and calculating WQBELs. Depending on the state's water quality standards and implementation policy, such a mixing consideration could be expressed in the form of a *dilution allowance* or *regulatory mixing zone*. A dilution allowance typically is expressed as the flow of a river or stream, or a portion thereof. A regulatory mixing zone generally is expressed as a limited area or volume of water in any type of waterbody where initial dilution of a discharge takes place and within which the water quality standards allow certain water quality criteria to be exceeded. Section 6.2.5 below discusses dilution allowances and mixing zones in greater detail.

State water quality standards or implementation policies might indicate specific locations or conditions (e.g., breeding grounds for aquatic species or bathing beaches) or water quality criteria (e.g., pathogens, pH, bioaccumulative pollutants, or narrative criteria) for which consideration of a dilution allowance or mixing zone is not allowed or is otherwise considered inappropriate.

6.2.3 Step 3: Select an Approach to Model Effluent and Receiving Water Interactions

Where consideration of a dilution allowance or mixing zone is not permitted by the water quality standards or is not appropriate, the relevant water quality criterion must be attained at the point of discharge. In such cases, there is no need for a water quality model to characterize the interaction between the effluent and receiving water. In this situation effluent limitations are based on attaining water quality criteria at the "end of the pipe."

Where a dilution allowance or mixing zone is permitted, however, characterizing the interaction between the effluent and receiving water generally requires using a water quality model. In the majority of situations, and in all of the examples provided in this manual, permit writers will use a steady-state water quality model to assess the impact of a discharge on its receiving water. Steady-state means that the model projects the impact of the effluent on the receiving water under a single or *steady* set of design conditions. Because the model is run under a single set of conditions, those conditions generally are set at *critical conditions* for protection of receiving water quality as discussed in section 6.2.4 below. The permit writer would determine the amount of the dilution allowance or the size of the mixing zone that is available under these critical conditions as provided in section 6.2.5 below.

6.2.4 Step 4: Identify Effluent and Receiving Water Critical Conditions

Where steady-state models are used for water quality-based permitting, an important part of characterizing the effluent and receiving water is identifying the critical conditions needed as inputs to the water quality model. Permit writers should discuss selection of critical conditions with water quality modelers or other water quality specialists. Identifying the right critical conditions is important for appropriately applying a water quality model to assess the need for WQBELs and to calculate WQBELs. Some key effluent and receiving water critical conditions are summarized below.

What if I am not a water quality modeler?

Permit writers are not always water quality modelers, nor do they necessarily need to be experts in this field. Many permitting authorities have a team of water quality specialists who model point source discharges to provide data required for permit writers to assess the need for and develop WQBELs. In some cases, this team might even calculate WQBELs directly for the permit writers, who then only need to compare them to TBELs and determine the final effluent limitations for the NPDES permit. Permit writers should, at a minimum, familiarize themselves with water quality modeling concepts presented in this manual, particularly the identification of critical conditions input to a steady-state water quality model, and should consult water quality modelers or other water quality specialists as needed in the process of NPDES permit development.

6.2.4.1 Effluent Critical Conditions

In most any steady-state water quality model there will be at least two basic critical conditions related to the effluent: flow and pollutant concentration.

Effluent Flow

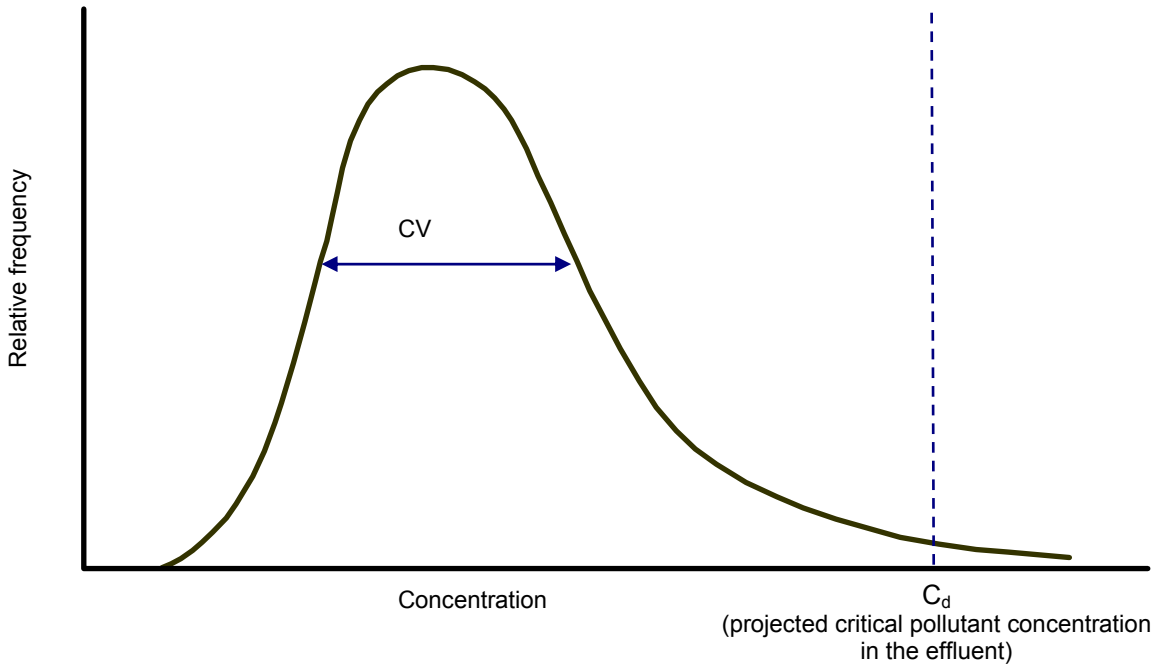
Effluent flow (designated Q_d in the water quality modeling equations used in this manual) is a critical design condition used when modeling the impact of an effluent discharge on its receiving water. A permit writer should be able to obtain effluent flow data from discharge monitoring reports or a permit application. Permitting authority policy or procedures might specify which flow measurement to use as the critical effluent flow value(s) in various water quality-based permitting calculations (e.g., the maximum daily flow reported on the permit application, the maximum of the monthly average flows from discharge monitoring reports for the past three years, the facility design flow). Permit writers should follow existing policy or procedures for determining critical effluent flow or, if the permitting authority does not specify how to determine this value, look at past permitting practices and strive for consistency.

Effluent Pollutant Concentration

Permit writers can determine the critical effluent concentration of the pollutant of concern (designated C_d) by gathering effluent data representative of the discharge. To establish the critical effluent pollutant concentration from the available data, EPA has recommended considering a concentration that represents something close to the maximum concentration of the pollutant that would be expected over time. In most cases, permit writers have a limited effluent data set and, therefore, would not have a high degree of certainty that the limited data would actually include the maximum potential effluent concentration of the pollutant of concern. In addition, the NPDES regulations at § 122.44(d)(1)(ii) require that permit writers consider the variability of the pollutant in the effluent when determining the need for WQBELs. To address those concerns, EPA developed guidance for permit writers on how to characterize effluent concentrations of certain types of pollutants using a limited data set and accounting for variability. This guidance is detailed in EPA's TSD.

By studying effluent data for numerous facilities, EPA determined that daily pollutant measurements of many pollutants follow a *lognormal distribution*. The TSD procedures allow permit writers to project a critical effluent concentration (e.g., the 99th or 95th percentile of a lognormal distribution of effluent concentrations) from a limited data set using statistical procedures based on the characteristics of the lognormal distribution. These procedures use the number of available effluent data points for the measured concentration of the pollutant and the coefficient of variation (or CV) of the data set, which is a measure of the variability of data around the average, to predict the critical pollutant concentration in the effluent. Exhibit 6-7 provides an example of a lognormal distribution of effluent pollutant concentrations and projection of a critical effluent pollutant concentration (C_d). For additional details regarding EPA's guidance, see Chapter 3 of the TSD. Many permitting authorities have developed procedures for estimating a critical effluent pollutant concentration that are based on or derived from those procedures. For pollutants with effluent concentrations that *do not* follow a lognormal distribution, permit writers would rely on alternative procedures developed by their permitting authority for determining the critical effluent pollutant concentration.

Exhibit 6-7 Example of lognormal distribution of effluent pollutant concentrations and projection of critical concentration (C_d)



6.2.4.2 Receiving Water Critical Conditions

As with the effluent, flow (for rivers and streams) and pollutant concentration are receiving water critical conditions used in steady-state water quality models. In addition, depending on the waterbody and pollutant of concern, there could be additional receiving water characteristics that permit writers need to consider in a water quality model.

Receiving Water Upstream Flow

For rivers and streams, an important critical condition is the stream flow upstream of the discharge (designated Q_s). That critical condition generally is specified in the applicable water quality standards and reflects the duration and frequency components of the water quality criterion that is being addressed. For most pollutants and criteria, the critical flow in rivers and streams is some measure of the low flow of that river or stream; however, the critical condition could be different (for example, a high flow, where wet weather sources are a major problem). If a discharge is controlled so that it does not cause water quality criteria to be exceeded in the receiving water at the critical flow condition, the discharge controls should be protective and ensure that water quality criteria, and thus designated uses, are attained under all receiving water flow conditions.

Examples of typical critical hydrologically based low flows found in water quality standards include the 7Q10 (7-day average, once in 10 years) low flow for chronic aquatic life criteria, the 1Q10 low flow for acute aquatic life criteria, and the harmonic mean flow for human health criteria for toxic organic pollutants. The permit writer might examine stream flow data from the state or the U.S. Geological

Survey to determine the critical flow at a point upstream of the discharge. The permit writer might also account for any additional sources of flow or diversions between the point where a critical low flow has been calculated and the point of discharge. EPA also has developed a biologically based flow method that directly uses the durations and frequencies specified in the water quality criteria.

Climate Change Considerations

As noted in this section, the receiving water upstream flow is an important factor in modeling the interaction between the effluent discharge and a river or stream. In most instances, state water quality standards or implementation policies establish the critical low flows that should be used in modeling this interaction. The most common source of upstream flow data for water quality modelers is historical flow gage data available through the U.S. Geological Survey. Modelers should be aware that the effects of climate change could alter historical flow patterns in rivers and streams, making these historical flow records less accurate in predicting current and future critical flows. Where appropriate, water quality modelers should consider alternate approaches to establishing critical low flow conditions that account for these climatic changes.

Receiving Water Background Pollutant Concentration

In addition to determining the critical effluent concentration of the pollutant of concern, the permit writer also should determine the critical background concentration of the pollutant of concern in the receiving water before the discharge (designated C_s) to ensure that any pollutant limitations derived are protective of the designated uses. Permitting authority policies or procedures often address how to determine that critical background concentration value for the pollutant. For example, using ambient data or working with the discharger to obtain reliable ambient data, the permit writer might use the maximum measured background pollutant concentration or, perhaps, an average of measured concentrations as the critical condition. Ambient data will provide the most reliable characterization of receiving water background pollutant concentration. EPA encourages permitting authorities to collect and use actual ambient data, where possible. Where data are not available, however, the state might have other procedures, such as establishing that without valid and representative ambient data, no dilution or mixing will be allowed (i.e., criteria end-of-pipe), or using a percentage of an applicable water quality criterion or a detection, quantitation, or other reporting level. The permit writer should consult the permitting authority's policies and procedures or, if there are no policies or procedures available, look at past permitting practices and maintain consistency with those practices when determining the critical receiving water background concentrations.

Other Receiving Water Characteristics

For waterbodies other than free-flowing rivers and streams, there might be critical environmental conditions that apply rather than flow (e.g., tidal flux, temperature). In addition, depending on the pollutant of concern, the effects of biological activity and reaction chemistry might be important in assessing the impact of a discharge on the receiving water. In such situations, additional critical receiving water conditions that might be used in a steady-state water quality model include conditions such as pH, temperature, hardness, or reaction rates, and the presence or absence of certain fish species or life stages of aquatic organisms, to name a few.

Sections 6.3 and 6.4 below provide further discussion of how critical conditions are applied in a water quality model to determine the need for and calculate WQBELs.

6.2.5 Step 5: Establish an Appropriate Dilution Allowance or Mixing Zone

Following verification of whether the applicable water quality standards allow any consideration of effluent and receiving water mixing and, for a steady-state modeling approach, the critical conditions that apply to the effluent and receiving water, permit writers can determine how the effluent and the receiving water mix under critical conditions. Based on this determination, permit writers can then establish the maximum dilution allowance or mixing zone allowed by the water quality standards for each pollutant of concern.

6.2.5.1 Type of Mixing Under Critical Conditions

On the basis of requirements in the water quality standards, the dilution allowance or mixing zone used in water quality models and calculations are likely to vary depending on whether there is rapid and complete mixing or incomplete mixing of the effluent and receiving water under critical conditions. Thus, the permit writer needs to understand something about *how* the effluent and receiving water mix under critical conditions.

Rapid and complete mixing is mixing that occurs when the lateral variation in the concentration of a pollutant in the direct vicinity of the outfall is small. The applicable water quality standards might specify certain conditions under which a permit writer could *assume* that rapid and complete mixing is occurring, such as the presence of a diffuser. Some standards may also allow a *demonstration* of rapid and complete mixing in cases where the conditions for simply assuming rapid and complete mixing are not met. For example, the applicable water quality standards might specify a distance downstream of a discharge point by which the pollutant concentration across the stream width must vary by less than a certain percentage to assume that there is rapid and complete mixing.

If the permit writer cannot assume rapid and complete mixing and there has been no demonstration of rapid and complete mixing, the permit writer should assume that there is incomplete mixing. Under incomplete mix conditions, mixing occurs more slowly and higher concentrations of pollutants are present in-stream near the discharge as compared to rapid and complete mixing. Thus, an assumption of incomplete mixing is more conservative than an assumption of rapid and complete mixing. For waterbodies other than rivers and streams (e.g., lakes, bays, and the open ocean) the permit writer usually would assume incomplete mixing.

6.2.5.2 Maximum Dilution Allowance or Mixing Zone Size

Once a permit writer determines whether the applicable water quality standards allows consideration of some ambient dilution or mixing and determines the type of mixing taking place (rapid and complete mixing versus incomplete mixing), he or she would again consult the water quality standards to determine the maximum size of the dilution allowance or mixing zone that may be considered in water quality modeling calculations.

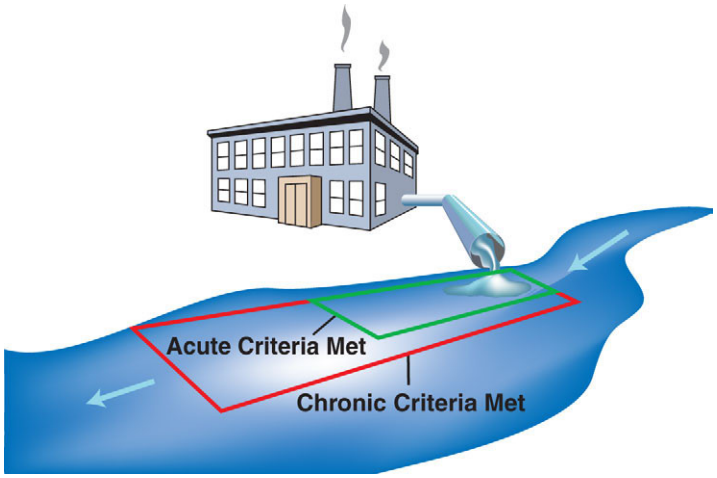
Dilution Allowances in Rapid and Complete Mix Situations

The maximum permissible dilution allowance for rivers and streams under conditions of rapid and complete mixing should be indicated in the water quality standards or standards implementation policy. For example, some water quality standards allow a permit writer to use up to 100 percent of the critical low flow of a river or stream as a dilution allowance in water quality models and calculations when there is rapid and complete mixing. In some cases, water quality standards implement a factor of safety by permitting only a percentage of the critical low flow to be used as a dilution allowance, even when there is rapid and complete mixing under critical conditions. Water quality standards might incorporate such a factor of safety to account for any uncertainty related to other conditions in the waterbody or to ensure that some assimilative capacity is retained downstream of the discharge being permitted. Recall as well that for some pollutants (e.g., pathogens in waters designated for primary contact recreation, bioaccumulative pollutants), the water quality standards or implementing procedures might not authorize any dilution allowance even where the effluent and receiving water mix rapidly and completely.

Dilution Allowances and Regulatory Mixing Zones in Incomplete Mix Situations

In an incomplete mixing situation, the water quality standards or implementation policies might allow some consideration of ambient dilution. Rather than permitting as much as 100 percent of the critical low flow as a dilution allowance, however, they will likely specify either a limited dilution allowance (such as a percentage of the critical low flow) or the maximum size of a regulatory mixing zone. A regulatory *mixing zone* is a limited area or volume of water where initial dilution of a discharge takes place and within which the water quality standards allow certain water quality criteria to be exceeded. While the criteria may be exceeded within the mixing zone, the use and size of the mixing zone must be limited such that the waterbody as a whole will not be impaired and such that all designated uses are maintained as discussed in section 6.2.5.3 below. Exhibit 6-8 is a diagram illustrating the concept of a regulatory mixing zone. The mixing zone often is a simple geometric shape inside of which a water quality criterion may be exceeded. The geometric shape does not characterize how mixing actually occurs. Actual mixing is described using field studies and a water quality model.

Exhibit 6-8 Regulatory mixing zones for aquatic life criteria



Note that Exhibit 6-8 above illustrates two different mixing zones, one for an acute aquatic life criterion and one for a chronic aquatic life criterion. The water quality standards could specify different maximum mixing zones sizes for different pollutants, different types of criteria, and different waterbody types. Exhibit 6-9 provides examples of different maximum mixing zone sizes and dilution allowances.

Exhibit 6-9 Examples of maximum mixing zone sizes or dilution allowances under incomplete mixing conditions by waterbody type*

For rivers and streams:
- Mixing zones cannot be larger than 1/4 of the stream width and 1/4 mile downstream
- Mixing must be less than 1/2 stream width with a longitudinal limit of 5 times the stream width
- Dilution cannot be greater than 1/3 of the critical low flow

For lakes and the ocean:
- Mixing zones for lakes cannot be larger than 5% of the lake surface
- A maximum of 4:1 dilution is available for lake discharges
- A maximum of 10:1 dilution is available for ocean discharges
- The maximum size mixing zone for the ocean is a 100-foot radius from the point of discharge

* Examples were adapted from state standards and procedures and do not reflect EPA guidance or recommendations.

Permit writers should always check the applicable water quality standards to see if mixing zones are permitted and determine the maximum mixing zone size for the waterbody type, pollutant of concern, and specific criterion being considered.

6.2.5.3 Restrictions on Dilution Allowance or Mixing Zone Size

In addition to specifying the maximum dilution allowance or mixing zone size allowed under both rapid and complete mixing conditions and incomplete mixing conditions, the water quality standards or implementation policies generally include constraints that could further limit the available dilution allowance or mixing zone size to something less than the absolute maximum allowed. For example, one restriction on the size of the acute mixing zone could be that it must be small enough to ensure that the potential time of exposure of aquatic organisms to a pollutant concentration above the acute criterion is very short, and organisms passing through that acute mixing zone will not die from exposure to the pollutant. Such a restriction might lead the permitting authority to give a discharger an acute mixing zone for a specific pollutant that is smaller than the maximum size allowed by the water quality standards or to not allow any acute mixing zone at all. Other possible restrictions on dilution and mixing zone size include preventing impairment of the integrity of the waterbody as a whole and preventing significant risks to human health. For example, a permitting authority might restrict the size of a mixing zone for a human health criterion to prevent the mixing zone from overlapping a drinking water intake.

6.3 Determine the Need for WQBELs

After determining the applicable water quality standards and characterizing the effluent and receiving water, a permit writer determines whether WQBELs are needed. This section provides an overview of that process.

6.3.1 Defining Reasonable Potential

EPA regulations at § 122.44(d)(1)(i) state, "Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which the Director determines are or may be discharged at a level that will *cause*, have the *reasonable potential to cause*, or *contribute* to an excursion above any [s]tate water quality standard, including [s]tate narrative criteria for water quality." [emphasis added] Because of that regulation, EPA and many authorized NPDES states refer to the process that a permit writer uses to determine whether a WQBEL is required in an NPDES permit as a *reasonable potential analysis*. Wording the requirements of the regulation another way, a reasonable potential analysis is used to determine whether a discharge, alone or in combination with other sources of pollutants to a waterbody and under a set of conditions arrived at by making a series of reasonable assumptions, could lead to an excursion above an applicable water quality standard. The regulation also specifies that the reasonable potential determination must apply not only to numeric criteria, but also to narrative criteria (e.g., *no toxics in toxic amounts*, *presence of pollutants or pollutant parameters in amounts that would result in nuisance algal blooms*). A permit writer can conduct a reasonable potential analysis using effluent and receiving water data and modeling techniques, as described above, or using a non-quantitative approach. Both approaches are discussed below.

6.3.2 Conducting a Reasonable Potential Analysis Using Data

When determining the need for a WQBEL, a permit writer should use any available effluent and receiving water data as well as other information pertaining to the discharge and receiving water (e.g., type of industry, existing TBELs, compliance history, stream surveys), as the basis for a decision. The permit writer might already have data available from previous monitoring or he or she could decide to work with the permittee to generate data before permit issuance or as a condition of the new permit. EPA recommends that monitoring data be generated before effluent limitation development whenever possible. Monitoring should begin far enough in advance of permit development to allow sufficient time to conduct chemical analyses. Where data are generated as a condition of the permit (for example for a new permittee), it might be appropriate for the permit writer to include a reopener condition in the permit to allow the incorporation of a WQBEL if the monitoring data indicate that a WQBEL is required.

A reasonable potential analysis conducted with available data can be divided into four steps as shown in Exhibit 6-10 and discussed in detail below.

Exhibit 6-10 Steps of a reasonable potential analysis with available data

Step 1.	Determine the appropriate water quality model
Step 2.	Determine the expected receiving water concentration under critical conditions
Step 3.	Answer the question, "Is there reasonable potential?"
Step 4.	Document the reasonable potential determination in the fact sheet

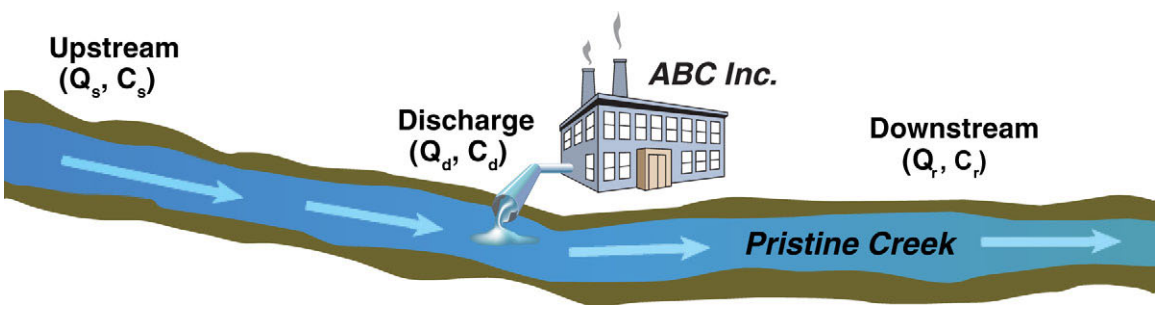
6.3.2.1 Step 1: Determine the Appropriate Water Quality Model

Steady-state or dynamic water quality modeling techniques can be used in NPDES permitting. As discussed in section 6.2.3 above, the examples in this manual consider only steady-state modeling techniques, which consider the impact of a discharge on the receiving water modeled under a single set of critical conditions.

The specific steady-state model used will depend on the pollutant or parameter of concern and whether there is rapid and complete mixing or incomplete mixing of the effluent and the receiving water under critical conditions. For example, to model dissolved oxygen in a river, the permit writer might choose the Streeter-Phelps equation. For modeling heavy metals in an incomplete mix situation, the permit writer might choose the CORMIX model. For pollutants such as BOD, nutrients, or non-conservative parameters, the effects of biological activity and reaction chemistry should be modeled, in addition to the effects of dilution, to assess possible impacts on the receiving water. This manual focuses only on dilution of a pollutant discharged to the receiving water and does not address modeling biological activity or reaction chemistry in receiving waters. For additional information, permit writers should discuss modeling that accounts for biological activity or reaction chemistry with water quality modelers or other water quality specialists as needed and consult EPA's Water Quality Models and Tools Website <www.epa.gov/waterscience/models/>.

For many pollutants such as most toxic (priority) pollutants, conservative pollutants, and pollutants that can be treated as conservative pollutants when near-field effects are of concern, if there is rapid and complete mixing in a river or stream, the permit writer could use a simple mass-balance equation to model the effluent and receiving water. The simple mass-balance equation as applied to a hypothetical facility, ABC, Inc., discharging Pollutant Z to a free-flowing stream called Pristine Creek is presented in Exhibit 6-11 below.

Exhibit 6-11 Simple mass-balance equation



Mass	=	**Flow** (Q) in million gallons per day (mgd) or cubic feet per second (cfs)	X	**Pollutant concentration** (C) in milligrams per liter (mg/L)

$$Q_sC_s + Q_dC_d = Q_rC_r$$

where

Q_s	=	stream flow in mgd or cfs above point of discharge
C_s	=	background in-stream pollutant concentration in mg/L
Q_d	=	effluent flow in mgd or cfs
C_d	=	effluent pollutant concentration in mg/L
Q_r	=	resultant in-stream flow, after discharge in mgd or cfs
C_r	=	resultant in-stream pollutant concentration in mg/L (after complete mixing occurs)

6.3.2.2 Step 2: Determine the Expected Receiving Water Concentration under Critical Conditions

When using a steady-state model, the permit writer, or water quality modeler, determines the impact of the effluent discharge on the receiving water under critical conditions. This step examines how this steady-state analysis is conducted in situations where there is incomplete mixing and then provides a detailed discussion of this analysis for situations where there is rapid and complete mixing.

How are *critical conditions* defined?

When using a steady-state water quality model, permit writers generally input values that reflect critical conditions. State permitting procedures should guide permit writers in this task. When characterizing the effluent and receiving water for water quality-based permitting, the permit writer should follow the permitting authority's policies and procedures for selecting the critical conditions to use in a steady-state model. The discussion in section 6.2.4 above provides a discussion of how those values might be selected.

Permit writers generally would input into a steady-state model for a reasonable potential analysis the critical conditions identified in the effluent and receiving water characterization discussed in section 6.2.4 above. Recall that critical conditions include the following:

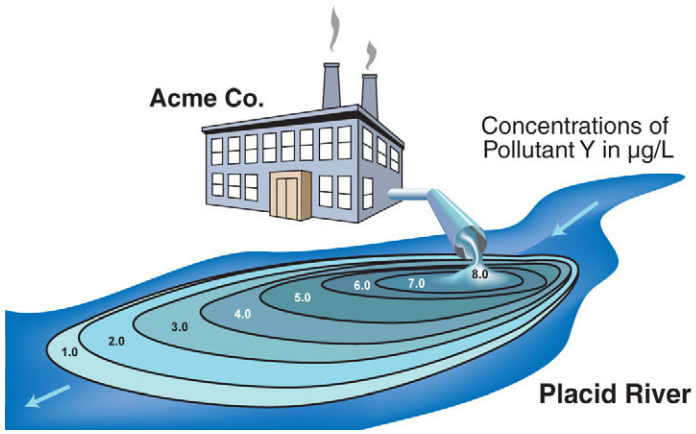
- Effluent critical conditions
  - Flow.
  - Pollutant concentration.
- Receiving water critical conditions
  - Flow (for rivers and streams).
  - Pollutant concentration.
  - Other receiving water characteristics such as tidal flux, temperature, pH, or hardness (depending on the waterbody and pollutant of concern)

As discussed in section 6.2.4.1 above, EPA and other permitting authorities have developed guidance for determining those critical conditions. Permit writers should rely on their permit authority's policies and procedures or past practices to determine values for all other critical conditions.

Expected Receiving Water Concentration in an Incomplete Mixing Situation

Exhibit 6-12 illustrates a situation where there is incomplete mixing of a discharge from a hypothetical facility, Acme Co., with the receiving water, the Placid River. The concentration of the pollutant of concern discharged by Acme Co. (Pollutant Y) is highest nearest the point of discharge and gradually decreases until the pollutant is completely mixed with the receiving water. To determine expected receiving water concentrations resulting from the Acme Co.'s discharge of Pollutant Y to the Placid River, the permit writer, or water quality modeler, would use the appropriate incomplete mixing model, calibrated to actual observations from field studies or dye studies, to simulate mixing under critical conditions. In Step 3 below, the concentrations of the pollutant of concern in the receiving water, as predicted by the water quality model, will be overlaid by a regulatory mixing zone established by the applicable water quality standard to determine whether WQBELs are needed.

Exhibit 6-12 Example of receiving water concentrations in an incomplete mixing situation determined using an incomplete mixing water quality model



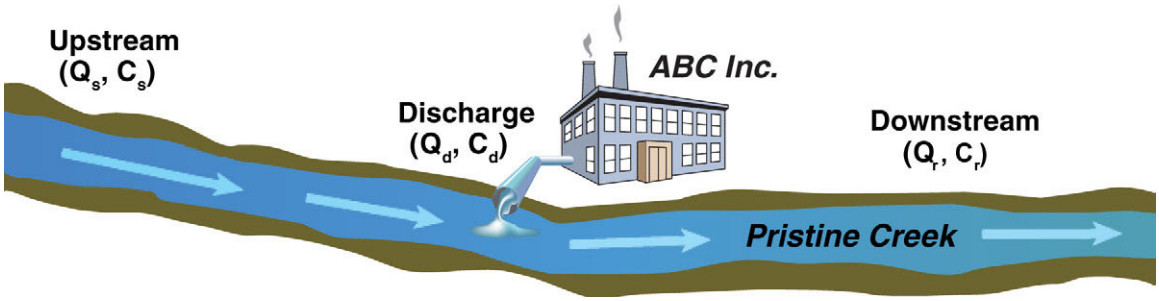
Expected Receiving Water Concentration in Rapid and Complete Mixing Situation

For many pollutants, if there is rapid and complete mixing in a river or stream, the permit writer could use the simple mass-balance equation presented in Exhibit 6-11 above to determine the expected receiving water concentration of the pollutant of concern under critical conditions. As noted previously, the simple mass-balance equation is a very basic steady-state model that can be used for most toxic pollutants, conservative pollutants, and other pollutants for which near-field effects are the primary concern. In Exhibit 6-13, that equation is applied to ABC Inc.'s, discharge of Pollutant Z (a conservative pollutant) to Pristine Creek under conditions of rapid and complete mixing. The mass-balance equation is rearranged to show how it would be used in a reasonable potential analysis.

To use the simple mass-balance equation to predict receiving water impacts for a reasonable potential analysis, the permit writer needs to input one value for each variable and solve the equation for C_r, the downstream concentration of the pollutant. Because this model, like other steady-state models, uses a single value for each variable, the permit writer should be sure that the values selected reflect critical conditions for the discharge and the receiving water. In Exhibit 6-14, those critical conditions have been identified and the equation has been solved for C_r.

It is important for permit writers to remember that, in some situations, the selected steady-state model could be more complex than the simple mass-balance equation shown. For example, there could be other pollutant sources along the stream segment; the pollutant might not be conservative (e.g., BOD); or the parameter to be modeled might be affected by multiple pollutants (e.g., dissolved oxygen affected by BOD and nutrients). For illustrative purposes, this example focuses on a situation where using a simple mass-balance equation is sufficient (i.e., rapid and complete mixing of a conservative pollutant in a river or stream under steady-state conditions).

Exhibit 6-13 Mass-balance equation for reasonable potential analysis for conservative pollutant under conditions of rapid and complete mixing



The mass-balance equation can be used to determine whether the discharge from ABC Inc., would cause, have the reasonable potential to cause, or contribute to an excursion above the water quality standards applicable to Pristine Creek. The equation is used to predict the concentration of Pollutant Z, a conservative pollutant, in Pristine Creek under critical conditions. The predicted concentration can be compared to the applicable water quality criteria for Pollutant Z. Assume the discharge mixes rapidly and completely with Pristine Creek.

Mass	=	**Flow** (Q) in million gallons per day (mgd) or cubic feet per second (cfs)	X	**Pollutant concentration** (C) in milligrams per liter (mg/L)

$$Q_sC_s + Q_dC_d = Q_rC_r$$

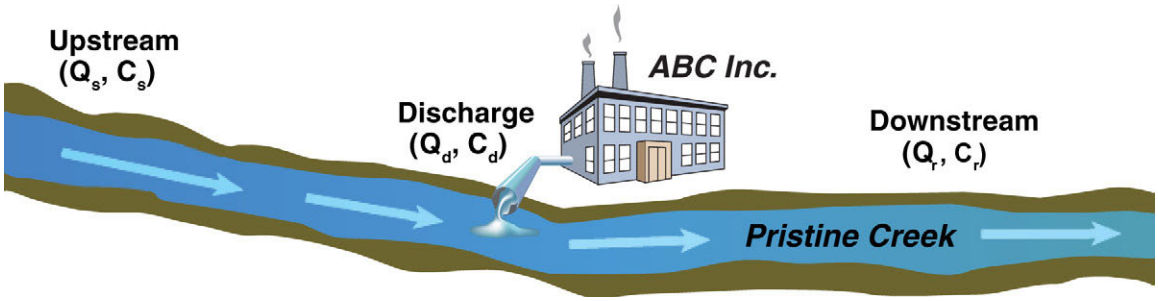
where

Q_s	=	critical stream flow in mgd or cfs above point of discharge
C_s	=	critical background in-stream pollutant concentration in mg/L
Q_d	=	critical effluent flow in mgd or cfs
C_d	=	critical effluent pollutant concentration in mg/L
Q_r	=	resultant in-stream flow, after discharge in mgd or cfs ($Q_r = Q_s + Q_d$)
C_r	=	resultant in-stream pollutant concentration in mg/L (after complete mixing occurs)

Rearrange the equation to determine the concentration of Pollutant Z in the waterbody downstream of a discharge under critical conditions:

$$C_r = \frac{(Q_d)(C_d) + (Q_s)(C_s)}{Q_r}$$

Exhibit 6-14 Example of applying mass-balance equation to conduct reasonable potential analysis for conservative pollutant under conditions of rapid and complete mixing



Mass-Balance Equation: $Q_sC_s + Q_dC_d = Q_rC_r$

Dividing both sides of the mass-balance equation by Q_r gives the following:

$$C_r = \frac{(Q_d)(C_d) + (Q_s)(C_s)}{Q_r}$$

where C_r is the receiving water concentration downstream of the discharge
The following values are known for ABC Inc. and Pristine Creek:

Q_s = critical upstream flow (water quality standards allow a dilution allowance of up to 100% of 1Q10 low flow for rapid and complete mixing)	= 1.20 cfs
C_s = critical upstream concentration of Pollutant Z in Pristine Creek	= 0.75 mg/L
Q_d = critical discharge flow	= 0.55 cfs
C_d = statistically projected critical discharge concentration of Pollutant Z	= 2.20 mg/L
Q_r = downstream flow	= Qd + Qs = 0.55 + 1.20 = 1.75 cfs

Acute aquatic life water quality criterion for Pollutant Z in Pristine Creek = 1.0 mg/L
Find the projected downstream concentration (C_r) by inserting the given values into the equation as follows:

$$C_r = \frac{(0.55\,\text{cfs})(2.20\,\text{mg/L}) + (1.20\,\text{cfs})(0.75\,\text{mg/L})}{(1.75\,\text{cfs})}$$

= 1.2 mg/L of Pollutant Z*

* calculated to 2 significant figures

6.3.2.3 Step 3: Answer the Question, Is There Reasonable Potential?

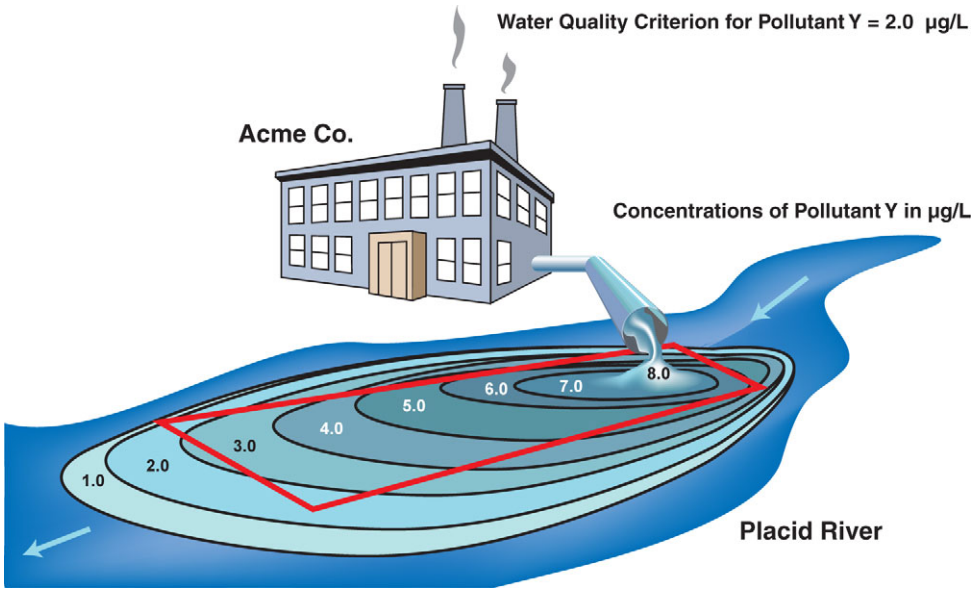
The next step in the reasonable potential analysis is to consider the results of water quality modeling to answer the question, *Is there reasonable potential?*

- For most pollutants, if the receiving water pollutant concentration projected by a steady-state model (e.g., a simple mass-balance equation or a more complex model) exceeds the applicable water quality criterion, there is *reasonable potential*, and the permit writer must calculate WQBELs. (Note that for dissolved oxygen, reasonable potential would occur if the water quality model indicates that the projected effluent concentration of the oxygen-demanding pollutants would result in depletion of dissolved oxygen below acceptable values in the receiving water).
- If the projected concentration is equal to or less than the applicable criterion, there is no reasonable potential and, thus far, there is no demonstrated need to calculate WQBELs.

Reasonable Potential Determination in an Incomplete Mixing Situation

To determine whether there is reasonable potential in an incomplete mixing situation, the permit writer would compare the projected concentration of the pollutant of concern at the edge of the regulatory mixing zone or after accounting for the available dilution allowance, with the applicable water quality criterion. Exhibit 6-15 illustrates the reasonable potential determination for Acme Co. in a situation where the regulatory mixing zone is described by a geometric shape. In the example, the water quality criterion for Pollutant Y being considered is 2.0 micrograms per liter (µg/L). The illustration shows that at many points along the edge of the regulatory mixing zone specified by the water quality standards, which is represented by the rectangle, the concentration of Pollutant Y exceeds 2.0 µg/L. Therefore, there is reasonable potential, and the permit writer must calculate WQBELs for Pollutant Y for Acme Co.

Exhibit 6-15 Reasonable potential determination in an incomplete mixing situation



Reasonable Potential Determination in a Rapid and Complete Mixing Situation

In the rapid and complete mixing example for ABC, Inc., shown in Exhibit 6-14 above, a projected downstream concentration (C_r) of 1.2 mg/L of Pollutant Z was calculated. The permit writer would compare the calculated concentration to the acute aquatic life water quality criterion of 1.0 mg/L for Pollutant Z in Pristine Creek presented in Exhibit 6-14. Because 1.2 mg/L > 1.0 mg/L, the projected downstream concentration exceeds the water quality criterion; therefore, there is a reasonable potential for the water quality criterion to be exceeded, and the permit writer must calculate WQBELs for Pollutant Z.

A permit writer should repeat the reasonable potential analysis for all applicable criteria for the pollutant of concern and must remember that the critical conditions could differ depending on the criterion being evaluated. For example, the critical stream flow used when considering the acute aquatic life criterion might be the 1Q10 low flow, whereas the critical stream flow used when considering the chronic aquatic life criterion might be the 7Q10 low flow. If calculations demonstrate that the discharge of a pollutant of concern would cause, have the reasonable potential to cause, or contribute to an excursion of *any one* of the applicable criteria for that pollutant, the permit writer must develop WQBELs for that pollutant.

In addition, it is important for permit writers to remember that they must repeat the reasonable potential analysis for each pollutant of concern and calculate WQBELs where there is reasonable potential. For each pollutant for which there is no reasonable potential, the permit writer should consider whether there are any existing WQBELs in the previous permit and whether they should be retained. The permit writer would complete an anti-backsliding analysis (see Chapter 7 of this manual) to determine whether it is possible to remove any existing WQBELs from the reissued permit.

6.3.2.4 Step 4: Document the Reasonable Potential Determination in the Fact Sheet

As a final step, permit writers need to document the details of the reasonable potential analysis in the NPDES permit fact sheet. The permit writer should clearly identify the information and procedures used to determine the need for WQBELs. The goal of that documentation is to provide the NPDES permit applicant and the public a transparent, reproducible, and defensible description of how each pollutant was evaluated, including the basis (i.e., reasonable potential analysis) for including or not including a WQBEL for any pollutant of concern.

6.3.3 Conducting a Reasonable Potential Analysis without Data

State implementation procedures might allow, or even require, a permit writer to determine reasonable potential through a qualitative assessment process without using available facility-specific effluent monitoring data or when such data are not available. For example, as noted in section 6.2.1.2 above, where there is a pollutant with a WLA from a TMDL, a permit writer must develop WQBELs or other permit requirements consistent with the assumptions of the TMDL. Even without a TMDL, a permitting authority could, at its own discretion, determine that WQBELs are needed for any pollutant associated with impairment of a waterbody. A permitting authority might also determine that WQBELs are required for specific pollutants for all facilities that exhibit certain operational or discharge characteristics (e.g., WQBELs for pathogens in all permits for POTWs discharging to contact recreational waters).

Types of information that the permit writer might find useful in a qualitative approach to determining reasonable potential include the following:

- Effluent variability information such as history of compliance problems and toxic impacts.
- Point and nonpoint source controls such as existing treatment technology, the type of industry, POTW treatment system, or BMPs in place.
- Species sensitivity data including in-stream data, adopted water quality criteria, or designated uses.
- Dilution information such as critical receiving water flows or mixing zones.

The permit writer should always provide justification for the decision to require WQBELs in the permit fact sheet or statement of basis and *must* do so where required by federal and state regulations. A thorough rationale is particularly important when the decision to include WQBELs is not based on an analysis of effluent data for the pollutant of concern.

After evaluating all available information characterizing the nature of the discharge without effluent monitoring data for the pollutant of concern, if the permit writer is not able to decide whether the discharge causes, has the reasonable potential to cause, or contributes to an excursion above a water

quality criterion, he or she may determine that effluent monitoring should be required to gather additional data. The permit writer might work with the permittee to obtain data before permit issuance, if sufficient time exists, or could require the monitoring as a condition of the newly issued or reissued permit. The permit writer might also include a clause in the permit that would allow the permitting authority to reopen the permit and impose an effluent limitation if the required monitoring establishes that there is reasonable potential that the discharge will cause or contribute to an excursion above a water quality criterion.

6.4 Calculate Parameter-specific WQBELs

If a permit writer has determined that a pollutant or pollutant parameter is discharged at a level that will cause, have reasonable potential to cause, or contribute to an excursion above any state water quality standard, the permit writer must develop WQBELs for that pollutant parameter. This manual presents the approach recommended by EPA's TSD for calculating WQBELs for toxic (priority) pollutants. Many permitting authorities apply those or similar procedures to calculate WQBELs for toxic pollutants and for a number of conventional or nonconventional pollutants with effluent concentrations that tend to follow a lognormal distribution. Permit writers should consult permitting authority policies and procedures to determine the methodology specific to their authorized NPDES permitting program, including the approach for pollutants with effluent concentrations that do not follow a lognormal distribution.

6.4.1 Calculating Parameter-specific WQBELs from Aquatic Life Criteria

The TSD process for calculating WQBELs from aquatic life criteria follows five steps as shown in Exhibit 6-16 and discussed in detail below.

Exhibit 6-16 Calculating parameter-specific WQBELs from aquatic life criteria

Step 1.	Determine acute and chronic WLAs
Step 2.	Calculate long-term average (LTA) concentrations for each WLA
Step 3.	Select the lowest LTA as the performance basis for the permitted discharger
Step 4.	Calculate an average monthly limitation (AML) and a maximum daily limitation (MDL)
Step 5.	Document the calculation of WQBELs in the fact sheet.

6.4.1.1 Step 1: Determine Acute and Chronic WLAs

Before calculating a WQBEL, the permit writer will first need to determine the appropriate WLAs for the point source discharge based on both the acute and chronic criteria. A WLA may be determined from a TMDL or calculated for an individual point source directly. Where an EPA-approved TMDL has been developed for a particular pollutant, the WLA for a specific point source discharger is the portion of that TMDL that is allocated to that point source, as discussed in section 6.2.1.2 above. Where no TMDL is available, a water quality model generally is used to calculate a WLA for the specific point source discharger. The WLA is the loading or concentration of pollutant that the specific point source may discharge while still allowing the water quality criterion to be attained downstream of that discharge. Of course, the WLA calculation should take into account any reserve capacity, safety factor, and contributions from other point and nonpoint sources as might be required by the applicable water quality standards regulations or implementation policies.

When a WLA is not given as part of a TMDL or where a separate WLA is needed to address the near-field effects of a discharge on water quality criteria, permit writers will, in many situations, use a steady-state water quality model to determine the appropriate WLA for a discharge. As discussed in section 6.3 above, steady-state models generally are run under a single set of critical conditions for protection of receiving water quality. If a permit writer uses a steady-state model with a specific set of critical conditions to assess reasonable potential, he or she generally may use the same model and critical conditions to calculate a WLA for the same discharge and pollutant of concern.

As with the reasonable potential assessment, the type of steady-state model used to determine a WLA depends on the type of mixing that occurs in the receiving water and the type of pollutant or parameter being modeled. As discussed in section 6.3.2 above, permit writers can use the mass-balance equation as a simple steady-state model for many pollutants, such as most toxic (priority) pollutants or any pollutant that can be treated as a conservative pollutant when considering near-field effects, if there is rapid and complete mixing in the receiving water. For pollutants or discharge situations that do not have those characteristics (e.g., non-conservative pollutants, concern about effects on a downstream waterbody), a water quality model other than the mass-balance equation would likely be more appropriate.

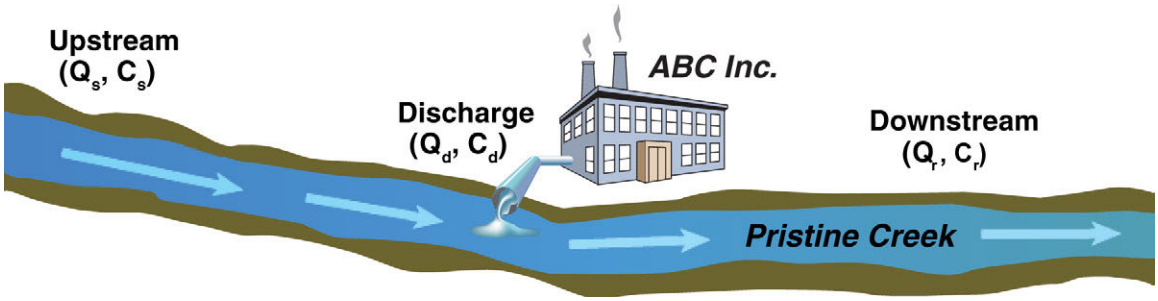
The mass-balance equation is presented again in Exhibit 6-17. In the exhibit, the equation is rearranged to show how it would be used to calculate a WLA for a conservative pollutant discharged to a river or stream under conditions of rapid and complete mixing.

6.4.1.2 Step 2: Calculate LTA Concentrations for Each WLA

The requirements of a WLA generally must be interpreted in some way to be expressed as an effluent limitation. The goal of the permit writer is to derive effluent limitations that are enforceable, adequately account for effluent variability, consider available receiving water dilution, protect against acute and chronic impacts, account for compliance monitoring sampling frequency, and assure attainment of the WLA and water quality standards. In developing WQBELs, the permit writer develops limitations that require a facility to perform in such a way that the concentration of the pollutant of concern in the effluent discharged is nearly always below the WLA.

To accomplish that goal, EPA has developed a statistical permit limitation derivation procedure to translate WLAs into effluent limitations *for pollutants with effluent concentration measurements that tend to follow a lognormal distribution*. EPA believes that this procedure, discussed in Chapter 5 of the TSD, results in defensible, enforceable, and protective WQBELs for such pollutants. In addition, a number of states have adopted procedures based on, but not identical to, EPA's guidance that also provide defensible, enforceable, and protective WQBELs. Permit writers should always use the procedures adopted by their permitting authority. In addition, permit writers should recognize that alternative procedures would be used to calculate effluent limitations for pollutants with effluent concentrations that cannot generally be described using a lognormal distribution.

Exhibit 6-17 Example of applying mass-balance equation to calculate WLAs for conservative pollutant under conditions of rapid and complete mixing



$$Q_sC_s + Q_dC_d = Q_rC_r$$

where

Q_s	=	background stream flow in mgd or cfs above point of discharge
C_s	=	background in-stream pollutant concentration in mg/L
Q_d	=	effluent flow in mgd or cfs
C_d	=	effluent pollutant concentration in mg/L **= WLA**
Q_r	=	resultant in-stream flow, after discharge in mgd or cfs
C_r	=	resultant in-stream pollutant concentration in mg/L (after complete mixing occurs)

Rearrange the equation to determine the WLA (C_d) for ABC Inc., necessary to achieve the acute water quality criterion for Pollutant Z in Pristine Creek (C_r) downstream of the discharge:

$$C_d = \frac{Q_rC_r - Q_sC_s}{Q_d}$$

The following values are known for ABC Inc., and Pristine Creek:

Q_s = critical upstream flow (water quality standards allow a dilution allowance of up to 100% of 1Q10 low flow for rapid and complete mixing)	= 1.20 cfs
C_s = upstream concentration of Pollutant Z in Pristine Creek	= 0.75 mg/L
Q_d =discharge flow	= 0.55 cfs
Q_r = downstream flow	= Qd + Qs = 0.55 + 1.20 = 1.75 cfs
C_r = acute water quality criterion for Pollutant Z in Pristine Creek	= 1.0 mg/L

Determine the WLA for ABC Inc., by inserting the given values into the equation as follows:

$$\text{WLA for ABC Inc.} = C_d = \frac{(1.75\text{ cfs})(1.0\text{ mg/L}) - (1.20\text{ cfs})(0.75\text{ mg/L})}{(0.55\text{ cfs})}$$

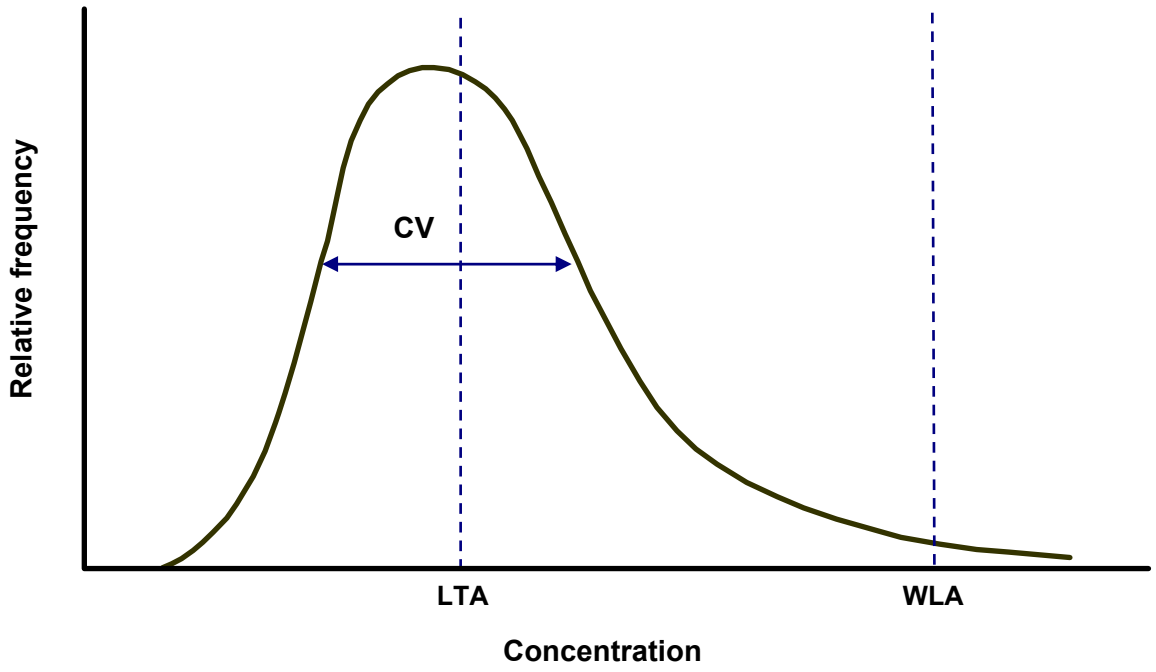
$$= 1.5\text{ mg/L of Pollutant Z *}$$

* calculated to 2 significant figures

For those pollutants with effluent concentrations that do follow a lognormal distribution, the distribution can be described by determining a long-term average (or LTA) that ensures that the effluent pollutant concentration remains nearly always below the WLA and by the CV, a measure of the variability of data around the LTA. Exhibit 6-18 illustrates a lognormal distribution with the LTA, CV, and WLA highlighted.

When applying aquatic life criteria, a permit writer generally establishes a WLA based on the acute aquatic life criterion and a WLA based on the chronic aquatic life criterion. Thus, the permit writer determines two LTAs—one that would ensure that an effluent concentration is nearly always below the acute WLA and one that would ensure that an effluent concentration nearly always below the chronic WLA. Each LTA, acute and chronic, would represent a different performance expectation for the discharger.

Exhibit 6-18 Example of lognormal distribution of effluent pollutant concentrations and calculation of LTA



6.4.1.3 Step 3: Select the Lowest LTA as the Performance Basis for the Permitted Discharger

EPA recommends that WQBELs be based on a single performance expectation for a facility; therefore, once a permit writer has calculated LTA values for each WLA, he or she would select only one of those LTAs to define the required performance of the facility and serve as the basis for WQBELs. Because WQBELs must assure attainment of all applicable water quality criteria, the permit writer would select the lowest LTA as the basis for calculating effluent limitations. Selecting the lowest LTA would ensure that the facility's effluent pollutant concentration remains below all the calculated WLAs nearly all the time. Further, because WLAs are calculated using critical receiving water conditions, the limiting LTA would also ensure that water quality criteria are fully protected under nearly all conditions.

6.4.1.4 Step 4: Calculate an Average Monthly Limitation (AML) and a Maximum Daily Limitation (MDL)

The NPDES regulations at § 122.45(d) require that all effluent limitations be expressed, unless impracticable, as both AMLs and MDLs for all discharges other than POTWs and as both AMLs and average weekly limitations (AWLs) for POTWs. The AML is the highest allowable value for the average of daily discharges over a calendar month. The MDL is the highest allowable daily discharge measured during a calendar day or 24-hour period representing a calendar day. The AWL is the highest allowable value for the average of daily discharges over a calendar week. For pollutants with limitations expressed in units of mass, the daily discharge is the total mass discharged over the day. For limitations expressed in other units, the daily discharge is the average measurement of the pollutant over the period of a day.

In the TSD, EPA recommends establishing an MDL, rather than an AWL, for discharges of toxic pollutants from POTWs. That approach is appropriate for at least two reasons. First, the basis for the AWL for POTWs is the secondary treatment requirements discussed in section 5.1.1.1 of this manual and is not related to the need for assuring attainment of water quality standards. Second, an AWL, which could be the average of up to seven daily discharges, could average out peak toxic concentrations and, therefore, the discharge's potential for causing acute toxic effects might be missed. An MDL would be more likely to identify potential acutely toxic impacts.

Chapter 5 of the TSD includes statistical tools for calculating MDLs and AMLs from the LTA value selected in Step 3 above. Again, note that those procedures apply to *pollutants with effluent concentration measurements that tend to follow a lognormal distribution*. EPA has not developed guidance on procedures for calculating effluent limitations for pollutants with effluent concentrations that generally cannot be described using a lognormal distribution. For such pollutants, permit writers should use other procedures as recommended by their permitting authority in its policies, procedures, or guidance.

Whether using the TSD procedures or other procedures for calculating WQBELs, the objective is to establish limitations calculated to require treatment plant performance levels that, after considering acceptable effluent variability, would have a very low statistical probability of exceeding the WLA and, therefore, would comply with the applicable water quality standards under most foreseeable conditions.

6.4.1.5 Step 5: Document Calculation of WQBELs in the Fact Sheet

Permit writers should document in the NPDES permit fact sheet the process used to develop WQBELs. The permit writer should clearly identify the data and information used to determine the applicable water quality standards and how that information, or any applicable TMDL, was used to derive WQBELs and explain how the state's antidegradation policy was applied as part of the process. The information in the fact sheet should provide the NPDES permit applicant and the public a transparent, reproducible, and defensible description of how the permit writer properly derived WQBELs for the NPDES permit.

6.4.2 Calculating Chemical-specific WQBELs based on Human Health Criteria for Toxic Pollutants

Developing WQBELs for toxic pollutants affecting human health is somewhat different from calculating WQBELs for other pollutants because (1) the exposure period of concern is generally longer (e.g., often a lifetime exposure) and (2) usually the average exposure, rather than the maximum exposure, is of concern. EPA's recommended approach for setting WQBELs for toxic pollutants for human health protection is to set the AML equal to the WLA calculated from the human health toxic pollutant criterion and calculate the MDL from the AML. Section 5.4.4 of the TSD describes statistical procedures used for such calculations for pollutants with effluent concentrations that follow a lognormal distribution. Once again, for pollutants with effluent concentrations that do not follow a lognormal distribution, permit writers should use other procedures as specified by their permitting authority.

If the permit writer calculates chemical-specific WQBELs from human health criteria, he or she should compare the limitations to any other calculated WQBELs (e.g., WQBELs based on aquatic life criteria) and TBELs and apply antidegradation and anti-backsliding requirements to determine the final limitations that meet all technology and water quality standards. As discussed above, that process should be documented in the fact sheet for the NPDES permit.

6.5 Calculate Reasonable Potential and WQBELs for WET

WET tests measure the degree of response of exposed aquatic test organisms to an effluent mixed in some proportion with control water (e.g., laboratory water or a non-toxic receiving water sample). WET testing is used as a second approach, in addition to the chemical-specific approach, to implementing water quality standards in NPDES permits. This section provides a brief introduction to WET testing and WET limitations.

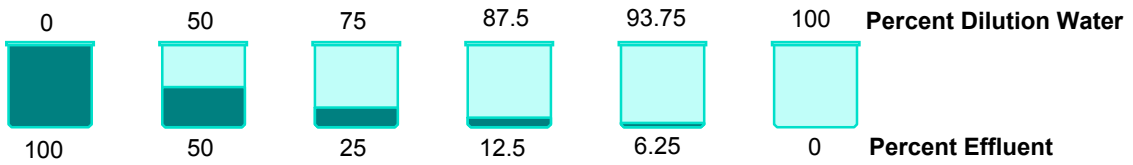
Test of Significant Toxicity (TST)

At the time of the writing of this guidance manual, EPA had recently published a new statistical approach that assesses the whole effluent toxicity (WET) measurement of wastewater effects on specific test organisms' ability to survive, grow, and reproduce. This new approach is called the Test of Significant Toxicity (TST) and is a statistical method that uses hypothesis testing techniques based on research and peer-reviewed publications. The hypothesis test under the TST approach examines whether an effluent, at the critical concentration (e.g., in-stream waste concentration [IWC]), and the control within a WET test differ by an unacceptable amount (the amount that would have a measured detrimental effect on the ability of aquatic organisms to thrive and survive). The TST implementation document and the TST technical document are available at the NPDES WET Website <www.epa.gov/npdes/wet>.

6.5.1 Types of WET Tests

In many WET tests, the effluent and control water are mixed in varying proportions to create a dilution series. Exhibit 6-19 is an example of a typical dilution series used in WET testing.

Exhibit 6-19 Example of typical dilution series



There are two types of WET tests: acute and chronic. An acute toxicity test usually is conducted over a short time, generally 96 hours or less, and the endpoint measured is mortality. The endpoint for an acute test is often expressed as an LC_{50} (i.e., the percent of effluent that is lethal to 50 percent of the exposed test organisms). A chronic toxicity test is usually conducted during a critical life phase of the organism and the endpoints measured are mortality and sub-lethal effects, such as changes in reproduction and growth. A chronic test can occur over a matter of hours or days, depending on the species tested and test endpoint. The endpoint of a chronic toxicity test often is expressed in one of the following ways:

- No observed effect concentration (NOEC), the highest concentration of effluent (i.e., highest percent effluent) at which no adverse effects are observed on the aquatic test organisms.
- Lowest observed effect concentration (LOEC), the lowest concentration of effluent that causes observable adverse effects in exposed test organisms.

- Inhibition concentration (IC), a point estimate of the effluent concentration that would cause a given percent reduction in a biological measurement of the test organisms.
- Effect concentration (EC), a point estimate of the effluent concentration that would cause an observable adverse effect in a given percentage of test organisms.

For additional information on WET monitoring and WET test methods, see section 8.2.4 of this manual.

6.5.2 Expressing WET Limitations or Test Results

There are two options for expressing WET limitations or test results. First, WET limitations or test results can be expressed directly in terms of the WET test endpoints discussed above (e.g., LC_{50}, NOEC, and IC_{25}). Alternatively, the limitations or test results can be expressed in terms of *toxic units* (TUs). A TU is the inverse of the sample fraction, calculated as 100 divided by the percent effluent. Exhibit 6-20 presents example TUs for expressing acute and chronic test results.

Exhibit 6-20 Example of toxic units

If an **acute test** result is a LC_{50} of 60 percent, that result can be expressed as

$$\frac{100}{60} = 1.7 \text{ acute toxic units} = 1.7\ TU_a$$

If a **chronic test** result is an IC_{25} of 40 percent effluent, that result can be expressed as

$$\frac{100}{40} = 2.5 \text{ chronic toxic units} = 2.5\ TU_c$$

It is important to distinguish acute TUs (TU_a) from chronic TUs (TU_c). The difference between TU_a and TU_c can be likened to the difference between miles and kilometers. Both miles and kilometers are used to measure distance, but a distance of 1.0 mile is not the same as a distance of 1.0 kilometer. Likewise, both TU_a and TU_c are expressions of the toxicity of an effluent, but 1.0 TU_a is not the same as 1.0 TU_c. It is possible, however, to determine the relationship between the acute toxicity of an effluent and the chronic toxicity of that same effluent, just as it is possible to determine the relationship between miles and kilometers (i.e., through a conversion factor). Unlike the conversion between miles and kilometers that remains constant, the conversion factor between acute and chronic toxic units varies from effluent to effluent.

For an effluent, the permit writer could develop a conversion factor that would allow conversion of TU_a into equivalent TU_c or vice versa. This conversion factor is known as an acute-to-chronic ratio (ACR) for that effluent. The ACR for an effluent may be calculated where there are at least 10 sets of paired acute and chronic WET test data available. The ACR is determined by calculating the mean of the individual ACRs for each pair of acute and chronic WET tests. Where there are not sufficient data to calculate an ACR for an effluent (i.e., less than 10 paired sets of acute and chronic WET test data), EPA recommends a default value of ACR = 10. Exhibit 6-21 presents examples showing how the ACR converts TU_a into TU_c, how to calculate an ACR from existing data, and how, once an ACR is calculated, a permit writer could estimate the chronic toxicity of an effluent sample from its measured acute toxicity or vice versa.

Exhibit 6-21 Using the ACR

The ACR is expressed

$$ACR = \frac{\text{Acute Endpoint}}{\text{Chronic Endpoint}} = \frac{LC_{50}}{IC_{25}}$$

A TU is the inverse of the sample fraction. Therefore, by definition

$$TU_a = \frac{100}{LC_{50}} \qquad TU_c == \frac{100}{IC_{25}}$$

Consequently, toxicity as percent sample, may be expressed

$$LC_{50} = \frac{100}{TU_a} \qquad IC_{25} = \frac{100}{TU_c}$$

Substituting into the original equation gives

$$ACR = \frac{LC_{50}}{IC_{25}} = \frac{\frac{100}{TU_a}}{\frac{100}{TU_c}} = \frac{TU_c}{TU_a}$$

Example 1
Given: LC_{50} = 28%, NOEC = 10%

$$ACR = \frac{LC_{50}{}^{0}}{IC_{25}} = \frac{28\%}{10\%} = 2.8$$

Example 2
Given: TU_a = 3.6, TU_c = 10.0

$$ACR = \frac{TU_c}{TU_a} = \frac{10.0}{3.6} = 2.8$$

Example 3
Given: Toxicity data for a facility's effluent for *C. dubia*. as presented in the table to the right.

LC_{50} (% effluent)	IC_{25} (% effluent)	ACR
62	10	6.2
18	10	1.8
68	25	2.7
61	10	6.1
63	25	2.5
70	25	2.8
17	5	3.4
35	10	3.5
35	10	3.5
35	25	1.4
47	10	4.7
Mean		**3.5**

The ACR in the third column is calculated using the following equation:

$$ACR = \frac{LC_{50}}{IC_{25}}$$

Example 4
Given: TU_a = 1.8, ACR = 3.5

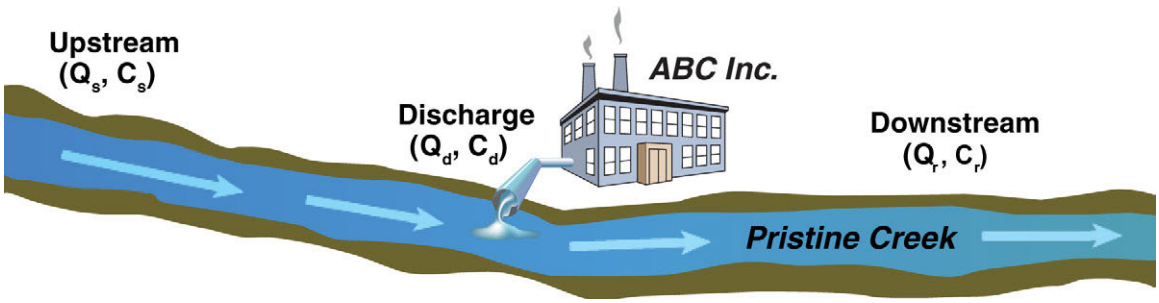
$$ACR = \frac{TU_c}{TU_a} \qquad TU_c = ACR \times TU_a$$

$$\text{Estimated } TUc = ACR \times TU_a = 3.5 \frac{TU_c}{TU_a} \times 1.8\ TU_a = 6.3\ TU_c$$

6.5.3 Determining the Need for WET Limitations

If a state has numeric criteria for WET, a permit writer could use the results of WET tests to project acute or chronic toxicity in the receiving water after accounting for the applicable dilution allowance or mixing zone made available in the water quality standards. The permit writer would compare the projected toxicity of the receiving water to the applicable water quality criterion for WET. If the projected toxicity exceeds the applicable numeric water quality criterion for WET, the discharge would cause, have the reasonable potential to cause, or contribute to an excursion above the applicable water quality standards, and the permit writer must develop a WQBEL for WET [see § 122.44(d)(1)(iv)]. In that way, numeric criteria for WET can be treated similarly to chemical-specific criteria. Exhibit 6-22 provides an example of how the mass-balance equation is used to conduct a reasonable potential analysis for WET.

Exhibit 6-22 Example of mass-balance equation for a WET reasonable potential analysis



The mass-balance equation can be used to determine whether the discharge from ABC Inc. would cause, have the reasonable potential to cause, or contribute to toxicity in Pristine Creek that exceeds the numeric water quality criteria for acute or chronic toxicity. Assume the discharge mixes rapidly and completely with Pristine Creek.

Mass-Balance Equation: $Q_sC_s + Q_dC_d = Q_rC_r$

Dividing both sides of the mass-balance equation by Q_r gives the following:

$$C_r = \frac{(Q_d)(C_d) + (Q_s)(C_s)}{Q_r}$$

The following values are known for ABC Inc. and Pristine Creek:

Q_s = Critical upstream flow (1Q10 for acute protection)	= 23.6 cfs
(7Q10 for chronic protection)	= 70.9 cfs
C_s = Upstream toxicity in Pristine Creek (acute)	= 0 TU_a
(chronic)	= 0 TU_c
Q_d = Discharge flow	= 7.06 cfs
C_d = Discharge toxicity (acute)	= 2.50 TU_a
(chronic)	= 8.00 TU_c
Q_r = Downstream flow	= $Q_d + Q_s$
Acute Water Quality Criterion in Pristine Creek	= 0.3 TU_a
Chronic Water Quality Criterion in Pristine Creek	= 1.0 TU_c

Find the downstream concentration (C_r) by inserting the given values into the equation as follows:

For acute toxicity:

$$C_r = \frac{(7.06\text{ cfs})(2.5\text{ TU}_a) + (23.6\text{ cfs})(0\text{ TU}_a)}{7.06\text{ cfs} + 23.6\text{ cfs}} = 0.58\text{ TU}_a$$

The downstream concentration (C_r) exceeds the water quality criterion for acute toxicity of 0.3 TU_a.

For chronic toxicity:

$$C_r = \frac{(7.06\text{ cfs})(8.00\text{ TU}_c) + (70.9\text{ cfs})(0\text{ TU}_c)}{7.06\text{ cfs} + 70.9\text{ cfs}} = 0.72\text{ TU}_c$$

The downstream concentration (C_r) does not exceed the water quality criterion for chronic toxicity of 1.0 TU_c.

In Exhibit 6-22 above, the downstream concentration under critical conditions for the acute water quality criterion (C_r = 0.58 TU_a) exceeds the water quality criterion for acute toxicity (0.3 TU_a); therefore there is reasonable potential and WET limitations are required. WET limitations would be calculated in much the same way as limitations on specific chemicals. The limitations would be calculated to ensure that WET criteria are not exceeded after any available dilution or at the edge of the applicable mixing zone.

Where state water quality standards do not include numeric criteria for WET, a permit writer could evaluate the need for WQBELs for WET on the basis of narrative criteria; specifically, a narrative criterion stating that waterbodies must be free from *toxics in toxic amounts*. To make it easier for a permit writer to readily establish WET limitations in this situation, the permitting authority should have a policy for implementing the narrative criterion. Following the permitting authority's policy, if the permit writer determines that a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative criterion, the regulations at § 122.44(d)(1)(v) require that the permit include WQBELs for WET unless the permit writer demonstrates that parameter-specific limitations for the effluent are sufficient to attain and maintain applicable numeric and narrative water quality criteria. In other words, the permit must include WET limitations unless the permit writer is able to determine the specific pollutants that are the source of toxicity and include parameter-specific limitations for those pollutants that assure, and will continue to assure, attainment of water quality standards. If there are no criteria in the state water quality standards for the specific parameters causing the toxicity, the permit writer can establish WQBELs using one of three approaches outlined in § 122.44(d)(1)(vi):

- Use EPA's national recommended criteria.
- Calculate a numeric criterion that will attain and maintain the applicable narrative criterion.
- Control the pollutant using an indicator parameter for the pollutant of concern.

A permit also could include a requirement to conduct a toxicity identification evaluation and toxicity reduction evaluation (TIE/TRE) as a special condition in an NPDES permit. (Chapter 9 of this manual presents more information on special conditions.) A TIE/TRE is a site-specific study designed to systematically investigate and identify the causes of effluent toxicity problems, isolate the sources of that toxicity, identify and implement appropriate toxicity control options, and confirm the effectiveness of those control options and the reduction in toxicity. The permit writer might require a TIE/TRE when WET limitations are exceeded or, if there are no WET limitations in the permit, where WET testing demonstrates an unacceptable level of effluent toxicity. Because WET testing indicates the degree of toxicity of an effluent, but does not specifically identify the cause of that toxicity or ways to reduce toxicity, a TIE/TRE is necessary to achieve compliance with effluent limitations or other effluent toxicity requirements in NPDES permits. If a TIE/TRE is not required through the special conditions section of the permit, it could be required via a CWA section 308 letter, a CWA section 309 administrative order, or a consent decree.

6.6 Antidegradation Review

Early in the permit development process, a permit writer should check the state's antidegradation policy and implementation methods to determine what tier(s) of protection, if any, the state has assigned to the proposed receiving water for the parameter(s) of concern. The regulations concerning antidegradation and each of the tiers are described above in section 6.1.1.3. The tier of antidegradation protection is important for determining the required process for developing the water quality-based permit limits and conditions. In some cases, where a waterbody is classified as Tier 3 for antidegradation purposes, the permit writer might find that it is not possible to issue a permit for the proposed activity.

If the state has not specified the tier, the permit writer will need to evaluate, in accordance with the state's implementation procedures, whether the receiving waterbody is of high water quality for the parameters of concern, and thus will require Tier 2 protection. After identifying the tier(s) of protection for the

proposed receiving waterbody and parameter(s) of concern, the permit writer should consult the state's antidegradation implementation procedures relevant to the tier(s).

The following sections provide methods permit writers should consider for implementing, through the WQBEL development process, the three levels of protection typically found in a state's antidegradation policy. Implementation of the state's antidegradation policy could have a significant effect on the calculation of WQBELs.

6.6.1 Tier 1 Implementation

All waterbodies receive at least Tier 1 protection. Tier 1 protection means that the permit writer must include limits in the permit sufficient to maintain and protect water quality necessary to protect existing uses. In practice, for a Tier 1 receiving waterbody, the permit writer typically calculates the WQBELs on the basis of the applicable criteria because the state's designated uses and criteria to protect those uses must be sufficient to protect the existing uses. If a Tier 1 waterbody is impaired for a parameter that would be present in the proposed discharge, the permit writer should identify and consult any relevant TMDLs to determine what quantity of pollutant (if any) is appropriate.

6.6.2 Tier 2 Implementation

For new or increased discharges that could potentially lower water quality in high-quality waters, Tier 2 protection provides the state with a framework for making decisions regarding the degree to which it will protect and maintain the high water quality. A new or expanded discharge permit application typically triggers a Tier 2 antidegradation review. Depending on the outcome of the review, the permit could be written to maintain the existing high water quality or could be written to allow some degradation.

Each state's antidegradation policy or implementation procedures should describe the Tier 2 antidegradation review process. Though the process varies among states, EPA's antidegradation regulation at § 131.12 outlines the common elements of the process. To permit a new or increased discharge that would lower water quality, the state is required to make a finding on the basis of the following:

- The state must find that allowing lower water quality is necessary for important social or economic development in the area in which the waters are located.
  - The state would perform an alternatives analysis to evaluate whether the proposed discharge is actually *necessary* (i.e., whether there are less degrading feasible alternatives) and that might include consideration of a wide range of alternatives (e.g. non-discharging options, relocation of discharge, alternative processes, and innovative treatments).
  - The state should provide a justification of important social or economic development (or both) that would occur as a result of permitting the proposed discharge.
- The state's finding must be made after full satisfaction of its own intergovernmental coordination and public participation provisions.
- The state must assure that the highest statutory and regulatory requirements for all new and existing point sources will be achieved.
- The state must assure that all cost-effective and reasonable BMPs for nonpoint source control will be achieved.

- The state must assure that water quality will still protect existing uses.

If, after fulfilling the above conditions of the Tier 2 antidegradation review process, the state makes a determination to allow a new or increased discharge that would lower water quality, the permit writer may include such limitations in the NPDES permit for that discharge provided the limitations meet all other applicable technology and water quality standards.

6.6.3 Tier 3 Implementation

States identify their own ONRWs for Tier 3 protection, which requires that the water quality be maintained and protected. This is the most stringent level of protection. ONRWs often include waters in national or state parks, wildlife refuges, and waters of exceptional recreational or ecological significance. Waterbodies can be given Tier 3 protection regardless of their existing level of water quality. Some states implement Tier 3 by prohibiting any new or increased discharges to ONRWs or their tributaries that would result in lower water quality, with the exception of some limited activities such as those that would result in temporary changes in water quality ultimately resulting in restoration. Some states allow increased discharges as long as they are offset by equivalent or greater reductions elsewhere in the waterbody.

In addition to Tiers 1, 2, and 3, some states have a class of waters considered outstanding to the state and for which the state might have specific antidegradation requirements. Such waterbodies are sometimes referred to as *Tier 2 ½* waters because implementation of the antidegradation policy for them affords a greater degree of protection than Tier 2 but more flexibility than Tier 3.

Chapter 4 of EPA's WQS Handbook and the *Water Quality Standards Regulation Advance Notice of Proposed Rulemaking* (64 FR 36742, July 7, 1998) include additional information on implementing antidegradation policies. The permit writer should clearly explain the antidegradation analysis and how it affects calculation of WQBELs in the fact sheet or statement of basis for the permit.

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[1] U.S. Environmental Protection Agency. 1994. *Water Quality Standards Handbook: Second Edition* (WQS Handbook). EPA 823-B-94-005a. U.S. Environmental Protection Agency, Office of Water, Washington DC. <www.epa.gov/waterscience/standards/handbook/>.

[2] U.S. Environmental Protection Agency. 2001. *Streamlined Water-Effect Ratio Procedure for Discharges of Copper*. EPA-822-R-01-005. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, DC. <www.epa.gov/waterscience/criteria/copper/copper.pdf>.

[3] Davies, Tudor T. 1997. *Establishing Site Specific Aquatic Life Criteria Equal to Natural Background.* U.S. Environmental Protection Agency, Office of Science and Technology, Washington, DC. <www.epa.gov/waterscience/library/wqcriteria/naturalback.pdf>.

[4] U.S. Environmental Protection Agency. 1991. *Technical Support Document for Water Quality-Based Toxics Control* (TSD). EPA-505/2-90-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC. <www.epa.gov/npdes/pubs/owm0264.pdf>.

[5] U.S. Environmental Protection Agency. 1990. *Biological Criteria: National Program Guidance for Surface Waters*. EPA-440/5-91-004. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, DC. <www.epa.gov/bioindicators/html/biolcont.html>.

CHAPTER 9. Special Conditions

Special conditions in National Pollutant Discharge Elimination System (NPDES) permits supplement numeric effluent limitations and require the permittee to undertake activities designed to reduce the overall quantity of pollutants being discharged to waters of the United States, to reduce the potential for discharges of pollutants, or to collect information that could be used in determining future permit requirements.

There are many different reasons to incorporate special conditions into a permit including

- To address unique situations, such as facilities discharging pollutants for which data are absent or limited, making development of technology- or water quality-based effluent limitations (TBELs or WQBELs) more difficult or impossible.
- To incorporate preventive requirements, such as requirements to install process control alarms, containment structures, good housekeeping practices, and the like.
- To address foreseeable changes to discharges, such as planned changes to process, products, or raw materials that could affect discharge characteristics.
- To incorporate compliance schedules to provide the time necessary to comply with permit conditions.
- To incorporate other NPDES programmatic requirements (e.g., pretreatment, sewage sludge).
- To impose additional monitoring requirements that provide the permit writer with data to evaluate the need for changes in permit limitations.
- To increase or decrease monitoring requirements, depending on monitoring results or changes in processes or products.
- To impose requirements for special studies such as ambient stream surveys, toxicity identification evaluations (TIEs) and toxicity reduction evaluations (TREs), bioaccumulation studies, sediment studies, mixing or mixing zone studies, pollutant reduction evaluations, or other such information-gathering studies.

Section 9.1 below addresses several types of special conditions that apply to both municipal and non-municipal facilities. Section 9.2 addresses special conditions unique to municipal facilities and section 9.3 addresses special conditions for stormwater discharges associated with industrial activity.

9.1 Special Conditions Potentially Applicable to Any Type of Discharger

This section discusses several types of special conditions that could be included in any NPDES permit (i.e., municipal or non-municipal). Those special conditions can be thought of as the *ABCs* of special conditions and include the following:

- **A**dditional monitoring and special studies.
- **B**est management practices (BMPs).
- **C**ompliance schedules.

A summary of the use of those special conditions follows.

9.1.1 Additional Monitoring and Special Studies

Additional monitoring requirements, beyond those required under the effluent limitations section of the permit, and special studies are useful for collecting data that were not available to the permit writer for consideration during permit development. Additional monitoring requirements and special studies generally are used to supplement numeric effluent limitations or support future permit development activities. Examples of the types of special studies that could be required in an NPDES permit include the following:

- **Treatability studies:** Might be required in a permit when insufficient treatability information for a pollutant or pollutants would hinder a permit writer from developing defensible TBELs. Treatability studies can also be required when the permit writer suspects that a facility might not be able to comply with an effluent limitation.
- **Toxicity identification evaluation/toxicity reduction evaluation (TIE/TRE):** Could be required in a permit when wastewater discharges are found to be toxic using whole effluent toxicity (WET) tests. The purpose of those evaluations is to identify and control the sources of toxicity in an effluent. Further guidance related to U.S. Environmental Protection Agency (EPA) recommended TIE/TRE procedures and requirements is found in the following guidance manuals:
  - *Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants*[1] <www.epa.gov/npdes/pubs/tre.pdf>.
  - *Clarifications Regarding Toxicity Reduction and Identification Evaluations in the National Pollutant Discharge Elimination System Program*[2] <www.epa.gov/npdes/pubs/owmfinaltretie.pdf>.
  - *Generalized Methodology for Conducting Industrial Toxicity Reduction Evaluations*[3] (No link—see the endnote for ordering instructions).
  - *Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures*. 2nd ed[4] <www.epa.gov/npdes/pubs/owm0330.pdf>.
  - *Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I*[5] <www.epa.gov/npdes/pubs/owm0255.pdf>.
  - *Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity*[6] <www.epa.gov/npdes/pubs/owm0343.pdf>.
  - *Methods for Aquatic Toxicity Identification Evaluations: Phase III Confirmation Procedures for Samples Exhibiting Acute and Chronic Toxicity*[7] <www.epa.gov/npdes/pubs/owm0341.pdf>.
- **Mixing or mixing zone studies:** Might be required in a permit to assist in determining how effluent and receiving water mix and in establishing a regulatory mixing zone that can be applied when developing WQBELs.
- **Sediment monitoring:** Could be included in a permit if a permit writer suspects that pollutants contained in wastewater discharges accumulate in the sediments of the receiving water.
- **Bioaccumulation studies:** Might be required in a permit to determine whether pollutants contained in wastewater discharges bioaccumulate in aquatic organisms (e.g., fish, invertebrates). Such studies could be required when water quality criteria are expressed in terms of fish tissue levels. Additional guidance related to evaluating the bioaccumulation potential of a pollutant can

be found in the *EPA Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors*[8] (No link—see the endnote for ordering instructions).

When establishing additional monitoring or special studies, permit writers must ensure that any requirements related to the study (e.g., special sampling or analytical procedures) are specified in the appropriate permit condition. In addition, permit writers should establish a reasonable schedule for completion and submission of the study or monitoring program. If the anticipated timeline is longer than one year, an interim progress report during the study is advisable.

9.1.2 Best Management Practices (BMPs)

In general, BMPs are actions or procedures to prevent or reduce the discharge of pollution to waters of the United States. Title 40 of the *Code of Federal Regulations* (CFR) section 122.2 includes the following in the definition of BMPs:

- Schedules of activities.
- Prohibitions of practices.
- Maintenance procedures.
- Treatment requirements.
- Operating procedures and practices to control
  - Plant site runoff.
  - Spillage or leaks.
  - Sludge or waste disposal.
  - Drainage from raw material storage areas.

9.1.2.1 When to Use BMPs

Clean Water Act (CWA) section 304(e) authorizes EPA to require BMPs as part of effluent limitations guidelines and standards (effluent guidelines) to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage that it determines are associated with or ancillary to the industrial manufacturing or treatment process and can contribute significant amounts of pollutants to navigable waters. Where effluent guidelines require specific control measures, including BMPs or development of a BMP plan, permit writers must include such requirements in permits. In addition, CWA section 402(p)(3)(B)(iii) states that permits for discharges from municipal storm sewers must require controls, including management practices, to reduce the discharge of pollutants. Finally, CWA sections 402(a)(1) and (2) give the permitting authority the ability to include BMPs in permits on a case-by-case basis to carry out the provisions of the CWA.

The NPDES regulations at § 122.44(k) track the statutory provisions cited above. This section of the regulations provides that permits must contain BMPs (when applicable) to control or abate the discharge of pollutants when any of the following are true:

- They are authorized under CWA section 304(e).
- They are authorized under CWA section 402(p) for the control of stormwater discharges.
- Numeric effluent limitations are infeasible.
- The practices are necessary to achieve effluent limitations and standards or carry out the purpose and intent of the CWA.

Circumstances under which numeric effluent limitations might be infeasible include the following:

- Regulating a pollutant for which limited treatability or aquatic impact data are available to allow development of numeric TBELs or WQBELs.
- Regulating discharges when the types of pollutants vary greatly over time.

In addition, a permit writer should consider using BMPs under any of the following circumstances:

- When chemical analyses are inappropriate or impossible.
- When there is a history of leaks and spills or when housekeeping is sloppy.
- When a complex facility lacks data for a pollutant or pollutants.

9.1.2.2 BMPs in NPDES Permits

Permit writers include BMP requirements in permits using two approaches: (1) site-, process-, or pollutant-specific BMPs, or (2) a requirement to develop a BMP plan. Site-, process-, or pollutant-specific BMPs might be appropriate in the case of an individual permit where a permit writer has the opportunity to review the circumstances at the facility. On the other hand, it might not be appropriate to include site-, process-, or pollutant-specific BMPs as conditions in a general permit, a permit for a particularly complex facility, or a permit for a facility with operations not familiar to the permit writer. Instead, complicated facilities and discharges covered under a general permit could be required to develop a BMP plan that requires the permittee to determine appropriate BMPs on the basis of circumstances at its facility.

Specific BMPs

Specific BMPs are designed to address conditions particular to a type of facility or to a specific site, process, or pollutant. Specific BMPs might be used in a permit when

- They are needed to address ancillary activities that could result in the discharge of pollutants to waters of the United States.
- Numeric effluent limitations for a specific process are otherwise infeasible and BMPs serve as effluent limitations for that process.
- They are required to supplement and ensure compliance with effluent limitations in the permit.

To select a specific BMP, the permit writer could

- Review the industry profiles or the specific facility to determine the applicable and appropriate management practices.
- Evaluate whether the BMP would help to achieve effluent limitations or other environmental objectives for that facility.
- Use information from other permits, pollution prevention sources, and EPA guidance documents to identify applicable and appropriate BMPs.

Specific BMPs frequently are required for certain types of dischargers such as concentrated animal feeding operations (CAFOs), combined sewer overflows (CSOs), and stormwater discharges. The use of BMPs in permits for CSOs and stormwater are discussed in sections 9.2.3 and 9.3 below, respectively.

BMP Plans

The *Guidance Manual for Developing Best Management Practices*[9] <www.epa.gov/npdes/pubs/owm0274.pdf> describes the activities and materials at an industrial or municipal facility that are best addressed by BMPs. The manual also describes how BMPs work and gives examples of types of BMPs.

If a permit writer requires a BMP plan, it is the facility's responsibility to develop, implement, and evaluate the success or shortfalls of its own plan. Often, a BMP committee (i.e., a group of individuals within the plant organization) is responsible for developing the BMP plan and assisting the plant management in implementing and updating the BMP plan.

EPA has identified several recommended components of effective BMP plans and detailed each component in the *Guidance Manual for Developing Best Management Practices*. The minimum suggested components of a general BMP plan are presented below:

- General Provisions
  - Name and location of facility.
  - Statement of BMP policy and objective.
  - Review by plant manager.
- Specific Provisions
  - BMP committee.
  - Risk identification and assessment.
  - Reporting of BMP incidents.
  - Materials compatibility.
  - Good housekeeping.
  - Preventive maintenance.
  - Inspections and records.
  - Security.
  - Employee training.

BMP plans used to supplement effluent limitations or to describe how the discharger plans to meet effluent limitations can be submitted to the regulatory agency or be kept on-site and made available to the permitting authority upon request. A general schedule for BMP plan development can be included in the permit (e.g., complete and submit the plan within 6 months of permit issuance and begin implementing the plan within 9 months of permit issuance).

Exhibit 9-1 presents example permit text for a requirement to develop and implement a BMP plan and should be adapted as necessary to reflect conditions at the individual facility.

Exhibit 9-1 Example BMP plan requirement

The following is example text for requiring development and implementation of a BMP plan through an NPDES permit. The text should be crafted and changed as necessary to meet the individual facility's needs and the permitting authority's goals. The bracketed text should be updated to be specific to the permit.

1. Implementation.

[IF A BMP PLAN DOES NOT EXIST:]
The permittee, must develop and implement a best management practices (BMP) plan that achieves the objectives and the specific requirements listed below. A copy of the plan must be submitted to the U.S. Environmental Protection Agency (EPA) **[AND/OR STATE AGENCY]** within six months of the effective date of this permit. The plan must be implemented as soon as possible but no later than nine months from the effective date of the permit. The permittee must update and amend the plan as needed.

[IF A BMP PLAN ALREADY EXISTS:]
The permittee must during the term of this permit operate the facility in accordance with the BMP plan **[CITE EXISTING PLAN]** and in accordance with subsequent amendments to the plan. The permittee must amend the plan to incorporate practices to achieve the objectives and specific requirements listed below, and a copy of the amended plan must be submitted to the U.S. Environmental Protection Agency (EPA) **[AND/OR STATE AGENCY]** within three months of the effective date of this permit. The amended plan must be implemented as soon as possible but not later than six months from the effective date of the permit.

2. Purpose

Through implementation of the BMP plan the permittee must prevent or minimize the generation and the potential for the release of pollutants from the facility to the waters of the United States through normal operations and ancillary activities.

3. Objectives

The permittee must develop and amend the BMP plan consistent with the following objectives for the control of pollutants.

a. The number and quantity of pollutants and the toxicity of effluent generated, discharged, or potentially discharged at the facility must be minimized by the permittee to the extent feasible by managing each influent waste stream in the most appropriate manner.
b. Under the BMP plan, and any Standard Operating Procedures (SOPs) included in the plan, the permittee must ensure proper operation and maintenance of the treatment facility as required by § 122.41(e).
c. The permittee must establish specific objectives for the control of pollutants by conducting the following evaluations.
    1. Each facility component or system must be examined for its waste minimization opportunities and its potential for causing a release of significant amounts of pollutants to waters of the United States because of equipment failure, improper operation, and natural phenomena such as rain or snowfall, etc. The examination must include all normal operations and ancillary activities including material storage areas, plant site runoff, in-plant transfer, process and material handling areas, loading or unloading operations, spillage or leaks, sludge and waste disposal, or drainage from raw material storage. **[NOTE THAT ONLY THE APPLICABLE AREAS SHOULD BE INCLUDED IN THE PREVIOUS LIST.]**
    2. Where experience indicates a reasonable potential for equipment failure (e.g., a tank overflow or leakage), natural condition (e.g., precipitation), or other circumstances that may result in significant amounts of pollutants reaching surface waters, the program should include a prediction of the direction, rate of flow and total quantity of pollutants that could be discharged from the facility as a result of each condition or circumstance.

4. Requirements

The BMP Plan must be consistent with the objectives in the Objectives section above and the general guidance contained in the publication entitled *Guidance Manual for Developing Best Management Practices (BMPs)*, EPA 833-B-93-004, <www.epa.gov/npdes/pubs/owm0274.pdf> or any subsequent revisions to the guidance document. The BMP plan must

a. Be documented in narrative form, must include any necessary plot plans, drawings or maps, and must be developed in accordance with good engineering practices. The BMP plan must be organized and written with the following structure:
    1. Name and location of the facility.
    2. Statement of BMP policy.
    3. Structure, functions, and procedures of the BMP Committee.
    4. Specific management practices and standard operating procedures to achieve the above objectives, including the following:

Exhibit 9-1 Example BMP plan requirement

a. Modification of equipment, facilities, technology, processes, and procedures,
b. Reformulation or redesign of products,
c. Substitution of materials, and
d. Improvement in management, inventory control, materials handling or general operational phases of the facility.

5. Risk identification and assessment.
6. Reporting of BMP incidents.
7. Materials compatibility.
8. Good housekeeping.
9. Preventative maintenance.
10. Inspections and records.
11. Security.
12. Employee training.

b. Include the following provisions concerning BMP plan review:
   1. Review by plant engineering staff and the plant manager.
   2. Review and endorsement by the permittee's BMP Committee.
   3. A statement that the above reviews have been completed and that the BMP plan fulfills the requirements set forth in this permit. The statement must include the dated signatures of each BMP Committee member as certification of the reviews.

c. Establish specific BMPs to meet the objectives identified in the Objectives section above, addressing each component or system capable of generating or causing a release of significant amounts of pollutants, and identifying specific preventive or remedial measures to be implemented.

d. Establish specific BMPs or other measures that ensure that the following specific requirements are met:
   1. Ensure proper management of solid and hazardous waste in accordance with regulations promulgated under the Resource Conservation and Recovery Act (RCRA). Management practices required under RCRA regulations must be referenced in the BMP plan.
   2. Reflect requirements for Spill Prevention, Control, and Countermeasure (SPCC) plans under Clean Water Act (CWA) section 311 and 40 CFR Part 112 and may incorporate any part of such plans into the BMP plan by reference.
   3. Reflect requirements for stormwater control under CWA section 402(p) and the regulations at 40 CFR 122.26 and 122.44, and otherwise eliminate to the extent practicable, contamination of stormwater runoff.
   4. etc.

[NOTE: SECTION d. ABOVE COULD BE TAILORED TO EACH FACILITY BY THE PERMIT WRITER AND MAY INCLUDE PROCESSES OR AREAS OF THE FACILITY WITH HOUSEKEEPING PROBLEMS, NONCOMPLIANCE, SPILLS/LEAKS, OR OTHER PROBLEMS THAT COULD BE REMEDIED THROUGH A BMP. IF THERE IS A KNOWN SOLUTION TO THE PROBLEM (E.G., MORE FREQUENT INSPECTIONS, PREVENTIVE MAINTENANCE, ETC.), THIS REMEDY COULD ALSO BE INCLUDED AS A PART OF THE BMP PLAN REQUIREMENTS. TO GATHER IDEAS FOR SUCH REQUIREMENTS, THE PERMIT WRITER MAY WANT TO CONTACT THE PERMITTEE, COMPLIANCE PERSONNEL, FACILITY INSPECTORS, OPERATIONS OFFICE PERSONNEL, AND STATE AGENCY COUNTERPARTS. THE PERMIT WRITER MIGHT ALSO WANT TO CHECK REQUIREMENTS IN OTHER PERMITS AND BMP PLANS FOR SIMILAR FACILITIES.]

5. Documentation

The permittee must maintain a copy of the BMP plan at the facility and must make the plan available to EPA **[AND/OR STATE AGENCY]** upon request. All offices of the permittee, which are required to maintain a copy of the NPDES permit, must also maintain a copy of the BMP plan.

6. BMP Plan Modification

The permittee must amend the BMP plan whenever there is a change in the facility, or in the operation of the facility, that materially increases the generation of pollutants or their release or potential release to the receiving waters. The permittee must also amend the plan, as appropriate, when plant operations covered by the BMP plan change. Any such changes to the BMP plan must be consistent with the objectives and specific requirements listed above. All changes in the BMP plan must be reported to EPA **[AND/OR STATE AGENCY]** in writing.

7. Modification for Ineffectiveness

If at any time the BMP plan proves to be ineffective in achieving the general objective of preventing and minimizing the generation of pollutants and their release and potential release to the receiving waters and/or the specific requirements above, the permit and/or the BMP plan must be subject to modification to incorporate revised BMP requirements.

9.1.2.3 Pollution Prevention in BMPs

BMPs are, by their nature, pollution prevention practices. Traditionally, BMPs have focused on good housekeeping measures and good management techniques that attempt to avoid contact between pollutants and water as a result of leaks, spills, and improper waste disposal. However, on the basis of the authority granted under the regulations, BMPs may include a range of pollution prevention options, including production modifications, operational changes, materials substitution, and materials and water conservation.

When developing BMPs, permit writers should be familiar with the fundamental principles of pollution prevention:

- Pollution should be prevented or reduced at the source, whenever feasible (*Reduce*).
- Pollution that cannot be prevented should be reused or recycled in an environmentally safe manner, whenever feasible (*Reuse-Recycle*).
- Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner, whenever feasible (*Treat*).
- Disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner (*Dispose of*).

When writing an NPDES permit, a permit writer who has familiarity with a certain type of processes might identify pollution prevention practices that are not used at a facility and that would help that facility achieve its pollution prevention goals. Where the pollution prevention practices are necessary to carry out the purposes and intent of the CWA, the permit writer may develop BMPs to implement those practices.

9.1.3 Compliance Schedules

The NPDES regulations at § 122.47 allow permit writers to establish schedules of compliance to give permittees additional time to achieve compliance with the CWA and applicable regulations. Schedules developed under this provision must require compliance by the permittee *as soon as possible*, but may not extend the date for final compliance beyond compliance dates established by the CWA. Thus, compliance schedules in permits are not appropriate for every type of permit requirement. Specifically, a permit writer may not establish a compliance schedule in a permit for TBELs because the statutory deadlines for meeting technology standards (i.e., secondary treatment standards and effluent guidelines) have passed. This restriction applies to both existing and new dischargers. Permit writers should note, however, that § 122.29(d)(4) allows a new source or new discharger up to 90 days to *start-up* its pollution control equipment and achieve compliance with its permit conditions (i.e., provides for up to a 90-day period to achieve compliance).

Examples of requirements for which a compliance schedule in an NPDES permit might be appropriate include:

- Pretreatment program development.
- Sludge use and disposal program development and implementation.
- BMP plan development and implementation.
- Effluent limitations derived from new or revised water quality standards.

An EPA Administrator's decision specifically addresses compliance schedules for effluent limitations derived from new or revised water quality standards. In the decision *In the Matter of Star-Kist Caribe, Inc*., documented in the memorandum *Order Denying Modification Request With Respect to the Administrator's 1990 Decision in Star-Kist Caribe, Inc. (NPDES Appeal No. 88-5)*[10] <www.epa.gov/npdes/pubs/owm0121.pdf>, the EPA Administrator interpreted section 301(b)(1)(C) of the CWA to mean that 1) after July 1, 1977, permits may not contain compliance schedules for effluent limitations based on water quality standards adopted before July 1, 1977, and 2) compliance schedules are allowed for effluent limitations based on standards adopted after that date *only* if the state has clearly indicated in its water quality standards or implementing regulations that it intends to allow them.

In May 2007, the Director of EPA's Office of Wastewater Management issued a memorandum to EPA Region 9 that clarified the requirements of § 122.47 as they relate to WQBELs [see *Compliance Schedules for Water Quality-Based Effluent Limitations in NPDES Permits*[11] <www.epa.gov/npdes/pubs/memo_complianceschedules_may07.pdf>. Permit writers should consider the principles outlined in this memo when assessing whether a compliance schedule for achieving a WQBEL is consistent with the CWA and its implementing regulations and when documenting the basis for a compliance schedule in a permit. Considerations outlined in the memo include the following:

- Demonstrate that the permittee cannot immediately comply with the new effluent limitation on the effective date of the permit.
- Include an enforceable *final* effluent limitation and a date for achievement in the permit.
- Justify and document the *appropriateness* of the compliance schedule; factors relevant to a determination that a compliance schedule is appropriate include how much time the discharger had to meet the WQBEL under prior permit(s), whether there is any need for modifications to treatment facilities, operations, or other measures and, if so, how long it would take to implement such modifications.
- Justify and demonstrate that compliance with the final WQBEL is required *as soon as possible*; factors relevant to a determination that a compliance is required as soon as possible include the steps needed to modify or install treatment facilities, operations, or other measures and the time those steps would take.
- Include an enforceable sequence of events leading to compliance with interim milestones for schedules longer than one year.
- Recognize that a schedule solely to provide time to develop a total maximum daily load (TMDL) or to conduct a use attainability analysis (UAA) is not appropriate.

Many of the principles outlined in the memo could be more generally applied to compliance schedules for requirements other than WQBELs.

9.2 Special Conditions for Municipal Facilities

This section explains several common special conditions that are applicable only to municipal facilities. These conditions reflect requirements for publicly owned treatment works (POTWs) to implement and enforce local pretreatment programs for their industrial users; biosolids (sewage sludge) disposal requirements; CSO requirements; SSO requirements; and municipal separate storm sewer system (MS4) requirements.

9.2.1 The National Pretreatment Program

CWA section 402(b)(8) requires that certain POTWs receiving pollutants from significant industrial sources (subject to CWA section 307(b) standards) establish a pretreatment program to ensure compliance with these standards. The implementing regulations at § 403.8(a) state that:

> Any POTW (or combination of POTWs operated by the same authority) with a total design flow greater than 5 million gallons per day (mgd) and receiving from industrial users pollutants which pass through or interfere with the operation of the POTW or are otherwise subject to pretreatment standards will be required to establish a POTW pretreatment program unless the NPDES state exercises its option to assume local responsibilities as provided in § 403.10(e).

As specified in § 403.8(a), the Regional Administrator or Director of an authorized state may require a POTW with a design flow of 5 mgd or less to develop a POTW pretreatment program. Program development could be determined to be necessary to prevent interference with or pass through of the POTW based on the nature, or volume, of the industrial influent, a history of treatment process upsets and violations of POTW effluent limitation(s), and contamination of municipal sludge.

Since 1978, approximately 1,500 POTWs have been required to develop and implement pretreatment programs through special conditions of NPDES permits. The pretreatment program was developed to control industrial discharges to POTWs and to meet the following objectives:

- To prevent pass through of pollutants.
- To prevent interference with POTW processes, including interference with the use or disposal of municipal sludge.
- To improve opportunities to recycle and reclaim municipal and industrial wastewater and sludges.

The pretreatment program also helps ensure POTW personnel health and safety.

As authorized by the pretreatment regulations at §§ 403.8(c), 403.8(d) and 403.8(e) and the NPDES regulations at § 122.44(j)(2), the requirements to develop and implement a POTW pretreatment program are included as enforceable conditions in the POTW's NPDES permit. NPDES permits drive the development and implementation of pretreatment programs by requiring the following:

- Adequate legal authority.
- Maintenance of an industrial user inventory.
- Development and implementation of local limits.
- Control mechanisms issued to significant industrial users (SIUs).
- Compliance monitoring activities.
- Swift and effective enforcement
- Data management and recordkeeping,
- Reporting to the approval authority (EPA or state).
- Public participation.

Through the NPDES permit, the POTW is required to develop and implement a pretreatment program. The POTW is required to submit an approvable program that meets the requirements in § 403.9(b). A more detailed description of these required program elements is in § 403.8(f). The POTW must have the legal authority enabling it to do the following:

- Deny or condition new or increased contributions of pollutants, or changes in nature of pollutants, to the POTW by industrial users.
- Require compliance with applicable pretreatment standards and requirements by industrial users.
- Control through a permit, order, or similar means the contribution to the POTW by each industrial user to ensure compliance with applicable pretreatment standards and requirements. These control mechanisms must have certain conditions as laid out in § 403.8(f)(1)(iii) and be enforceable.
- Require the development of compliance schedules where necessary by each industrial user for the installation of technology required to meet applicable pretreatment standards and requirements, and submission of all notices and self-monitoring reports to assess and ensure compliance.
- Carry out all inspection, surveillance, and monitoring procedures necessary to determine compliance with applicable pretreatment standards and requirements independent of information submitted by the industrial user (including the authority to enter the premises of the industrial user).
- Obtain remedies for noncompliance (e.g., injunctive relief, penalties).
- Comply with confidentiality requirements.

Further, at a minimum, the POTW must have procedures to do the following:

- Identify and locate all possible industrial users that might be subject to the POTW pretreatment program.
- Identify the character and volume of pollutants contributed to the POTW by the industrial users.
- Notify industrial users of applicable pretreatment standards and applicable requirements under CWA sections 204(b) and 405 and RCRA Subtitles C and D.
- Receive and analyze self-monitoring reports.
- Conduct sampling, inspections and other surveillance activities to determine compliance with applicable pretreatment standards and requirements independent of information supplied by the industrial user.
- Investigate instances of noncompliance.
- Comply with public participation requirements, including annual public notice of industrial users determined to be in significant noncompliance during the previous 12-month period.

Also, as part of the POTW pretreatment program, POTWs must have adequate resources and funding to implement the program, evaluate the need for and, as necessary, develop local limits and develop an enforcement response plan.

The NPDES permit should include the conditions specified in § 403.9, including that the POTW be required to submit the program documentation, detailing the authority and procedures to be implemented, along with other information about the program. The permit will allow the POTW up to one year, from the time when written notification from the approval authority determined the need for a pretreatment program, to develop and submit a program for approval as stated in § 403.8(b). Once the permitting authority reviews and approves the program, the requirement to implement the approved program is then incorporated into the permit.

The permit writer generally incorporates the requirement to develop a pretreatment program at the time of permit reissuance. The requirement, however, may also be incorporated through a modification of the permit if there is *cause*, as defined in detail in § 403.8(e), to make such a modification. The permit writer must follow procedures outlined by § 122.62 related to modifications when including the requirement to develop a pretreatment program in an NPDES permit

During the life of the permit, it might be necessary for the POTW to modify its approved pretreatment program (changes to local limits, changes to the ordinance, and such). The changes can be brought about by the POTW's desire to change the way the program operates, or they can be the result of changes that are necessary to address deficiencies in the program found during inspections or audits done by the permitting authority. Whatever the reason for the modification, the permitting authority must review and approve any modification to the approved program that is considered substantial, as required by § 403.18. All substantial program modifications to the POTW's approved pretreatment program require minor modifications to the NPDES permit and are subject to the procedural requirements in §§ 122.63(g) and 403.18. In addition, incorporating the requirement for a previously approved pretreatment program for the purpose of making the implementation of the program an enforceable part of the permit is also considered a minor modification to the NPDES permit.

The majority of POTWs that need pretreatment program requirements in their permits currently have them in place. In addition, an NPDES state or an EPA region will often designate a pretreatment coordinator to serve as the pretreatment expert to review the annual report from the POTW and recommend any action to be taken. The state or EPA regional pretreatment coordinator is a key resource on pretreatment issues, particularly at the time of NPDES permit reissuance. EPA regions and approved states have developed standard pretreatment development or implementation conditions (with minor modifications made to tailor the conditions to the specific discharger) that are placed in all applicable NPDES permits in that region or state. The permit writer can usually obtain examples of these NPDES pretreatment conditions from the EPA or state pretreatment coordinators. The permit writer might need to update or modify pretreatment implementation language or initiate corrective action related to the pretreatment program.

EPA has developed the Pretreatment Program Website <www.epa.gov/npdes/pretreatment> and prepared a number of guidance manuals for POTWs on how to implement their local pretreatment programs that are accessible through this website. In addition, EPA prepared the *Introduction to the National Pretreatment Program*[12] <www.epa.gov/npdes/pubs/final99.pdf> as a reference for anyone interested in understanding the basics of pretreatment program requirements and to provide a roadmap to additional and more detailed guidance materials for those trying to implement specific elements of the pretreatment program.

Pretreatment program information and monitoring data obtained through the POTW's pretreatment program are useful to the permit writer in identifying possible modifications to the pretreatment program's local limits or procedures, or the need for water quality-based controls. The permit writer should obtain such data with the aid of the pretreatment coordinator. Permits must include conditions requiring a POTW to provide a written technical evaluation of the need to revise local limits under § 403.5(c)(1) following permit issuance or reissuance [§ 122.44(j)(2)(ii)]. In addition, POTWs with a design flow greater than or equal to one mgd and with an approved pretreatment program or required to develop a pretreatment program must sample and analyze their effluent for priority (toxic) pollutants listed in Part 122, Appendix J, Table 2 as part of the permit application process [see § 122.21(j)(4)(iv)]. Those data and information also are useful for determining the need for WQBELs.

9.2.2 Biosolids (Sewage Sludge)

CWA section 405(d) requires that EPA regulate the use and disposal of sewage sludge to protect public health and the environment from any reasonably anticipated adverse effects of these practices. In the CWA, Congress directed EPA to develop technical standards for municipal sludge use and disposal options and enacted strict deadlines for compliance with these standards. Within one year of promulgation of the standards, compliance was required unless construction of new pollution control facilities was necessary, in which case compliance was required within two years.

EPA promulgated Part 503, Standards for the Use or Disposal of Sewage Sludge in 58 *Federal Register* (FR) 9248, February 19, 1993, with amendments in 59 FR 9095, February 19, 1994 and 60 FR 54764, October 25, 1995. These regulations address four sludge use and disposal practices: land application, surface disposal, incineration, and disposal in a municipal solid waste landfill. The standards for each end use and disposal method consist of general requirements, numeric effluent limitations, operational standards, and management practices, as well as monitoring, recordkeeping, and reporting requirements. Unlike technology standards, which are based on the ability of treatment technologies to reduce the level of pollutants, EPA's sewage sludge standards are based on health and environmental risks. Part 503 imposes requirements on four groups:

- Persons who prepare sewage sludge or material derived from sewage sludge.
- Land appliers of sewage sludge.
- Owners/operators of sewage sludge surface disposal sites.
- Owners/operators of sewage sludge incinerators.

Details of that rule are described in *A Plain English Guide to the EPA Part 503 Biosolids Rule*[13] <www.epa.gov/owm/mtb/biosolids/503pe/>.

The risk assessment for the Part 503 rule that governs the land application of biosolids took nearly 10 years to complete and had extensive rigorous review and comment. The risk assessment evaluated and established limitations for a number of pollutants. These limitations are in chapter 4 of *A Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule*[14] <www.epa.gov/owm/mtb/biosolids/503rule/>.

The regulation is largely self-implementing, and anyone who engages in activities covered by the regulation must comply with the appropriate requirements on or before the compliance deadlines. A person who violates Part 503 requirements is subject to administrative, civil, and criminal enforcement actions.

CWA section 405(f) requires the inclusion of sewage sludge use or disposal requirements in any NPDES permit issued to a Treatment Works Treating Domestic Sewage (TWTDS) and authorizes the issuance of sewage sludge-only permits to non-discharging TWTDS. In response, EPA promulgated revisions to the NPDES permit regulations at Parts 122 and 124 in 54 FR 18716, May 2, 1989, to address inclusion of sewage sludge use and disposal standards in NPDES permits and NPDES permit issuance to treatment works that do not have an effluent discharge to waters of the United States, but are involved in sewage sludge use or disposal as preparers, appliers, or owners/operators. TWTDS includes all sewage sludge generators and facilities, such as blenders, that change the quality of sewage sludge.

EPA recognizes that implementation of Part 503 requirements is a source of confusion for permit writers and permittees who might already have NPDES permits with special conditions addressing sewage sludge requirements. EPA has provided several guidance documents to help clarify NPDES permitting expectations, and explain the requirements of Part 503:

- *Part 503 Implementation Guidance*[15] <www.epa.gov/npdes/pubs/owm0237.pdf>.
- *Land Application of Sewage Sludge—A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge Management in 40 CFR Part 503*[16] <www.epa.gov/npdes/pubs/sludge.pdf>.
- *Surface Disposal of Sewage Sludge—A Guide for Owners/Operators of Surface Disposal Facilities on the Monitoring, Recordkeeping, and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge in 40 CFR Part 503*[17] <No Link–see the endnote for ordering instructions>.
- *Preparing Sewage Sludge for Land Application or Surface Disposal—A Guide for Preparers of Sewage Sludge on the Monitoring, Record Keeping, and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge in 40 CFR Part 503*[18] <No Link–see the endnote for ordering instructions>.
- *Domestic Septage Regulatory Guidance, A Guide to the EPA 503 Rule*[19] <www.epa.gov/npdes/pubs/owm0026.pdf>.
- *Control of Pathogens and Vector Attraction in Sewage Sludge*[20] <www.epa.gov/nrmrl/pubs/625r92013/625R92013.pdf>.

The permit writer should refer to the *Part 503 Implementation Guidance* and EPA Region and state guidelines or policies for instructions on how to implement the applicable Part 503 standards into the permit. The permit writer will need to determine the type of sewage sludge use or disposal practice(s) used by the discharger and apply the appropriate Part 503 standards. In general, conditions will need to be established to address the following:

- Pollutant concentrations or loading rates.
- Operational standards (such as pathogen and vector attraction reduction requirements for land application and surface disposal and total hydrocarbons (THC) concentrations for incinerators).
- Management practices (e.g., siting restrictions, design requirements, operating practices).
- Monitoring requirements (e.g., pollutants to be monitored, sampling locations, frequency, and sample collection and analytical methods).

- Recordkeeping requirements.
- Reporting requirements (e.g., contents of reports and frequency or due dates for submission of reports).
- General requirements (e.g., specific notification requirements before land application, submission of closure and post closure plan for surface disposal sites).

In addition to any specific applicable Part 503 standards, three boilerplate conditions must be written in the NPDES permit where applicable. These consist of the following:

- Text requiring the POTW/TWTDS to comply with all existing requirements for sewage sludge use and disposal, including the Part 503 standards [see § 122.44(b)(2)].
- A reopener clause, which authorizes reopening a permit to include technical standards if the technical standards are more stringent or more comprehensive than the conditions in the permit [see § 122.44(c)].
- A notification provision requiring the permittee to give notice to the permitting authority when a significant change in the sewage sludge use or disposal practice occurs (or is planned) [see standard conditions in § 122.41(l)(1)(iii)].

If permit conditions based on existing regulations are insufficient to protect public health and the environment from adverse effects that could occur from toxic pollutants in sewage sludge, permit conditions should be developed on a case-by-case basis using best professional judgment (BPJ) to fulfill the statutory requirement. The *Part 503 Implementation Guidance* contains information to assist permit writers in developing effluent limitations and management practice requirements on a case-by-case basis to protect public health and the environment from adverse effects that could occur from toxic pollutants in sewage sludge. For more information on biosolids, see section 2.3.1.3 of this manual and the Biosolids Website <www.epa.gov/owm/mtb/biosolids/index.htm>

9.2.3 Combined Sewer Overflows (CSOs)

Combined sewer systems were designed and built in the 19th and early 20th centuries to collect sanitary and industrial wastewater and stormwater runoff. During dry weather, combined sewers carry sanitary wastes and industrial wastewater to a treatment plant. In periods of heavy rainfall, however, stormwater is combined with untreated wastewater, which can overflow and discharge directly to a waterbody without being treated. These overflows are called combined sewer overflows (CSOs).

EPA published a CSO Control Policy in 59 FR 18688, April 19, 1994. That policy represents a comprehensive national strategy to ensure that municipalities, permitting authorities, water quality standards authorities, and the public engage in a comprehensive and coordinated planning effort to achieve cost-effective CSO controls that ultimately meet appropriate health and environmental objectives.

The CSO Control Policy includes expectations for NPDES permitting authorities. In general, EPA envisioned a phased permit approach, including initial requirements to implement Nine Minimum CSO Controls (NMC) and develop a Long-Term CSO Control Plan (LTCP), followed by requirements to implement the controls in the approved LTCP. The Wet Weather Water Quality Act of 2000 amended the CWA to add section 402(q), which required that CSO permits be issued in conformance with the CSO Control Policy.

CSOs are point source discharges subject to both the technology-based requirements of the CWA and applicable state water quality standards. Under the CWA, CSOs must comply with Best Available Technology Economically Achievable (BAT) for nonconventional and toxic pollutants and Best Conventional Technology (BCT) for conventional pollutants. However, there are no promulgated BAT or BCT limitations in effluent guidelines for CSOs. As a result, permit writers must use BPJ in developing technology-based permit requirements for controlling CSOs. Permit conditions also must achieve compliance with applicable water quality standards.

The 1994 CSO Control Policy contains the recommended approach for developing and issuing NPDES permits to control CSOs. In addition, EPA has developed the following CSO guidance documents to help permit writers and permittees implement the CSO Control Policy:

- *Combined Sewer Overflows–Guidance for Long-Term Control Plan*[21] <www.epa.gov/npdes/pubs/owm0272.pdf>.
- *Combined Sewer Overflows–Guidance for Nine Minimum Controls*[22] <www.epa.gov/npdes/pubs/owm0030.pdf>.
- *Combined Sewer Overflows–Guidance for Screening and Ranking*[23] <www.epa.gov/npdes/cso>.
- *Combined Sewer Overflows–Guidance for Monitoring and Modeling*[24] <www.epa.gov/npdes/pubs/sewer.pdf>.
- *Combined Sewer Overflows–Guidance for Financial Capability Assessment and Schedule Development*[25] <www.epa.gov/npdes/pubs/csofc.pdf>.
- *Combined Sewer Overflows–Guidance for Funding Options*[26] <www.epa.gov/npdes/pubs/owm0249.pdf>.
- *Combined Sewer Overflows–Guidance for Permit Writers*[27] <www.epa.gov/npdes/cso>.
- *Combined Sewer Overflows–Guidance: Coordinating Combined Sewer Overflow Long-Term Planning with Water Quality Standards Reviews*[28] <www.epa.gov/npdes/pubs/wqs_guide_final.pdf>.

Combined Sewer Overflows–Guidance for Permit Writers[24] contains guidance and example permit language that permit writers can use. Controlling CSOs typically requires substantial long-term planning, construction, financing and continuous reassessment; therefore, the implementation of CSO controls will probably occur over several permit cycles. The guidance explains a phased permitting approach to CSOs. Exhibit 9-2 depicts this phased permitting approach and the types of permit conditions that should be developed for each phase.

Exhibit 9-2 Categories of CSO permitting conditions

NPDES permit	Phase I	Phase II	Post phase II
A. Technology-based	• NMC, at a minimum	• NMC, at a minimum	• NMC, at a minimum
B. Water Quality-based	• Narrative	• Narrative + performance-based standards	• Narrative + performance-based standards + numeric WQBELs (as appropriate)
C. Monitoring	• Characterization, monitoring, and modeling of CSS	• Monitoring to evaluate water quality impacts • Monitoring to determine effectiveness of CSO controls.	• Post-construction compliance monitoring
D. Reporting	• Documentation of NMC implementation • Interim LTCP deliverables.	• Implementation of CSO controls (both NMC and long-term controls)	• Report results of post-construction compliance monitoring
E. Special conditions	• Prohibition of dry weather overflows (DWO) • Development of LTCP	• Prohibition of DWO • Implementation of LTCP • Reopener clause for water quality standards violations • Sensitive area reassessment	• Prohibition of DWO • Reopener clause for water quality standards violations

Depending on the permittee's situation, a permit may contain both Phase I and Phase II elements. Phase I permits require demonstration of implementation of the NMC, shown in Exhibit 9-3.

Exhibit 9-3 Nine minimum CSO controls

1. Proper operation and regular maintenance programs for the sewer system and the CSOs
2. Maximum use of the collection system for storage
3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized
4. Maximization of flow to the POTW for treatment
5. Prohibition of CSOs during dry weather
6. Control of solid and floatable materials in CSOs
7. Establishment of pollution prevention programs
8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls

In the Phase I permit issued/modified to reflect the CSO Control Policy, the NPDES authority should at least require permittees to

- Immediately implement BAT/BCT, which at a minimum includes the NMC, as determined on a BPJ basis by the permitting authority.
- Develop and submit a report documenting the implementation of the NMC within 2 years of permit issuance/modification.

- Comply with applicable water quality standards, no later than the date allowed under the state's water quality standards expressed in the form of a narrative limitation.
- Develop and submit, consistent with the CSO Control Policy and based on a schedule in an appropriate enforceable mechanism, an LTCP, as soon as practicable, but generally within 2 years after the effective date of the permit issuance/modification. Permitting authorities may establish a longer timetable for completion of the long-term CSO control plan on a case-by-case basis to account for site-specific factors that could influence the complexity of the planning process. Exhibit 9-4 shows the minimum elements of the LTCP.

Exhibit 9-4 Elements of the long-term CSO control plan

1. Characterization, monitoring, and modeling of the combined sewer system
2. Public participation
3. Consideration of sensitive areas
4. Evaluation of alternatives
5. Cost/performance considerations
6. Operational plan
7. Maximizing treatment at the existing POTW treatment plant
8. Implementation schedule
9. Post-construction compliance monitoring program.

Phase II permits require the implementation of an LTCP. The Phase II permit should contain the following:

- Requirements to implement the technology-based controls including the NMC determined on a BPJ basis.
- Narrative requirements that ensure that the selected CSO controls are implemented, operated and maintained as described in the LTCP.
- Water quality-based effluent limits under §§ 122.44(d)(1) and 122.44(k), requiring, at a minimum, compliance with, no later than the date allowed under the state's water quality standards, the numeric performance standards for the selected CSO controls, based on average design conditions specifying at least one of the following:
  - A maximum number of overflow events per year for specified design conditions consistent with II.C.4.a.i of the CSO Control Policy.
  - A minimum percentage capture of combined sewage by volume for treatment under specified design conditions consistent with II.C.4.a.ii of the CSO Control Policy.
  - A minimum removal of the mass of pollutants discharged for specified design conditions consistent with II.C.4.a.iii of CSO Control Policy.
  - Performance standards and requirements that are consistent with II.C.4.b of the CSO Control Policy.
- A requirement to implement, with an established schedule, the approved post-construction water quality assessment program including requirements to monitor and collect sufficient information to demonstrate compliance with water quality standards and protection of designated uses as well as to determine the effectiveness of CSO controls.

- A requirement to reassess overflows to sensitive areas in those cases where elimination or relocation of the overflow is not physically possible and economically achievable.
- Conditions establishing requirements for maximizing the treatment of wet-weather flows at the POTW, as appropriate, consistent with section II.C.7. of the CSO Policy.
- A reopener clause authorizing the NPDES authority to reopen and modify the permit upon determination that the CSO controls fail to meet water quality standards or protect designated uses.

Reviewing the permittee's LTCP and consultations with other staff involved in the CSO control process and the permittee are important steps in the process of determining the appropriate Phase II permit conditions. Water quality-based controls in phase II generally are expressed as narrative requirements and performance standards for the combined sewer system. Finally, post Phase II permit conditions would address continued implementation of the NMC, long-term CSO controls, and post-construction compliance monitoring. There may also be numeric WQBELs when there are sufficient data to support their development.

LTCP implementation schedules were expected to include project milestones and a financing plan for design and construction of necessary controls as soon as practicable. The CSO Control Policy expected permitting authorities to undertake the following:

- Review and revise, as appropriate, state CSO permitting strategies developed in response to the National CSO Control Strategy.
- Develop and issue permits requiring CSO communities to immediately implement the NMC and document their implementation and develop and implement an LTCP.
- Promote coordination among the CSO community, the water quality standards authority, and the general public through LTCP development and implementation.
- Evaluate water pollution control needs on a watershed basis and coordinate CSO control with the control of other point and nonpoint sources of pollution.
- Recognize that it might be difficult for some small communities to meet all the formal elements of LTCP development, and that compliance with the NMC and a reduced scope LTCP might be sufficient.
- Consider sensitive areas, use impairment, and a CSO community's financial capability in the review and approval of implementation schedules.

Communities must develop and implement LTCPs to meet water quality standards, including the designated uses and criteria to protect those uses for waterbodies that receive CSO discharges. The CSO Control Policy recognized that substantial coordination and agreement among the permitting authority, the water quality standards authority, the public, and the CSO community would be required to accomplish this objective. The CSO Control Policy also recognized that the development of the LTCP should be coordinated with the review and appropriate revision of water quality standards and their implementation procedures.

In developing permit requirements to meet technology-based requirements and applicable state water quality standards, the permit writer, in conjunction with staff involved in water quality standards and the

permittee, should identify the appropriate site-specific considerations that will determine the CSO conditions to be established in the permit. EPA believes that the following information will be particularly relevant in developing the appropriate conditions:

- CSO Discharge
  - Flow, frequency, and duration of the CSO discharge.
  - Available effluent characterization data on the CSO discharge.
  - Available information and data on the impacts of the CSO discharge(s) (e.g., CWA section 305(b) reports, ambient survey data, fish kills, CWA section 303(d) lists of impaired waters).
  - Compliance history of the CSO owner, including performance and reliability of any existing CSO controls.
  - Current NPDES permit and NPDES permit application.
  - Facility planning information from the permittee that addresses CSOs.
- Technologies
  - Performance data (either from the manufacturer or from other applications) for various CSO technologies that may be employed, including equipment efficiency and reliability.
  - Cost information associated with both the installation, operation and maintenance of CSO technologies.
  - Reference materials on various types of CSO.

For more information on CSOs, see section 2.3.1.4 of this manual and the Combined Sewer Overflows Website <www.epa.gov/npdes/cso>.

9.2.4 Sanitary Sewer Overflows (SSOs)

EPA's *Report to Congress on the Impacts and Control of CSOs and SSOs*[29] <www.epa.gov/npdes/csossoreport2004> shows that NPDES permit requirements establishing clear reporting, recordkeeping and third party notification of overflows from municipal sewage collection systems, as well as clear requirements to properly operate and maintain the collection system, are critical to effective program implementation. NPDES authorities should be improving NPDES permit requirements for SSOs and sanitary sewer collection systems, which could lead to improved performance of municipal sanitary sewer collection systems and improved public notice for SSO events.

The NPDES regulations provide standard conditions that are to be in NPDES permits for POTWs as discussed in Chapter 10 of this manual. Standard conditions in a permit for a POTW apply to portions of the collection system for which the permittee has ownership or has operational control. When reissued, permits for POTW discharges should clarify how key standard permit conditions apply to SSOs and sanitary sewer collection systems. On August 20, 2007, EPA circulated a draft fact sheet, NPDES Permit Requirements for Municipal Sanitary Sewer Collection Systems and SSOs <www.epa.gov/npdes/pubs/sso_fact_sheet_model_permit_cond.pdf>, which explains the ways NPDES permitting authorities should be improving implementation of NPDES permit requirements to address SSOs and sanitary sewer collection systems.

The draft fact sheet indicates that clarifications should address the particular application of standard permit conditions to SSOs and municipal sanitary sewer collection systems as discussed below.

- **Immediate reporting.** Permits should clarify that the permittee is required to notify the NPDES authority of an overflow that could endanger health or the environment from portions of the collection system over which the permittee has ownership or operational control as soon as practicable but within 24 hours of the time the permittee becomes aware of the overflow. [See § 122.41(l)(6).]
- **Written reports**. Permits should clarify that the permittee is required to provide the NPDES authority a written report within 5 days of the time it became aware of any overflow that is subject to the immediate reporting provision. [See § 122.41(l)(6)(i).] In addition, permits should clarify that any overflow that is not immediately reported as indicated above, should be reported in the discharge monitoring report. [See § 122.41(l)(7).]
- **Third party notice.** Permits should establish a process for requiring the permittee or the NPDES authority to notify specified third parties of overflows that could endanger health because of a likelihood of human exposure; or unanticipated bypass and upset that exceeds any effluent limitation in the permit or that could endanger health because of a likelihood of human exposure. Permits should clarify that the permittee is required to develop, in consultation with appropriate authorities at the local, county, or state level (or any combination), a plan that describes how, under various overflow (and unanticipated bypass and upset) scenarios, the public, and other entities, would be notified of overflows that may endanger health. The plan should identify all overflows that would be reported, to whom they should be reported, the specific information that would be reported, a description of lines of communication, and the identities of responsible officials. [See § 122.41(l)(6).]
- **Recordkeeping**. Permits should clarify that the permittee is required to keep records of overflows. Clarified permit language for recordkeeping should require the permittee to retain the reports submitted to the NPDES authority and other appropriate reports that could include work orders associated with investigation of system problems related to an overflow, that describes the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the overflow. [See § 122.41(j).]
- **Capacity, management, operation and maintenance programs.** Permits should clarify requirements for proper operation and maintenance of the collection system. [See §§ 122.41(d) and 122.41(e).]. This may include requiring the development and implementation of capacity, management, operation and maintenance (CMOM) programs. EPA's Region 4 has developed materials and guidance that can help a municipality with its CMOM program on the Management, Operation and Maintenance (MOM) Programs Project Website <www.epa.gov/region4/water/wpeb/momproject/>. The CMOM program may use a process for self-assessment and information management techniques for ongoing program improvement and may develop and implement emergency response procedures to overflows. In addition, the CMOM permit condition may specify appropriate documentation requirements, including the following:
  - CMOM program summary. Permittees may be required to develop a written summary of their CMOM programs, which would be available to the NPDES authority and public on request. The program summary would give an overview of the management program and summarize major implementation activities.

- Program audit report. Permittees may be required to conduct comprehensive audits of their programs during the permit cycle, and submit a copy of the audit report to the NPDES authority with the application for permit renewal. EPA's Sanitary Sewer Overflow Toolbox Website <www.epa.gov/npdes/sso/ssotoolbox> provides information on CMOM.
- System evaluation and capacity assurance plan. Capacity assurance refers to a process to identify, characterize and address hydraulic deficiencies in a sanitary sewer collection system. The permit may require the permittee to implement a program to assess the current capacity of the collection system and treatment facilities that they own or over which they have operational control to ensure that discharges from unauthorized locations do not occur. Where peak flow conditions contribute to an SSO discharge or to noncompliance at a treatment plant, the permittee may be required to prepare and implement a system evaluation and capacity assurance plan. In some instances, the permittee may already be under an enforceable obligation and schedule, in which case this permit provision would be redundant and, thus, unnecessary.

Section 2.3.1.5 of this manual and EPA's Sanitary Sewer Overflows Website <www.epa.gov/npdes/sso> provide more information on SSOs.

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Endnotes for this chapter continued on the next page.

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U.S. Environmental Protection Agency

NPDES Permit Writers' Manual

U.S. Environmental Protection Agency
Office of Wastewater Management, Water Permits Division
State and Regional Branch

EPA-833-K-10-001 • September 2010

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United States
Environmental Protection
Agency

Office of Water
Washington, DC

United States Environmental Protection Agency

National Pollutant Discharge Elimination System (NPDES) Permit Writers' Manual

This guidance was developed by staff within the U.S. Environmental Protection Agency's (EPA's) Office of Wastewater Management and addresses development of wastewater discharge permits under the National Pollutant Discharge Elimination System (NPDES). NPDES permit development is governed by existing requirements of the Clean Water Act (CWA) and the EPA NPDES implementing regulations. CWA provisions and regulations contain legally binding requirements. This document does not substitute for those provisions or regulations. Recommendations in this guidance are not binding; the permitting authority may consider other approaches consistent with the CWA and EPA regulations. When EPA makes a permitting decision, it will make each decision on a case-by-case basis and will be guided by the applicable requirements of the CWA and implementing regulations, taking into account comments and information presented at that time by interested persons regarding the appropriateness of applying these recommendations to the situation. This guidance incorporates, and does not modify, existing EPA policy and guidance on developing NPDES permits. EPA may change this guidance in the future.

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EPA-833-K-10-001
September 2010

Acknowledgements

David Hair and Pravin Rana, *United States Environmental Protection Agency (EPA), Office of Water, Office of Wastewater Management, Water Permits Division, Washington, DC*, were the team leaders for the development and production of this manual.

Many individuals assisted in this effort, including the following:

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- Pat Bradley
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- Louis Eby
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- Sara Hilbrich
- Jamie Hurley
- Caitlin Kovzelove
- Tom Laverty
- Jennifer Molloy
- Deborah Nagle
- Jan Pickrel
- Jane Rice, ORISE Intern
- Greg Schaner
- Martha Segall
- George Utting
- Kevin Weiss
- Marcus Zobrist

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- Tom Gardner, Office of Science and Technology, Standards and Health Protection Division
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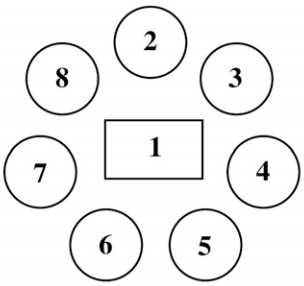

Contents

Introduction to the Manual vii
Purpose of this Manual vii
Publications Referenced viii
Legislative and Regulatory Citations viii
Electronic NPDES Information ix

CHAPTER 1. Development of the Clean Water Act and the NPDES Program 1-1
1.1 History of Water Pollution Control in the United States 1-1
1.2 Evolution of the NPDES Program 1-3
1.3 NPDES Statutory Framework 1-5
1.3.1 Permit 1-5
1.3.2 Pollutant 1-6
1.3.3 Waters of the United States 1-6
1.3.4 Point Source 1-7

CHAPTER 2. Regulatory Framework and Program Areas of the NPDES Program 2-1
2.1 Regulatory Framework of the NPDES Program 2-1
2.2 Federal and State Responsibilities 2-2
2.2.1 State NPDES Program Authority 2-2
2.2.2 Roles and Responsibilities of the Federal and State Authorities 2-4
2.3 NPDES Program Areas 2-5
2.3.1 NPDES Program Areas Applicable to Municipal Sources 2-5
2.3.2 NPDES Program Areas Applicable to Non-Municipal Sources 2-10
2.4 Major/Minor Facility Designation 2-17
2.5 Growth and Change in the NPDES Program 2-17

CHAPTER 3. Overview of the NPDES Permitting Process 3-1
3.1 Types of Permits 3-1
3.1.1 Individual Permits 3-1
3.1.2 General Permits 3-1
3.2 Major Components of a Permit 3-2
3.3 Overview of the Development and Issuance Process for NPDES Individual Permits 3-3
3.4 Overview of the Development and Issuance Process for NPDES General Permits 3-5

CHAPTER 4. NPDES Permit Application Process 4-1
4.1 Who Applies for an NPDES Permit? 4-1
4.2 Application Deadlines 4-3
4.3 Application Forms and Requirements for Individual Permits 4-3
4.3.1 Form 1: General Information 4-5
4.3.2 Form 2A: New and Existing POTWs 4-5
4.3.3 Form 2S: New and Existing TWTDS 4-6
4.3.4 Form 2B: New and Existing Concentrated Animal Feeding Operations (CAFOs) and Concentrated Aquatic Animal Production (CAAP) Facilities 4-7
4.3.5 Form 2C: Existing Manufacturing, Commercial, Mining, and Silvicultural Discharges 4-8
4.3.6 Form 2D: New Manufacturing, Commercial, Mining, and Silvicultural Discharges of Process Wastewater 4-8
4.3.7 Form 2E: Manufacturing, Commercial, Mining, and Silvicultural Facilities that Discharge Only Non-Process Wastewater 4-8

4.3.8 Form 2F: Stormwater Discharges Associated with Industrial Activities 4-9
4.3.9 Stormwater Discharges Associated with Construction Activity 4-9
4.3.10 Stormwater Discharges from Small MS4s 4-11
4.3.11 Cooling Water Intake Structures 4-11
4.4 Requirements for NPDES General Permits 4-12
4.5 Application Review 4-13
4.5.1 The Complete Application 4-14
4.5.2 Common Omissions in Applications 4-14
4.5.3 The Accurate Application 4-16
4.6 Facility Information Review 4-17
4.6.1 Permit File Review 4-17
4.6.2 Facility Site Visits 4-19
4.7 Confidential Information 4-21

CHAPTER 5. Technology-Based Effluent Limitations 5-1
5.1 Technology-based Effluent Limitations for POTWs 5-2
5.1.1 Secondary and Equivalent to Secondary Treatment Standards 5-2
5.1.2 Adjustments to Equivalent to Secondary Standards 5-4
5.1.3 Applying Secondary Treatment Standards, Equivalent to Secondary Treatment Standards, and Adjusted Standards 5-6
5.2 Technology-Based Effluent Limitations for Industrial (Non-POTW) Dischargers 5-13
5.2.1 Effluent Guidelines 5-14
5.2.2 Applying Effluent Guidelines through NPDES Permits 5-23
5.2.3 Case-by-Case TBELs for Industrial Dischargers 5-44

CHAPTER 6. Water Quality-Based Effluent Limitations 6-1
6.1 Determine Applicable Water Quality Standards 6-2
6.1.1 Components of Water Quality Standards 6-3
6.1.2 Water Quality Standards Modifications 6-9
6.1.3 Water Quality Standards Implementation 6-11
6.2 Characterize the Effluent and the Receiving Water 6-12
6.2.1 Step 1: Identify Pollutants of Concern in the Effluent 6-13
6.2.2 Step 2: Determine Whether Water Quality Standards Provide for Consideration of a Dilution Allowance or Mixing Zone 6-15
6.2.3 Step 3: Select an Approach to Model Effluent and Receiving Water Interactions 6-16
6.2.4 Step 4: Identify Effluent and Receiving Water Critical Conditions 6-16
6.2.5 Step 5: Establish an Appropriate Dilution Allowance or Mixing Zone 6-20
6.3 Determine the Need for WQBELs 6-22
6.3.1 Defining Reasonable Potential 6-23
6.3.2 Conducting a Reasonable Potential Analysis Using Data 6-23
6.3.3 Conducting a Reasonable Potential Analysis without Data 6-30
6.4 Calculate Parameter-specific WQBELs 6-31
6.4.1 Calculating Parameter-specific WQBELs from Aquatic Life Criteria 6-31
6.4.2 Calculating Chemical-specific WQBELs based on Human Health Criteria for Toxic Pollutants 6-35
6.5 Calculate Reasonable Potential and WQBELs for WET 6-36
6.5.1 Types of WET Tests 6-36
6.5.2 Expressing WET Limitations or Test Results 6-37
6.5.3 Determining the Need for WET Limitations 6-38
6.6 Antidegradation Review 6-40
6.6.1 Tier 1 Implementation 6-41
6.6.2 Tier 2 Implementation 6-41
6.6.3 Tier 3 Implementation 6-42

CHAPTER 7. Final Effluent Limitations and Anti-backsliding 7-1
7.1 Determining Final Effluent Limitations 7-1
7.2 Applying Anti-backsliding Requirements 7-2
7.2.1 Anti-backsliding Statutory Provisions 7-2
7.2.2 Anti-backsliding Regulatory Provisions 7-4

CHAPTER 8. Monitoring and Reporting Conditions 8-1
8.1 Establishing Monitoring Conditions 8-1
8.1.1 Purposes of Monitoring 8-2
8.1.2 Monitoring Location 8-2
8.1.3 Monitoring Frequency 8-5
8.1.4 Sample Collection 8-7
8.2 Additional Monitoring Requirements and WET Testing 8-9
8.2.1 Biosolids (Sewage Sludge) 8-9
8.2.2 Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs) .. 8-11
8.2.3 Stormwater Monitoring Considerations 8-11
8.2.4 WET Monitoring 8-12
8.3 Analytical Methods 8-13
8.4 Reporting Monitoring Results 8-14
8.5 Recordkeeping Requirements 8-14

CHAPTER 9. Special Conditions 9-1
9.1 Special Conditions Potentially Applicable to Any Type of Discharger 9-1
9.1.1 Additional Monitoring and Special Studies 9-2
9.1.2 Best Management Practices (BMPs) 9-3
9.1.3 Compliance Schedules 9-8
9.2 Special Conditions for Municipal Facilities 9-9
9.2.1 The National Pretreatment Program 9-10
9.2.2 Biosolids (Sewage Sludge) 9-13
9.2.3 Combined Sewer Overflows (CSOs) 9-15
9.2.4 Sanitary Sewer Overflows (SSOs) 9-20

CHAPTER 10. Standard Conditions of NPDES Permits 10-1
10.1 Types of Standard Conditions 10-1
10.2 Other Standard Conditions 10-3

CHAPTER 11. NPDES Permit Administration 11-1
11.1 Other Federal Laws Applicable to NPDES Permits 11-1
11.1.1 Endangered Species Act 11-1
11.1.2 National Environmental Policy Act 11-2
11.1.3 National Historic Preservation Act Amendments 11-3
11.1.4 Coastal Zone Management Act 11-3
11.1.5 Wild and Scenic Rivers Act 11-3
11.1.6 Fish and Wildlife Coordination Act 11-4
11.1.7 Essential Fish Habitat Provisions 11-4
11.2 Documentation for Development of the Draft Permit 11-4
11.2.1 Administrative Record 11-8
11.2.2 Fact Sheets and Statements of Basis 11-8
11.3 Items to Address before Issuing a Final Permit 11-10
11.3.1 Public Notice 11-11
11.3.2 Public Comments 11-12
11.3.3 Public Hearings 11-13
11.3.4 Environmental Justice Considerations 11-14
11.3.5 EPA and State/Tribal Roles in Reviewing Draft Permits 11-14

11.3.6 Schedule for Final Permit Issuance 11-15
11.4 Administrative Actions after Final Permit Issuance 11-16
11.4.1 Permit Appeals 11-16
11.4.2 Modification or Revocation and Reissuance of Permits 11-18
11.4.3 Permit Termination 11-20
11.4.4 Permit Transfer 11-21
11.5 Permit Compliance and Enforcement 11-21
11.5.1 Compliance Monitoring 11-22
11.5.2 Quarterly Noncompliance Reports 11-23
11.5.3 Enforcement 11-25

Appendix A. Acronyms, Abbreviations and Glossary A-1
A.1 Acronyms and Abbreviations A-1
A.2 Glossary A-4

Appendix B. Index to the CWA and NPDES Regulations B-1
B.1 Index to Sections of the CWA B-1
B.2 Index to NPDES Regulations B-3

Appendix C. Priority Pollutants C-1

Appendix D. New Source Dates by Effluent Guideline Category D-1

Exhibits

Exhibit 1-1 Important milestones of clean water program development 1-1
Exhibit 1-2 Common point source discharges of pollutants to waters of the United States 1-8
Exhibit 2-1 Regulations related to the NPDES program 2-2
Exhibit 2-2 Federal NPDES regulations (40 CFR Part 122) 2-3
Exhibit 2-3 Summary of federal and state/territorial/tribal roles in the NPDES permitting program 2-5
Exhibit 2-4 NPDES program areas and applicable regulations 2-6
Exhibit 3-1 Permit components 3-3
Exhibit 3-2 Major steps to develop and issue NPDES individual permits 3-4
Exhibit 3-3 Major steps to develop and issue NPDES general permits 3-5
Exhibit 4-1 Effect of court decisions on § 122.3 4-2
Exhibit 4-2 When to apply for an NPDES permit 4-3
Exhibit 4-3 EPA application requirements for NPDES individual permits 4-4
Exhibit 4-4 Permit application review process 4-13
Exhibit 4-5 Considerations for an application to be complete 4-15
Exhibit 4-6 Example of required testing during application review 4-16
Exhibit 4-7 Considerations for an application to be accurate 4-18
Exhibit 5-1 Developing effluent limitations 5-1
Exhibit 5-2 Secondary treatment standards 5-2
Exhibit 5-3 Equivalent to secondary treatment standards 5-3
Exhibit 5-4 State-specific adjusted TSS requirements 5-5

Exhibit 5-5 Steps to establish technology-based discharge limitations for POTWs 5-6
Exhibit 5-6 Effluent limitations calculated from secondary treatment standards 5-7
Exhibit 5-7 POTW mass based limitation calculation equation and example calculations 5-8
Exhibit 5-8 Summary of CWA technology levels of control 5-15
Exhibit 5-9 Visual example of TSS LTA, maximum daily limitation and average monthly limitation 5-21
Exhibit 5-10 Steps for applying effluent guidelines to direct discharges 5-23
Exhibit 5-11 Table of existing point source categories (June 2010) 5-24
Exhibit 5-12 Examples of identifying applicable effluent guidelines using SIC codes 5-25
Exhibit 5-13 Examples of identifying the subcategory with the applicable effluent guidelines 5-27
Exhibit 5-14 Example of calculating mass-based effluent limitation from production-normalized effluent guidelines 5-31
Exhibit 5-15 Example narrative requirement from the Concentrated Aquatic Animal Production effluent guideline—Subpart A [§ 455.11(a)] 5-33
Exhibit 5-16 Exclusion of wastewaters in metal finishing effluent guidelines 5-34
Exhibit 5-17 Excerpts from preamble to OCPSF effluent guidelines regarding applicability of effluent guidelines 5-34
Exhibit 5-18 Building block approach for applying effluent guidelines 5-36
Exhibit 5-19 Example of tiered discharge limitations 5-38
Exhibit 5-20 Variances from effluent guidelines 5-40
Exhibit 5-21 Summary of factors considered when developing case-by-case TBELs 5-46
Exhibit 5-22 Tools for developing case-by-case TBELs using BPJ 5-48
Exhibit 6-1 Developing effluent limitations 6-1
Exhibit 6-2 Standards-to-permits process 6-2
Exhibit 6-3 Aquatic life criteria example: Cadmium (dissolved) 6-5
Exhibit 6-4 Human health criteria example: Dichlorobromomethane 6-7
Exhibit 6-5 Steps for characterizing the effluent and receiving water 6-13
Exhibit 6-6 Parts of a TMDL 6-14
Exhibit 6-7 Example of lognormal distribution of effluent pollutant concentrations and projection of critical concentration (C_d) 6-18
Exhibit 6-8 Regulatory mixing zones for aquatic life criteria 6-21
Exhibit 6-9 Examples of maximum mixing zone sizes or dilution allowances under incomplete mixing conditions by waterbody type 6-22
Exhibit 6-10 Steps of a reasonable potential analysis with available data 6-23
Exhibit 6-11 Simple mass-balance equation 6-24
Exhibit 6-12 Example of receiving water concentrations in an incomplete mixing situation determined using an incomplete mixing water quality model 6-26
Exhibit 6-13 Mass-balance equation for reasonable potential analysis for conservative pollutant under conditions of rapid and complete mixing 6-27
Exhibit 6-14 Example of applying mass-balance equation to conduct reasonable potential analysis for conservative pollutant under conditions of rapid and complete mixing 6-28
Exhibit 6-15 Reasonable potential determination in an incomplete mixing situation 6-29

Exhibit 6-16 Calculating parameter-specific WQBELs from aquatic life criteria....6-31
Exhibit 6-17 Example of applying mass-balance equation to calculate WLAs for conservative pollutant under conditions of rapid and complete mixing 6-33
Exhibit 6-18 Example of lognormal distribution of effluent pollutant concentrations and calculation of WLA 6-34
Exhibit 6-19 Example of typical dilution series 6-36
Exhibit 6-20 Example of toxic units 6-37
Exhibit 6-21 Using the ACR....6-38
Exhibit 6-22 Example of mass-balance equation for a WET reasonable potential analysis 6-39
Exhibit 7-1 Developing effluent limitations....7-1
Exhibit 7-2 Application of anti-backsliding rules 7-5
Exhibit 7-3 Backsliding examples....7-6
Exhibit 8-1 Examples of specifying monitoring locations in permits 8-3
Exhibit 8-2 Visual interpretation of time-proportional composite monitoring....8-8
Exhibit 8-3 Visual interpretation of flow-proportional composite monitoring 8-8
Exhibit 8-4 Minimum requirements for sewage sludge monitoring, based on method of sludge use or disposal....8-10
Exhibit 9-1 Example BMP plan requirement....9-6
Exhibit 9-2 Categories of CSO permitting conditions 9-17
Exhibit 9-3 Nine minimum CSO controls 9-17
Exhibit 9-4 Elements of the long-term CSO control plan 9-18
Exhibit 11-1 Other federal laws applicable to NPDES permits 11-1
Exhibit 11-2 Reasons for good documentation....11-5
Exhibit 11-3 Administrative process for EPA-issued NPDES permits 11-6
Exhibit 11-4 Typical administrative process for state-issued NPDES permits....11-7
Exhibit 11-5 Elements of the administrative records for a draft permit 11-8
Exhibit 11-6 Required elements of a fact sheet....11-9
Exhibit 11-7 Actions for which public notice is required....11-11
Exhibit 11-8 Contents of the public notice 11-12
Exhibit 11-9 Elements of the administrative records for a final permit....11-16
Exhibit 11-10 Causes for permit modification 11-19
Exhibit A-1 Acronyms and abbreviations.... A-1
Exhibit A-2 Glossary.... A-5
Exhibit B-1 Index to sections of the CWA.... B-1
Exhibit B-2 Index to NPDES regulations B-3
Exhibit C-1 Priority pollutants from 40 CFR Part 423, Appendix A C-1
Exhibit D-1 New source dates by effluent category.... D-2

Introduction to the Manual

This manual reviews the statutory and regulatory framework of the National Pollutant Discharge Elimination System (NPDES) program and examines technical considerations for developing NPDES permits for wastewater discharges. The manual is designed, primarily, for new permit writers becoming acquainted with the NPDES program and the process of permit writing, but can also serve as a reference for experienced permit writers or anyone interested in learning about the legal and technical aspects of developing NPDES permits. This manual replaces the *1996 U.S. EPA NPDES Permit Writers' Manual*[1] <www.epa.gov/npdes/pubs/owm0243.pdf>, which updated the *1993 Training Manual for NPDES Permit Writers*[2] <www.epa.gov/npdes/pubs/owm0339.pdf>.

To assist the reader, acronyms and abbreviations are defined for the first use in each chapter and in Appendix A of the manual. Endnotes are provided at the end of each chapter.

Purpose of this Manual

The purpose of this *NPDES Permit Writers' Manual* (manual) is to provide a general reference for permitting authorities that outlines and explains the core elements of the NPDES permit program. The core elements form the foundation of the NPDES program on which guidance for specific areas of the program (e.g., stormwater, concentrated animal feeding operations) can be built. While the guidance for these core program areas will be applicable in many cases, the U.S. Environmental Protection Agency (EPA) recognizes that each EPA Regional Office or authorized state, territory, or tribe (hereafter *state*) will tailor specific aspects of its NPDES permitting procedures to address state and local laws and site-specific concerns and conditions.

The specific objectives and functions of this manual are as follows:

- Provide an overview of the scope and the statutory and regulatory framework of the NPDES program.
- Describe the essential components of a permit and provide an overview of the permitting process.
- Describe the different types of effluent limitations and the legal and technical considerations involved in developing effluent limitations.
- Describe the legal and technical considerations involved in developing other permit conditions including
  - Monitoring and reporting requirements.
  - Special conditions.
  - Standard conditions.
- Describe other permitting considerations including
  - Variances.
  - Anti-backsliding.
  - Other applicable statutes.

- Explain the administrative process for issuing, modifying, revoking and terminating NPDES permits.

This manual is not intended to be a standalone reference document. Rather, it establishes the framework for NPDES permit development and should be supplemented, where necessary, by additional EPA and state regulations, policy, and detailed guidance applicable to specific types of dischargers and circumstances. To that end, this manual identifies and references relevant regulations, policy, and other guidance documents throughout the text.

Publications Referenced

This manual provides links to publications available online that supplement the information in the manual. All documents available electronically were accessed and available as of the date of this manual's publication. Some documents are not available in an electronic format. In those instances, readers should check the following sources to determine the availability of and to obtain printed copies of the documents:

- Office of Water Resource Center (OWRC) <www.epa.gov/safewater/resource/>
  OWRC is a contractor-operated facility providing document delivery, information/referral, and reference services to public users and EPA staff interested in Office of Water Program information
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Legislative and Regulatory Citations

There are a number of different conventions used to cite legislation and regulations. In this manual, the following conventions have been used:

- When citing the *United States Code*, the abbreviation U.S.C. is used. The abbreviation is preceded by the Title of the U.S.C. and then followed by the section number.
  Example: 16 U.S.C. 1531 *et seq*. and 33 U.S.C. §§ 1251-1387.

- When citing the Clean Water Act, the abbreviation CWA is used. The abbreviation is followed by the word *section* and then the section number.
  Example: CWA section 402 and CWA section 402(o).
- When citing the *Code of Federal Regulations* (CFR), the convention depends on the location of the reference. For first references, the abbreviation CFR is preceded by the title number of the CFR and followed either by the word *Part* (if it is a part—a whole number) or the number of the subsection (if it is a subpart/subsection). For subsequent references, the title and CFR are omitted and just the word *Part* or the section symbol (§) is used.
  Example: First citation: 40 CFR Part 136 or 40 CFR 122.44
  Subsequent citations: Part 136 or § 122.44.

Almost all the regulatory citations in this manual are for Title 40 of the CFR (with the exception of the other federal laws referenced in section 11.1 of this manual). Any other Titles are explicitly referenced and in the format for the first regulatory citation (e.g., 50 CFR Part 402).

Electronic NPDES Information

Websites and electronically stored publications and data are available to help permit writers draft NPDES permits. Tools have been created to assist permit writers with specific aspects of permit development and are discussed in their respective sections. The electronic tools listed below apply to all aspects of permit development and serve as valuable references for the permit writer.

NPDES Website and Resources

The Water Permits Division (WPD) within the EPA Office of Water (OW), Office of Wastewater Management, has developed a comprehensive NPDES Website <www.epa.gov/npdes> with technical and regulatory information about the NPDES permit program, information on related programs and initiatives, and documents published by WPD. Where applicable, this manual references the NPDES Website and provides links to relevant documents on that site. This manual also references other EPA and non-EPA websites that contain information that might be helpful to NPDES permit writers. Note, however, that EPA is not responsible for information provided on websites outside the EPA Website <www.epa.gov>.

WPD also has prepared several websites and other resources to help permit writers draft permits. This manual references those websites and resources in the appropriate section of this manual.

Electronic Permitting Tools

Many EPA Regions and authorized states have developed tools to help them manage the permit issuance process. Electronic permitting tools range from spreadsheets and word processing applications to sophisticated Web-based systems that enable permitting authorities to manage their entire environmental program. For example, some states have built systems that enable dischargers to electronically sign and submit discharge reports; create, track, and store permit documents; and manage enforcement, compliance, and inspections related to permits. As technologies continue to evolve, many permitting authorities are likely to begin using more information technology applications to manage the process of permitting.

ICIS-NPDES

Together with OW, the Office of Enforcement and Compliance Assurance (OECA) is responsible for oversight of implementation of the NPDES program. OW is responsible for the NPDES implementing regulations and oversight of permit issuance by states and EPA Regions. OECA, along with its regional, state, tribal and local counterparts, is responsible for tracking and maintaining enforcement and compliance activities, monitoring and enforcement and compliance status of the regulated community, and reviewing and evaluating program performance. OECA also maintains national data systems to support program management and oversight of the NPDES program.

The Permit Compliance System (PCS), one of two national NPDES electronic databases, supports the management and oversight of the NPDES program. Since the last modernization of PCS in 1985, the NPDES program has evolved significantly to include additional program requirements, such as the NPDES program for stormwater and implementation of the Combined Sewer Overflow Control Policy. Because of limitations to PCS, OECA is working to phase out this system and move to a more modern data management system described below.

The Integrated Compliance Information System for NPDES permits (ICIS-NPDES) <https://icis.epa.gov/icis>, the successor to PCS, provides an updated system that enables national program management and oversight activities such as

- Permit tracking and management.
- Compliance monitoring.
- NPDES program management.
- Enforcement actions.

ICIS-NPDES is a Web-based system with an electronic database capable of handling the large amount of data generated by and about the NPDES program. Section 11.5.1.1 of this manual provides more information on ICIS-NPDES as it relates to NPDES permit compliance.

Hyperlinks in this Document

Where a website provides supplementary information or is referenced in this manual, the actual site or higher level site address appears in the symbols < > so that readers will have a reference to the address even in a printed version of this document. In the electronic version of the manual, the text in carats is also the hyperlink to the referenced website. Care has been taken to provide the correct Web addresses and hyperlinks; however, these references can change or become outdated after this manual's publication.

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[1] U.S. Environmental Protection Agency. 1996. *U.S. EPA NPDES Permit Writers' Manual*. EPA-833-B-96-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC. <www.epa.gov/npdes/pubs/owm0243.pdf>. Separate sections of this document are also available on the NPDES Website by going to <www.epa.gov/npdes>, clicking on Publications and entering NPDES Permit Writers' Manual in the Search box.

[2] U.S. Environmental Protection Agency. 1993. *Training Manual for NPDES Permit Writers*. EPA-833-B-93-003. U.S. Environmental Protection Agency, Office of Wastewater Management, Washington, DC. <www.epa.gov/npdes/pubs/owm0339.pdf>.

United States
Environmental Protection
Agency

Office Of Water
(EN-336)

EPA/505/2-90-001
PB91-127415
March 1991

EPA

Technical Support Document For Water Quality-based Toxics Control

3. EFFLUENT CHARACTERIZATION

3.1 INTRODUCTION

Once the applicable designated uses and water quality criteria for a waterbody are determined, the effluent must be characterized and the permitting authority must determine the need for permit limits to control the discharge. The purpose of effluent characterization is to determine whether the discharge causes, has the reasonable potential to cause, or contributes to an excursion of numeric or narrative water quality criteria. **Once the permitting authority determines that a discharge causes, has the reasonable potential to cause, or contributes to the excursion of water quality criteria, the permitting authority must develop permit limits that will control the discharge.** At a minimum, the permitting authority must make this determination at each permit reissuance. The effluent characterization procedures described in the following sections apply only to the water quality-based approach, not to end-of-the-pipe technology-based controls.

Although many waterbodies receive discharges from only single point sources, permitting authorities will also occasionally encounter receiving waters where several dischargers are in close proximity. In such situations, the permitting authority may find that each discharger alone does not cause, have the reasonable potential to cause, or contribute to an excursion above water quality criteria. Yet, the dischargers may collectively cause, have the reasonable potential to cause, or contribute to an excursion. **Under these circumstances, limits must be developed for each discharger to protect against collective excursions of applicable water quality standards consistent with the Environmental Protection Agency's (EPA) existing regulations in 40 *CFR* 122.44(d)(1)(ii) for controlling multiple discharges.** The terms "cause," "reasonable potential to cause," and "contribute to" are the terms used in the National Pollutant Discharge Elimination System (NPDES) regulations for conditions under which water quality-based limits are required. Permitting authorities are required to consider each of these concepts when performing effluent characterizations.

This chapter is divided into two parts: Section 3.2, Determining the Need for Permit Limits Without Effluent Data, and Section 3.3, Determining the Need for Permit Limits With Effluent Data. Section 3.3 includes effluent characterization for whole effluent toxicity and for specific chemicals (including those for human health protection) and is based on the cumulative experience gained by EPA, States, publicly owned treatment works (POTWs), and industry when implementing the water quality-based approach to toxics control. The effluent bioconcentration evaluation procedures described in the section on human health are currently draft and are subject to further validation before being used. Until the procedures are fully developed, reviewed, and finalized, permitting authorities should not use them to characterize effluents.

3.1.1 NPDES Regulation Requirements

Effluent characterization is an essential step in determining the need for an NPDES permit limit. NPDES regulations under 40 *CFR* 122.44(d)(1) specify the minimum requirements and general types of analyses necessary for establishing permit limits. Each of these regulations is described below.

40 *CFR* 122.44(d)(1)(ii)

> When determining whether a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative or numeric criteria within a State water quality standard, the permitting authority shall use procedures which account for existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the species to toxicity testing (when evaluating whole effluent toxicity), and where appropriate, the dilution of the effluent in the receiving water.

This regulation requires at a minimum the consideration of each of these elements in determining the need for a limit.

40 *CFR* 122.44(d)(1)(iii)

> When the permitting authority determines, using the procedures in paragraph (d)(1)(ii) of this section, that a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above the allowable ambient concentration of a State numeric criteria within a State water quality standard for an individual pollutant, the permit must contain effluent limits for that pollutant.

Under this regulation, permitting authorities need to investigate for the existence of pollutants in effluents if there is a numeric water quality criterion for that pollutant and to implement limits for those pollutants where necessary.

40 *CFR* 122.44(d)(1)(iv)

> When the permitting authority determines, using the procedures in paragraph (d)(1)(ii) of this section, that a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above the numeric criterion for whole effluent toxicity, the permit must contain effluent limits for whole effluent toxicity.

Under this regulation, permitting authorities need to investigate for the existence of whole effluent toxicity in effluents if there is a numeric water quality criterion for that parameter and to implement whole effluent toxicity limits where necessary.

40 *CFR* 122.44(d)(1)(v)

> Except as provided in this subparagraph, when the permitting authority determines, using the procedures in paragraph (d)(1)(ii) of this section, toxicity testing data, or other information, that a discharge causes, has the reasonable potential to cause, or contributes to an in-stream excursion above a narrative criterion within an applicable State water quality standard, the permit must contain effluent limits for whole effluent toxicity. Limits on whole effluent toxicity are not necessary where the permitting authority demonstrates in the fact sheet or statement of basis of the NPDES permit, using the procedures in paragraph (d)(1)(ii) of this section, that chemical-specific limits for the effluent are sufficient to attain and maintain applicable numeric and narrative State water quality standards.

Under this regulation, permitting authorities need to investigate for the existence of whole effluent toxicity in effluents. If the permitting authority can demonstrate that control of specific chemicals is sufficient to control toxicity to the point of achieving compliance with the water quality criteria, then chemical-specific permit limits alone will be sufficient to comply with the regulation.

40 *CFR* 122.44(d)(1)(vi)

> Where a State has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits using one or more of the following [three] options: ....

Under this regulation, permitting authorities need to investigate for the existence of specific chemicals in effluents for which the State has not adopted numeric criteria, but which may be contributing to aquatic toxicity or impairment of human health. Narrative criteria apply when numeric criteria do not protect all the designated or existing uses. For example, the narrative criteria need to be used to protect human health if a State has only adopted a numeric criteria for protecting aquatic life. Conversely, the narrative criteria need to be used to protect aquatic life if a State has only adopted a numeric criteria for protecting human health. Once the permitting authority determines that one or more specific chemicals in an effluent must be controlled, the authorities can use EPA's national criteria, develop their own criteria, or control the pollutant through use of an indicator pollutant, as provided in subparagraph (d)(1)(vi). In any case, the permitting authority will need to characterize the effluent in a manner consistent with the selected approach for controlling the pollutant.

3.1.2 Background for Toxic Effects Assessments on Aquatic Life and Human Health

Aquatic toxicity effects can be characterized by conducting a general assessment of the effluent, or by measuring effluent toxicity or concentrations of individual chemicals and comparing these measurements to the expected exposure concentrations in the receiving water. The "receiving water concentration" (RWC) is the measured or projected exposure concentration of a toxicant or the parameter toxicity (when dealing with the whole effluent toxicity) in the receiving water after mixing. The RWC is calculated at the edge of a mixing zone if such a zone is allowed by a State's water quality standards.

As with aquatic life protection, there are two possible approaches to characterizing effluents for human health effects: chemical-by-chemical and whole effluent. However, only the chemical-by-chemical approach currently is practical for assessing and controlling human health impacts. Appendix G discusses developing procedures for assessing human health impacts from whole effluents.

A fundamental principle in the development of water quality-based controls is that the RWC must be less than the criteria that comprise or characterize the water quality standards. With individual toxicants (or the parameter toxicity), the potential for toxicity in the receiving water is minimized where the RWC is less than the criterion continuous concentration (CCC), the criterion maximum concentration (CMC), and the reference ambient concentration (RAC). Toxicity becomes maximized where the RWC exceeds these criteria. **Therefore, to prevent impacts to aquatic life or human health, the RWC of the parameter effluent toxicity or an individual toxicant (based on allowable dilution for the criterion) must be less than the most limiting of the applicable criterion, as indicated below.** (The RAC as used throughout this chapter incorporates EPA human health criteria and State standards as well.)

RWC < CCC (chronic aquatic life)
RWC < CMC (acute aquatic life)
RWC < RAC (human health)

The water quality analyst will use the same basic components in the above-described relationship (i.e., critical receiving water flows, ambient criteria values, measures of effluent quality) for both effluent characterization and wasteload allocation (WLA) development, albeit from different perspectives. In the case of effluent characterization, the objective is to project receiving water concentrations based upon existing effluent quality to determine whether or not an excursion above ambient criteria occurs, or has the reasonable potential to occur. In developing WLAs, on the other hand, the objective is to fix the RWC at the desired criteria level and determine an allowable effluent loading that will not cause excursions above the criteria.

Recommendations for projecting the RWC are described within this chapter. Chapter 4, Exposure Assessment and Wasteload Allocation, provides recommendations for determining allowable effluent loadings to achieve established ambient criteria and for calculating WLAs for establishing permit limits. The procedures described within Chapter 4 can also be used to calculate the dilution for analyses within Chapter 3. Chapter 5, Permit Requirements, describes the actual calculation of permit limits after effluent characterization and loadings, as well as WLAs, are complete.

3.1.3 General Considerations in Effluent Characterization

There are two possible ways to characterize an effluent to determine the need for effluent limits for the protection of aquatic life and human health. First, an assessment may be made without generating effluent data; second, an assessment may be conducted after effluent data have been generated. Regulatory authorities must determine whether a discharge causes, has the "reasonable potential" to cause, or contributes to an excursion above an applicable narrative or numeric water quality criterion. An analysis of "reasonable potential" determines an effluent's capability to cause such excursions.

In determining the need for a permit limit for whole effluent toxicity or for an individual toxicant, the regulatory authority is required to consider, at a minimum, existing controls on point and nonpoint sources of pollution, the variability of the pollutant or pollutant parameter in the effluent, the sensitivity of the involved species to toxicity testing (for whole effluent), and, where appropriate, the dilution of the effluent in the receiving water (40 *CFR* 122.44(d)(ii)).

The regulatory authority is also required by NPDES regulations to consider whether technology-based limits are sufficient to maintain State water quality standards. There are two possibilities that will need to be assessed. First, if the limits based on appropriate treatment technology have already been specified in a previous permit, and if the facility is operating at the required level, then historical effluent and receiving water information can be used. Second, if the facility has yet to achieve the required technology performance (best available technology or best conventional technology), the regulatory authority will need to assess the technology-based limit for reasonable potential for causing or contributing to an excursion above the water quality standard.

In addition, the regulatory authority should consider all other available data and information pertaining to the discharger to assist in making an informed judgment. Where both effluent testing data and important other factors exist, the regulatory authority will need to exercise discretion in the determination of the need for a limit. **The authority should employ the principle of "independent application" of the data and information that characterizes the effluent.** In other words, effluent data alone, showing toxicity at the RWC, may be adequate to demonstrate the need for a limit for toxicity or for individual toxicants. Likewise, other factors may form an adequate basis for determining that limits are necessary. For example, where available dilution is low and monitoring information shows that toxic pollutants are frequently discharged at concentrations that have caused toxicity when discharged from similar facilities, the permitting authority may reason that a whole effluent toxicity limit is necessary even without whole effluent toxicity data from the specific facility. In all cases, the decision must be based upon consideration of factors cited in 40 *CFR* 122.44(d)(1)(ii). The regulatory authority will need to prioritize, on a case-by-case basis, the importance of all data and information used in making a determination. To assist in case-by-case determinations, recommended guidelines for characterizing an effluent for the need for a permit limit for whole effluent toxicity or individual toxicants are discussed below and summarized in Boxes 3-1 through 3-3.

Box 3-1. Determining "Reasonable Potential" for Excursions Above Ambient Criteria Using Factors Other than Facility-specific Effluent Monitoring Data

When determining the "reasonable potential" of a discharge to cause an excursion above a State water quality standard, the regulatory authority must consider all the factors listed in 40 *CFR* 122.44(d)(1)(ii). Examples of the types of information relating to these factors are listed below.

Existing controls on point and nonpoint sources of pollution

- Industry type: Primary, secondary, raw materials used, products produced, best management practices, control equipment, treatment efficiency, etc.
- Publicly owned treatment work type: Pretreatment, industrial loadings, number of taps, unit processes, treatment efficiencies, chlorination/ammonia problems, etc.

Variability of the pollutant or pollutant parameter in the effluent

- Compliance history
- Existing chemical data from discharge monitoring reports and applications.

Sensitivity of the species to toxicity testing

- Adopted State water quality criteria, or EPA criteria
- Any available in-stream survey data **applied under independent application of water quality standards**
- Receiving water type and designated/existing uses

Dilution of the effluent in the receiving water

- Dilution calculations

3.2 DETERMINING THE NEED FOR PERMIT LIMITS WITHOUT EFFLUENT MONITORING DATA FOR A SPECIFIC FACILITY

If the regulatory authority so chooses, or if the circumstances dictate, the authority may decide to develop and impose a permit limit for whole effluent toxicity or for individual toxicants without facility-specific effluent monitoring data, or prior to the generation of effluent data. Water quality-based permit limits can be set for a single toxicant or for whole effluent toxicity based on the available dilution and the water quality criterion or the State standard in the absence of facility specific effluent monitoring data. However, in doing so, the regulatory authority must satisfy all the requirements of 40 *CFR* 122.44(d)(1)(ii).

When determining whether or not a discharge causes, has the reasonable potential to cause, or contributes to an excursion of a numeric or narrative water quality criterion for individual toxicants or for toxicity, the regulatory authority can use a variety of factors and information where facility-specific effluent monitoring data are unavailable. These factors also should be considered with available effluent monitoring data. Some of these factors are the following:

- **Dilution**—Toxic impact is directly related to available dilution for the effluent. Dilution is related to the receiving stream flow and the size of the discharge. The lower the available dilution, the higher the potential for toxic effect. If an effluent's concentration at the edge of a mixing zone in a receiving water is expected to reach 1 percent or higher during critical or worst-case design periods, then such an effluent may require a toxicity limit (see discussion in Section 3.3.3). Assessment of the amount of stream dilution available should be made at the conditions required by the water quality standards or, if not specified in the standards, at the harmonic mean flow and the 7Q10 flow. Figure 3-3 (Pg. 57) shows that, whereas a majority of NPDES permittees nationwide discharge to areas during annual mean flow ranging in dilution from 100 to 1,000, the majority of dischargers fall into the 1 to 10 dilution range during low-flow conditions.

- **Type of industry**—Although dischargers should be individually characterized because toxicity problems are site-specific, the primary industrial categories should be of principal toxicity concern. EPA's treatment technology data base generally suggests that secondary industrial categories may have less potential for toxicity than primary industries. However, based on experience, it is virtually impossible to generalize the toxicity of effluents with any certainty. If two plants produce the same type of product, one effluent may be toxic while the other may not be toxic due to the type and efficiency of the treatment applied, general materials handling practices, and the functional target of the compound(s) being produced.

- **Type of POTW**—POTWs with loadings from indirect dischargers (particularly primary industries) may be candidates for toxicity limits. However, absence of industrial input does not guarantee an absence of POTW discharge toxicity problems. For example, commercial pesticide applicators often discharge to POTWs, resulting in pesticide concentrations in the POTW's effluent. Household disposal of pesticides, detergents, or other toxics may have a similar effect. The types of industrial users, their product lines, their raw materials, their potential and actual discharges, and their control equipment should be evaluated. POTWs should also be characterized for the possibility of chlorine and ammonia problems.

- **Existing data on toxic pollutants**—Discharge monitoring reports (DMRs) and data from NPDES permit application forms 2C and 2A may provide some indication of the presence of toxicants. The presence or absence of the 126 "priority pollutants" may or may not be an indication of the presence or absence of toxicity. There are thousands of "nonpriority" toxicants that may cause effluent toxicity. Also, combinations of several toxicants can produce ambient toxicity where the individual toxicants would not. EPA regulations at 40 *CFR* 122.21(j) require POTWs with design flows equal to or greater than 1 MGD and POTWs with approved pretreatment programs, or POTWs required to develop a pretreatment program, to submit the results of whole effluent toxicity tests with their permit applications. These regulations also provide discretion to the permitting authority to request such data from other POTWs at the time of permit application.

- **History of compliance problems and toxic impact**—Regulatory authorities may consider particular dischargers that have had difficulty complying with limits on toxicants or that have a history of known toxicity impacts as probable priority candidates for effluent toxicity limits.

- **Type of receiving water and designated use**—Regulatory authorities may compile data on water quality. Examples of available data include fish advisories or bans, reports of fish kills, State lists of priority waterbodies, and State lists of waters that are not meeting water quality standards. Regulatory authorities should use this information as a means of identifying point sources that discharge to impaired waterbodies and that thus may be contributing to this impairment. One source of this information is the lists of waters generated by states to comply with Section 304(l) regulations at 40 *CFR* 130.10(d)(6); 50 *FR* 23897-98, June 2, 1989:

    1) Waters where fishing or shellfish bans and/or advisories are currently in effect or are anticipated;

    2) Waters where there have been repeated fish kills or where abnormalities (cancers, lesions, tumors, etc.) have been observed in fish or other aquatic life during the last ten years;

    3) Waters where there are restrictions on water sports or recreational contact;

    4) Waters identified by the state in its most recent state section 305(b) report as either "partially achieving" or "not achieving" designated uses;

5) Waters identified by the states under section 303(d) of the Clean Water Act as waters needing water quality-based controls;

6) Waters identified by the state as priority water bodies;

7) Waters where ambient data indicate potential or actual excursions of water quality criteria due to toxic pollutants from an industry classified as a primary industry in Appendix A of 40 CFR Part 122;

8) Waters for which effluent toxicity test results indicate possible or actual excursions of state water quality standards, including narrative "free from" water quality criteria or EPA water quality criteria where state criteria are not available;

9) Waters with primary industrial major dischargers where dilution analyses indicate exceedances of state narrative or numeric water quality criteria (or EPA water quality criteria where state standards are not available) fortoxic pollutants, ammonia, or chlorine;

10) Waters with POTW dischargers requiring local pretreatment programs where dilution analyses indicate exceedances of state water quality criteria (or EPA water quality criteria where state water quality criteria are not available) for toxic pollutants, ammonia, or chlorine;

11) Waters with facilities not included in the previous two categories such as major POTWs, and industrial minor dischargers where dilution analyses indicate exceedances of numeric or narrative state water quality criteria (or EPA water quality criteria where state water quality criteria are not available) for toxic pollutants, ammonia, or chlorine;

12) Water classified for uses that will not support the "fishable/swimmable" goals of the Clean Water Act;

13) Waters where ambient toxicity or adverse water quality conditions have been reported by local, state, EPA or other Federal Agencies, the private sector, public interest groups, or universities;

14) Waters identified by the state as impaired in its most recent Clean Lake Assessments conducted under 314 of the Clean Water Act; and

15) Surface waters impaired by pollutants from hazardous waste sites on the National Priority List prepared under section 105(8)(A) of CERCLA.

16) Waters judged to be impaired as a result of a bioassessment/biosurvey.

The presence of a combination of these factors, such as low available dilution, high-quality receiving water, poor compliance record, and clustered industrial and municipal discharges, could constitute a high priority for effluent limits.

Regardless, the regulatory authority, if it chooses to impose an effluent limit after conducting an effluent assessment without facility-specific monitoring data, will need to provide adequate justification for the limit in its permit development rationale or in its permit fact sheet. A clear and logical rationale for the need for the limit covering all of the regulatory points will be necessary to defend the limit should it be challenged. In justification of a limit, **EPA recommends that the more information the authority can acquire to support the limit, the better a position the authority will be in to defend the limit if necessary.** In such a case, the regulatory authority may well benefit from the collection of effluent monitoring data prior to establishing the limit.

If the regulatory authority, after evaluating all available information on the effluent, in the absence of effluent monitoring data, is not able to decide whether the discharge causes, has the reasonable potential to cause, or contributes to, an excursion above a numeric or narrative criterion for whole effluent toxicity or for individual toxicants, the authority should require whole effluent toxicity or chemical-specific testing to gather further evidence. In such a case, the regulatory authority can require the monitoring prior to permit issuance, if sufficient time exists, or it may require the testing as a condition of the issued/reissued permit.

Under these circumstances, the regulatory authority may find it protective of water quality to include a permit reopener for the imposition of an effluent limit should the effluent testing establish that the discharge causes, has the reasonable potential to cause, or contributes to excursion above a water quality criteria. A discussion of these options is provided later in this chapter.

3.3 DETERMINING THE NEED FOR PERMIT LIMITS WITH EFFLUENT MONITORING DATA

3.3.1 General Considerations

When characterizing an effluent for the need for a whole effluent toxicity limit, and/or an individual toxicant limit, the regulatory authority should use any available effluent monitoring data, together with any information like that discussed under Section 3.2 above, as the basis for a decision. The regulatory authority may already have effluent toxicity data available from previous monitoring, or it may decide to require the permittee to generate effluent monitoring data prior to permit issuance or as a condition of the issued permit. EPA regulations at 40 *CFR* 122.21(j) require POTWs with design flows equal to or greater than 1 MGD and POTWs with approved pretreatment programs, or POTWs required to develop a pretreatment program, to submit the results of whole effluent toxicity tests with their permit applications. These regulations also provide discretion to the permitting authority to request such data from additional POTWs at the time of permit application.

In the instance where the permittee is required to generate data in advance, data collection should begin 12 to 18 months in advance of permit development to allow adequate time for conducting toxicity tests and chemical analyses. The type of data, including toxicity testing data, should be specified by the regulatory authority at the outset so that decisions on permit actions will not be delayed. **EPA recommends monitoring data be generated on effluent toxicity prior to permit limit development for the following reasons: (1) the presence or absence of effluent toxicity can be more clearly established or refuted and (2) where toxicity is shown, effluent variability can be more clearly defined.** Several basic factors that should be considered in generating effluent monitoring data are discussed below.

3.3.2 Addressing Uncertainty in Effluent Characterization by Generating Effluent Monitoring Data

All toxic effects testing and exposure assessment parameters, for both effluent toxicity and individual chemicals, have some degree of uncertainty associated with them. The more limited the amount of test data available, the larger the uncertainty. The least amount of uncertainty of an effluent's impact on the receiving water exists where (1) a complete data base is available on the effects of acute and chronic toxicity on many indigenous species, (2) there is a clear understanding of ecosystem species composition and functional processes, and (3) actual measured exposure concentrations are available for all chemicals during seasonal changes and dilution situations. The uncertainty associated with such an ideal situation would be minimal. However, generation of these data can be very resource intensive.

An example of uncertainty that results from limited monitoring data is if a regulatory authority has only one piece of effluent data (e.g., an LC_{50} of 50 percent) for a facility. Effluent variability in such a case, given the range of effluent toxicity variability seen in other effluents, may range between 20 percent and 100 percent (see Appendix A). It is impossible to determine from one piece of monitoring data where in this range the effluent variability really falls. More monitoring data would need to be generated to determine the actual variability of this effluent and reduce this source of uncertainty.

To better characterize the effects of effluent variability and reduce uncertainty in the process of deciding whether to require an effluent limit, EPA has developed the statistical approach described below and in Box 3-2. This approach combines knowledge of effluent variability as estimated by a coefficient of variation with the uncertainty due to a limited number of data to project an estimated maximum concentration for the effluent. The estimated maximum concentration is calculated as the upper bound of the expected lognormal distribution of effluent concentrations at a high confidence level. The projected effluent concentration after consideration of dilution can then be compared to an appropriate water quality criterion to determine the potential for exceeding that criterion and the need for an effluent limit.

The statistical approach has two parts. The first is a characterization of the highest measured effluent concentration based on the desired confidence level. The relationship that describes this is the following:

$$p_n = (1 - \text{confidence level})^{1/n}$$

where p_n is the percentile represented by the highest concentration in the data and n is the number of samples. The following are some examples of this relationship at a 99 percent confidence level:

- The largest value of 5 samples is greater than the 40 percentile
- The largest value of 10 samples is greater than the 63 percentile
- The largest value of 20 samples is greater than the 79 percentile
- The largest value of 100 samples is greater than the 96 percentile.

The second part of the statistical approach is a relationship between the percentile described above and the selected upper bound of the lognormal effluent distribution. EPA's effluent data base suggests that the lognormal distribution well characterizes effluent concentrations (see Appendix E). For example, if five samples were collected (which represents a 40th percentile), the coefficient of variation is 0.6, and the desired upper bound of the effluent distribution is the 99th percentile, then the two percentiles can be related using the coefficient of variation (CV) as shown below:

$$\frac{C_{99}}{C_{40}} = \frac{\exp(2.326\sigma - 0.5\sigma^2)}{\exp(-0.258\sigma - 0.5\sigma^2)} = 4.2$$

where $\sigma^2 = \ln(CV^2+1)$ and 2.326 and -0.258 are the normal distribution values for the 99th and 40th percentiles, respectively. The use of the 99th percentile is for illustrative purposes here. Although it does represent a measure of the upper bound of an effluent distribution, other percentiles could be selected by a regulatory agency. The relationship shown above can be calculated for other percentiles and CVs by replacing the values in the equation.

Tables 3-1 and 3-2 show the combined effects of both parts for a 99-percent confidence level and upper bounds of the 99th and 95th percentiles, respectively. The factors shown in the tables are multiplied by the highest concentration in an effluent sample to estimate the maximum expected concentration.

This procedure can be used for both single and multiple discharges to the same receiving waterbody. This is accomplished for multiple dischargers by summing the projected RWCs for the pollutant or pollutant parameter of concern from each individual discharger, and comparing it to the water quality standard. This involves an assumption of conservative additivity of the pollutant after discharge, which may not accurately reflect the true behavior of the toxicant. To overcome this, and to further refine the proportional contribution of each discharger and the resultant limits, the permitting authority should supplement this evaluation with multiple source WLA modeling and/or ambient water concentration monitoring.

Box 3-2. Determining "Reasonable Potential" for Excursions Above Ambient Criteria Using Effluent Data Only

EPA recommends finding that a permittee has "reasonable potential" to exceed a receiving water quality standard if it cannot be demonstrated with a high confidence level that the upper bound of the lognormal distribution of effluent concentrations is below the receiving water criteria at specified low-flow conditions.

Step 1 Determine the number of total observations ("*n*") for a particular set of effluent data (concentrations or toxic units [TUs]), and determine the highest value from that data set.

Step 2 Determine the coefficient of variation for the data set. For a data set where $n<10$, the coefficient of variation (CV) is estimated to equal 0.6, or the CV is calculated from data obtained from a discharger. For a data set where $n>10$, the CV is calculated as standard deviation/mean (see Figure 3-1). For less than 10 items of data, the uncertainty in the CV is too large to calculate a standard deviation or mean with sufficient confidence.

Step 3 Determine the appropriate ratio from Table 3-1 or 3-2.

Step 4 Multiply the highest value from a data set by the value from Table 3-1 or 3-2. Use this value with the appropriate dilution to project a maximum receiving water concentration (RWC).

Step 5 Compare the projected maximum RWC to the applicable standard (criteria maximum concentration, criteria continuous concentration [CCC], or reference ambient concentration). EPA recommends that permitting authorities find reasonable potential when the projected RWC is greater than an ambient criterion.

Example

Consider the following results of toxicity measurements of an effluent that is being characterized: 5 TU_c, 2 TU_c, 9 TU_c, and 6 TU_c. Assume that the effluent is diluted to 2 percent at the edge of the mixing zone. Further assume that the CV is 0.6, the upper bound of the effluent distribution is the 99th percentile, and the confidence level is 99 percent.

Step 1 There are four samples, and the maximum value of the sample results is 9 TU_c.

Step 2 The value of the CV is 0.6.

Step 3 The value of the ratio for four pieces of data and a CV of 0.6 is 4.7.

Step 4 The value that exceeds the 99th percentile of the distribution (ratio times x_{max}) after dilution is calculated as:

$$[9\ TU_c \times 4.7 \times 0.02] = 0.85\ TU_c.$$

Step 5 0.85 TU_c is less than the ambient criteria concentration of 1.0 TU_c. There is no reasonable potential for this effluent to cause an excursion above the CCC.

3.3.3 Effluent Characterization for Whole Effluent Toxicity

Once an effluent has been selected for whole effluent toxicity characterization after consideration of the factors discussed above, the regulatory authority should require toxicity testing in accordance with appropriate site-specific considerations and the recommendations discussed below. In the past 5 years, significant additional experience has been gained in generating effluent toxicity data upon which to make decisions as to whether or not an effluent will cause toxic effects in the receiving water in both freshwater and marine environments.

General Considerations and Assumptions

EPA has revised its initial effluent toxicity data generation recommendations based on three observations made over the last 5 years:

1) Only rarely have effluents discharged by NPDES permittees been observed to have LC_{50}s less than 1.0 percent or no observed effect concentrations (NOECs) less than 0.1 percent. However, there is always a chance that an effluent could be toxic at such low effluent concentrations.

Table 3-1. Reasonable Potential Multiplying Factors: 99% Confidence Level and 99% Probability Basis

Number of	Coefficient of Variation																			
Samples	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
1	1.6	2.5	3.9	6.0	9.0	13.2	18.9	26.5	36.2	48.3	63.3	81.4	102.8	128.0	157.1	190.3	227.8	269.9	316.7	368.3
2	1.4	2.0	2.9	4.0	5.5	7.4	9.8	12.7	16.1	20.2	24.9	30.3	36.3	43.0	50.4	58.4	67.2	76.6	86.7	97.5
3	1.4	1.9	2.5	3.3	4.4	5.6	7.2	8.9	11.0	13.4	16.0	19.0	22.2	25.7	29.4	33.5	37.7	42.3	47.0	52.0
4	1.3	1.7	2.3	2.9	3.8	4.7	5.9	7.2	8.7	10.3	12.2	14.2	16.3	18.6	21.0	23.6	26.3	29.1	32.1	35.1
5	1.3	1.7	2.1	2.7	3.4	4.2	5.1	6.2	7.3	8.6	10.0	11.5	13.1	14.8	16.6	18.4	20.4	22.4	24.5	26.6
6	1.3	1.6	2.0	2.5	3.1	3.8	4.6	5.5	6.4	7.5	8.6	9.8	11.1	12.4	13.8	15.3	16.8	18.3	19.9	21.5
7	1.3	1.6	2.0	2.4	2.9	3.6	4.2	5.0	5.8	6.7	7.7	8.7	9.7	10.8	12.0	13.1	14.4	15.6	16.9	18.2
8	1.2	1.5	1.9	2.3	2.8	3.3	3.9	4.6	5.3	6.1	6.9	7.8	8.7	9.6	10.6	11.6	12.6	13.6	14.7	15.8
9	1.2	1.5	1.8	2.2	2.7	3.2	3.7	4.3	5.0	5.7	6.4	7.1	7.9	8.7	9.6	10.4	11.3	12.2	13.1	14.0
10	1.2	1.5	1.8	2.2	2.6	3.0	3.5	4.1	4.7	5.3	5.9	6.6	7.3	8.0	8.8	9.5	10.3	11.0	11.8	12.6
11	1.2	1.5	1.8	2.1	2.5	2.9	3.4	3.9	4.4	5.0	5.6	6.2	6.8	7.4	8.1	8.8	9.4	10.1	10.8	11.5
12	1.2	1.4	1.7	2.0	2.4	2.8	3.2	3.7	4.2	4.7	5.2	5.8	6.4	7.0	7.5	8.1	8.8	9.4	10.0	10.6
13	1.2	1.4	1.7	2.0	2.3	2.7	3.1	3.6	4.0	4.5	5.0	5.5	6.0	6.5	7.1	7.6	8.2	8.7	9.3	9.9
14	1.2	1.4	1.7	2.0	2.3	2.6	3.0	3.4	3.9	4.3	4.8	5.2	5.7	6.2	6.7	7.2	7.7	8.2	8.7	9.2
15	1.2	1.4	1.6	1.9	2.2	2.6	2.9	3.3	3.7	4.1	4.6	5.0	5.4	5.9	6.4	6.8	7.3	7.7	8.2	8.7
16	1.2	1.4	1.6	1.9	2.2	2.5	2.9	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.1	6.5	6.9	7.3	7.8	8.2
17	1.2	1.4	1.6	1.9	2.1	2.5	2.8	3.1	3.5	3.8	4.2	4.6	5.0	5.4	5.8	6.2	6.6	7.0	7.4	7.8
18	1.2	1.4	1.6	1.8	2.1	2.4	2.7	3.0	3.4	3.7	4.1	4.4	4.8	5.2	5.6	5.9	6.3	6.7	7.0	7.4
19	1.2	1.4	1.6	1.8	2.1	2.4	2.7	3.0	3.3	3.6	4.0	4.3	4.6	5.0	5.3	5.7	6.0	6.4	6.7	7.1
20	1.2	1.3	1.6	1.8	2.0	2.3	2.6	2.9	3.2	3.5	3.8	4.2	4.5	4.8	5.2	5.5	5.8	6.1	6.5	6.8

Table 3-2. Reasonable Potential Multiplying Factors: 95% Confidence Level and 95% Probability Basis

Number of	Coefficient of Variation																			
Samples	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
1	1.4	1.9	2.6	3.6	4.7	6.2	8.0	10.1	12.6	15.5	18.7	22.3	26.4	30.8	35.6	40.7	46.2	52.1	58.4	64.9
2	1.3	1.6	2.0	2.5	3.1	3.8	4.6	5.4	6.4	7.4	8.5	9.7	10.9	12.2	13.6	15.0	16.4	17.9	19.5	21.1
3	1.2	1.5	1.8	2.1	2.5	3.0	3.5	4.0	4.6	5.2	5.8	6.5	7.2	7.9	8.6	9.3	10.0	10.8	11.5	12.3
4	1.2	1.4	1.7	1.9	2.2	2.6	2.9	3.3	3.7	4.2	4.6	5.0	5.5	6.0	6.4	6.9	7.4	7.8	8.3	8.8
5	1.2	1.4	1.6	1.8	2.1	2.3	2.6	2.9	3.2	3.6	3.9	4.2	4.5	4.9	5.2	5.6	5.9	6.2	6.6	6.9
6	1.1	1.3	1.5	1.7	1.9	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2	4.5	4.7	5.0	5.2	5.5	5.7
7	1.1	1.3	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9
8	1.1	1.3	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8	3.0	3.2	3.3	3.5	3.7	3.9	4.0	4.2	4.3
9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.2	3.4	3.5	3.6	3.8	3.9
10	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.2	2.3	2.4	2.6	2.7	2.8	3.0	3.1	3.2	3.3	3.4	3.6
11	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.0	3.1	3.2	3.3
12	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.0
13	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9
14	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.6	2.7
15	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.5
16	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.4
17	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.1	2.2	2.2	2.3	2.3
18	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2
19	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.0	2.1	2.1
20	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.0

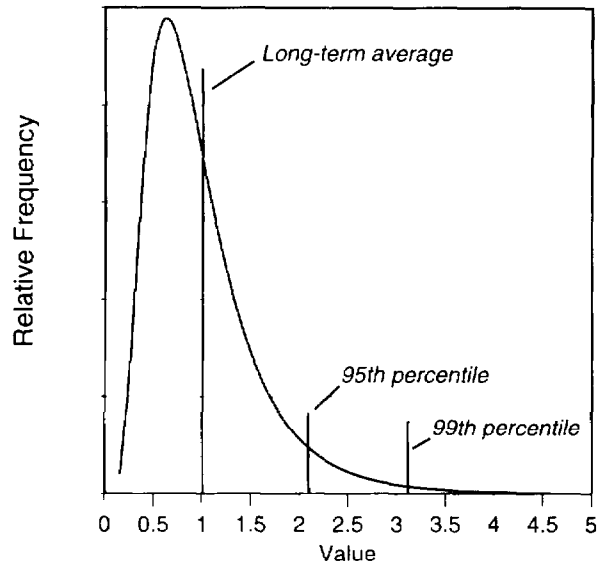


Figure 3-1a. Frequency Distribution of Values for a Lognormal Distribution with a Mean of 1.0 and a Coefficient of Variation of 0.6

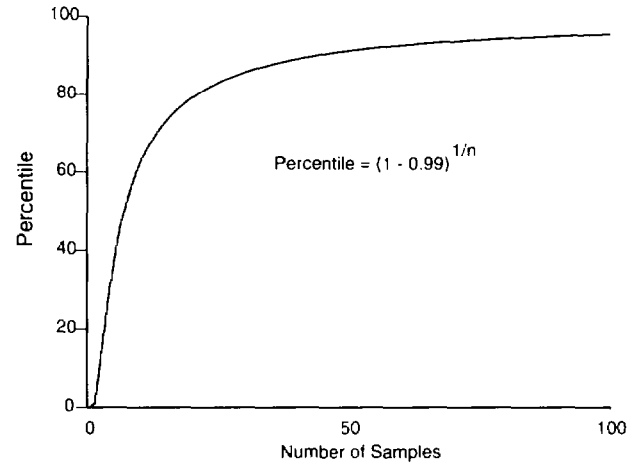


Figure 3-1c. Relationship Between the Largest Value of n Samples and the Percentile It Exceeds with 99 Percent Confidence

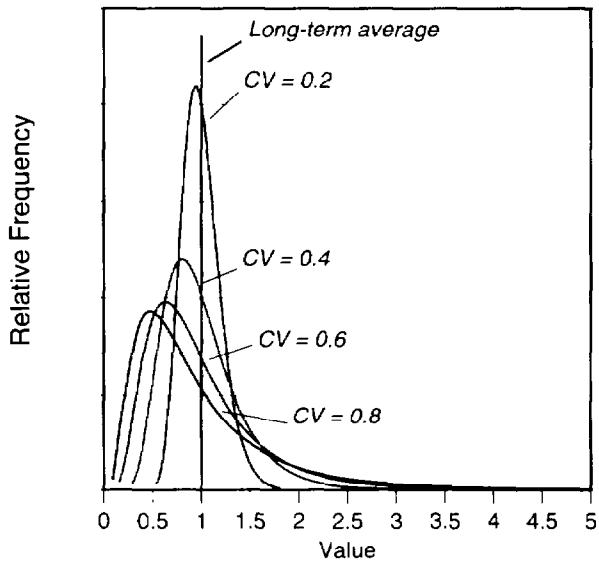


Figure 3-1b. Comparison of Relative Frequencies of Lognormal Distributions with a Mean of 1.0 for Different Coefficients of Variation

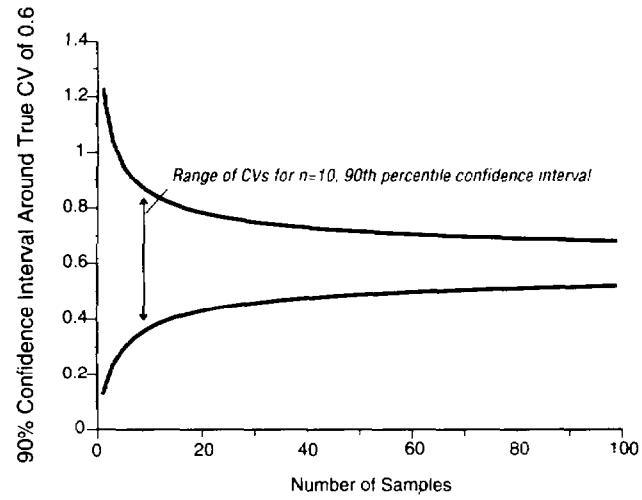
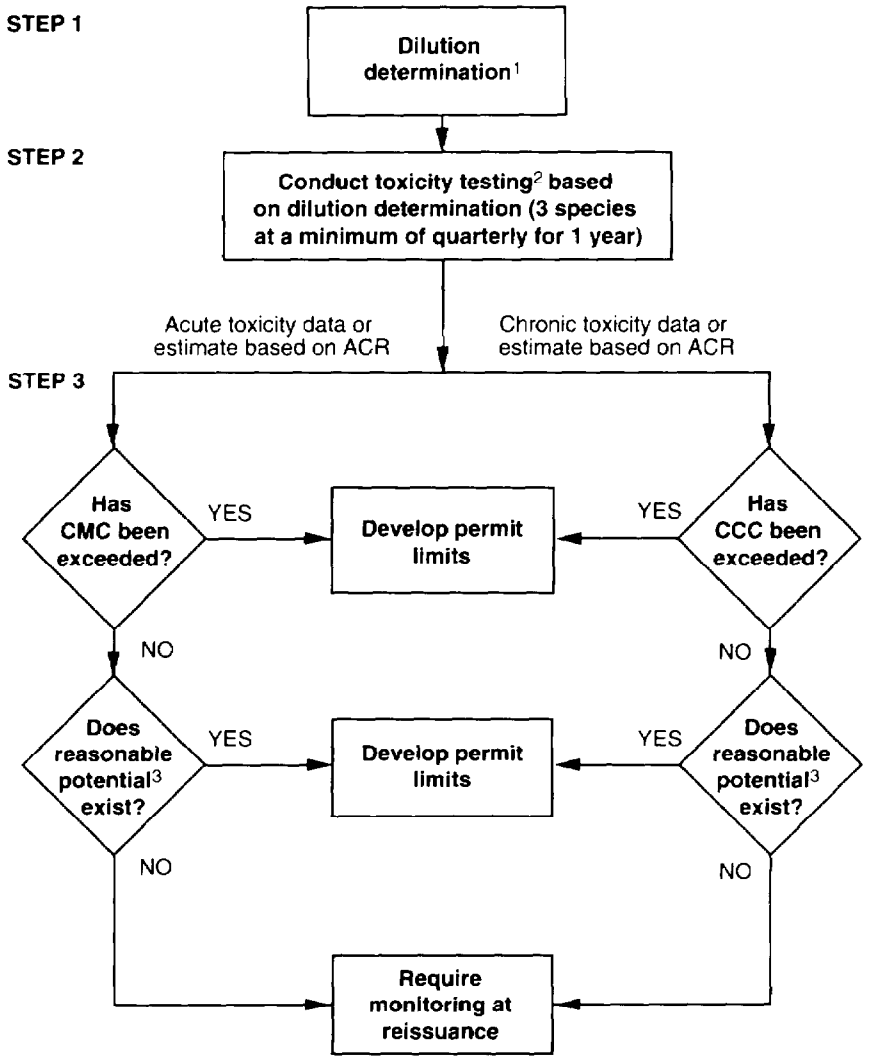


Figure 3-1d. Example of 90 Percent Confidence Intervals Around Coefficient of Variation Estimates for Numbers of Samples

2) With the exception of a small number of "outliers" for which confirmation is not possible, acute-to-chronic ratios (ACRs) above 20 for effluents discharged by NPDES permittees have not been observed by EPA. The majority of observed ACRs are very seldom above 10. However, higher ACRs may be found for selected facilities.

3) The use of the three commonly used freshwater species and of three of the five commonly used marine organisms has generally been sufficient to measure any effluent's toxicity for the purposes of projecting effluent toxicity impact and making regulatory decisions.

Figure 3-2 is a flow chart of EPA's recommendations for data generation for three different dilution scenarios. It is divided into three basic steps: determining initial dilution, developing toxicity testing procedures, and developing decision criteria for permit limit. There are certain basic assumptions built into this flow chart. The basic principle used in making decisions is to compare available dilution to known or projected toxic effect concentrations in order to place an effluent into one of three categories:



Notes:

[1]Dilution determinations should be performed for critical flows and any applicable mixing zones.

[2]Toxicity testing recommendations

a. Dilution > 1000:1: acute testing, check CMC only.

b. 100:1 < Dilution < 1000:1: acute or chronic testing, check CMC and CCC with data or ACR.

c. Dilution < 100:1: conduct chronic testing, check CCC with data and CMC using acute data or ACR.

[3]Reasonable potential: Use procedures in Box 3-3.

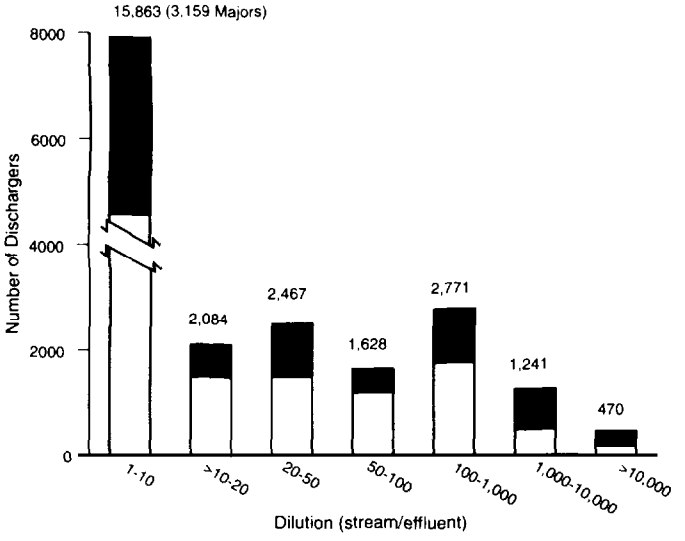
Figure 3-2. Effluent Characterization for Whole Effluent Toxicity

1) The effluent causes or contributes to an excursion of a numeric or narrative water quality criterion and the permit requires a limit on toxicity.

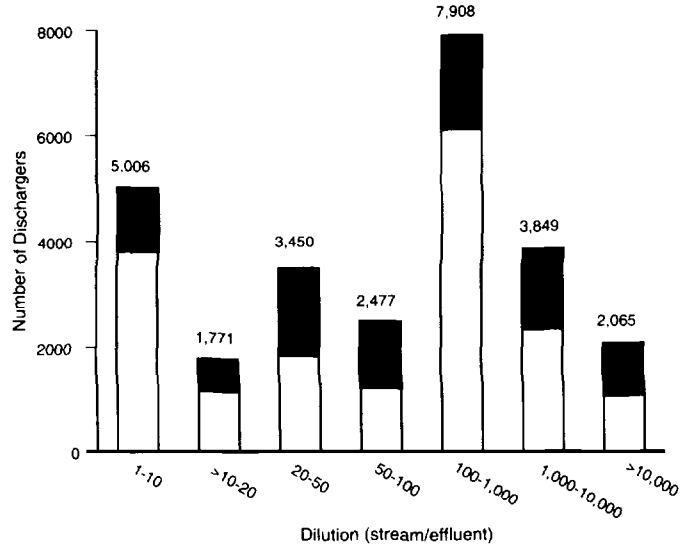
2) The effluent has a reasonable potential of causing or contributing to an excursion of a numeric or narrative water quality criterion and a limit is required.

3) The effluent has a very low probability of causing or contributing to an excursion of a water quality standard and no limit is required.

This categorization is accomplished by using dilution estimates in the first step and the results of the toxicity tests in the next steps. In addition, all these impact estimates assume discharge at critical conditions and imposition of any applicable mixing zone requirements. Therefore, a conservative assumption is used to determine whether or not an impact is projected to occur. Estimates of possible toxic impact are made assuming that the effluent is most toxic to the most sensitive species or lifestage at the time of lowest available dilution.



(a) At Low Flow (7Q10)



(b) At Annual Mean Flow

Figure 3-3. National Distribution of NPDES Dilution Conditions at 7Q10 and at Annual Mean Flow

The changes to the EPA's data generation recommendations eliminate the application of multiple sets of safety margins that was proposed in the 1985 version of this document. Rather, general observations on effluent toxicity described above now allow regulatory authorities to tighten the bounds of the initial dilution categorization, eliminate the species sensitivity uncertainty factor and target LC_{50}s of 1 percent and NOECs of 0.1 percent as the most extreme toxicity measurements that can normally be expected for the vast majority of effluents discharged by NPDES permittees for acute and chronic toxicity, respectively. The observation of toxicity was based on multiple dilution tests. The same observation may not hold for toxicity measured with single dilution tests (pass/fail). As reflected in Chapter 1, single dilution toxicity tests are much more variable than multiple dilution tests. **Therefore, the use of single concentration toxicity tests is strongly discouraged for this data generation process.**

Since the new data generation requirements are much less expensive than the previous requirements, tiered testing (less expensive, single-concentration, initial screening followed by increasingly expensive definitive data generation, using multiconcentration tests, as described in the September 1985 version of the technical support document) is unnecessary. However, **elimination of the requirement to conduct toxicity testing on the basis of projections using dilution alone is not recommended.** Although EPA's data review suggests that an LC_{50} of 1 percent and an NOEC of 0.1 percent are the lower bounds on effluent toxicity, there may be other effluents that are presently unmeasured that are more toxic. Testing data are always desirable for fully characterizing discharges of concern.

Steps in Whole Effluent Characterization Process

The following is a detailed description of the major steps presented in Figure 3-2 and the rationale behind each.

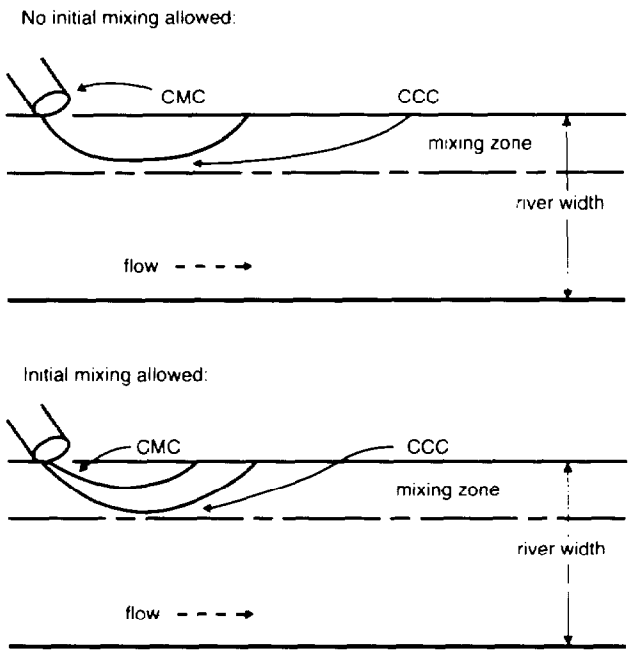
Step 1: Dilution Determination

The initial step is to determine the dilution of the effluent at the edge of the mixing zone, assuming the State allows mixing zones. Figure 3-4 shows a schematic representation of typical mixing zone requirements for both acute and chronic toxicity. Calculating the dilution at the edges of mixing zones for site-specific situations can be complicated. Modeling can be employed using either steady-state or dynamic approaches to calculate the dilution (see Chapter 4). However, for complex situations, such as marine and estuarine waters or lakes, dye studies (or other techniques used to assess mixing zones) may still be required.

Some State water quality standards do not allow the use of mixing in the control of acute toxicity. For these States, acute toxicity is often limited at the end of the pipe. Permit limits derived to enforce such requirements would be considered "water quality-based" because they would be based upon an ambient criterion (as opposed to an arbitrary test endpoint). Regardless, both chronic and acute toxicity must be assessed in these situations.

Step 2: Toxicity Testing Procedures

Where toxicity tests are required in order to make decisions regarding appropriate next steps in a screening protocol, **EPA recommends as a minimum that three species (for example, a vertebrate, an invertebrate, and a plant) be tested quarterly for a minimum of 1 year.** As discussed in Chapter 1, the use of three species is strongly recommended. Experience indicates that marine algae can be a highly sensitive test species for some effluents. Using a surrogate species of the plant kingdom adds another trophic level to the testing regimen. For both freshwater and marine situations, the use of three species is more protective than two species since a wider range of species sensitivity can be measured. EPA is continuing to develop toxicity test methods using additional organisms including plants. In addition, EPA has revised the test for *Selenastnum*, which has improved the test precision.



where

$CMC = 0.3\ TU_a$

$CCC = 1.0\ TU_c$

Figure 3-4. Schematic Representation of Mixing Zone Areas Where the CMC and CCC Apply

EPA recommends against selecting a "most sensitive" species for toxicity testing. For one organism to consistently be the most sensitive in a battery of toxicity tests, two conditions must occur: (1) the toxicants causing toxicity must remain the same, and (2) the ratios of the toxicants in the effluent (if more than one) must remain the same. Based on EPA's experience at the Duluth research laboratory, neither of these conditions is likely to occur. For example, the causes of effluent toxicity in POTWs can vary on a seasonal basis. Toxicity in the summer can be caused by pesticides to which invertebrates are most sensitive. However, the winter toxicity could be caused by ammonia to which fathead minnows will respond most sensitively. The most sensitive species for an effluent actually may not exist and at best is difficult to identify.

Conducting toxicity tests using three species quarterly for 1 year is recommended to adequately assess the variability of toxicity observed in effluents. Below this minimum, the chances of missing toxic events increase. The toxicity test result for the most sensitive of the tested species is considered to be the measured toxicity for a particular effluent sample.

The data generation recommendations in Figure 3-2 represent minimum testing requirements. Since uncertainty regarding whether or not an effluent causes toxic impact is reduced with more data, **EPA recommends that this test frequency be increased where necessary to adequately assess effluent variability.** If less frequent testing is required in the permit, it is preferable to use three species tested less frequently than to test the effluent more frequently with only a single species whose sensitivity to the effluent is not well characterized.

EPA recommends that a discharger conduct <u>acute</u> toxicity testing if the dilution of the effluent is greater than 1000:1 at the edge of the mixing zone [3]. Such a discharger would be considered a low priority for chronic toxicity testing. The rationale for this is that the effluent concentration would be below 0.1 percent at the edge of the mixing zone and thus incapable of causing an excursion above the CCC. A worst case NOEC of 0.1 percent translates into 1,000 TU_c, which would result in a concentration of less than 1.0 TU_c at the edge of the mixing zone for this dilution category. The test results would be compared to the CMC after consideration of any allowable mixing.

EPA recommends that a discharger conduct either <u>acute or chronic</u> toxicity testing if the dilution of the effluent falls between 100:1 and 1,000:1 at the edge of the mixing zone. Effluents have been shown to be both acutely and chronically toxic within this range of receiving water dilution. Under worst-case scenarios, LC_{50}s of 1.0 percent and ACRs of 10 will result in excursions above both the CCC and CMC at the edge of the regulatory mixing zone.

Although either acute or chronic testing can be required within this dilution range, acute testing would be more appropriate at the higher end of this dilution range (1,000:1 or 0.1 percent). At the lower end of this dilution range (100:1 or 1.0 percent), chronic tests may be more appropriate. Where other factors are equal, chronic testing may be preferable since the interim results in a chronic test gives data on acute toxicity as well. The acute endpoint data can then be used to compare directly to the CMC without the need for an ACR.

Whichever type of toxicity test (either acute or chronic) is specified, the results from that test should be compared to the criterion associated with that type of test. For example, a chronic test would be compared to the CCC. Comparisons to the other criteria can be made by using the ACR or additional data generated to convert a chronic test result to an acute endpoint and vice versa. For example, a chronic NOEC of 5 percent effluent (or 20 TU_c) represents an acute LC_{50} of 50 percent (or 2 TU_a) at an ACR of 10.

EPA recommends that a discharger conduct chronic toxicity testing if the dilution of the effluent falls below 100:1 at the edge of the mixing zone. The rationale for this recommendation is that chronic toxicity has been observed in some effluents down to the 1.0 percent effect concentration. Therefore, chronic toxicity tests, although somewhat more expensive to conduct, should be used directly in order to make decisions about toxic impact.

There is a potential for acute toxicity within this dilution range, although this is less likely as the 100:1 dilution level is approached. Thus, the recommended screening protocol shown in Figure 3-2 includes a determination of whether excursions above the CMC are projected [4]. This analysis may be performed by assuming an ACR, applying this value to the chronic toxicity testing data, and allowing for any allowable initial mixing. Alternatively, the regulatory authority may use the interim results in the chronic test to calculate the acute toxicity.

Both the chronic and acute toxicity test data would be compared to their respective criterion. The chronic test results would be compared to the CCC, and the acute results, regardless of how calculated, would be compared to the CMC.

Step 3: Decision Criteria for Permit Limit Development

Once the toxicity data have been generated for a discharger, the regulatory authority must decide whether or not the results show that the permittee causes, has the reasonable potential to cause, or contributes to an excursion of an applicable numeric or narrative water quality criterion and therefore needs to limit effluent toxicity. To do this, these data should be used to project receiving water concentrations, which are then compared to the CCC and CMC. One of four outcomes will be reached when following the screening protocol shown in Figure 3-2:

1) Excursion Above CMC or CCC—Where any one data point shows an excursion above the State's numeric or narrative criterion for the parameter toxicity, EPA regulations require a permit limit be set for whole effluent toxicity (40 *CFR* 122.44(d)(1)(iv or v)), unless limits on a specific chemical will allow the narrative water quality criterion to be attained or maintained. In the absence of a State numeric criterion for the parameter toxicity, **EPA recommends that 1.0 TU_c and 0.3 TU_a be used as the CCC and CMC, respectively.** The decision to develop permit limits based upon an excursion above either the CMC or CCC will lead to protection against both acute and chronic toxicity if the permit derivation procedures in Chapter 5 are used to set effluent limits.

2) Reasonable Potential for Excursion Above CMC or CCC—**EPA believes that "reasonable potential" is shown where an effluent is projected to cause an excursion above the CCC or CMC. This projection is based upon a statistical analysis of available data that accounts for limited sample size and effluent variability.** EPA's detailed recommendations for making a statistical determination based upon effluent monitoring data alone are shown in Box 3-2. Where a regulatory authority finds that test results alone indicate a "reasonable potential" to cause an excursion above a State water quality criterion in accordance with 40 *CFR* 122.44(d)(1)(ii), a permit limit must be developed.

   A regulatory authority may select an alternative approach for assessing reasonable potential. For example, an authority may opt to use a stochastic dilution model that incorporates both ambient dilution and effluent variability for determining reasonable potential. Such an approach is analogous to the statistical approach shown in Box 3-2. Whatever approach selected by the authority, it must use all the factors that account for all the factors listed in 40 *CFR* 122.44(d)(1)(ii).

   In some cases the statistical analysis of the effluent data may not actually project an excursion above the CMC or CCC but may be close. Under such conditions, reasonable potential determinations will include an element of judgment on the part of the regulatory authority. Other factors will need to be considered and given appropriate weight in the decisionmaking process, including value of waterbody (e.g., high-use fishery), relative proximity to the CCC or CMC, existing controls on point and nonpoint sources, information on effluent variability, compliance history of the facility, and type of treatment facility. These factors are summarized in Box 3-2 and are discussed in detail in Section 3.1. **EPA recommends regulatory authorities establish a written policy and procedure for making determinations of "reasonable potential" under these circumstances.**

3) No Reasonable Potential for Excursions Above CMC or CCC—In these situations, **EPA recommends that the toxicity tests recommended above be repeated at a frequency of at least once every 5 years as a part of the permit application.** Such testing is required for certain POTWs under 40 *CFR* 122.21(j).

4) Inadequate Information—Where a regulatory authority has inadequate information to determine reasonable potential for an excursion of a numeric or narrative water quality criterion, there may still be a basis for concern on the part of the authority. The permit should contain whole effluent toxicity monitoring requirements and a reopener clause. This clause would require reopening of the permit and establishment of a limit based upon any test results, or other new factors, which substantiate that the effluent causes, has the reasonable potential of causing, or contributes to an excursion above the CCC or CMC.

3.3.4 Use of Toxicity Testing in Multiple-source Discharge Situations

Where more than one discharge to the same receiving waterbody contributes, or has the reasonable potential to contribute to an excursion of water quality standards, permit limits must be developed for each individual discharger on that waterbody. For the regulatory authority to make this assessment, additional testing may be needed to provide the authority with the information necessary to assess the relative impact of each source. For purposes of this discussion, a multiple-source discharge situation is defined as a situation where impact zones overlap, or where ambient receiving water concentrations of a pollutant are elevated due to upstream discharges. In multiple-source discharge situations, additivity, antagonism, and persistence of toxicity can be of concern. To collect additional data, the permit authority should employ the toxicity testing procedures for multiple dischargers described in Box 3-3. In addition, ambient toxicity testing, as described below, could be used.

Assuming that screening has been conducted that reveals the need for permit limits, two options for controlling the discharges exist. The first option is for the permit authority to regulate each source separately using the procedures for individual point sources. In this option, the permitting authority would require use of upstream ambient water as a diluent in the toxicity test so as to be able to evaluate the contributions of upstream sources of toxicity. A second option is to treat each discharge as an interactive component of a whole system. In this option, the permit writer would determine a total maximum daily load for the receiving waterbody and develop individual wasteload allocations for each discharger using the procedures discussed in Chapter 4.

Box 3-3. Recommend Multiple-source Toxicity Testing Procedures

Tests

Where the combined effluents make up 1 percent or greater of the receiving waters, conduct chronic toxicity tests following the testing procedures described in Section 3.3.3.

Where the combined effluents make up less than 1 percent of the receiving waters, conduct acute toxicity tests following the testing procedures described in Section 3.3.3 (see Figure 3-2) to determine if any of the effluents are exhibiting toxicity.

An additional data requirement is the assessment of relative and absolute toxicity of each source so that appropriate permit conditions can be set for individual dischargers. The following procedure is suggested.

1) Conduct one set of toxicity tests on the effluents using a control of reconstituted or uncontaminated dilution water. The set of tests will give an absolute toxicity measurement of the effluent.

2) Run a parallel set of toxicity tests on the effluent using dilution water taken directly upstream from the point of discharge or, for estuarine waters, from an area outside of the immediate discharge impact zone (this will have to be determined by a dye study). This dilution water may be contaminated with upstream effluents or other toxicant sources. The purpose of this test is to project toxic impact of the effluent after it is mixed at its point of discharge. This is a relative effluent toxicity measurement. The relative testing procedure could result in a change in the standard concentration-effect curve generated by the testing. The dilution water for the relative toxicity test may cause significant mortality, growth, or reproductive effects at the lower effluent concentrations (including the 100 percent diluent control concentration) if the diluent from the receiving water is toxic (from an upstream discharge). Such mortality does not invalidate the test. Instead, analysis of toxicity trends resulting from the relative toxicity tests can be used to assess the effluent's toxicity in relation to other sources and ambient receiving water conditions. However, a control dilution water with no toxicity must be used for quality assurance and determination of absolute toxicity of the effluent.

3) Conduct ambient toxicity tests to (a) determine whether or not the effluent has a measurable toxicity after mixing, (b) measure persistence of toxicity from all sources contributing to receiving water toxicity, and (c) determine combined toxicity resulting from the mixing of multiple, point, and nonpoint sources of toxicity. See Appendix C for a discussion of ambient toxicity testing procedures.

The ambient testing can be required of each discharger and conducted during low-flow or worst-case design periods.

Frequency for Ambient Testing

All testing should be conducted simultaneously by each discharger, if possible. At a minimum, the tests should be conducted concurrently starting within a short time period (1 to 2 days). Repeated ambient toxicity analyses will be desirable when variable effluents are involved. Effluent toxicity data showing variability can be used to assess what frequency will be most applicable. The level of repetition for variability analysis should be similar to that used in effluent variability analyses.

Other Considerations

Dye studies of effluent dispersion for rivers, lakes, reservoirs, and estuaries are strongly recommended. This allows analysis of effluent concentration at the selected sampling stations above and below the discharge points.

The procedures suggested in this multiple source section are based on actual multiple source site investigations conducted under the Complex Effluent Toxicity Testing Program. Site reports from that study can be used to obtain further description of the toxicity testing procedures used to analyze multiple source toxic impact [1, 2].

3.3.5 Ambient Toxicity Testing

Ambient toxicity testing also is useful in screening receiving water bodies for existing toxic conditions. The procedure described in Appendix C uses short-term chronic toxicity tests to measure the toxicity of samples of receiving water taken above, at, and below outfalls. It can be used in freshwater, marine, and estuarine systems. The procedure must be conducted during an appropriate low-flow or worst-case design period.

The utility of the ambient toxicity screening approach is that actual receiving water toxicity is directly measured. No extrapolation from exposure or ACR is needed. Further, impact from multiple source discharge situations, which may not be apparent from individual discharger data, is identified. Finally, the technique can provide an assessment of the persistence of effluent toxicity.

3.3.6 Special Considerations for Discharges to Marine and Estuarine Environments

Special problems are encountered when assessing and controlling impacts of toxic pollutants discharged to marine and estuarine waterbodies. These special problems include the following:

- Determining the physical characteristics of estuaries and the complex mixing and effluent dilution situations for RWCs of effluents.
- Generating toxicity data on nonsaline effluents that discharge to brackish or saline waters and establishing cause-effect relationships on that basis.
- Assessing exposure and controlling impacts from persistent toxicants accumulating in fish and shellfish tissues and in sediments. These factors are particularly important in estuaries and near coastal waters because of high use of estuaries as breeding and fishing areas for important commercial seafood supplies and recreational fishing, and because many estuaries and near coastal waters act as sinks for pollutants that accumulate in sediments.

Where these special problems are encountered, additional information may need to be gathered to better quantify dilution, to determine metals partitioning, and to identify potential interferences in whole effluent toxicity tests.

To characterize the type of whole effluent toxicity that is most relevant for a particular discharge to marine and estuarine waters, the following questions should be considered [5]:

- What is the salinity of the receiving water, and is this important in terms of the State standards?
- What is the appropriate test organism to require for toxicity testing under differing salinity conditions?

The answers to these questions will enable the permitting authority to determine what type of toxicity testing is most suitable for effluent characterization and whole effluent toxicity control.

For most marine and estuarine discharges the choice of test species and dilution water should be made based on the characteristics of the receiving water at the critical conditions for flow, mixing, and salinity. Foremost in this determination should be the salinity of the receiving water and, to a lesser extent, the salinity of the effluent itself.

The primary objective of whole effluent toxicity tests is to identify sources of toxicity that can potentially cause an excursion of a State's narrative or numeric water quality criteria. For this reason, the toxicity tests should reflect the natural conditions of the receiving water so to be able to measure any effluent characteristic that could contribute to ambient toxicity. The marine toxicity test methods identify 1,000 mg/l as the point at which salinity begins to exert an effect on freshwater species. **As a general rule, EPA recommends that freshwater organisms be used when the receiving water salinity is less than 1,000 mg/l, and that marine organisms be used when the receiving water salinity equals or exceeds 1,000 mg/l.**

Saline Effluent Discharges to Saltwater

The dissolved salts in the effluent are pollutants. These salts may or may not be the same as those present in the receiving water. Also, the proportion of dissolved salts in the effluent may be different from that of the salts in the receiving water. In this case, the toxicity test needs to be able to determine if these salts contribute to ambient toxicity. For this reason, marine organisms are needed.

Saline Effluent Discharged to Freshwater

In this case, the dissolved salts in the effluent is a pollutant that does not exist in the receiving water. The toxicity test needs to determine whether the dissolved salts can be one of the toxicants that contribute to ambient toxicity. For this reason, freshwater organisms are needed.

Freshwater Effluent Discharged to Saltwater

In this instance, the lack of dissolved salts in the effluent can cause an apparent toxic effect to the marine organisms in the toxicity test. However, in contrast to the instances presented above, the toxicity test does not need to be able to measure this effect because a lack of salts is not a pollutant. The marine toxicity test methods account for this by requiring that the salinity of the effluent be adjusted to approximate the salinity of the receiving water. As an alternative to using a marine organism, a freshwater organism can be used if the test is being conducted only on a 100-percent effluent sample and if State water quality standards do not require that a marine organism be used.

3.3.7 Using a Chemical-specific Limit to Control Toxicity

EPA regulations at 40 *CFR* 122.44(d)(1)(v) provide that limits on whole effluent toxicity are not necessary where the permitting authority demonstrates in the fact sheet or statement of basis of the NPDES permit that chemical-specific limits for the effluent are sufficient to attain and maintain applicable numeric and narrative State water quality criteria. To make this demonstration that chemical-specific limits are sufficient, additional effluent information will be needed. **EPA recommends that the discharger conduct a toxicity identification evaluation to identify the causative agent(s) in the effluent.** Where the permitting authority determines that the demonstration required by 40 *CFR* 122.44(d)(1)(v) has been made, limits on whole effluent toxicity

need not be imposed. Effluent limits on the controlling chemical with concurrent whole effluent monitoring will be sufficient. Where subsequent whole effluent toxicity testing reveals the presence of toxicity in the effluent, the above process will need to be repeated, or alternatively a whole effluent toxicity limit will be needed. If continued toxicity testing shows that additional chemical-specific effluent limits are insufficient to control whole effluent toxicity, then toxicity limits may be the only practical way to control toxicity.

3.3.8 Effluent Characterization for Specific Chemicals

The previous section discussed effluent characterization for whole effluent toxicity. This section will describe EPA's recommendations for data generation to determine whether or not permit limits are needed to control specific chemical pollutants in effluents. While many of the same principles apply when developing chemical-specific limits, there are some differences based upon regulatory and analytical considerations.

Characterization of impacts due to specific chemicals do not require a determination of the type of testing as is required for whole effluent toxicity because there is generally only one type of test for specific chemicals. However, there are some antecedent steps that are unique to effluent characterization for specific chemicals: determination of the chemicals of concern and determination of acceptable ambient levels (RAC, CMC, or CCC) for these pollutants.

Steps for Chemical-specific Effluent Characterization Process

Figure 3-5 illustrates EPA's recommendations for determining whether or not permit limits need to be developed according to an evaluation of a limited data set. The following discussion corresponds to the various activities shown in Figure 3-5. (Refer to the human health discussion in Section 3.3.9 for additional details on procedures to characterize the bioconcentration potential of effluents.)

Step 1: Identify the Pollutants of Concern

This process should begin with an examination of existing data to determine the presence of specific toxicants for which criteria, standards, or other toxicity data are available. Sources of data include the following:

- Permit application forms, DMRs, permit compliance systems (PCS), and permit files
- Pretreatment industrial surveys
- STORET for ambient monitoring data
- SARA Title III Toxic Chemical Release Inventory
- Industrial effluent guidelines development documents
- The Treatability Manual [6]
- Effluent bioconcentration assessment (see Section 3.3.9).

Data on specific chemicals that are typically submitted with NPDES application forms will consist of a limited number of analytical test results for many of the reported parameters. Where the regulatory authority has reason to believe that additional data for key parameters of concern are needed in order to adequately characterize the effluent, this information should be requested as a part of the application or, in some cases, through the use of Section 308 letters. **It is recommended that 8 to 12 samples be analyzed for key parameters of concern.** In some cases, special analytical protocols will need to be specified in order to gather all appropriate information.

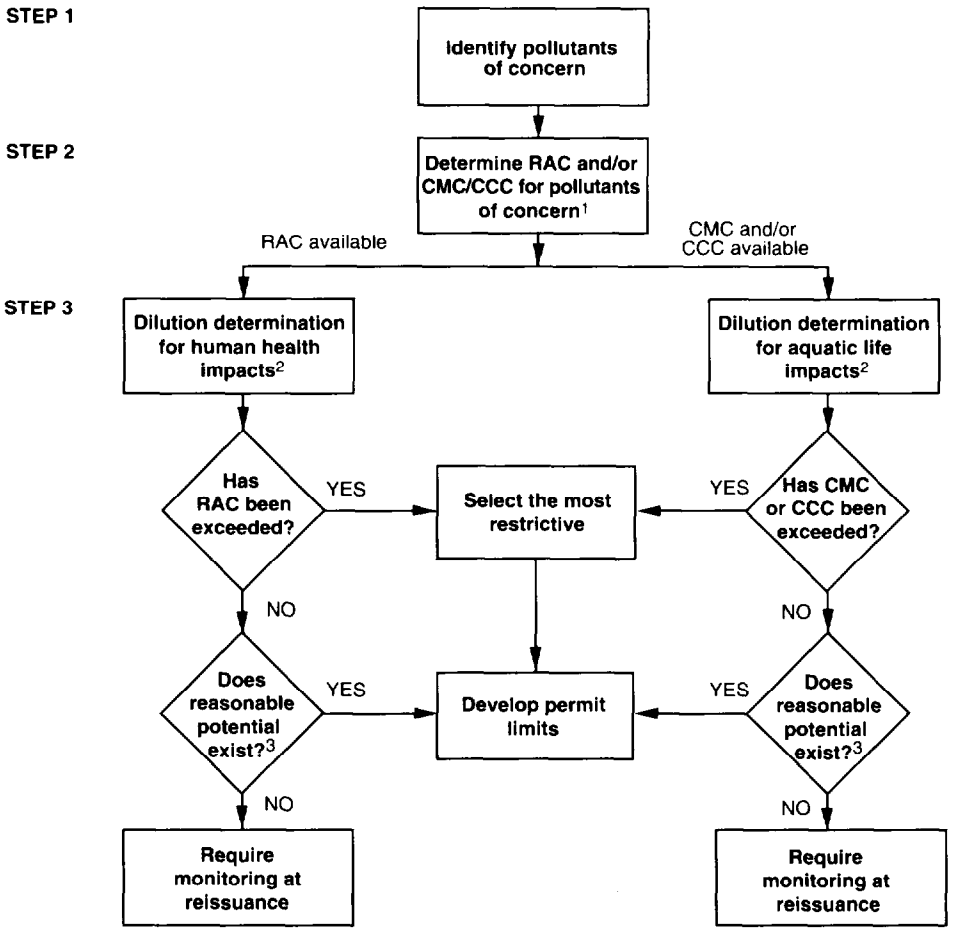
Step 2: Determine the Basis for Establishing RACs, CMCs, and CCCs for the Pollutants of Concern

The second step is to identify the appropriate water quality standard, including designated or existing use, and criteria for use. Ideally, the State water quality standards include aquatic life and human health criteria for the pollutants of concern. If a State does not have a numeric water quality criterion for the pollutant of concern, then one of three options for using the narrative criterion may be used (40 *CFR* 122.44(d)(1)(vi)) to determine whether a discharge causes, has the reasonable potential to cause, or contributes to an excursion above a narrative criteria because of an individual pollutant. Although the provisions of 40 *CFR* 122.44(d)(1)(vi) are presented in the regulation in the context of permit limit development, these same considerations should be applied in characterizing effluents in order to determine whether limits are necessary. The options available are as follows:

- **Option A** allows the regulatory authority to establish limits using a "calculated numeric water quality criterion" that the regulatory authority demonstrates will attain and maintain applicable narrative water quality criteria and fully protect the designated use. This option allows the regulatory authority to use any criterion that protects aquatic life and human health. This option also allows the use of site-specific factors, including local human consumption rates of aquatic foods, the State's determination of an appropriate risk level, and any other current data that may be available.

- **Option B** allows the regulatory authority to establish effluent limits using EPA's Water Quality Criteria guidance documents, if EPA has published a criteria document for the pollutant supplemented where necessary by other relevant information. As discussed earlier, EPA criteria documents provide a comprehensive summary of available data on the effects of a pollutant.

- **Option C** may be used to develop limits for a pollutant of concern based on an indicator parameter under limited circumstances. An example of an indicator parameter is total toxic organics (TTO); effluent limits on TTO are useful where an effluent contains organic compounds. However, use of this option must be justified to show that controls on one pollutant control one or more other pollutants to a level that will attain and maintain applicable State narrative water quality criteria and will protect aquatic life and human health (see 40 *CFR* 122.44(d)(1)(vi)(C)). Use of this option is restricted by regulation to those instances where it can be demonstrated that controls on indicator pollutants serve to control the toxicant of concern. Using Option A or Option B is a more direct and perhaps more defensible approach.



Notes:

[1] RAC and/or CMC/CCC: Use State numeric criterion or interpret State narrative criterion using one of three options specified under 40 *CFR* 122.44(d).

[2] Dilution determination: Perform for critical flow and for any applicable mixing zones for aquatic life and human health protection procedures, respectively.

[3] Reasonable potential: Use procedures in Boxes 3-2 and 3-4.

Figure 3-5. Effluent Characterization for Specific Chemicals

Step 3: Dilution Determination

The third step is to calculate the effluent dilution at the edge of the mixing zone. The pertinent factors for consideration here are the same as were previously presented for whole effluent toxicity with one difference: there are two levels of dilution analysis for chemical data. The first level is to use simple fate models based on a dilution analysis and comparison with the RAC, CMC, or CCC. The second level of analysis is to use more complex fate models, including dynamic models to estimate persistence, and may be applied to lakes, rivers, estuaries, and coastal systems using a desktop calculator or microcomputer. EPA has supported development of a second level of analysis that estimates point source wasteload allocations and nonpoint source allocations and predicts the resulting pollutant concentrations in receiving waters [7].

Step 4: Decision Criteria for Permit Limit Development

After this dilution analysis has been performed, the projected RWC is compared to the RAC, CMC, or CCC (either the State numeric criteria or an interpretation of the narrative criteria as described earlier). Whereas analysis of aquatic impacts should include evaluations with respect to both the CCC and the CMC, analysis of human health impacts will only involve comparisons with the RAC. The four possible outcomes discussed above in the triggers for permit limit development discussion in Section 3.3.3 also apply here:

- Excursion above the RAC, CMC, or CCC
- Reasonable potential for excursion above the RAC, CMC, or CCC

- No reasonable potential for excursion above the RAC, CMC, CCC

- Inadequate information.

If these evaluations project excursions or the reasonable potential to cause or contribute to an excursion above the RAC, CMC, or CCC, then a permit limit is required (40 *CFR* 122.44(d)(1)(iii)). The statistical approach shown in Box 3-2 or an analogous approach developed by a regulatory authority can be used to determine the reasonable potential. Effluents that are shown not to cause or that have a reasonable potential to cause or contribute to an excursion above an RAC, CMC, or CCC should be reevaluated at permit reissuance.

Where chemical-specific test results do not show a reasonable potential but indicate a basis for concern after consideration of the other factors discussed in Section 3.2, or if there were inadequate information to make a decision, the permit should contain chemical testing requirements and a reopener clause. This clause would require reopening of the permit and establishment of a limit based upon any test results that show effluent toxicity at levels that cause or have a reasonable potential to cause or contribute to an excursion above the RAC, CCC, or CMC.

3.3.9 Effluent Characterization for Bioconcentratable Pollutants

The previous section discussed how to characterize effects of specific chemicals, including those that may threaten human health, to determine whether or not a discharge causes, has the reasonable potential to cause, or contributes to excursions above an water quality criterion. The primary disadvantage of this approach is that it does not identify all effluent chemicals of potential concern for human health. To help address this gap, EPA is developing a procedure for identifying pollutants with the propensity to bioconcentrate in fish tissue. This procedure is presently in draft form and should not be used for establishing NPDES permit limits until EPA releases the final document on the procedure. This section describes the outline of this procedure.

The overall approach illustrated in Figure 3-6 is a seven-step procedure that starts with collecting samples and ends with developing permit effluent limits. The effluent characterization step unique to this approach lies in Step 3. There are two alternatives under this step: fish tissue residue and effluent assessment. An analytical chemistry laboratory with residue chemistry and gas chromatograph/mass spectometer (GC/MS) capability is needed to conduct the analytical methods for both alternatives. A summary of the alternatives follows:

- Tissue Residue Alternative: This alternative measures the concentrations of organic bioconcentratable chemicals in tissue samples of indigenous organisms from the receiving water. This analysis involves the collection of fish or shellfish samples, the extraction of the organic chemicals from the tissue and the analysis of these extracts with GC/MS to identify and quantify the bioconcentratable contaminants. The procedure provides recommendations to sort the results of this screening analysis in order to determine which of the contaminants pose a hazard and require regulatory action. The approach recommends that the identity of those contaminants then be confirmed prior to taking subsequent action.

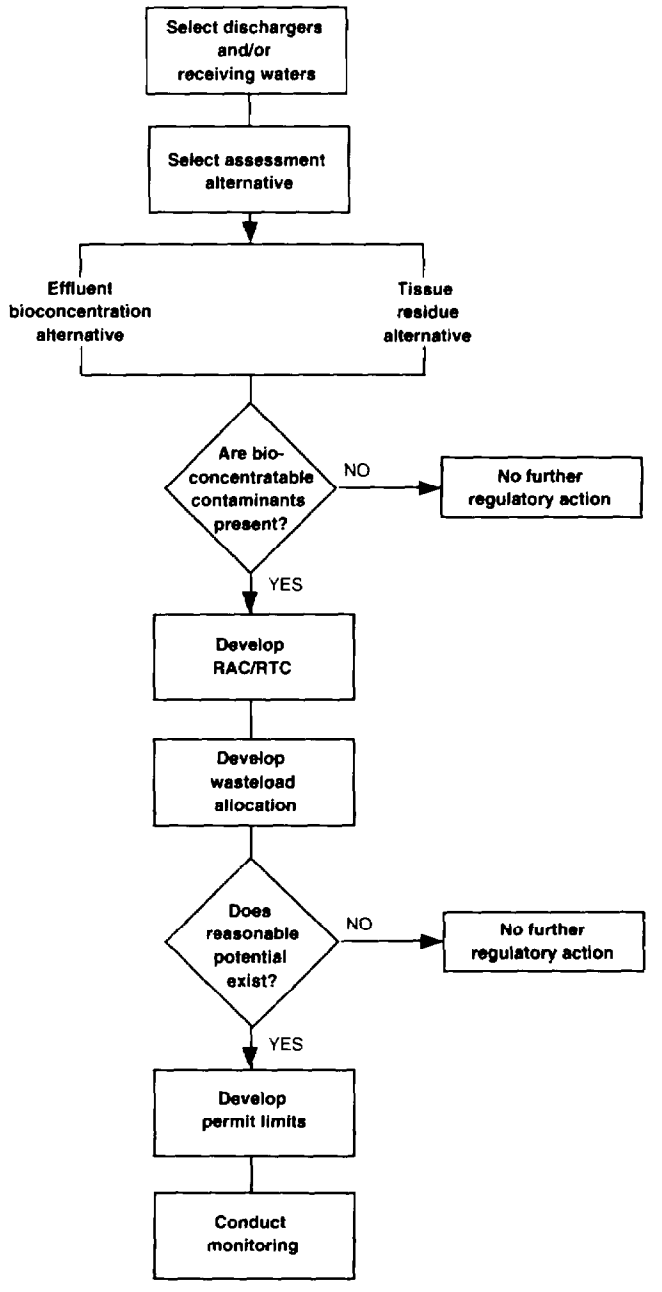


Figure 3-6. Procedure for Assessment and Control of Bioconcentratable Contaminants in Surface Waters

- Effluent Alternative: This alternative measures the concentrations of organic bioconcentratable chemicals in effluent samples from point source dischargers. This analysis involves the collection of effluent samples, the extraction of the organic chemicals from the effluent sample, and the separation of the chemicals that have characteristics known to result in bioconcentration from the other chemical components of the effluent sample. This separation is achieved by way of an analytical chemistry methodology called high-

pressure liquid chromotography (HPLC). The HPLC also separates (fractionates) an effluent sample into three subsamples or "fractions." These three fractions contain chemicals with increasing potential to bioconcentrate, with the third fraction containing those chemicals with the highest bioconcentration rates. Following HPLC fractionation, each fraction is then analyzed with GC/MS to identify and quantify the bioconcentratable contaminants. The effluent procedure also provides recommendations to sort the results of the initial screening analysis to determine which of the contaminants pose a hazard and require subsequent regulatory action. The approach then recommends that the identity of those contaminants then be confirmed prior to taking further regulatory action.

While both of the assessment alternatives described above may be used for a given discharger, generally one of these alternatives may be preferred by the regulatory authority. The regulatory authority would select the assessment approach based on the available site- and facility-specific information and the objectives of the application.

Although the approach provides a means to identify chemicals that can bioconcentrate, it does not identify all bioconcentratable chemicals. Chemicals that bioconcentrate include many organic compounds, and a small number of metals (e.g., mercury and selenium) and organometals (e.g., tributyltin). The new approach is limited to nonpolar organic chemicals that produce measurable chemical residues in aquatic organisms or that have log octanol-water partition coefficients greater than 3.5.

3.3.10 Analytical Considerations for Chemicals

Analysis of discharges for toxic substances requires special quality control procedures beyond those necessary for conventional parameters. Toxicants can occur in trace concentrations and are frequently volatile or otherwise unstable. An EPA publication entitled, *Test Methods—Technical Additions to Methods for Chemical Analysis of Water and Wastes* [8], contains sampling and handling procedures recommended by EPA for a number of toxic and conventional parameters. Additional methods for analyses for toxicants are described in Standard Methods of Water and Wastewater Analyses (ASTM, 17th edition, 1989, or most recent edition) and 40 CFR Part 136. Chapter 5 discusses detection limits and sampling requirements.

CHAPTER 3
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Spokane River PCB Source Assessment 2003-2007

DEPARTMENT OF ECOLOGY
State of Washington

April 2011
Publication No. 11-03-013

Publication and Contact Information

This report is available on the Department of Ecology's website at
www.ecy.wa.gov/biblio/1103013.html

Data for this project are available at Ecology's Environmental Information Management (EIM) website www.ecy.wa.gov/eim/index.htm. Search User Study ID, DSER0010.

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Spokane River
PCB Source Assessment
2003-2007

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by

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Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

Waterbody Numbers:

WA-57-1010: Middle Spokane River
WA-54-1010, WA-54-1020: Lower Spokane River
WA-54-9040: Lake Spokane (formerly Long Lake-Spokane River)
WA-55-1010: Little Spokane River

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Table of Contents

Page

List of Figures 5
List of Tables 7
Abstract 9
Acknowledgements 10
Executive Summary 11
The 303(d) List 15
Spokane River PCB Listings 16
Water Quality Standards and Designated Uses 19
  Regulations 19
  Guidance 22
Watershed Description 23
  Hydrology 23
  Sediment 24
PCB Contamination of the Spokane River 27
  Uses, Structure, and Analysis 27
  Environmental Fate 28
  Historical Data on PCBs in the Spokane River 29
  Fish Consumption Advisories 33
  National Pollutant Discharge Elimination System (NPDES) Permits 34
  Historic NPDES Effluent PCB Concentrations 34
  PCBs Behind Upriver Dam, 1995-2004 36
2003-2007 PCB Source Assessment 39
  Goals 39
  Objectives 39
  Field Data Collection 40
Sample Preparation 55
Analytical Methods 55
Data Quality Assessment 56
Results and Discussion 57
  Dissolved PCBs in Spokane River Water 57
  PCBs in Spokane River Suspended Particulate Matter 61
  PCBs in Industrial and Municipal Effluents Discharged to the Spokane River 65
  PCBs in Stormwater Discharged to the Spokane River 68
  PCBs in Spokane River Bottom Sediments 77
  PCBs in Spokane River Fish 83

Assessment of PCB Sources 91
PCB Loading Calculations.....92
Instream Loads.....96
Load Reductions Needed to Meet Human Health Criteria 100

Food Web Bioaccumulation Model 101

Conclusions.....107

Recommendations.....109

References.....111

Appendices.....117
Appendix A: Spokane River Basin NPDES Permits 119
Appendix B: Sampling Locations for Spokane River PCB Source Assessment Study 121
Appendix C: Method Used to Convert PCB Concentrations in SPMD to Water.....125
Appendix D: Ancillary Parameters for Suspended Particulate Matter Sampling.....134
Appendix E: Biological Data for Fish and Crayfish Specimens Used for PCB Analysis.....135
Appendix F: Fish Tissue Preparation, 2003-2005 141
Appendix G: Results on Quality Control Samples for 2003-2005 143
Appendix H: Details of Arnot-Gobas Food Web Bioaccumulation Model.....146
Appendix I: Glossary Acronyms, Symbols, and Units 151

List of Figures

Page

Figure 1. Location Map of Spokane River Showing Water Resource Inventory Areas. 17
Figure 2. Spokane River Basin. 23
Figure 3. Spokane River Monthly Harmonic Mean Flows for Water Years 1969-2002..... 25
Figure 4. Generic PCB Molecular Structure and Numbering System. 27
Figure 5. Location of Fine-Grained Wood Waste Sediment Deposit Behind Upriver Dam. 36
Figure 6. Sampling Maps for Spokane River PCB Source Assessment Study..... 40
Figure 7. Sampling Map 1: Spokane River Mouth to Long Lake (Lake Spokane) Dam. 41
Figure 8. Sampling Map 2: Long Lake (Lake Spokane) Dam to Ninemile Dam. 42
Figure 9. Sampling Map 3: Ninemile Dam to Upriver Dam. 43
Figure 10. Sampling Map 4: Upriver Dam to Idaho Border. 44
Figure 11. Dissolved Total PCBs in the Spokane River, 2003-2004..... 60
Figure 12. Dissolved Total PCBs at Mid-depth and Near the Bottom at Upriver Dam. 61
Figure 13. Measured Particle-Bound PCB Concentrations and Theoretical Dissolved PCB Concentrations Based on Suspended Particulate Matter Collected by Three 2-Day Centrifugation Sampling Events of Spokane River Water in October and November 2003. 64
Figure 14. Stormwater Basins in the City of Spokane Sampled for PCBs During 2007 by Parsons. 68
Figure 15. Stormwater Basins in the City of Spokane, Parsons, (2007)..... 75
Figure 16. Surficial Sediment PCB Concentrations in Spokane River and Little Spokane River Sediments Normalized to Organic Carbon..... 79
Figure 17. Chronology of PCB Concentrations in Upper Lake Spokane Sediments. 81
Figure 18. Chronology of PCB Concentrations in Lower Lake Spokane Sediments. 81
Figure 19. Schematic of PCB Sources and Instream Loads in the Spokane River..... 99
Figure 20. Dissolved Water and Sediment Total PCB Concentrations Predicted to Yield 0.1 ng/g in Rainbow Trout and Sucker Fillet (Stateline to Lake Spokane). 103
Figure 21. Dissolved Water and Sediment Total PCB Concentrations Predicted to Yield 0.1 ng/g in Rainbow Trout and Sucker Fillet (Little Falls and Spokane Arm). 104

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List of Tables

Page

Table 1. 303(d) Listings for Total PCBs in Spokane River Fish Tissue for 2008. 16
Table 2. Additional 303(d) Listings Not Addressed in this Report. 18
Table 3. Water and Fish Tissue Criteria or Thresholds for Total PCBs. 19
Table 4. Summary of PCB Data Collected on the Spokane River, 1980-2007. 30
Table 5. Summary of Total PCB Concentrations in Fish Tissue from the Spokane River..... 32
Table 6. April 2008 Spokane River Fish Consumption Advisories..... 33
Table 7. Summary of Spokane Area PCB Point Source Data. 35
Table 8. Locations and Dates of SPMD Deployments. 45
Table 9. Locations and Sampling Dates for Suspended Particulate Matter and Whole River Water. 47
Table 10. Outfall Locations and Dates of Industrial and Municipal Wastewater Effluent Samples. 48
Table 11. Outfall Locations and Date of 2004 Storm Drain and CSO Samples..... 49
Table 12. 2007 Stormwater Sampling Locations..... 50
Table 13. Locations and Dates of Surficial Sediment Samples. 51
Table 14. Locations and Dates of Sediment Cores. 52
Table 15. Locations and Dates of Fish and Crayfish Samples. 53
Table 16. Preparation Methods, Analytical Methods, and Reporting Limits for the Spokane River Samples. 55
Table 17. Ancillary Parameters at SPMD Sites (mg/L)..... 58
Table 18. SPMD Dissolved PCB Concentrations Grouped by Homologues (pg/l), 2003-2004. 59
Table 19. PCB Concentrations Grouped by Homologues in Suspended Particulate Matter and Whole River Water Collected at the Centrifuge Inlet (pg/l) During Three Sampling Events from October to November 2003. 63
Table 20. Kaiser Trentwood Effluent Concentrations of Total PCBs (Kaiser, 2005). 65
Table 21. PCB Concentrations Grouped by Homologues in Industrial/Municipal Effluent (pg/l). 67
Table 22. June 10, 2004 Stormwater PCB Concentrations Grouped by Homologues (pg/l). 69
Table 23. May 2, 2007 Stormwater PCB Concentrations Grouped by Homologues (pg/l). 70
Table 24. May 21, 2007 Stormwater PCB Concentrations Grouped by Homologues (pg/l). 71
Table 25. June 5, 2007 Stormwater PCB Concentrations Grouped by Homologues (pg/l). 72
Table 26. Summary Statistics for Total PCB Concentrations in Spokane Stormwater (pg/l). 73
Table 27. Total PCB Results, Impervious Fraction, and Runoff for Spokane Stormwater Basins. 76
Table 28. Bottom Sediment Locations and Sampling Dates. 77
Table 29. Grain Size in Bottom Sediments (%)..... 77

Table 30. PCB Concentrations Grouped by Homologues in Surficial Bottom Sediments..... 78
Table 31. Total PCB Concentrations in Sediment Cores from Upper and Lower Lake Spokane (ng/g, dw). 80
Table 32. 2003-2004 PCB Concentrations in Rainbow Trout from Plante Ferry and Ninemile (ng/g, ww) 84
Table 33. 2003-2004 PCB Concentrations in Suckers and Crayfish Tissue from the Spokane River (ng/g, ww). 85
Table 34. Summary of PCB Concentrations Measured in Spokane River Fish Collected in 2005..... 87
Table 35. Significant Changes Identified in Total PCB Concentrations in Spokane River Sportfish Fillets: Results from Analysis of Variance on Comparable Data Sets, 1994-2005. 88
Table 36. Total PCB Concentrations in Spokane River Fish vs. Statewide Data..... 89
Table 37. Total PCB Concentrations in Spokane River Fish vs. Statewide Freshwater Background (ug/Kg, wet weight; fillet samples). 90
Table 38. Estimated PCB Loads in Industrial and Municipal Effluents Discharged to the Spokane River. 92
Table 39. PCB Load from Sampled Stormwater Basins based on Simple Method Discharges, Parsons (2007)..... 94
Table 40. PCB Load from Un-Sampled Stormwater Basins based on 2005 City Discharge Data, Parsons (2007). 95
Table 41. PCB Loads in Spokane River at Idaho Border. 96
Table 42. PCB Loads in the Little Spokane River..... 97
Table 43. Instream PCB Loads in Spokane River Reaches and the Little Spokane River. 97
Table 44. Estimates of PCB Load Reductions Needed to Meet Human Health Water Quality Criteria in the Spokane River..... 100
Table 45. Target Sediment and Water Total PCB Concentrations Needed to Yield the Spokane Tribe Fish Tissue Criterion (0.1 ng/g) in the Spokane River, Based on the Arnot-Gobas Food web Bioaccumulation Model. 105

Abstract

The Spokane River does not meet Washington State human health criteria for polychlorinated biphenyls (PCBs) in edible fish tissue. During 2003 to 2007, the Department of Ecology conducted a series of water quality studies in an effort to assess sources of these legacy pollutants to the river. PCBs were analyzed in river water, industrial and municipal wastewater effluents, stormwater, suspended particulate matter, bottom sediments, sediment cores, and fish tissue. The study area covered the Spokane River from the Idaho border (river mile 96.1) to the mouth at the Columbia River. The lower part of the river flows through the Spokane Tribe of Indians reservation.

Total PCB concentrations in water increased with successive reaches moving downstream from the Idaho border (106 pg/l, parts per quadrillion) to lower Lake Spokane (formerly Long Lake; 399 pg/l), with a corresponding eight-fold increase in loads (477 – 3,664 mg/day), on average. The Washington State PCB human health criterion for surface water is 170 pg/l. Although PCB concentrations in Spokane River fish are generally much lower than historical levels, fish in most areas did not meet the state's human health criterion in edible tissue (5.3 ng/g, parts per billion).

Overall, PCB loading to Washington reaches of the river can be divided into the following source categories; City of Spokane stormwater (44%), municipal and industrial discharges (20%), and Little Spokane River (6%). In addition, PCB loading from Idaho at the state line represented 30% of the overall loading.

A PCB loading scenario was proposed to meet the Spokane Tribe human health water quality criterion for total PCBs (3.37 pg/l, equivalent to 0.1 ng/g in tissue). The scenario requires a 95% PCB load reduction at the Idaho border, a 97% load reduction in the Little Spokane River, and ≥99% reductions in municipal, industrial, and stormwater discharges. A food web bioaccumulation model indicated that PCB loads in water and PCB concentrations in sediment would require large reductions to meet the Spokane Tribe criterion.

Acknowledgements

The authors of this report thank the following people for their contribution to this study:

- Pat Blau (Kaiser Trentwood), Rick Fink (Inland Empire), Dan Grogg (Liberty Lake Wastewater Treatment Plant), and Tim Pelton (Spokane Wastewater Treatment Plant) permitted sampling of their facilities.
- Gary Bussiere and Michael Coster (City of Spokane) arranged and conducted stormwater sampling.
- Bob Hughes (Plante Ferry Park), Dennis Dalton, Jack Hartt, and Mark Nickelson (Riverside State Park), Brett Walker (Washington Department of Natural Resources Long Lake Campground), Mark Bloss and Larry Ford (Avista Long Lake and Little Falls Dam), and Mark Cleveland (Upriver Dam) provided access to the Spokane River.
- John Sneva and Lucinda Morrow (Washington Department of Fish and Wildlife) aged fish specimens.
- Jim Huckins and David Alvarez (U.S. Geological Survey) provided advice on interpreting semipermeable membrane devices data.
- Larry Gadbois (Environmental Protection Agency) reviewed the report.
- Staff from the Washington State Department of Ecology (* formerly with Ecology):
    - John Roland of Ecology's Eastern Regional Office (ERO) provided valuable advice from project inception through completion.
    - John Roland, David Moore, Patrick Hallinan, Arianne Fernandez, and Brendan Dowling reviewed the project report for ERO.
    - Nigel Blakley*, Brandee Era-Miller, Richard Jack*, Aspen Madrone, Dale Norton, Jim Ross, Lawrence Sullivan*, and Sandra Treccani assisted with sampling.
    - Steve Golding* conducted sampling at NPDES permitted facilities.
    - Chad Wiseman* identified benthic organisms in fish stomachs.
    - Nigel Blakley* assisted with food web modeling.
    - Casey Deligeannis and Keith Seiders helped prepare tissue samples.
    - Pam Covey* and Will White* tracked and transported samples for laboratory analysis.
    - Karin Feddersen managed outside laboratory contracts.
    - Heidi Chuhran, Kamilee Ginder, Meredith Jones, Randy Knox, Myrna Mandjikov, Jamie Martin, Bridget Mason, Dean Momohara, and Aileen Richmond analyzed samples at Manchester Environmental Laboratory.
    - David Sternberg reviewed the project report for the Toxics Cleanup Program.
    - Dale Norton supervised this project.
    - Joan LeTourneau, Cindy Cook, and Gayla Lord edited and formatted the final report.

Executive Summary

Section 303(d) of the federal Clean Water Act requires states to prepare a list every two years of waterbodies that do not meet water quality standards. In Washington, the 303(d) list is compiled by the Washington State Department of Ecology (Ecology). The Clean Water Act requires that waterbodies on the 303(d) list be cleaned up by pollution-control programs or that a Total Maximum Daily Load (TMDL) be developed for the pollutants of concern. A TMDL determines the amount of pollutant that can be discharged to a waterbody and still meet standards (loading capacity) and allocates that load among the various sources."

Fifteen waterbody segments of the Spokane River and Lake Spokane (also known as Long Lake), and one segment of the Little Spokane River are on the 2008 303(d) list for not meeting (exceeding) Washington State's human health water quality criterion for polychlorinated biphenyls (PCBs) in edible fish tissue (Table ES-1). PCBs are legacy pollutants no longer produced or no longer put into new use in the United States. PCBs had numerous industrial applications as insulating fluids, plasticizers, in inks, and carbonless paper, and as heat transfer and hydraulic fluids. Environmental Protection Agency (EPA) has classified these compounds as probable human carcinogens.

Table ES-1. 303(d) Listings for Total PCBs in the Spokane River.

Waterbody	Reach	Waterbody Number	Watercourse Number	Listing ID
Spokane River	Idaho Border to Latah Creek	WA-57-1010	QZ45UE	14397 14398 8201 8207 8202 14402
Spokane River	Latah Creek to Ninemile Dam	WA-54-1010	QZ45UE	14400 14385 9033
Little Spokane River	Near mouth	WA-55-1010	JZ70CP	9051
Lake Spokane (Long Lake)	Ninemile Dam to Lake Spokane Dam	WA-54-9040	QZ45UE	9021 36441 9015 36440
Spokane River	Lake Spokane Dam to Mouth	WA-54-1020	QZ45UE	9027

Ecology conducted the water quality studies described in this report from 2003 to 2007 to assess PCB sources to the Spokane River. The goal of these efforts was to quantify PCB contamination and identify necessary reductions in sources and the receiving waters to meet applicable PCB water quality criteria in the Spokane River. The studies analyzed PCBs in river water, industrial and municipal effluents, stormwater, suspended particulate matter, bottom sediments, sediment cores, and fish tissue.

The Spokane River, shown in Figure ES-1, begins in northern Idaho at the outlet of Lake Coeur d'Alene and flows west 112 miles to the Columbia River (Lake Roosevelt). The study area covered the Spokane River from the Idaho border (river mile 96.1) to the Columbia. The watershed encompasses over 6,000 square miles (15,500 km^2) in Washington and Idaho. The river flows through the smaller cities of Post Falls and Coeur d'Alene in Idaho and large urban areas of the Spokane Valley and Spokane in Washington. Other cities in the watershed include Liberty Lake, Deer Park, and Medical Lake Washington as well as Wallace and Kellogg Idaho upstream from Lake Coeur d'Alene. The Spokane Tribe of Indians reservation lies along the north bank of the lower river (Spokane Arm of Lake Roosevelt).

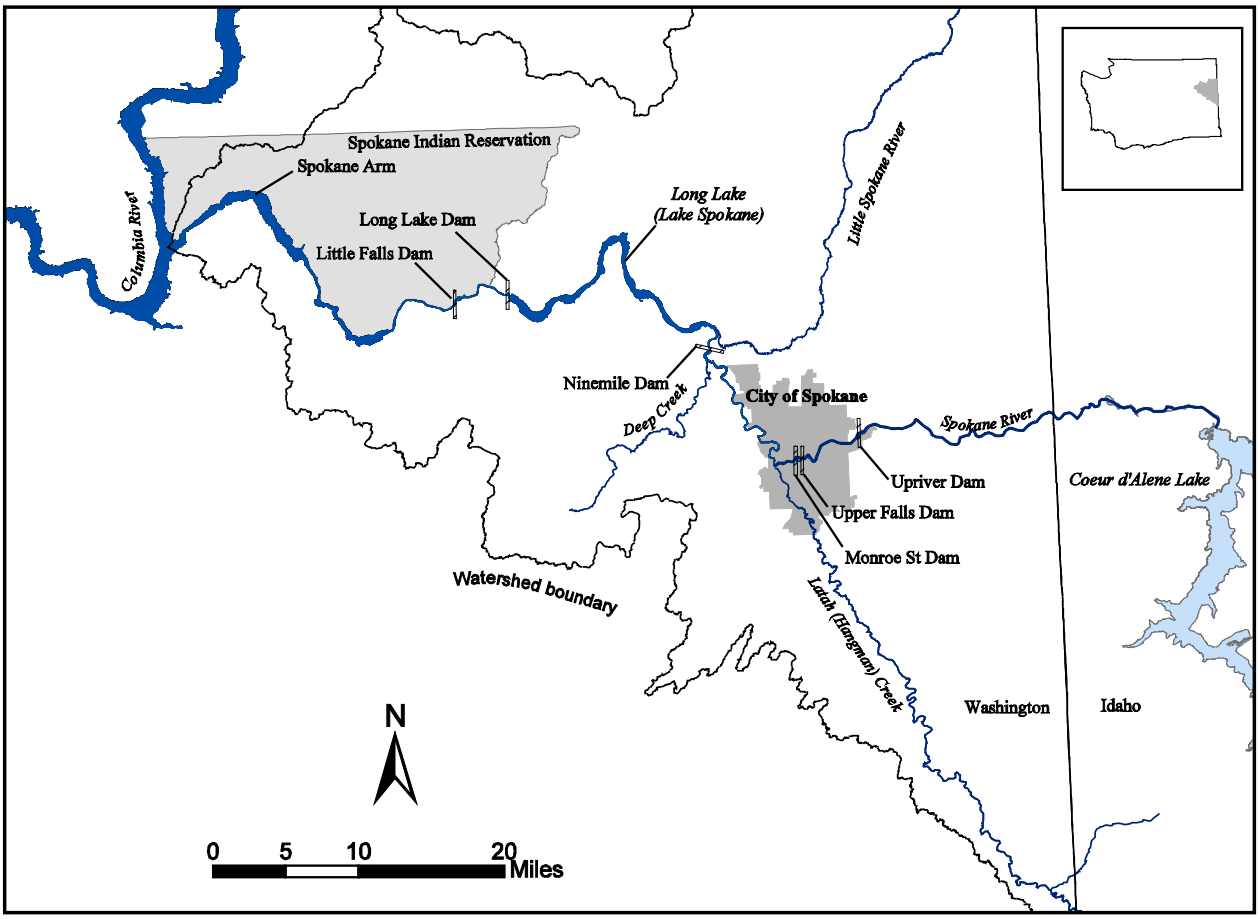

Figure ES-1: Spokane River Basin.

The Spokane Tribe human health PCB water quality criterion of 3.37 pg/l (parts per quadrillion) was used as the basis for calculating necessary PCB load reductions. The criterion is equivalent to 0.1 ng/g (parts per billion) in edible fish tissue. Although this criterion only applies to the Spokane Arm and lower half of the Little Falls reservoir, it cannot reasonably be met within these bounds unless PCB concentrations in upstream reaches are reduced to levels near the criterion. Washington State's human health criteria for PCBs is 170 pg/l (5.3 ng/g in fish tissue), the difference primarily being due to assumptions about human consumption rates of fish.

A PCB loading scenario is proposed to meet the Spokane Tribe human health criterion. The scenario requires a 95% PCB load reduction at the Idaho border, a 97% load reduction in the Little Spokane River, and ≥99% reductions in municipal, industrial, and stormwater discharges. Based on the loads estimated in this report, the largest current contributor of PCBs to the river (44%) is the City of Spokane's partially combined sewer-stormwater system. This is the most important source to reduce.

A food web bioaccumulation model used to predict PCB concentrations in fish tissue from the levels in water and sediments indicates that reductions of ≥99% would be required to meet the Spokane Tribe's fish tissue criterion where the Spokane River enters the reservation. Even with large reductions in PCBs, it seems unlikely that the Spokane tribal target (0.1 ng/g) in fish tissue is achievable. This concentration is approximately an order of magnitude lower than the median level (1.4 ng/g) reported in fish tissue from background areas of Washington in a 2010 statewide study conducted by Ecology (Johnson et al., 2010). Despite the extremely low tribal criteria, it is clear that further reductions in PCB loading are achievable. Implementing an adaptive management narrative limit in National Pollutant Discharge Elimination System (NPDES) permits might be a productive approach to establish a set of achievable targets for toxic chemical reductions.

Recommendations

Even though significant reductions in PCB levels have been measured in the Spokane River over the last two decades, achieving further reductions in PCBs will be a challenging long-term process which will require a strategy that uses a combination of activities to achieve water quality targets. To start meeting this challenge, Ecology has drafted a long-term strategy for reducing PCBs and other toxic chemicals in the Spokane River watershed.

The Spokane River Toxics Reduction Strategy requires coordination across several Ecology programs, including the Spokane River Urban Waters Program (UWP) which was formed in 2007. The primary purpose of this program is to identify and eliminate toxic chemicals at their source. The UWP also works cooperatively with local governments including the City of Spokane and the Spokane Regional Health District.

Under the reduction strategy, source identification and control will largely be carried out by the UWP. The strategy uses a three-pronged approach (prevention, management, and cleanup) to reduce sources. Priority is placed on using a systematic step-wise process for identifying potential PCB sources within a conveyance system, then reducing and/or eliminating sources as they are located.

The conceptual approach to reduce PCBs discharged to the Spokane River should continue to focus on:

1. Identifying PCB sources and reducing or eliminating them from stormwater and wastewater effluents.
2. Examining treatment alternatives for effluent PCB removal.
3. Implementing necessary treatment plant controls.
4. Characterizing PCB transport through groundwater.

Implementation of an adaptive management approach using narrative limits in NPDES permits should be explored as an option to establish a set of achievable targets for toxic chemical reductions. In addition, source reduction efforts should be coupled with an ongoing effectiveness monitoring program to evaluate progress in reaching water quality targets.

The 303(d) List

The federal Clean Water Act established a process to identify and clean up polluted waters. The Clean Water Act requires each state to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards include (1) designated uses for aquatic life, recreation, water supply, and harvesting (fish consumption) and (2) criteria, usually numeric criteria, to protect those uses.

Every two years, states are required to prepare a list of waterbodies – lakes, rivers, streams, or marine waters – that do not meet water quality standards. This list is called the 303(d) list and is prepared by the Washington State Department of Ecology (Ecology). To develop the list, Ecology compiles its own ambient water quality data along with data from local, state, and federal governments, tribes, industries, and citizen monitoring groups. All data are reviewed to ensure that they were collected using appropriate scientific methods before being used to develop the 303(d) list. The 303(d) list is part of the larger Water Quality Assessment (www.ecy.wa.gov/programs/wq/303d/index.html).

The last comprehensive freshwater and marine water 303(d) list for Washington was prepared in 2008. Listing updates are now staggered, with the marine list completed in 2010 and the freshwater list scheduled to be completed in 2012. The next opportunity to evaluate compliance with water quality standards in the Spokane River will be in 2012.

The Clean Water Act requires that waterbodies on the 303(d) list be cleaned up by pollution-control programs or that a TMDL be developed. A pollution-control program needs to address the sources of pollution and have a monitoring and enforcement component. A TMDL identifies pollution problems in the watershed and specifies how much pollution needs to be reduced or eliminated to achieve clean water. When developing a pollution-control program or a TMDL, Ecology works with the local communities and other relevant stakeholders to identify all actions that need to occur to address the sources of pollution. A monitoring plan to assess the effectiveness of those implementation actions is also developed. That monitoring plan is used to determine success or the next steps needed.

Spokane River PCB Listings

The Spokane River begins in northern Idaho at the outlet of Lake Coeur d'Alene and flows west 112 miles to the Columbia River. Within Washington this includes Water Resource Inventory Areas (WRIAs) 54, 55, 56, and 57 (Figure 1). The designated uses for this area include aquatic life uses, recreation, fish consumption, and Spokane Tribe of Indians ceremonial, spiritual, and cultural uses (see *Water Quality Standards and Designated Uses* section).

Elevated levels of polychlorinated biphenyls (PCBs) are found in Spokane River water, sediments, fish tissue, and effluents being discharged to the river. Ecology first documented PCB contamination in Spokane River fish in the early 1980s (Hopkins et al., 1985), and numerous investigations have evaluated the extent of the contamination (e.g., Ecology, 1995; Johnson, 1997; Johnson, 2001; Anchor, 2004). One location behind Upriver Dam required clean-up of PCBs in bottom sediments under the Model Toxics Control Act (MTCA, WAC 173-340). Cleanup was completed in January 2007, and long-term monitoring for PCBs at this site began in the fall of 2008.

Most of the Spokane River fish analyzed for PCBs fail to meet (exceeded) state surface water quality standards established to protect beneficial uses of surface waters, such as fish consumption. Fish consumption advisories have been issued for parts of the river (Spokane Regional Health District and Washington State Department of Health, 2003).

Fifteen waterbody segments of the Spokane River and Lake Spokane (also known as Long Lake, herein referred to as Lake Spokane) and one segment of the Little Spokane River are on the 2008 303(d) list for exceeding human health water quality criteria for PCBs (Table 1; www.ecy.wa.gov/programs/wq/303d/index.html).

Table 1. 303(d) Listings for Total PCBs in Spokane River Fish Tissue for 2008.

Waterbody	Reach	WB number	Watercourse Number	Listing ID
Spokane River	Idaho Border to Latah Creek	WA-57-1010	QZ45UE	Spokane River
	Latah Creek to Ninemile Dam	WA-54-1010		
Little Spokane River	Near mouth	WA-55-1010	JZ70CP	Little Spokane River
Lake Spokane (Long Lake)	Ninemile Dam to Lake Spokane Dam	WA-54-9040	QZ45UE	Lake Spokane (Long Lake)
Spokane River	Lake Spokane Dam to Mouth	WA-54-1020	QZ45UE	Spokane River

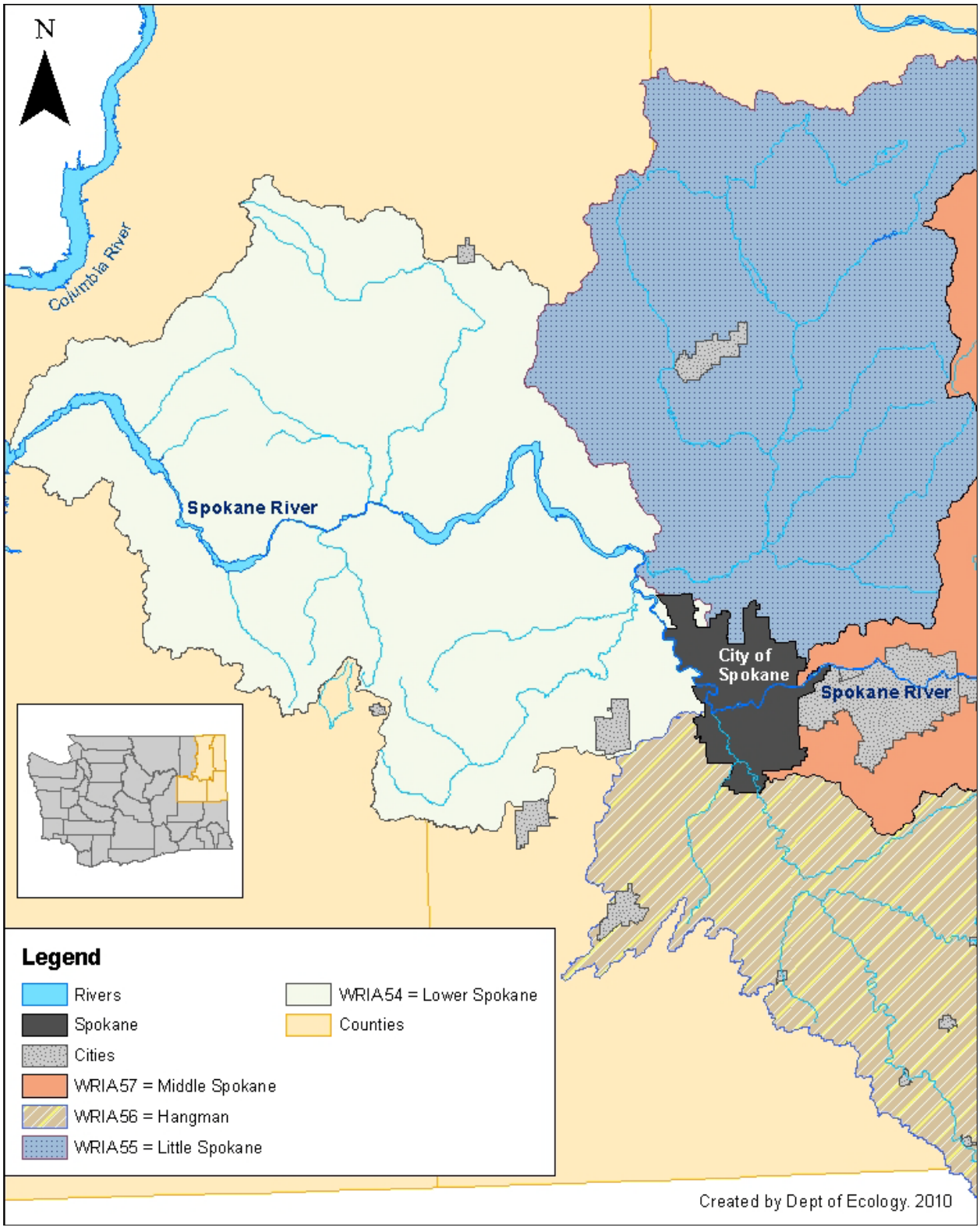

Figure 1. Location Map of Spokane River Showing Water Resource Inventory Areas.

The Spokane River and Lake Spokane have other water quality criteria exceedances that are not addressed in this source assessment. Table 2 shows the 303(d) listings for parameters other than PCBs that occur in the study area.

Table 2. Additional 303(d) Listings Not Addressed in this Report.

Waterbody	Parameter	Medium	Listing ID	Township	Range	Section
Spokane River	Temperature	Water	3737	25N	46E	06
	Total dissolved gas		15183	27N	39E	20
			15184	27N	39E	14
	Fecal coliform		16853	25N	42E	04
Lake Spokane (Long Lake)	Dioxin	Fish Tissue	42410	27N	41E	22
Spokane River			42411	26N	42E	20
			51586	26N	42E	28
			51587	25N	44E	03
Lake Spokane (Long Lake)	Dissolved oxygen	Water	40939	27N	40E	15
Spokane River			15188	26N	42E	17
			17523	25N	43E	02
			15187	25N	43E	18
			11400	25N	46E	06

The listings for dioxin in Spokane River and Lake Spokane fish are based on rainbow trout and mountain white fish collected by Ecology between 2001 and 2005 (Seiders et al., 2004, 2006, 2007). The listings are either for marginal exceedances of the human health criterion for 2,3,7,8-TCDD (dioxin) or for exceedances due to other polychlorinated dioxins and furans (PCDDs/PCDFs). These listings were not addressed in the present series of studies.

Ecology plans to address dioxin listings on a larger scale (possibly region- or state-wide) in the future. Because dioxins are often carried via air and can pollute sizeable areas not necessarily limited to watersheds, a larger TMDL footprint will likely be more effective and efficient at determining sources and subsequent evaluation of possible controls.

A TMDL for lead, cadmium, and zinc was completed for the Spokane River in 1999 (Pelletier and Merrill, 1998; Butkus and Merrill, 1999).

Water Quality Standards and Designated Uses

Applicable water quality criteria for PCBs to protect human health were promulgated by the U.S. Environmental Protection Agency (EPA) in the National Toxics Rule (NTR). The Washington State Water Quality Standards for Surface Waters (WAC 173-201A-240) contain aquatic life criteria for PCBs, and the Spokane Tribe of Indians' Surface Water Quality Standards (Resolution 2003-259) contain both human health and aquatic life-based PCB criteria. These regulations and other guidance are discussed separately below. The applicable numeric criteria are shown in Table 3.

Table 3. Water and Fish Tissue Criteria or Thresholds for Total PCBs [a] (pg/l: picograms per liter; parts per quadrillion; ng/g: nanograms per gram; parts per billion).

Regulation or Guidance	Aquatic Life - Water		Human Health [bc]		Fish Tissue Consumption Rate (kg/day)
	(chronic) (pg/l)	(acute) (pg/l)	Water (pg/l)	Tissue (ng/g)	
National Toxics Rule (40 CFR 131)	--	--	170	5.3	0.0065
Washington Water Quality Standards (Ch. 173-201A WAC)	1.4 x $10^{4(d)}$	2 x $10^{6(d)}$	--	--	--
Spokane Tribe Water Quality Standards (Resolution 2003-259)	1.4 x $10^{4(e)}$	2 x $10^{6(f)}$	3.37	0.1	0.0863
EPA National Recommended Water Quality Criteria (EPA, 2002)	--	--	64	2.0	0.0175
EPA Screening Value for Recreational Fishers (EPA, 2000a)	--	--	--	2.0	0.0175
EPA Screening Value for Subsistence Fishers (EPA, 2000a)	--	--	--	0.245	0.142

[a] total PCBs (sum of detected Aroclors, homologue groups, or congeners).
[b] based on a one-in-a-million (10^{-6}) excess lifetime cancer risk.
[c] for consumption of organisms and water.
[d] 24-hr average not to be exceeded.
[e] A one-hour average not to be exceeded more than once every three years on average.
[f] A four-day average not to be exceeded more than once every three years on average.

Regulations

National Toxics Rule

Criteria for the protection of human health were issued to the state in the NTR (40 CFR 130.36). Promulgated by EPA in 1992, and subsequently amended for PCBs in 1999, the NTR establishes numeric, chemical-specific water quality criteria for most priority pollutants. In fresh waters, human health criteria take into account the combined exposure of both drinking the water and eating fish and shellfish that live in the water. Criteria are calculated such that the upper-bound excess cancer risk is less than or equal to one in one million (10^{-6} risk level). Criteria for non-carcinogens are calculated such that effects should not be seen at exposures reflecting standard EPA exposure parameters (see equation below).

NTR human health criteria for PCBs (170 pg/l (parts per quadrillion) for a 10^{-6} risk level) were derived primarily to protect people from contaminated fish, the predominant exposure pathway. Exposure through water consumption is negligible, representing approximately 1% of the total PCB intake. The human health criteria are calculated using the following equation:

Equation 1. $$\boldsymbol{HHC = \frac{RF \times BW \times (10^9\, pg/mg)}{q1^* \times [WC + (FC\ x\ BCF)]}}$$

Where:

- HHC = human health criteria.
- RF (risk factor) = the acceptable level of cancer risk. Washington's acceptable upper-bound excess cancer risk is one in a million (10^{-6}) for a lifetime exposure.
- BW (body weight) = the average body weight of the consumer. The NTR uses an average consumer body weight of 70 kg.
- q1* (cancer slope factor) = the cancer potency of each chemical. The NTR uses a q1* of 2 per mg/kg-day for PCBs.
- WC (water consumption) = the average daily consumption of water by a consumer. The NTR uses a water consumption rate of 2 L/day.
- FC (fish consumption) = the average fish tissue consumption by a consumer. The NTR uses a fish tissue consumption rate of 0.0065 kg/day.
- BCF (bioconcentration factor) = the concentration of a chemical in tissue accumulated through gill and skin divided by the concentration in the water column. The NTR uses a BCF of 31,200 L/kg for PCBs.

The water quality criterion can be converted to an equivalent fish tissue criterion using the BCF in Equation 2, where Cw is the concentration in water and Ct is the concentration in tissue:

Equation 2. $$\boldsymbol{BCF = \frac{C_t}{C_W}}$$

NTR-equivalent fish tissue concentrations may then be calculated by $C_t = BCF \times C_w$. The calculated NTR-equivalent concentration for PCBs in edible tissue (C_t) is 5.3 ng/g (parts per billion; Table 3).

The values used by EPA to derive the NTR human health criteria are not always used by public health agencies to establish fish consumption advisories in Washington and other NTR states. The Washington State Department of Health (WDOH), which has primary responsibility for assessing the need for fish consumption advisories, examines local information about higher fish consumption rates, and sub-populations at increased risk. Additionally, differences are present in the use of chemical toxicity factors and health effect endpoints. For example, water quality criteria for PCBs are based on protection against cancer, while state fish advisories for PCBs are based on protection against non-cancer effects.

Washington State

Water quality standards for surface waters of Washington State are contained in Chapter 173-201A of the Washington Administrative Code (WAC), last amended in 2006 and approved by EPA in 2008. The numeric criteria to protect aquatic life from PCB exposure is found in WAC 173-201A-240. The acute exposure criterion for PCBs in freshwater is 2×10^6 pg/l. The chronic exposure criterion is 1.4×10^4 pg/l (Table 3).

The standards also include a provision that "Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent on those waters, or adversely affect public health as determined by the department (WAC 173-201A-240(1)."

Designated uses (defined in WAC 173-201A-200(1)) in the Spokane River, from its mouth to the Idaho border include:

- Core summer habitat
- Spawning/rearing
- Recreation
- Water supply
- Harvesting
- Other miscellaneous uses

Spokane Tribe

The Spokane Tribe of Indians (Spokane Tribe) Surface Water Quality Standards (Resolution 2003-259) are similar to the Washington State Water Quality Standards in terms of narrative and numeric criteria. They apply to the westernmost part of the river defined by a line bisecting the Spokane Arm and Little Falls reservoir from river mile (RM) 32.5 to RM 0 (see Figure 2). The Tribal standards consider the Spokane River and most of its tributaries to be Class A surface water, with the exception of Blue Creek, Orazada Creek, and Sand Creek which are all Class AA tributaries to the Spokane Arm between RM 8 and RM 13. Designated uses for Spokane Tribe Class A and AA waters are similar to the Washington State standards, but also include primary contact (Washington waters are also designated for primary contact), ceremonial and spiritual, and cultural uses.

The Spokane Tribal narrative section for toxic pollutant standards is nearly identical to that of Washington State, including the adoption of a 10^{-6} risk level of for carcinogens. However, the Tribal numeric human health criteria are substantially lower (more restrictive) than those issued to Washington in the NTR (3.37 vs. 170 pg/l) due to different values used to derive the human health criteria. Tribal standards employ an aquatic organism consumption rate of 0.0863 kg/day, as opposed to the 0.0065 kg/day fish consumption rate in the NTR. In addition, the Spokane Tribe PCB criteria include an older cancer slope factor of 7.7 per mg/kg-d. Using the same approach used to derive an NTR-equivalent tissue value as described above in Eq. 2, the Spokane Tribe human health criteria of 3.37 pg/l translates to an equivalent edible tissue concentration of 0.1 ng/g.

Guidance

EPA Recommended National Water Quality Criteria

In 2002, EPA recommended new national water quality criteria including a new human health criterion for PCBs based on an upward revision of the fish consumption rate to 0.0175 kg/day (EPA, 2002). All other factors used to derive the recommended criterion (RF, BW, q1*, WC, and BCF) remained unchanged. The resulting recommended criterion for PCBs is 64 pg/l for water. The equivalent fish tissue concentration for this criterion is 2.0 ng/g (Table 3).

EPA Screening Values for Fish Advisories

Other threshold values which have no regulatory standing but are often used to assess potential public health risk are the EPA (2000a) tissue screening values (Table 3) used to evaluate fish advisories. Tissue screening values are derived in the same manner as NTR criteria and EPA's 2002 recommended national criteria, with adjustments only to the fish consumption rates. The screening value for recreational fishers is 2.0 ng/g, based on a consumption rate representing the 90th percentile of sport fishers (0.0175 kg/day). The screening value for subsistence fishers (0.24 ng/g) is based on a 99th percentile consumption rate (0.142 kg/day).

Watershed Description

Hydrology

The Spokane River begins in northern Idaho at the outlet of Coeur d'Alene Lake and flows west 112 miles to the Columbia River (Franklin D. Roosevelt Lake) (Figure 2). The watershed encompasses over 6,000 square miles (15,500 km^2) in Washington and Idaho. The river flows through the smaller cities of Post Falls and Coeur d'Alene in Idaho and large urban areas of the Spokane Valley and Spokane in Washington. Other cities in the basin include Liberty Lake, Deer Park, and Medical Lake Washington as well as Wallace and Kellogg Idaho upstream from Lake Coeur d'Alene.

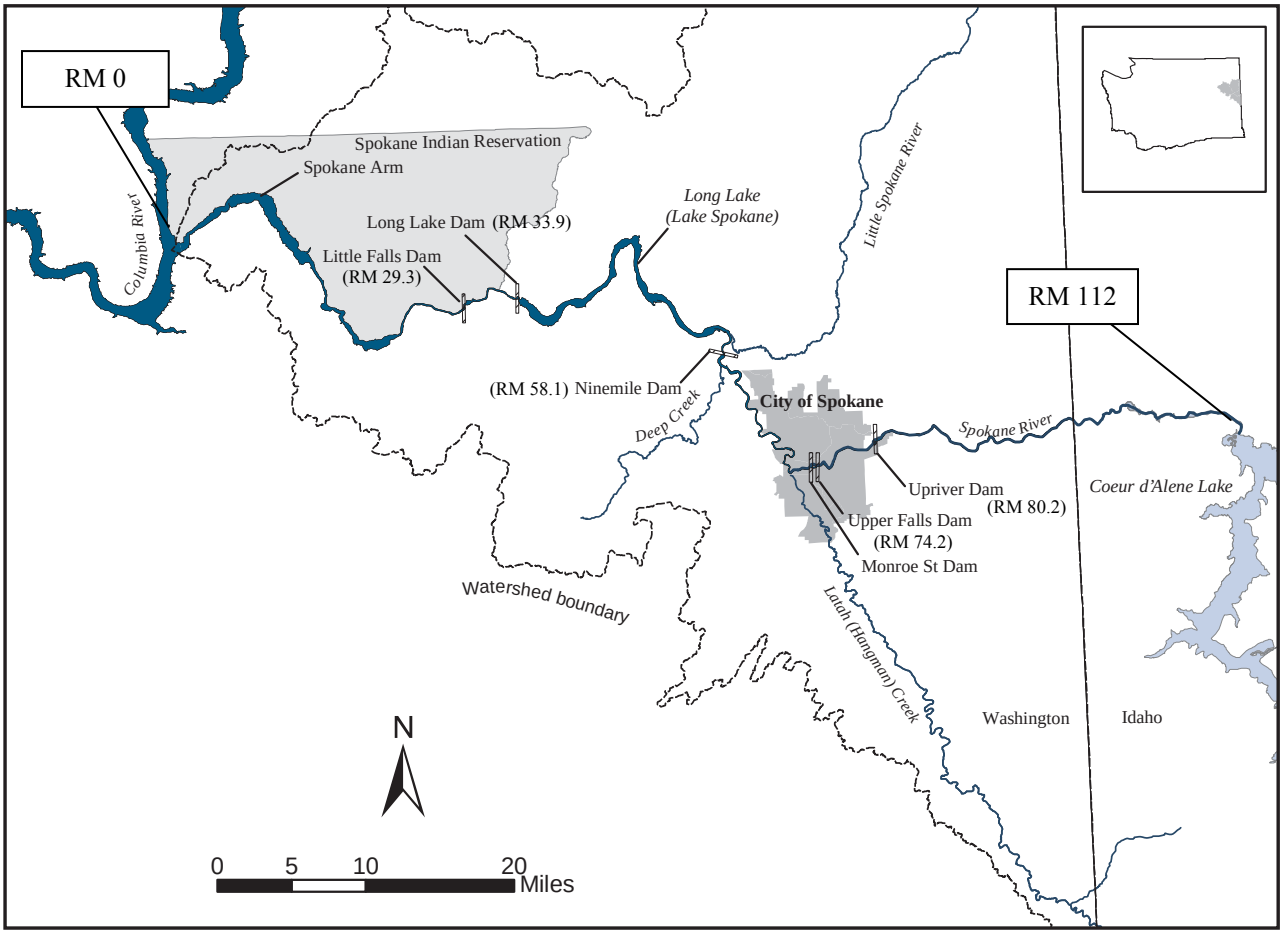

Figure 2. Spokane River Basin.

There are seven dams along the Spokane River:

1. Post Falls Dam (RM 100.8).
2. Upriver Dam (RM 80.2).
3. Upper Falls Dam (RM 74.5).
4. Monroe Street Dam (RM 74.0).
5. Ninemile Dam (RM 58.1).
6. Lake Spokane (Long Lake) Dam (RM 33.9).
7. Little Falls Dam (RM 29.3).

The dams create a series of pools which vary in length, the largest being 23-mile long Lake Spokane. Downstream from Lake Spokane, the Spokane River forms the southern boundary of the Spokane Tribe of Indians reservation from Chamokane Creek (RM 32.5) to the Columbia River at RM 639.0. The reservation occupies approximately 160,000 acres and is home to 2,441 tribal members (as of 2006).

The flow regime in the Spokane River is dictated largely by freezing temperatures in the winter followed by spring snowmelt. Figure 3 shows the harmonic mean flow at four points in the Spokane River. The harmonic mean is recommended by EPA (1991a) for use in assessing a river's loading capacity for long-term exposure to carcinogens such as PCBs. This is the appropriate measure of central tendency when dealing with rates, in this case rates of flow. Harmonic mean is discussed in more detail later in this report (see *Instream Loads*).

The annual mean flow for 1969-2002 was approximately 61,000 L/sec (2,154 cfs) where the Spokane River crosses the Idaho border. Flows increased to 82,000 L/sec (2,895 cfs) downstream of Spokane, reflecting the influx of groundwater through this river reach. Prior to 1969 there were un-quantified agricultural diversions for irrigation from the Spokane River in the vicinity of Post Falls.

Sediment

Downstream of Spokane the river corridor is largely undeveloped. The two major tributaries – Latah Creek (formerly Hangman Creek) and Little Spokane River – enter the Spokane River at RM 72.2 and RM 56.3, respectively. Latah Creek has an extremely flashy flow regime, responding rapidly to rainfall or snowmelt and is prone to erosion of its banks, thus delivering substantial sediment loads to the Spokane River (SCCD, 2002). In comparison, the Little Spokane River has an order of magnitude higher mean flow than Latah Creek, but carries slightly lower sediment loads.

One particular macro characteristic of the Spokane River is the general lack of fine depositional sediments in most of the river. Lake Coeur d'Alene acts as a settling basin for sediments transported in the upper watershed, and there are no tributaries to the river between the outlet of the lake and Latah Creek. Spokane River is essentially a free-stone stream environment. Although the dams break the river into a series of pools, there are few areas of placid water above Lake Spokane. The river velocities are high enough and the sediment load low enough to

scour the bed or prevent settling of significant fine particulate matter, even immediately behind the dams. As a result, almost the entire riverbed upstream of Lake Spokane (the largest reservoir) is composed of gravel, cobble, and boulders with the finer sediment reserved for limited locations behind the dams, interstitial spaces within the river bed, isolated shoreline deposits, and certain fluvial bar features. One notable exception is the narrow band of fine, organic carbon rich sediments found near the Upriver Dam reservoir that constituted the MTCA cleanup site, previously mentioned.

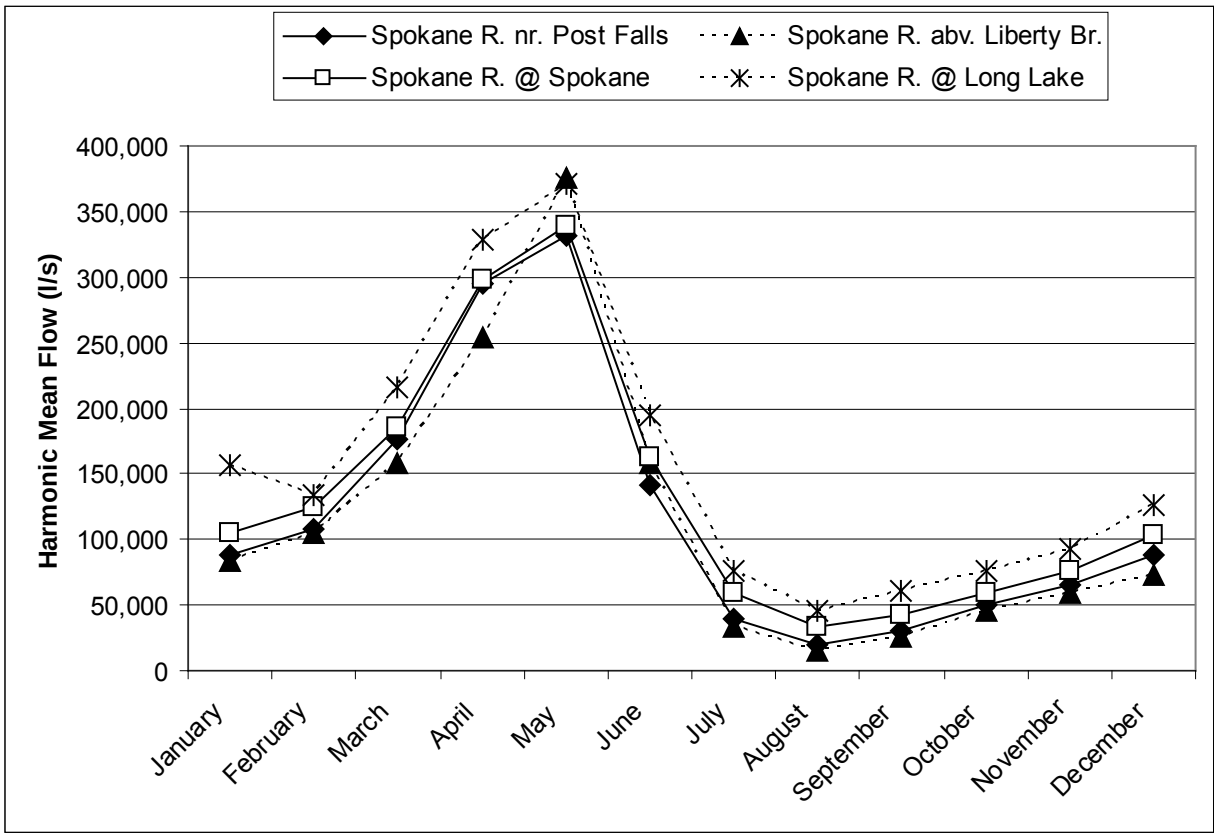

Figure 3. Spokane River Monthly Harmonic Mean Flows for Water Years 1969-2002.

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PCB Contamination of the Spokane River

Uses, Structure, and Analysis

PCBs were first produced for commercial use in 1929. Production continued until a 1979 ban on all PCB manufacturing, processing, and distribution due to evidence that PCBs build up in the environment and concerns about possible human carcinogenicity (Sittig, 1980). Principal uses were as heat transfer fluids, plasticizers, wax and pesticide extenders, lubricants, and fluids for hydraulic machinery, vacuum pumps, and compressors.

There are 209 individual forms of PCBs, known as congeners. The naming system for congeners is based on the number and location of chlorine atoms on the biphenyl rings (Figure 4).

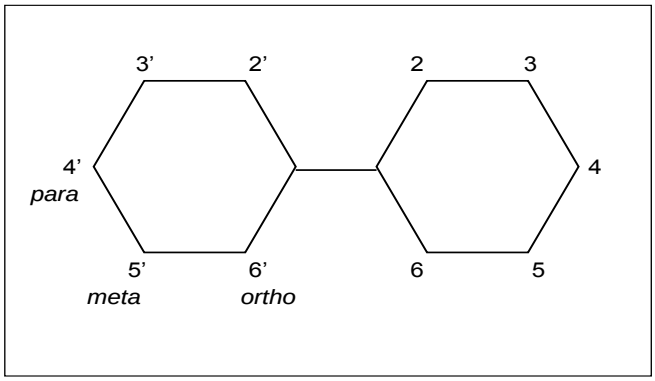

Figure 4. Generic PCB Molecular Structure and Numbering System.

In the U.S., PCBs were produced almost exclusively as Aroclors, the trade name for congener mixtures containing 21 to 68% chlorine by weight. The names given to the different Aroclors reflect this composition; Aroclor [PCB]-1248, for instance, contains approximately 48% chlorine by weight (12 refers to the number of carbon atoms in the biphenyl ring). Many different commercial Aroclor mixtures have been quantified as to their congener composition by Frame et al. (1996).

PCBs can be analyzed as individual congeners or Aroclor-equivalents. Congeners are usually analyzed by high-resolution gas chromatography/mass spectrometry (GC/MS) methods that are more costly, but more sensitive and thus give lower detection limits than the gas chromatography/electron capture (GC/ECD) method typically employed for Aroclor mixtures. Most of the historical fish tissue data for Washington State is from Aroclor analysis.

Much of the 600 million kg of PCBs used domestically has found its way into the environment through improper disposal or by leakage of sealed systems (Sittig, 1980). Loss to the environment through PCB use in open systems such as hydraulic fluids in die cast machinery, heat transfer systems, and specialty inks was also not uncommon (EPA, 2000a). Their primary uses are associated more with heavy industry or urban centers rather than agriculture (EPA,

1992). Direct application to the environment occurred on a lesser scale through use as pesticide extenders or oil mixtures applied to roads for dust control. Many of the same properties that made PCBs commercially desirable – their stability and resistance to degradation – make them extremely persistent in the environment. They have become one of the most ubiquitous of all environmental contaminants.

Environmental Fate

The persistence of PCBs increases with the degree of chlorination. Mono-, di- and tri-chlorinated biphenyls biodegrade relatively rapidly, tetrachlorinated biphenyls biodegrade slowly, and higher chlorinated biphenyls are resistant to biodegradation.

In soils, PCBs experience tight adsorption which generally increases with the degree of chlorination of the PCB. PCBs generally do not leach significantly in aqueous soil systems; the higher chlorinated congeners have a lower tendency to leach than the less chlorinated congeners. Vapor loss of PCBs from soil surfaces appears to be an important fate mechanism with the rate of volatilization decreasing with increasing chlorination.

In water, adsorption to sediment and suspended matter are important fate processes; PCB concentrations in sediment and suspended matter are typically much greater than in the water column. Although adsorption can immobilize PCBs (especially the higher chlorinated congeners) for relatively long periods of time, eventual re-solution into the water column has been shown to occur. The PCB composition in water will be enriched in the lower chlorinated PCBs because of their greater water solubility, and the least water soluble PCBs (highest chlorine content) will tend to remain adsorbed.

However, strong PCB adsorption to sediment significantly competes with volatilization, with the higher chlorinated PCBs having longer half-lives than the lower chlorinated PCBs. Lower chlorinated PCBs and ortho-substituted congeners are more volatile than the highly chlorinated PCBs. Henry's Law constants generally range from approximately 1 to 400 Pa m^3/mol (Pascals cubic meter/mole), indicating volatilization is an important transport process for PCBs in the environment. PCB volatilization from water, particularly at falls or dams, and from exposed contaminated soils can be an important transport process for PCBs and, in the absence of adsorption, PCBs volatilize relatively rapidly from water.

Losses of PCBs from the Great Lakes have been estimated by Eisenreich et al. (1992) as 66% via volatilization, 27% via sedimentation, and 7% through the outflow to other waterbodies. Dam spillways may cause significant transformations of an Aroclor mixture, with differential loss of constituent congeners (McLachlan et al., 1990). The dams along the Spokane River likely modify the dissolved and particulate fractions of PCBs as water moves downstream.

The combination of differential solubility, variable octanol-water partitioning coefficients (K_{ow}), and volatilization leads to weathering of Aroclor mixtures. In environmental samples, these physical and chemical processes change the composition of released PCB mixtures over time. Thus, sediment and water samples rarely have congener patterns which match a commercial Aroclor due to weathering. If released to the atmosphere, PCBs will primarily exist in the vapor-

phase; the tendency to become associated with the particulate-phase will increase as the degree of chlorination increases. Physical removal of PCBs from the atmosphere is accomplished by wet and dry deposition.

PCBs accumulate in the lipids (fats) of fish and other animals. Lipid solubility increases with the degree of chlorination (Mabey et al., 1982), reflected in their high K_{ow}. The range of log K_{ow} is from approximately 4.6 for monochlorinated congeners to 8.2 for decachlorobiphenyl. Peak bioaccumulation occurs between log K_{ow} 6.5 and 7.0 (Fisk et al., 1998), those congeners with 5 or 6 chlorines. It is believed that congeners with log $K_{ow} > 7.0$ are too large to be efficiently assimilated in the fish digestive tract.

All known aerobic and anaerobic biotic processes act to de-chlorinate PCBs (ATSDR, 1997). Substitution of either a hydrogen or chlorine atom is generally required by an organism to excrete a PCB molecule. Congeners which do not have chlorines in meta positions can be metabolized and excreted. Organisms preferentially metabolize and excrete different PCB congeners depending on their resistance to substitution. Substitution is generally more difficult for the richly chlorinated congeners, leading to preferential bioaccumulation of heavier, but not the heaviest, congeners.

Historical Data on PCBs in the Spokane River

Ecology has analyzed PCBs in a variety of water, sediment, and fish tissue samples collected from the Spokane River over the past two decades. Additional data have been collected by or in cooperation with the U.S. Geological Survey (USGS) and various NPDES dischargers. More recent work has focused attention on characterizing PCB contaminated sediments behind Upriver Dam. The various data collection efforts going back to 1980 are listed in Table 4.

PCBs were first analyzed in the Spokane River during Ecology statewide screening-level surveys of contaminants in fish from rivers and lakes (Hopkins et al., 1985; Hopkins, 1991; Serdar et al., 1994). Spokane River fish almost always had high PCB concentrations. For instance, total PCBs in whole fish ranged up to 2,300 ng/g (parts per billion) in northern pikeminnow (*Ptychocheilus oregonensis*) collected in 1983. Fillets from mountain whitefish (*Prosopium williamsoni*) and bridgelip sucker (*Catostomus columbianus*) from Riverside State Park in the City of Spokane were also elevated with total PCB concentrations of 230 and 370 ng/g, respectively. Largescale suckers (*Catostomus macrocheilus*) sampled from Lake Spokane had a whole body concentration of 720 ng/g.

In 1993, Ecology expanded its investigation of PCBs in the Spokane River by analyzing multiple fish species and sediments at reaches encompassing the entire river. Johnson et al. (1994) confirmed the high PCB levels seen earlier and found the highest fish tissue and sediment levels in the reach above Upriver Dam (up to 2,800 ng/g in whole largescale suckers and 3,200 ng/g in sediments) with levels gradually declining downstream.

Table 4. Summary of PCB Data Collected on the Spokane River, 1980-2007.

Investigator	Sample Type	Year Collected	Purpose
Ecology (Hopkins et al., 1985)	Fish tissue	1980-1983	Statewide survey of contaminants in rivers
Ecology (Hopkins, 1991)	Sediment	1989	Statewide survey of contaminants in rivers
Ecology (Serdar et al., 1994)	Fish tissue[1,2] Sediment	1992	Statewide survey of contaminants in lakes
Ecology (Johnson, et al., 1994)	Tissue Sediment	1993	Survey for PCBs in the Spokane River
Ecology (Davis et al., 1995)	Fish tissue		Statewide survey of pesticides and PCBs
Ecology (Ecology, 1995)	Fish and crayfish, tissue, sediment, surface water, effluent, sludge	1994	Synoptic survey of PCBs in the Spokane River
Hart Crowser, 1995	Effluent		Sampled Kaiser Trentwood effluent coincidental with Ecology sampling
Ecology (Huntamer, 1995)	Sediment		Microscopic examination and PCB analysis of sediments behind Upriver Dam
Ecology (Golding, 1996)	Effluent Sludge	1995	Follow-up to effluent and sludge sampling conducted during 1994 synoptic survey
Ecology (Johnson, 1997)	Fish tissue	1996	Survey to determine PCB levels in Spokane River fish
Ecology and USGS (Johnson, 2000)	Fish and crayfish tissue	1999	Survey to determine PCB levels in Spokane River fish
Ecology (Johnson and Norton, 2001)	Sediment	2000	Chemistry and bioassays of Spokane River
Ecology (Golding, 2001)	Surface water Effluent		Survey of PCBs in Kaiser Trentwood effluents and receiving waters
Ecology (Golding, 2002)	Effluent	2001	Survey of PCBs in industrial and WWTP effluents
Ecology (Jack and Roose, 2002)	Fish tissue		Intensive survey of PCBs in Lake Spokane fish
Exponent and Anchor, 2001	Sediment		Survey of PCBs in sediments behind Upriver Dam
SAIC, 2003a	Effluent Sludge	2002	Survey of PCBs in effluent and sludge from Inland Empire
SAIC, 2003b	Fish tissue		Intensive survey of PCBs in Lake Coeur d'Alene fish
Anchor Environmental (Anchor, 2004)	Surface water Groundwater	2003	Remedial investigation of PCBs in the vicinity of Upriver Dam MTCA site
Merill and Bala, 2004	Effluent	2002-2003	Bi-weekly monitoring of PCBs in Kaiser Trentwood effluent
Kaiser (Kaiser, 2005)	Effluent	2004-2005	PCBs in Kaiser Trentwood effluent
Merill and Bala, 2004	Effluent	2002-2003	Bi-weekly monitoring of PCBs in Kaiser Trentwood effluent
Ecology (Serdar and Johnson, 2006)	Fish tissue	2005	Synoptic survey of PCBs in Spokane River fish
Ecology (Seiders, Deligeannis, and Kinney, 2006)	Surface water Fish tissue		Statewide survey of toxic contaminants in waters and fish, including Spokane River
Parsons, 2007	Stormwater	2007	Survey of PCBs in Spokane stormwater

WWTP: wastewater treatment plant.

In 1994, Ecology further increased the number of organisms and locations analyzed for PCBs in the Spokane River. Results again confirmed the pattern of contamination among sites seen in 1993. The 1994 study also found that Little Spokane River fish had higher than expected PCB levels. Crayfish had low accumulations of PCBs.

The 1994 samples also included bottom sediments and potential industrial/municipal sources of PCBs to the river. This helped define the extent of contamination behind Upriver Dam, largely by delineating the area of depositional material. Nearly the entire river was surveyed for the presence of significant bulk fine sediment deposits between the state line and Lake Spokane, but the "hot spot" behind Upriver Dam was the only sediment deposit found during that study.

Perhaps the most important findings from 1994 were the characterizations of PCB sources to the river. Sewage treatment plants, industrial facilities, and industrial sites along the river were sampled to assess their relative contribution of PCBs. Results showed that sources upstream of the Idaho border were negligible, but downstream there was a substantial ongoing PCB source at the Kaiser Trentwood aluminum plant, potentially significant sources such as the Liberty Lake wastewater treatment plant (WWTP) and the former Inland Metals site, and a historically large source from the Spokane Industrial Park, which now discharged to the Spokane WWTP. Low PCB concentrations were found at a Washington Water Power yard, located just above the river bank, ruling this site out as a potentially significant source. PCB discharges from industrial and municipal treatment plants are discussed in more detail later in this section of the report.

Ecology analyzed more fish in 1996, specifically to determine if the trend toward decreasing PCB concentrations continued. The three species used most often for comparisons in the Spokane River – rainbow trout, mountain whitefish, and largescale suckers – all showed substantial decreases in PCB concentrations from earlier data (Table 5). However, PCB levels continued to remain high relative to other areas in the state.

Since 1999, surveys in the Spokane River have verified previous data or further characterized the contamination so that its implications are better understood. The three major areas where study efforts have concentrated in the past decade are:

- Continued sampling of fish to evaluate temporal trends and conduct human health risk assessment.
- Continued monitoring of known PCB sources.
- Characterization of the Upriver Dam cleanup site.

In July 1999, USGS collaborated with Ecology to further document PCB contamination in fish from the mainstem of the Spokane River (USGS, 1999; Johnson, 2000). This study found that whole largescale suckers exceeded a criterion of 110 ng/g used to protect fish-eating wildlife (Newell et al., 1987). Concentrations in whole suckers ranged from 120 to 700 ng/g total PCBs. For mountain whitefish and rainbow trout (*Oncorhynchus mykiss*), fillets and whole fish were analyzed. Peak concentrations were found in rainbow trout in the vicinity of RM 85 (Plante Ferry) and in mountain whitefish in the vicinity of RM 63 (Ninemile). Maximum concentrations were about 1,600 ng/g for both species.

Table 5. Summary of Total PCB Concentrations in Fish Tissue from the Spokane River (mean concentrations in ng/g, ww).

Location and Tissue Type	Total PCB Concentrations Measured by:					
	Aroclor Analysis					Congener Analysis
	1993[a]	1994[b]	1996[c]	1999[d]	2001[e]	2005[f]
Rainbow trout - fillet						
State line	--	--	--	106	--	55
Plante Ferry	918	424	799	891	--	153
Above Monroe Dam*	--	145	76	226	--	73
Ninemile	490	371	76	143	--	
Mountain whitefish - fillet						
Above Monroe Dam	--	568	381	339	--	234
Ninemile	522	139	444	632	--	139
Little Spokane	--	222	145	--	--	--
Upper Lake Spokane	--		--	--	73	43
Lower Lake Spokane	780	113	--	--	--	76
Largescale suckers - whole						
State line	--	--	--	120	--	56
Plante Ferry	2,005	531	530	283	--	122
Above Monroe Dam	--	201	116	445	--	1,823
Ninemile	1,210		345	680	--	--
Little Spokane	--	440	366	--	--	--
Upper Lake Spokane	--	--	--	--	265	327
Lower Lake Spokane	410	820	--	--	357	254

--no data
[a] Johnson et al., 1994
[b] Ecology, 1995
[c] Johnson, 1997
[d] Johnson, 2000
[e] Jack and Roose, 2002
[f] Serdar and Johnson, 2006
*Same reach as Mission Park

In 2001, Ecology, WDOH, and the Washington Department of Fish and Wildlife (WDFW) collaborated in the collection of five species to evaluate PCB concentrations in Lake Spokane fish tissues (Jack and Roose, 2002). In general, largescale suckers and mountain whitefish had the highest PCB concentrations. Total PCBs in whole suckers ranged from 160 to 340 ng/g, while mountain whitefish fillets ranged from 60 to 89 ng/g. The greater uptake and retention of PCBs in suckers is likely influenced by their relatively high lipid content, benthic (bottom feeding) habits, limited capabilities for PCB excretion, and longevity. Largescale suckers analyzed from Lake Spokane were up to 24 years old (Jack and Roose, 2002). Fish consumption advisories were issued in 2003 and are further discussed below.

In 2005, another intensive study was conducted to expand and update the information on chemical contaminants in Spokane River fish (Serdar and Johnson, 2006). Fish from six locations between the Washington/Idaho state line and lower Lake Spokane were collected. Samples of fillets and whole fish were analyzed for PCBs, polybrominated diphenyl ether flame

retardants (PBDEs), arsenic, cadmium, lead, and zinc. A subset of samples was also analyzed for polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/PCDFs).

Compared to historical levels, PCB concentrations appeared to have decreased in all parts of the Spokane River except the Mission Park reach. Relative to other parts of the state, Spokane River fish were within the mean and median for fillet PCB concentrations. However, whole fish results for Mission Park and Lake Spokane were at or above the upper end of the range of whole fish statewide.

Spokane River fish also substantially exceeded statewide comparisons for concentrations of PBDEs, zinc, lead, and cadmium (whole fish samples only). The Urban Waters Program at Ecology is currently pursuing sources of PBDEs to the river. Metals contamination of the Spokane River is from historic mining in Idaho's Silver Valley and has been the subject of many past studies. As previously mentioned, a TMDL has been established for lead, cadmium, and zinc in the Spokane River.

Ecology's Washington State Toxics Monitoring Program also sampled fish from the Spokane River in 2003-04 for a suite of toxic compounds. PCBs were not analyzed due to concurrent intensive PCBs surveys on the river. A recommendation from this effort was to list the Spokane River as impaired on the 303(d) list for 2,3,7,8-TCDD (dioxin) (Seiders et al., 2006).

Table 5 provides a comparison of the total PCB concentrations from the various Ecology studies.

Fish Consumption Advisories

Based on the elevated PCB and lead levels in Spokane River fish, WDOH and the Spokane Regional Health District issued an advisory in 2003 to avoid or limit consumption of fish in parts of the Spokane River (www.doh.wa.gov/ehp/oehas/fish/consumpadvice.htm#Spokane%20River). The health departments later concluded that the advisory would also be protective for PBDEs. The advisory, updated in April 2008 based on fish tissue samples collected for the present 2003-07 study, is summarized in Table 6.

Table 6. April 2008 Spokane River Fish Consumption Advisories.

Location	Species	Consumption Advice
Spokane River – All Areas	All Species	Do not eat the fish head or entrails.
Idaho Border to Upriver Dam	All Species	Do not eat
Upriver Dam to Ninemile Dam	Largescale Sucker	Do not eat
	All Other Species	One meal per month
Lake Spokane (Long Lake)	Largescale Sucker	One meal per month
	Brown Trout	
	Largemouth Bass	Two meals per month
	Smallmouth Bass	
	Rainbow Trout	Two meals per week
	Yellow Perch	

National Pollutant Discharge Elimination System (NPDES) Permits

Ecology has issued NPDES wastewater discharge permits to a variety of industrial and municipal facilities in the Spokane River basin. Some of these facilities have discharged PCBs in the past. Ecology-directed MTCA sediment cleanup actions upstream of Upriver Dam identified the Kaiser Trentwood facility and the Spokane Industrial Park as the most prominent historic sources of PCB releases in that portion of the river. Recent studies have confirmed the presence of PCBs in the waste streams of some permitted Spokane River dischargers. Appendix A lists the permitted discharges to the greater Spokane watershed by WRIA and permit number.

The NPDES permits in Appendix A are coded based on the type of discharge to waters of the state. Those permit numbers beginning with ST are for the discharge of municipal and industrial effluents to ground or industrial effluents to municipal sewer systems. The City of Spokane WWTP receives effluent from a number of these industrial dischargers. Permit numbers beginning with WAG are general NPDES permits. "WA" permits are those allowing discharge of effluents to surface waters.

In addition to the industrial and municipal discharges in Appendix A, the City of Spokane has a partially combined sewer-stormwater system. Spokane is permitted for stormwater discharges under the NPDES Phase II program. A combined sewer is a conjoined system of (1) stormwater collection from areas such as roofs and parking lots and (2) raw sewage. During heavy rain or snowmelt events, the influx of stormwater to the combined system may overwhelm its carrying capacity. At that time, a combined sewer overflow (CSO) event occurs, and a portion of the stormwater-sewage mixture bypasses the local WWTP and discharges directly to the river.

There are a total of 24 CSO points within the City of Spokane (City of Spokane, 2002). These sewers may discharge during high-flow periods or inadvertently during maintenance activities. Because of the variety of previous uses of PCBs, they may be discharged to the river during these overflow events. Some of the stormwater is delivered directly to the river through storm sewers and into ground via drywells or infiltration basins.

Historic NPDES Effluent PCB Concentrations

Some of the NPDES-permitted effluents discharged to the Spokane River have been sampled for PCBs by Ecology and others (Table 7). Ecology (1995), Golding (1996, 2001, 2002), and SAIC (2003a) report effluent data from July 1994 through June 2002 (Table 7). These samples were analyzed by both Aroclor-equivalents and congener-specific methods. While the methods may not be directly comparable to each other, these data are included to illustrate the range of loads and potential variability from these sources.

Historic PCB loads from the Kaiser Trentwood aluminum mill were consistently higher than other facilities by about an order of magnitude, although loads appear to have declined from 1994 to 2001. Kaiser also monitored PCBs in their outfall bi-weekly in 2002 and 2003 (Merrill and Bala, 2004). The median concentration of total PCBs in 2002 was 2,700 pg/l (140 mg/day), decreasing to 1,200 pg/l (90 mg/day) in 2003.

PCB concentrations in Kaiser effluent during 2002-2003 were generally consistent, with variability expressed by peaks – an order of magnitude increase from normal levels – occurring at two to five month intervals. The monitoring result for 4/9/2002 showed an unusually high PCB level in the effluent, 2.2 x 10^6 pg/l (0.125 kg/day), which persisted for a maximum of three weeks before returning to typical levels. PCB levels jumped again in November 2002 when four consecutive monitoring events from 11/18/2002 to 12/29/2002 found effluent concentrations of 2.6 x 10^7 pg/l, 3.2 x 10^6 pg/l, 4.8 x 10^7 pg/l, and 3.4 x 10^6 pg/l. Assuming an average daily load of 0.99 kg/day for a period of six weeks (one week prior to discovery until one week following the last elevated measurement), approximately 53 kg total PCB was delivered to the Spokane River from the Kaiser facility during this period.

Table 7. Summary of Spokane Area PCB Point Source Data.

Source	Date	Method	Total PCBs (pg/l)	Identified Aroclor	Effluent Flow (ML/day)	PCB Load to River (mg/Day)
Kaiser Trentwood	08/1/94 [a]	Aroclor	21,000	PCB-1248	109	2,290
	12/5/95 [b]		29,000		67.8	1,970
			34,000			2,300
	12/6/95 [b]		25,000		68.5	1,710
			29,000			1,990
	08/14/00 [c]		53,000		96.1	5,100
			900 U	NA	96.1	0
	08/15/00 [c]		900 U			0
			25,000	PCB-1248		2,400
	05/1/01 [d]		10,174 NJ	NA	62.1	630
	05/2/01 [d]		5,165 NJ			320
Spokane WWTP	05/1/01 [d]	congener	1,813 NJ	NA	142	260
	05/2/01 [d]		1,767 NJ			250
Liberty Lake WWTP	05/1/01 [d]	congener	1,917 NJ	NA	2.46	4.7
	05/2/01 [d]		1,543 NJ			3.8
Inland Empire Paper	05/1/01 [d]	congener	2,436 NJ	NA	16.3	40
	06/5/02–a.m. [e]		5,484		20.0	110
	06/5/02–p.m. [e]		4,305		18.0	78
Spokane Industrial Park	07/31/94 [a]	Aroclor	9,000 U	NA	*	*
	08/4/94 [a]		31,000 U			
	05/1/01 [d]	congener	9,371 NJ			
	05/2/01 [d]		7,108 NJ			

Bold: Analyte detected
NJ: There is evidence that the analyte is present. Associated numerical result is an estimate.
U: Analyte not detected at or above the reported value.
NA: not applicable
ML/day: 0.264 MGD (million gallons per day)
* Currently discharges to Spokane WWTP; formerly discharged to Spokane River.
[a] Ecology, 1995
[b] Golding, 1996
[c] Golding, 2001
[d] Golding, 2002
[e] SAIC, 2003a

PCB levels in effluent samples collected from the Spokane WWTP, Liberty Lake WWTP, and Inland Empire Paper in 2001-2002 ranged from 1,543 to 5,484 pg/l. Higher concentrations of 7,108 and 9,371 pg/l were reported in effluent from the Spokane Industrial Park analyzed in 1994. This facility now discharges to the Spokane WWTP.

PCBs Behind Upriver Dam, 1995-2004

As mentioned previously, bulk fine sediment deposits are sparse in the Spokane River upstream of Lake Spokane, with the exception of scattered shoreline, bar feature, and lower energy zones. Two notable exceptions are the narrow bands of silt and organically-enriched sediments deposited behind Upriver Dam (Figure 5).

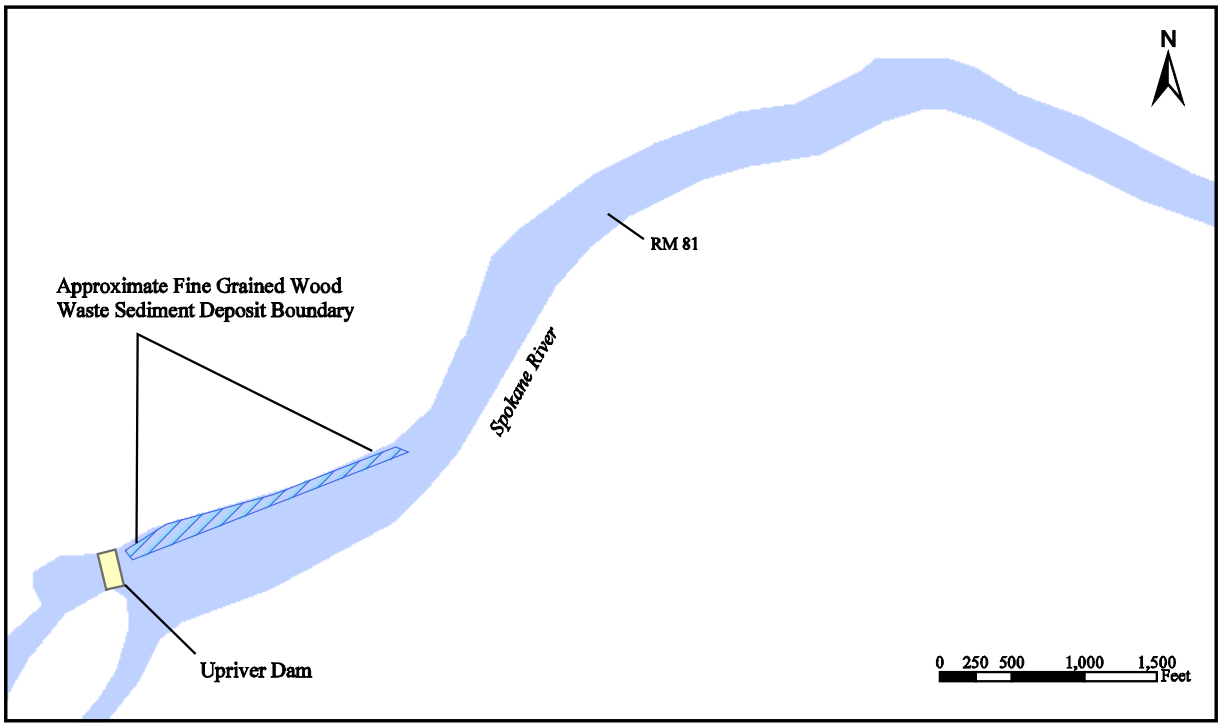

Figure 5. Location of Fine-Grained Wood Waste Sediment Deposit Behind Upriver Dam.

Following discovery of PCB contamination behind Upriver Dam in 1993 and confirmation of high PCB levels in 1994, subsequent sampling consisted mainly of defining the boundary of contamination and distribution of fine sediments upstream of the dam. Sediments within a band located immediately behind the dam generally showed PCBs at 1,000-5,000 ng/g dry weight (dw) and in some samples contained >10% total organic carbon, gradually becoming sandier at the margins (Ecology, 1995; Johnson and Norton, 2001). Huntamer (1995) conducted a microscopic analysis of the organic-enriched sediments and found them to be largely composed of wood particles, consistent with un-aided visual observation made earlier. Huntamer also observed charcoal which he speculated may have originated from recent wildfires in the area.

In February 2003, Ecology entered into a Consent Decree with Kaiser and Avista (formerly Washington Water Power) to evaluate site conditions at Upriver Dam. The remedial investigation (RI) and feasibility study (FS) (Anchor 2005a and 2005b) required under the Consent Decree informed decisions that led to the completion of a cleanup under MTCA. Aside from sediment characterization, the RI/FS addressed other components of the aquatic ecosystem associated with the Upriver Dam contamination, such as sampling PCBs in the water column and in hydraulically-connected groundwater wells, as well as bathymetric surveys of the reach.

Groundwater monitoring in the area indicates there is localized loss of surface water to the aquifer due to the hydraulic difference between the reservoir pool and the river surface downstream of the dam. Monitoring wells located downgradient of the dam showed low PCB concentrations (9-116 pg/l), which were in the range of associated field and laboratory blanks (10-226 pg/l), suggesting the presence of PCBs was due to sampling or lab contamination rather than PCB movement from the reservoir to groundwater (Anchor, 2004).

Surface water sampling was conducted both upstream and downstream of the Upriver Dam site as part of the RI/FS. During the RI/FS, upstream surface water samples and surface water samples collected at the Upriver Dam site (120 and 110 pg/l respectively) exceeded the EPA National Recommended Water Quality Criterion of 64 pg/l. As being an applicable, relevant, and appropriate requirement (ARAR) under MTCA, the 64 pg/l criterion was selected as the surface water criterion at the Upriver Dam site.

Numerous sediment samples were analyzed in and around the known area of contamination as part of the RI/FS. Samples were also collected upstream in backwaters identified as potential depositional areas. Results identified a second significant fine sediment deposit above Upriver Dam at RM 83.4 (Donkey Island) and corroborated earlier findings that deposited fine material and elevated PCB concentrations are absent outside the known areas of bulk fine sediment accumulation.

The Cleanup Action Plan by Ecology (2005) identified a sediment cleanup value of 62 µg/kg total PCBs as protective of human health and the river ecological community. The 62 µg/kg PCB sediment cleanup value was derived for the protection of aquatic life inhabiting the upper layer (0 - 10 cm) of the sediment. The selected sediment cleanup level is based on the lowest apparent effects threshold (AET) suggested for use in freshwater sediments (Michelson, 2003).

The Upriver Dam cleanup was completed in January 2007. A sediment cap was placed over the primary contaminated area on the river bed behind Upriver Dam (Deposit 1) using an excavator on a floating barge. A second smaller area of contaminated sediment was excavated in the Donkey Island area just east of Argonne Road (Deposit 2). The sediment cap that was placed at Deposit 1 was required to be 13 inches in depth. Of the 13 inches, 4 inches were bituminous coal, followed by 6 inches of clean sand, and then armored with 3 inches of gravel. The total size of the cap at Deposit 1 encompassed approximately 3.5 acres. Deposit 2 covered approximately 0.2 acres of contaminated sediment that was excavated as part of the remedial action. The estimated amount of contaminated sediment that was excavated at Deposit 2 is 600 cubic yards.

The first scheduled monitoring event at Deposit 1 to check the integrity of the sediment cap and sample the sediments for PCBs began in the fall of 2008. The results of the 2008 monitoring event found that the cap was fully intact with an additional 1 to 2 feet of deposited sand and woody material on top of the cap. The additional material is suspected to be as a result of the high spring-runoff flows that occurred in 2008. The core samples that were taken of the cap and the grab samples of the newly deposited sand did not detect PCBs higher than the cleanup value.

2003-2007 PCB Source Assessment

Goals

Sampling for the Spokane River PCB source assessment study was initially conducted by the Ecology Environmental Assessment Program from September 2003-July 2004. Additional fish and stormwater samples were collected in late 2005 and early 2007, respectively. The overall goal of this effort was to quantify PCB contamination and identify necessary reductions in sources and the receiving waters to meet applicable PCB water quality criteria for the Spokane River.

Objectives

Specific objectives of the study were to:

1. Obtain representative data on PCB concentrations and ancillary parameters in the Spokane River water column, NPDES permitted discharges, bottom sediments, and fish tissue.
2. Assess trends and natural recovery rates for PCBs in Spokane River sediments.
3. Determine the Spokane River's loading capacity for PCBs.
4. Evaluate a food web bioaccumulation model to predict PCB concentrations in Spokane River fish.

The first objective was addressed by sampling PCBs in industrial and municipal effluent, surface water, suspended particulate matter, stormwater, surface and sub-surface sediments, and fish tissue.

The second objective was achieved by analyzing PCBs in sediment cores.

Water column PCB measurements from semi-permeable membrane devices, a passive sampling technique, were used to assess the loading capacity of the Spokane River. Estimates of the PCB load reductions needed to meet the more stringent human health criteria of the Spokane Tribe were based on loading capacity and on current estimates of PCB discharges in effluent and stormwater.

The Arnot-Gobas food web bioaccumulation model (Arnot and Gobas, 2004) was employed to estimate site-specific critical PCB concentrations in water and sediment. Needed load reductions to meet water quality criteria were then estimated using PCB loading capacities derived from the model.

Field Data Collection

Sampling Locations

Sampling station locations for the source assessment study are shown in Figures 6-10. Coordinates and a description of each station location are in Appendix B.

For the purpose of this report, "Stations" are identical to the "User Location ID" in Ecology's Environmental Information Management (EIM) database (available on the internet at www.ecy.wa.gov/eim/). All of the data for this project are available through EIM under the User Study ID named "DSER0010", with two exceptions:

1) The Ninemile rainbow trout fillet data are under the User Location ID "Spokane-F" or the User Study ID "WSTMP03T".

2) The 2007 stormwater data from the Parsons, (2007) study were entered into EIM under the User Study ID "brwa0004".

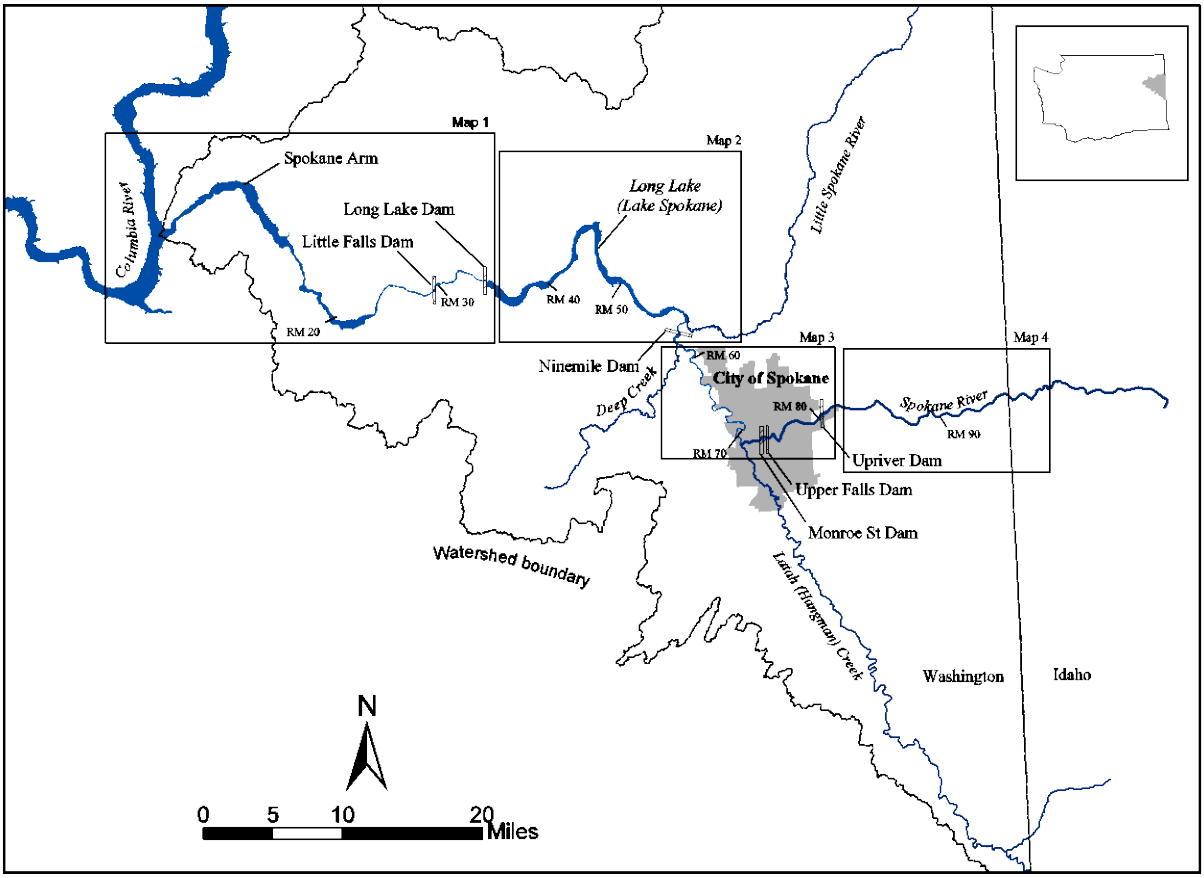

Figure 6. Sampling Maps for Spokane River PCB Source Assessment Study.

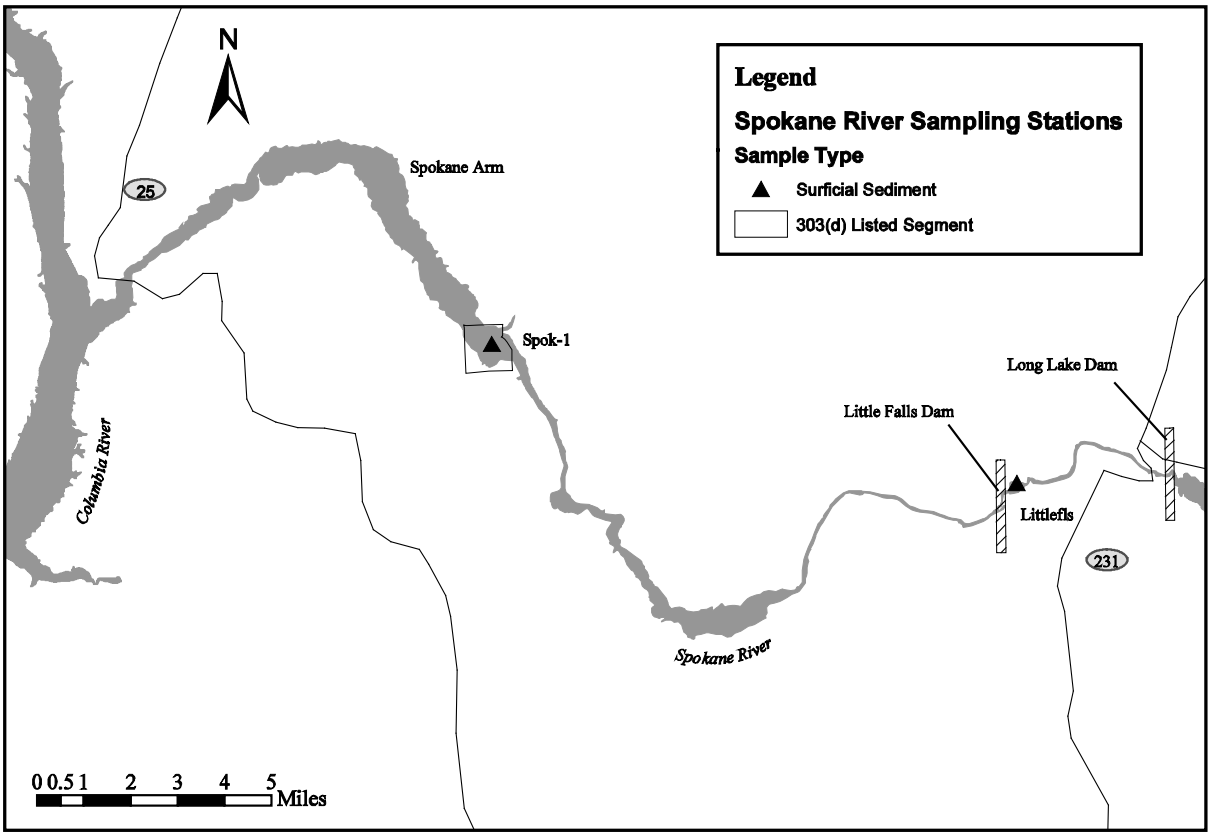

Figure 7. Sampling Map 1: Spokane River Mouth to Long Lake (Lake Spokane) Dam.

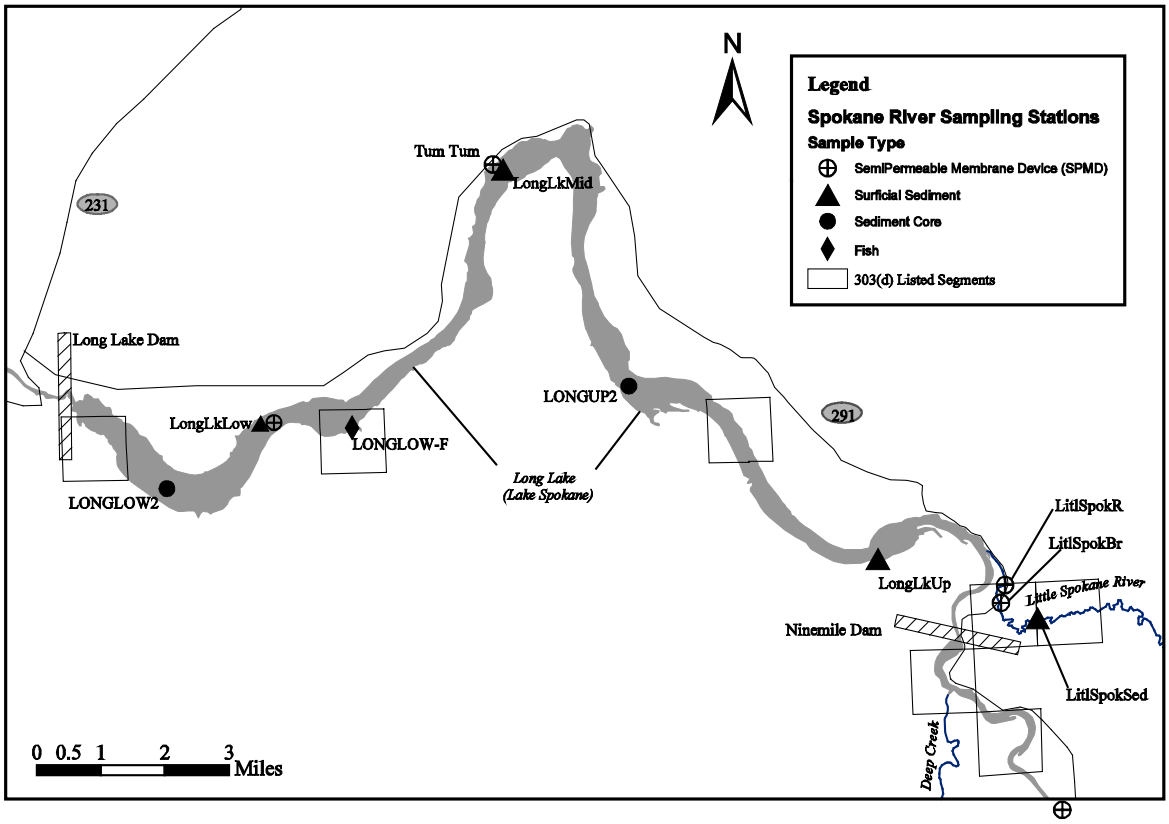

Figure 8. Sampling Map 2: Long Lake (Lake Spokane) Dam to Ninemile Dam.

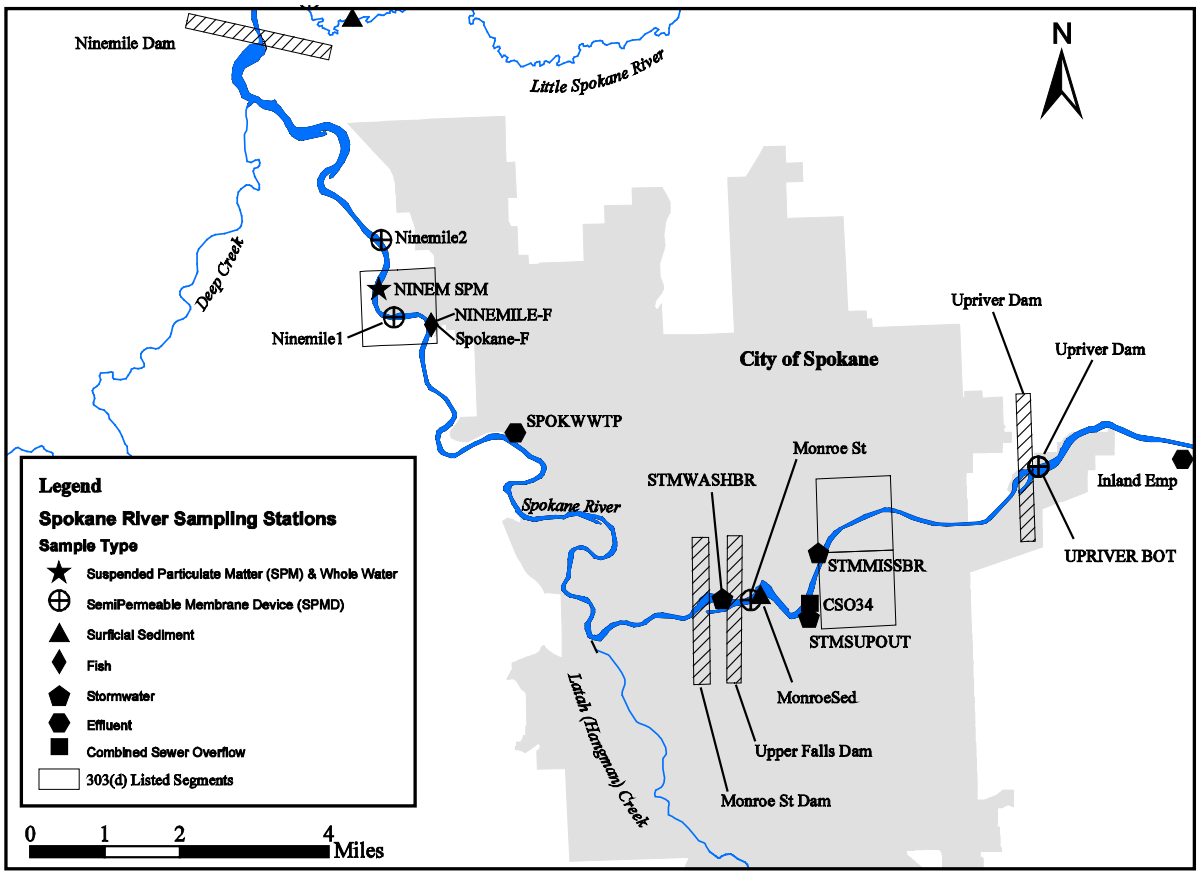

Figure 9. Sampling Map 3: Ninemile Dam to Upriver Dam.

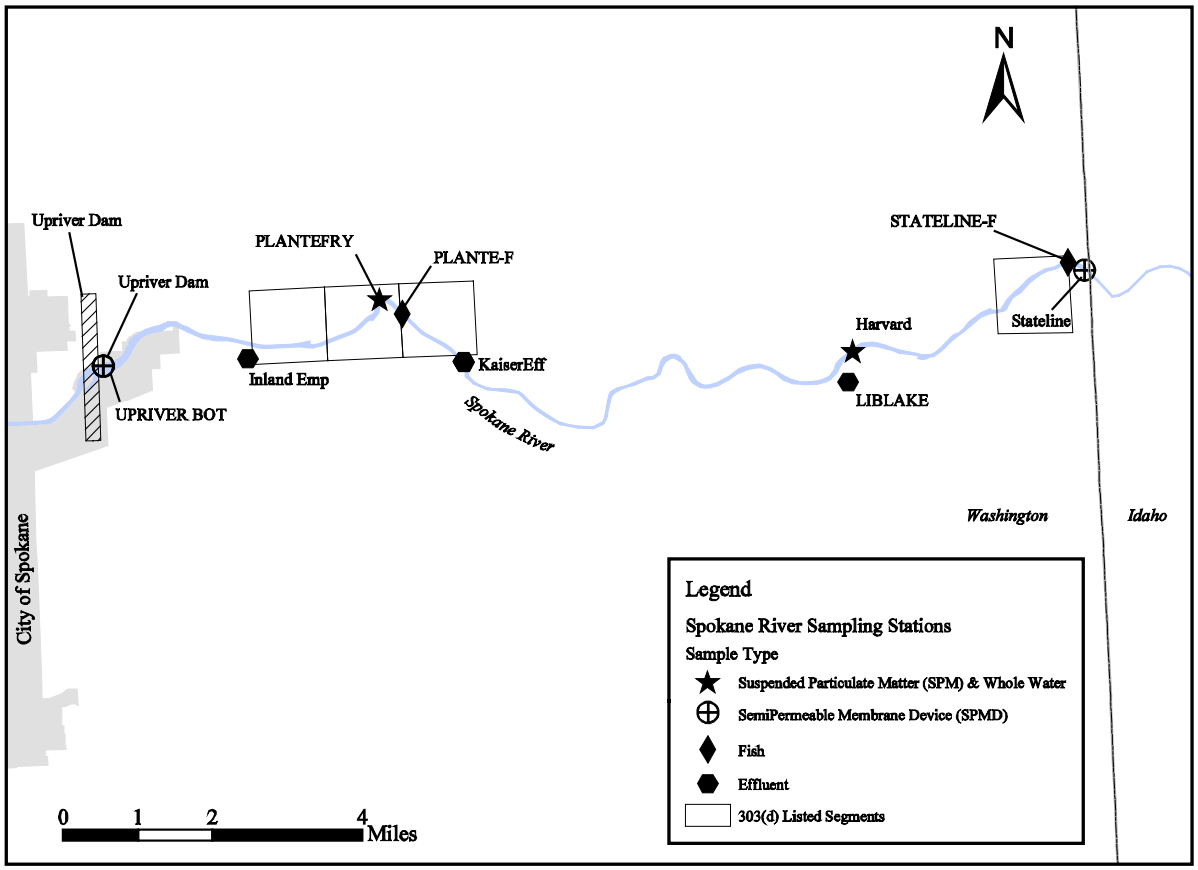

Figure 10. Sampling Map 4: Upriver Dam to Idaho Border.

Surface Water

Semipermeable Membrane Devices

Surface water at five Spokane River and one Little Spokane River locations was sampled using semipermeable membrane devices (SPMDs) obtained from Environmental Sampling Technologies (EST). SPMDs are passive samplers which consist of a 91 x 2.5 cm lay-flat polyethylene membranes filled with 1 mL triolein, a synthetic lipid that mimics biological uptake of dissolved organic compounds like PCBs. Membranes are mounted on "spider carriers" that hold the membranes during deployment and placed inside perforated stainless steel canisters, up to five membranes per can. The chemical residues accumulated in an SPMD can be used to calculate the ambient water column concentration for the chemicals of interest. Detailed information on SPMDs is in Appendix C. Table 8 shows locations where SPMDs were deployed.

Table 8. Locations and Dates of SPMD Deployments.

Location	Station	RM	Dates
State line	Stateline	96.1	10/1 - 10/29/2003 1/28 - 2/24/2004 4/14/04 - 5/12/2004
Behind Upriver Dam at mid-depth	Upriver Dam	80.3	10/1 - 10/29/2003 1/28 - 2/25/2004 4/14 - 5/12/2004
Behind Upriver Dam near bottom	UPRIVER BOT	80.3	10/1 - 10/29/2003 1/28 - 2/25/2004 4/14 - 5/12/2004
Behind Monroe St./Upper Falls Dam	Monroe St	74.8	10/2 - 10/29/2003 1/28 - 2/25/2004 4/14 - 5/12/2004
Ninemile Dam Pool upstream of Plese Flats	Ninemile1	63.6	10/1 - 10/29/2003 1/28 - 2/24/2004*
Ninemile Dam Pool near Sevenmile Bridge	Ninemile2	62.4	4/14 - 5/12/2004
Tum Tum	Tum Tum	44.2	1/29 - 2/24/2004
Lower Lake Spokane	LongLkLow	38.4	10/2 - 11/4/2003 4/13 - 5/11/2004
Little Spokane River at Rt. 291 bridge	LitlSpokBr	1.1	1/29 - 2/24/2004 4/14 - 5/12/2004
Little Spokane River ½ mile upstream of mouth	LitlSpokR	0.5	10/2 - 10/30/2003

*SPMD lost.

Canisters were deployed in the middle of the water column at Stateline, behind Upriver Dam, behind Upper Falls Dam (Monroe St.), upstream of Seven Mile Bridge (Ninemile), in Lake Spokane, and in the Little Spokane River near the mouth. In addition to the mid-depth SPMDs, deployments were also done approximately one foot above the bottom at the Upriver Dam site. The project plan called for one additional SPMD deployment in the lower two miles of Deep Creek, but the creek was too shallow for the sampler (Jack et al., 2003).

SPMD deployments occurred during October 2003, January-February 2004, and April-May 2004. These periods were selected to represent a range of river conditions: low flow in October, moderate flow in February, and high flows during spring runoff. Exposure periods were generally 28 days.

On arriving at the sampling site, the cans were opened, spider carriers were slid into the canisters, and the device was suspended in the water column. Because SPMDs are potent air samplers, the procedure was done as quickly as possible, typically one minute or less. Air exposure times were recorded for each event. Three SPMD membranes were used in each canister, with two canisters per sampling site. The dual canisters were used to minimize the risks of loss or vandalism. If both canisters were successfully recovered, the six membranes were combined for extraction. During each deployment period, one of the SPMD pairs from Upriver Dam was analyzed separately as a replicate. The dual canisters were deployed several meters apart at each station.

In some cases, alternative site selection was necessary due to variable flows or ice. The Lake Spokane SPMD was moved upstream to Tum Tum in January-February because the lower lake was frozen. The April deployment at Ninemile was moved downstream due to high flows, and the Little Spokane site was moved upstream from its original location for February and April sampling to improve accessibility. One of the two canisters was lost at Ninemile during October and at Stateline in April-May. In both instances the single canister (with three membranes each) contained enough material for complete analysis without compromising data quality. Both canisters were lost from Ninemile during January-February, the only event with lost data.

The SPMD retrieval procedure was essentially the opposite of deployment. Cans holding the SPMDs were sealed and shipped back to EST for extraction. EST then shipped the extracts to an accredited contract laboratory, Pace Analytical Services Inc., for PCB analysis.

A trip/field blank was prepared for each SPMD deployment by exposing dedicated membranes to air for the average time sample membranes were exposed. Trip blank membranes were treated the same as other membranes before and after sampling.

Temperature was monitored at 30-minute intervals throughout each deployment using a Tidbit® or I-button® temperature logger attached to the SPMD canister. At the beginning and end of each deployment period, grab samples for total organic carbon (TOC), dissolved organic carbon (DOC), and total suspended solids (TSS) were collected.

Suspended Particulate Matter and Whole River Water

Suspended particulate matter and whole water samples were collected at several locations to further assess water column PCB concentrations. Since hydrophobic organic chemicals like PCBs preferentially sorb to suspended particles, concentrations are more readily detectable, making it a useful surrogate for whole water. Suspended particles were collected using Sedisamp II continuous-flow centrifuges (model 101IL) in a manner described by Serdar et al. (1997) and previously used to collect particles in the Spokane River (Ecology, 1995). Table 9 shows locations and dates for sampling.

Table 9. Locations and Sampling Dates for Suspended Particulate Matter and Whole River Water.

Location	Station	RM	Dates (2003)
Harvard Road	Harvard	92.8	10/20 – 10/22
Plante Ferry Park	PLANTEFRY	84.8	10/28 – 10/30
Ninemile Pool at Plese Flats	NINEM SPM	63.2	11/3 – 11/5

A peristaltic pump set at a rate of 3-4 L/min. was used to draw water from an intake strainer situated in the middle of the water column approximately 10-20 meters offshore. All tubing and fittings were Teflon®, except for Silastic® tubing used at the pump head, and all centrifuge bowl parts in contact with samples were high quality stainless steel.

Water samples for TSS were collected from the centrifuge intake and outlet water each day to estimate particle removal efficiency. TOC and DOC samples were also collected during suspended particle sampling. Aliquots of intake water were periodically collected to provide a composite sample of whole river water for PCB analysis. Once sufficient material was obtained, the centrifuges were disassembled. Then the particulate matter was removed using a Teflon® spatula, and the particulate matter placed in appropriate sample containers. All samples were stored on ice in locked coolers while in the field.

Total mass of particulate matter collected was 9-17 g (dry weight), extracted from 8,700-9,600 L of river water. TSS concentrations in whole river water averaged 1-2 mg/L, and no TSS was detectable in the centrifuge outlet water at a reporting limit of 1 mg/L. Based on the average TSS values in the river and the dry weight of the particulate matter collected, the centrifuge extraction efficiencies were 71-89%, which is in the range of typical values using these centrifuges in similar water conditions (Yake, 1993). Ancillary data for suspended particulate samples are in Appendix D.

Effluents

Industrial and Municipal Wastewater Effluent

Final effluent from wastewater streams of four facilities were collected during unannounced visits on three occasions (Table 10). Samples were composites from two consecutive days,

except at Kaiser Trentwood where final effluent was collected as discrete samples each day. Composite grab samples were also collected at the Kaiser wastewater stabilization lagoon and at the outlet of bed filters to assess the effect of particle removal on PCB concentrations.

Table 10. Outfall Locations and Dates of Industrial and Municipal Wastewater Effluent Samples.

Facility	Station	RM	Dates
Liberty Lake Sewer District WWTP	LIBLAKE	92.7	10/21– 22/2003 2/2 – 3/2004 4/26 – 27/2004
Kaiser Trentwood - Effluent	KaiserEff	86.0	10/21 – 22/2003 2/2 – 3/2004 4/26 – 27/2004
Kaiser Trentwood - Lagoon	KaiserLag	--	10/21 – 22/2003 2/2 – 3/2004 4/26 – 27/2004
Kaiser Trentwood - Below Filter	KaiserFilt	--	10/21 – 22/2003 2/2 – 3/2004 4/26 – 27/2004
Inland Empire Paper Company	Inland Emp	82.5	10/21 – 22/2003 2/2 – 3/2004 4/26 – 27/2004
City of Spokane WWTP	SPOKWWTP	67.4	10/21 – 22/2003 2/2 – 3/2004 4/26 – 27/2004

Samples were obtained by dipping a pre-cleaned glass container into the waste stream, either by hand or a stainless steel pole. Two-day composites included two quart grabs per day (morning and afternoon). A transfer blank was also collected during each round of sampling by pouring deionized water prepared at Manchester Environmental Laboratory into sample containers while on site. TSS samples were also collected as two-day grab composites at all facilities. Samples were placed on ice while in the field and maintained in coolers for transport with a chain-of-custody record.

Urban Stormwater

2004 Sampling

Three storm drains and one CSO were sampled during June 2004 (Table 11). Sampling was conducted by City of Spokane personnel during a runoff event produced by approximately 0.5 inches of rain in a 24-hour period. This event represented approximately one-half of the total precipitation for the month.

The storm-drain and CSO sites were selected by City of Spokane personnel based on recommendations by Ecology that the sites should be heavily developed with industrial land use

preferred, outfalls should be upstream of the Monroe St. Dam, and at least one should be a CSO outfall.

Table 11. Outfall Locations and Date of 2004 Storm Drain and CSO Samples.

Drain	Station	RM	Date
Mission Ave. and Perry St.	STMMISSBR	76.5	6/10/04
CSO at Erie St.	CSO34	75.8	
Superior St. near Cataldo St.	STMSUPOUT	75.7	
Washington St. Bridge	STMWASHBR	74.3	

The plan called for five storm drain/CSOs sampled during two runoff events, but a lack of precipitation, poor timing, and interference with other priorities of the City's stormwater sampling program precluded the successful completion of the plan.

2007 Contracted Sampling

In 2007 Ecology commissioned Parsons Inc. to conduct a Spokane stormwater study that sampled 14 sites including the four previously sampled storm drains/CSO. Stormwater sites were selected to be within the city limits and to discharge stormwater directly to the Spokane River. Parsons' subcontractor, TerraGraphics Environmental Engineering Inc., collected stormwater grab samples for PCBs and TSS during three storm events in May and June of 2007. The storm-event rainfall measured ranged from 0.29 to 0.86 inches and was preceded by more than four days of dry weather (Parsons, 2007).

Stormwater sampling locations for the Parsons study are described in Table 12.

Table 12. 2007 Stormwater Sampling Locations

Location ID	City Manhole Identifier	Latitude†	Longitude†	Location Description
STMWTR_ HWY291	0106436ST	47.73423	-117.507	Near the southwest corner of the intersection of Parkway Road and Ninemile Road (Hwy 291).
STMWTR_ 7TH	2000318ST	47.64898	-117.445	Next to light pole on southeast side of curb at intersection of 7th Street and Inland Empire. This is a combined sewer overflow (CSO 26).
STMWTR_ HSTREET	0400621ST	47.69031	-117.464	In the middle of H Street next to the alley north of Glass and south of Northwest Boulevard. This is a combined sewer overflow (CSO 07).
STMWTR_ COCHRAN	0501142ST	47.68353	-117.448	In the middle of Cochran Street, north of Grace Avenue west of TJ Meenach Drive Southern (and downstream) of two manholes.
STMWTR_ LINCOLN	0906615IN	47.66256	-117.425	Catch basin in sidewalk east of Lincoln Street next to Anthony's Restaurant, north of Post Street Bridge.
STMWTR_ CLARKE	1900330ST	47.65836	-117.439	Off north side of the curb of Clarke Street, east of Elm Street. This is a combined sewer overflow (CSO 24A).
STMWTR_ HOWARDBR	1000124ST	47.66485	-117.421	Northeast of Howard Bridge (walking bridge), just south of intersection with Mallon Avenue. In the middle of the trail. South of circle, approximately 12 feet east of catch basin, near map sign.
STMWTR_ UNION	1382924ST	47.66148	-117.392	In the middle of the street in front of the Union Gospel Mission, just south of intersection of Erie Street and Trent Avenue.
STMWTR_ RIVERTON	1800130ST	47.66751	-117.389	At the intersection of South Riverton Avenue and Desmet Avenue on the river side of the guardrail.
STMWTR_ GREENE	1680120ST	47.67772	-117.364	South of the Greene Street bridge, located on the sidewalk east of the bridge.
STMWTR_ WASHINGT	1100230ST	47.664	-117.418	North and west of Washington Street bridge. Located where the two paved walking trails converge. Previously named "stmwashbr."
STMWTR_ SUPERIOR	1300136ST	47.66579	-117.393	In the middle of Superior Street, south of Cataldo Avenue. Previously named "stmsupout ."
STMWTR_ ERIECSO	0521966CD	47.66108	-117.393	South of Trent Avenue on Erie Street south of site 4217. Middle of three manhole covers in parking area of park. This is a combined sewer overflow (CSO 34). Previously named "CS034."
STMWTR_ MISSION	1400224ST	47.67227	-117.39	Northeast of the intersection of Perry Street and Mission Avenue near Avista. Previously named "stmmissbr ."

† in decimal degrees
From Parsons, 2007.

Bottom Sediment

Surficial Deposits

Ecology collected surficial (top 2 cm) bottom sediments at several locations in the Spokane River, Little Spokane River, and a reference site. Surface sediment samples were collected from an Ecology boat using a 0.1 m^2 stainless steel van Veen or a 0.01 m^2 Petite Ponar grab sampler. Sediments from the Little Spokane were taken from the right bank using a pipe dredge. Sites were selected to assess the possibility of high concentrations of PCBs behind Monroe St. Dam, assess the longitudinal PCB concentration gradient in Lake Spokane, evaluate the potential of the Little Spokane River as a significant PCB source, and assess PCB concentrations in previously unexamined Spokane River reaches downstream of Lake Spokane.

The same reference site (Buffalo Lake) selected for an earlier bioassay survey of the Spokane Arm of Lake Roosevelt (Era-Miller, 2004) was used to provide reference sediments for the present 2003-07 study. It is located in a remote area of Okanogan County west of Spokane and receives contamination only through atmospheric deposition. An EPA study conducted during 2002 found low a PCB concentration (5.6 ng/g total PCBs) in largemouth bass fillets from Buffalo Lake (unpublished EPA data).

Table 13 lists locations for surficial sediment sampling. The riverbed behind the Monroe St. Dam in the vicinity of RM 76 and downstream of Little Falls Dam in the vicinity of RM 18-29 was composed almost entirely of gravel and cobble, and therefore no samples were collected.

Table 13. Locations and Dates of Surficial Sediment Samples.

Location	Station	RM	Date
Behind Monroe St./Upper Falls Dam	MonroeSed	74.9	4/14/2004
Lake Spokane (Long Lake)	LongLkUp	54.3	5/11/2004
	LongLkMid	44.3	11/4/2003
	LongLkLow	38.4	11/4/2003
Little Falls Pool	Littlefls	29.9	11/4/2003
Spokane Arm at Porcupine Bay	SPOK-1	12.6	11/6/2003
Little Spokane River	LitlSpokSed	2.3	12/10/2003
Buffalo Lake (reference)	BUFFALO REF	--	11/5/2003

Sediment Cores

Ecology collected sediment cores from the upper and lower reaches of Lake Spokane to assess trends in historic PCB deposition and to estimate sediment recovery rates (Table 14). Cores were collected using a Wildco 50-cm stainless steel gravity box corer fitted with a 13 cm by 13 cm (inner diameter) transparent acrylic liner.

Table 14. Locations and Dates of Sediment Cores.

Location	Station	RM	Date
Upper Lake Spokane	LONGUP2	49.2	6/9/2004
Lower Lake Spokane	LONGLOW2	36.0	11/4/2003

Fish and Crayfish Tissue

Ecology obtained fish and crayfish for PCB analysis from seven locations in the Spokane River from 2003 to 2005 (Table 15). For 2003 and 2004, the goal was to collect rainbow trout (>250 mm) and two size classes of largescale suckers (250-350 mm and <200 mm) at each site except Upriver Dam. Crayfish were collected at Upriver Dam due to interest in their possible accumulation of PCBs at the cleanup site. All biological data on specimens used for analysis are in Appendix E.

The goal for 2005 sampling was to provide high quality representative data to WDOH for use in a human health assessment and in reviewing the current fish consumption advisory stemming from data collected in 1999 and 2001. A secondary objective was to examine contaminant trends within the river system. Rainbow trout were not found during extensive efforts to capture them at Stateline and lower Lake Spokane. Largescale suckers were numerous at all sites except in the Ninemile reach where bridgelip suckers were the dominant species. The smaller size class of largescale suckers was not found at any of the sites sampled, even when various capture methods were employed.

Fish were collected primarily using Ecology's 16' Smith-Root electrofishing boat. Largescale suckers from Lake Spokane were captured using variable mesh gillnet sets on the lake bottom. Specimens were held in the vessel's live well and checked for species identification and desired length. Crayfish were collected using basket-cone style crayfish traps baited with cat food and set on the bottom overnight.

Fish selected for analysis were killed by a blow to the head. Each fish was given a unique identifying number, and its length and weight were recorded. The fish were individually wrapped in aluminum foil, put in plastic bags, and placed on ice for transport to Ecology headquarters, where the samples were frozen pending preparation of the tissue samples.

Crayfish were placed in a pre-cleaned 1 gallon glass jar and held on ice in coolers while in the field. Upon returning to Ecology headquarters, specimens were measured, weighed, and identified using an invertebrate species key. Following identification, specimens were returned to the jar and frozen until resection.

Table 15. Locations and Dates of Fish and Crayfish Samples.

Location	Station ID	RM	Latitude	Longitude	Species	Tissue	Dates
Near state line with Idaho	STATELINE-F	96.0	47.6981	-117.044	Largescale sucker	Whole body	7/14/04*
	SPK 96	96.0	47.69832	-117.044			8/22/05†
Near Plante Ferry Park	PLANTE-F	85.0	47.69459	-117.239	Rainbow trout	Fillet Gut contents	9/15/03*
					Largescale suckers	Whole body Gut contents	
	SPK 85	85.0	47.69498	-117.24	Rainbow trout Largescale suckers	Fillet Whole body	8/23/05†
Behind Upriver Dam	Upriver Dam	80.3	47.6869	-117.325	Crayfish	Tail muscle	5/13/04*
Mission Park	SPK 77	77.0	47.67655	-117.382	Mountain whitefish	Fillet	9/28/05- 9/29/05†
	SPK 75.2	75.2	47.66401	-117.404	Largescale sucker Rainbow trout	Whole body Fillet	9/28/05†
Ninemile reservoir (near Seven Mile Bridge)	Spokane-F	61.7	47.7324	-117.51	Rainbow trout	Fillet	9/16/03*
	NINEMILE-F	61.7	47.74299	-117.522	Rainbow trout	Gut contents	
	NINEMILE-F	61.7	47.74299	-117.522	Bridgelip sucker	Whole body Gut contents	7/13/04*
	SPK 64.0	64.0	47.72043	-117.501	Rainbow trout	Fillet Whole body	9/29/05†
					Mountain whitefish	Fillet Whole body	
					Bridgelip sucker	Fillet Whole body	
Upper Lake Spokane	SPK 55.6	55.6	47.80089	-117.549	Largescale sucker Smallmouth bass Mountain whitefish	Whole body Fillet Fillet	9/27/05†
	SPK 55.2	55.2	47.80156	-117.558	Brown trout	Fillet	11/3/05†
Lower Lake Spokane	SPK 40.1	40.1 40.8	47.83472 47.84152	-117.737 -117.725	Mountain whitefish Smallmouth bass	Fillet Fillet	11/3/05†
	LONGLOW-F	39.4	47.82769	-117.745	Largescale sucker	Whole body	7/13/04- 7/14/04*

* Sampling conducted in support of the present study. See Jack et al. (2003) for Quality Assurance Project Plan.
† Serdar and Johnson (2006).

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Sample Preparation

Sample containers and holding times for 2003-2005 are shown in Table 16. The fish and crayfish tissue preparation techniques used are described in Appendix F. See Parsons (2007) for sample preparation, analytical methods, and data quality information for stormwater samples collected in 2007.

Analytical Methods

All PCB congener samples and percent lipid in tissue were analyzed at Pace Analytical Services, Inc., Minneapolis, MN. PCB Aroclors, TOC in sediments, and TOC, DOC, and TSS in water were analyzed at Manchester Environmental Laboratory. SPMD preparation and dialysis was done at Environmental Sampling Technologies (EST), St. Joseph, MO. Radioisotope analysis of sediment cores was done at Teledyne Brown Engineering, Knoxville, TN. Grain size analysis was done at Analytical Resources, Inc., Tukwila, WA.

Table 16 shows analysis methods and reporting limits for sample media.

Table 16. Preparation Methods, Analytical Methods, and Reporting Limits for the Spokane River Samples.

Sample Media	Parameter	Preparation Method	Analytical Method	Reporting Limits
Semipermeable Membrane Device (SPMD)	PCB Congeners	Dialysis and ampulization - EST SOP	GC/HRMS, EPA Method 1668A	100 ng/4 ML dialysate (per congener) translates to approx. 0.1 - 1 pg/l (per congener)
Water	PCB Congeners	--	GC/HRMS, EPA Method 1668A	100 pg/l (per congener)
	TSS	--	EPA Method 160.3	1 mg/L
	TOC	--	EPA Method 415.1	1 mg/L
	DOC	--	EPA Method 415.1	1 mg/L
Sediment (Suspended particulate matter and surficial sediment)	PCB Congeners	Soxhlet extraction	GC/HRMS, EPA Method 1668A	0.05 ng/g (per congener)
Sediment	PCB Congeners	Soxhlet extraction	GC/HRMS, EPA Method 1668A	0.05 ng/g (per congener)
	TOC (104 °C)	--	Combustion	0.1%
	Grain size	--	Sieve and Pipet	±0.5% for each fraction
Sediment (Core)	PCB Aroclors	Soxhlet extraction	GC/ECD, EPA Method 8082	1 - 25 ng/g (per Aroclor)
	TOC (104 °C)	--	Combustion	0.1%
	Pb-210	--	Gamma detection	--
Tissue	PCB Congeners	Soxhlet extraction	GC/HRMS, EPA Method 1668A	0.01 - 0.05 ng/g (per congener)
	% lipids	--	Gravimetric	0.1%

SOP = Standard operating procedure.

Data Quality Assessment

Ecology's Manchester Laboratory reviewed the chemical data for this project. For results generated by Manchester, final data review was performed by the unit supervisor or an analyst experienced with the method. Manchester chemists performed the review for analytical work sub-contracted to commercial laboratories. Quality assurance and quality control at Manchester are described in the *Lab Users Manual* http://aww.ecologydev/programs/eap/forms/labmanual.pdf (Ecology Intranet).

Manchester prepared written case narratives assessing the quality of all data collected. These reviews include a description of analytical methods and an assessment of holding times, initial and continuing calibration and degradation checks, method blanks, surrogate recoveries, internal standard recoveries, matrix spike recoveries, laboratory control samples, and laboratory duplicates. The reviews and the complete Manchester data reports are available from the author on request.

A Quality Assurance Project Plan (Jack, 2003) established measurement quality objectives (MQOs) for accuracy, bias, and reporting limits. To determine if MQOs were met, the project lead compared results on field and laboratory quality control samples to the MQOs. To evaluate whether the reporting limit targets were met, the results were examined for non-detects and to determine if any values exceeded the lowest concentration of interest. Based on these assessments and a review of the laboratory data packages and Manchester's data verification reports, the data were either accepted, accepted with appropriate qualifications, or rejected and re-analyzed or re-sampled where possible.

The precision and accuracy of the 2003-2005 data reported here can be gauged from results on laboratory duplicates, field replicate samples, and standard reference materials, detailed in Appendix G. The relative percent difference (RPD) between duplicate (split) and replicate (separately collected) samples was 20% or better for PCBs in effluents, fish tissue, and sediment. Greater variability was encountered in analyzing PCBs in SPMD extracts, 9-55% RPD. Results from analyzing PCB congeners in a sediment standard reference material agreed within 13% of certified values, on average.

Results and Discussion

Dissolved PCBs in Spokane River Water

Ancillary water quality data collected in concert with SPMD deployments are shown in Table 17. Organic carbon concentrations were low at all sites. DOC constituted approximately 92% of the TOC on average. TSS concentrations were generally ≤3 mg/L with higher values (4-10 mg/L) occurring in February and April.

With a few exceptions, average temperatures were similar at all mainstem locations during each deployment. Stateline and Lake Spokane were approximately 1.5ºC warmer than other sites in October, but Stateline temperatures were slightly colder in February. Lake Spokane temperatures were also the warmest among mainstem sites in February. At Upriver Dam, bottom and middle water column temperatures were nearly identical.

Dissolved PCB concentrations determined from analyzing the SPMD membranes are shown in Table 18. A summary of the PCB residues accumulated in the membranes (raw data) is in Appendix C.

Concentration estimates for dissolved total PCBs ranged from 34 pg/l (parts per quadrillion) at Stateline during February (2004) to a maximum of 656 pg/l at lower Lake Spokane during October (2003). PCBs were composed primarily of tri- through heptachlorobiphenyl congeners. Spokane River total PCBs showed a fairly consistent trend of increasing concentrations moving downstream. Generally, dissolved total PCB concentrations were comparatively low at Stateline and Upriver Dam (34-145 pg/l), intermediate at Monroe St. and Ninemile (76-305 pg/l), and highest at Lake Spokane (78-656 pg/l). Total PCB concentrations in the Little Spokane River were 118-178 pg/l. The PCB mixture in the Little Spokane was enriched in octa, nona, and deca homologues compared to the mainstem Spokane River, suggesting a difference in sources.

There was evidence of seasonal differences in total PCB levels, with concentrations highest during October and lowest during February (Figure 11). Total PCB measured during October and April appeared similar at all reaches except for a large divergence at Lake Spokane. One possible reason for the much higher PCB concentration in Lake Spokane in October is the fall breakdown of stratification, which allowed bottom water enriched in PCBs to mix with the upper water column. This is consistent with SPMD findings for Upriver Dam, discussed below.

Table 17. Ancillary Parameters at SPMD Sites (mg/L).

Station Name	Sample Number	Collection Date	DOC		TOC		TSS		Mean Temp. (ºC)
Stateline	3408971	10/1/03	1.1		1.3		1	U	14.4
	3448107	10/29/03	1.1		1.2		2		
	4058111	1/28/04	1.4		1.3		1	U	3.2
	4094040	2/24/04	1.2		1.3		1		
	4164041	4/14/04	1.2		1.6		3		10.8
	4208134	5/12/04	1		1.2		2		
Upriver Dam	3408966/72*	10/1/03	1.2		1.5		2		12.7
	3448108	10/29/03	1		1.2		1		
	4058112	1/28/04	1.2		1.4		1		3.5
	4094044/5*	2/25/04	1.2		1.3		2		
	4164042/3*	4/14/04	1.6		1.7		3		10.8
	4208135	5/12/04	1		1.1		2		
UPRIVER BOT	--	10/1/03	--		--		--		12.7
	--	10/29/03	--		--		--		
	--	1/28/04	--		--		--		3.6
	4094046	2/25/04	1.1		1.3		2		
	4164044	4/14/04	1.3		1.4		3		9.8
	4208136/7*	5/12/04	1.1		1.1		2		
Monroe St	3408968	10/2/03	1	U	1	U	1	U	12.0
	3448109	10/29/03	1	U	1.1		1		
	4058113	1/28/04	1	U	1.1		2		4.0
	4094047	2/25/04	1.2		1.2		1		
	4164045	4/14/04	1.4		1.3		3		10.8
	4208138	5/12/04	1	U	1.3		2		
Ninemile1	3408967	10/1/03	1	U	1	U	1	U	12.3
	3448110	10/29/03	1.1		1.3		2		
	4058114/5*	1/28/04	1.2		1.3		2		--
	4094041	2/24/04	1.4		1.8		4		
Ninemile2	4164046	4/14/04	1.4		1.4		6		10.8
	4208139	5/12/04	1		1.1		2		
LongLkLow	3408969	10/2/03	1.1		1.1		2		14.4
	3454120	11/4/03	1	U	1	U	2		
	4164040	4/13/04	1.1		1.5		4		10.8
	4208133	5/11/04	1.1		1.3		3		
Tum Tum	4058117	1/29/04	1		1.1		2		4.5
	4094043	2/24/04	2.1		2.6		4		
LitlSpokR	3408970	10/2/03	1	U	1	U	1		
	3448111	10/30/03	1	U	1	U	2		14.4
LitlSpokBr	4058116	1/29/04	1	U	1	U	8		4.5
	4094042	2/24/04	2.7		2.2		10		
	4164047	4/14/04	1.3		1.7		7		
	4208140	5/12/04	1.1		1	U	5		10.8

*Mean of replicate analysis.
U: The analyte was not detected at or above the reported result, equivalent to <1.
Stateline: Spokane River at the Idaho state line just downstream of Interstate 90 bridge.
Upriver Dam: Spokane River upstream of Upriver Dam.
UPRIVER: Spokane River upstream of Upriver Dam, 2 feet from bottom of riverbed.
Monroe St: Spokane River upstream of Monroe Street Dam.
Ninemile1: Spokane River at Riverside State Park.
Ninemile2: Spokane River downstream of boat launch at Plese Flats
LongLkLow: Lower Lake Spokane.
Tum Tum: Lake Spokane near Tum Tum.
LitlSpokR: Little Spokane River at State Route 291 bridge.

Table 18. SPMD Dissolved PCB Concentrations Grouped by Homologues (pg/l), 2003-2004.

Station Name	Sample Number	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
October 2003												
Stateline	474155	0.4	1.5	11	15	56	19	7.9	2.4	0.0	0.0	113
Upriver Dam	474156/7*	0.7	5.5	25	26	32	10	3.7	0.0	0.0	0.0	103
UPRIVER BOT	474158	0.4	5.0	31	48	43	13	4.8	0.7	0.0	0.0	145
Monroe St	474159	0.6	8.6	32	60	65	42	18	3.0	0.0	0.0	231
Ninemile1	474160	0.3	13	63	61	95	49	21	3.1	0.0	0.0	305
LongLkLow	474161	0.7	15	59	269	195	74	32	9.3	2.3	0.0	656
LitlSpokR	474162/3*	0.2	1.0	12	27	33	16	12	11	6.4	0.0	118
February 2004												
Stateline	194130	0.0	0.0	1.8	4.6	14	8.9	5.0	0.0	0.0	0.0	34
Upriver Dam*	194131/2*	0.1	0.6	5.6	12	15	3.7	19	0.0	0.0	0.0	56
UPRIVER BOT	194133	0.0	0.3	10	40	22	4.1	0.8	0.0	0.0	0.0	78
Monroe St	194134	0.0	1.0	9.5	21	20	13	11	0.0	0.0	0.0	76
Ninemile1	--	--	--	--	--	--	--	--	--	--	--	--
Tum Tum	194135	0.0	1.4	12	24	18	8.9	13	0.1	0.0	0.0	78
LitlSpokBr*	194136/7*	0.1	0.4	9.1	35	51	16	12	13	6.9	0.0	143
April 2004												
Stateline	208134	0.0	0.3	8.0	17	60	32	27	2.1	0.0	0.0	145
Upriver Dam	208135	0.0	0.0	2.1	16	14	6.6	4.6	0.9	0.0	0.0	45
UPRIVER BOT*	208136/7*	1.8	1.0	24	78	57	17	11	0.5	0.0	0.0	191
Monroe St	208138	0.1	1.8	21	53	80	40	31	4.0	0.0	0.0	231
Ninemile2	208139	0.5	2.6	25	57	68	40	28	3.9	0.0	0.0	225
LongLkLow	208133	0.6	6.0	25	94	84	34	16	3.3	0.0	0.0	263
LitlSpokBr*	208140/1*	0.4	0.8	18	37	53	19	23	14	10	3.1	178

*Mean of replicate analysis.
Note: Reporting limits were variable, 0.1 – 10 pg/l.

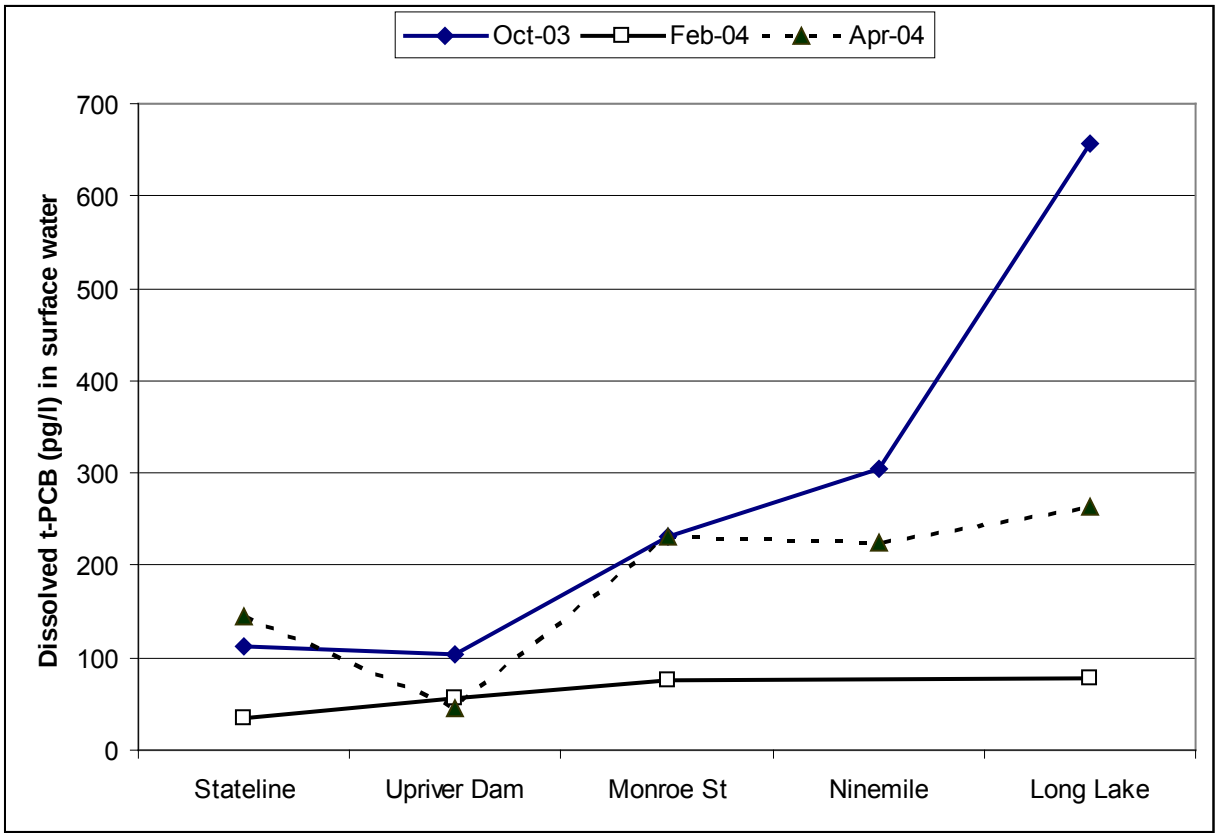


Figure 11. Dissolved Total PCBs in the Spokane River, 2003-2004.

Dissolved PCBs at Monroe Street, Ninemile, and lower Lake Spokane did not meet (exceeded) Washington State's human health water quality criterion of 170 pg/l. During October, the total PCB concentrations at these sites ranged from 231 to 656 pg/l. In April, the concentration range was 231 to 263 pg/l. The Little Spokane River was at the criterion in April (178 pg/l).

The February total PCB concentrations were similar among reaches and low compared to other months. Lower concentrations during this deployment may have been more a result of colder temperatures which reduce the SPMD sampling rate but is not accounted for in calculations used to translate SPMD PCB residues to surface water concentrations (see Appendix C). This may also explain the consistent total PCB concentrations in the Little Spokane River, since February and April temperatures at this location were 2-3ºC warmer. Simple flow dilution does not explain the differences among deployments since Spokane River discharge was highest during April (325 m^3/s at Spokane), lowest during October (49 m^3/s), and intermediate during February (114 m^3/s).

One objective of the SPMD sampling at the Upriver Dam cleanup site was to assess PCB levels at different depths. Samplers deployed 1-2 feet from the bottom had consistently higher concentrations than those at mid-depth (12-13 feet above bottom, Figure 12). The difference was pronounced in April when the bottom sample was four times the mid-column sample, even though the temperature was 1ºC lower (and thus a slightly lower sampling rate) at the bottom. Temperatures at both depths were identical during the other deployments.

At the time of sampling, higher PCB concentrations near the bottom were expected at this site which has PCB contaminated sediments that had yet to undergo state-directed cleanup (see previous Upriver Dam discussion). Although the high level of organic carbon in some of the PCB contaminated sediments theoretically sequesters PCBs, some diffusion to the water column occurs which was captured by the near-bottom SPMDs.

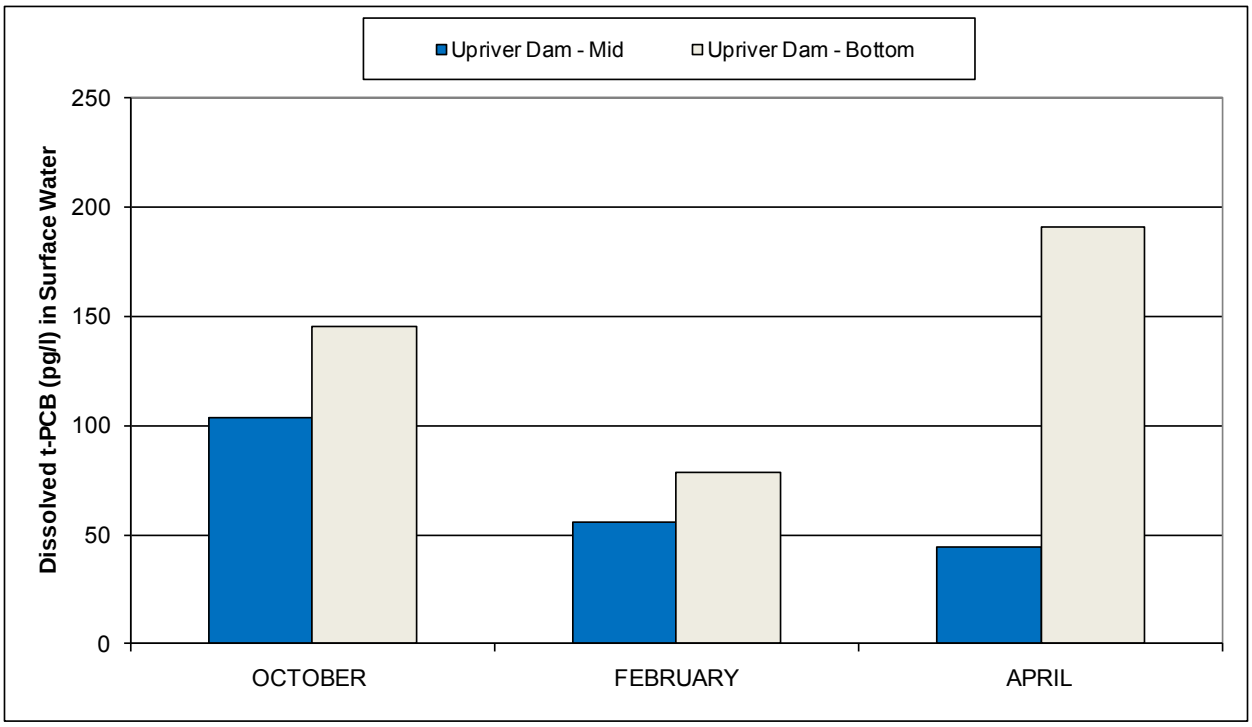


Figure 12. Dissolved Total PCBs at Mid-depth and Near the Bottom at Upriver Dam.

PCBs in Spokane River Suspended Particulate Matter

PCBs were measured in suspended particulate matter (SPM) and whole water from the Spokane River at Harvard Rd., Plante Ferry, and Ninemile during three two-day events in October-November 2003. For each sample collection (Oct 20-21, Oct 28-29, and Nov 3-4), a generator run pump was used to draw water up to a large centrifuge. Whole water samples were pumped to a sample container immediately upstream of the centrifuge. Ancillary water quality parameters included TOC, DOC, and TSS (Appendix D). TOC and DOC values were generally ≤1 mg/L. TSS averaged 1 mg/L at Harvard Road and Ninemile and 2 mg/L at Plante Ferry.

In SPM, PCBs were composed primarily of tetra-, penta-, and hexachlorobiphenyl congeners (Table 19). [Compared to dissolved PCBs which were composed primarily of tri- through heptachlorobiphenyl congeners. See previous discussion on dissolved results for the Spokane River.] Total PCB concentrations in suspended particles from Ninemile (69 ng/g, parts per billion) were an order of magnitude higher than those upstream (7.1-9.6 ng/g). The low TSS concentrations during all three sampling events indicate that differences in total PCB concentrations were not due to sediment entrainment.

For the most part, detection limits in the whole surface water samples were not low enough to afford a useful comparison with the SPM data. No PCBs were detected in the whole water samples collected at Harvard Rd. or Plante Ferry at the 110 pg/l level, and only a low concentration (130 pg/l) of dichlorobiphenyl congeners was detected at Ninemile (Table 19). This is an unusual finding considering the relatively low concentration of this homologue group in SPM and SPMDs.

Earlier (1994) SPM sampling by Ecology (1995) at Plante Ferry yielded much higher PCB concentrations (220 ng/g) using the same collection methods as the present 2003-07 study. Although that result was obtained using an Aroclor rather than congener analysis, river conditions were similar, TSS was low (<1 mg/L), and the sampling site was nearly identical.

To examine the proportion of solid and dissolved phase PCB concentrations in the Spokane River, the following partition formula was applied to the SPM data:

Equation 3. $$\boldsymbol{Fraction\ of\ dissolved\ PCB} = \frac{1}{(1+(f_s * f_{oc} * K_{oc}))}$$

Where:

- f_s = fraction of solid in water.
- f_{oc} = fraction of organic carbon in the solid phase.
- K_{oc} = sediment-water partition coefficient normalized for organic carbon.

This formula assumes that PCBs are in equilibrium between the solid and dissolved phases, and the proportion in each phase is governed by the amount of solids in the water and the organic carbon content of the solid material. K_{oc}, the sediment-water partition coefficient normalized for organic carbon, is a field or laboratory-derived constant for each chemical. Values for f_s were from TSS measurements (1 or 2 mg/L; i.e., f_s = 0.000001 or 0.000002). Values for f_{oc} (0.15) and K_{oc} (449,000) are from EPA (1994) and DiToro et al. (1991), respectively, and are the same values used by Ecology (1995) to calculate a dissolved PCB concentration in water from earlier sampling.

Based on sediment-water partitioning, approximately 94% of the PCBs are in the dissolved phase. Dissolved total PCB concentration for Harvard Rd. and Plante Ferry are 142 and 105 pg/l, respectively, similar to results derived from SPMD deployments at Stateline and Upriver Dam during the same period (≈110 pg/l). The theoretical dissolved concentration of total PCBs was 1,020 pg/l at Ninemile, more than three times the concentration measured with SPMDs (305 pg/l) during October (in Table 18).

Table 19. PCB Concentrations Grouped by Homologues in Suspended Particulate Matter (ng/g, dw) and Whole River Water Collected at the Centrifuge Inlet (pg/l) During Three Sampling Events from October to November 2003.

	Station	Sample Number	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
Suspended Particulate Matter													
Spokane R at Harvard Rd	Harvard	3438100	<0.09	0.11	0.51	0.96	2.91	3.40	1.39	0.32	<0.09	0.09	9.60
Spokane R at Plante Ferry Park	PLANTEFRY	3448100	<0.05	0.09	0.41	1.34	2.49	1.98	0.70	0.08	<0.05	0.05	7.09
Spokane R at Riverside State Park	NINEM SPM	3454105	<0.07	0.39	3.71	12.9	24.6	18.6	6.30	1.71	0.39	0.15	68.8
Whole Water Centrifuge Inlet													
Spokane R at Harvard Rd	Harvard	3438100	REJ	<111	<111	<111	<111	<111	<111	<111	<111	<122	<111
Spokane R at Plante Ferry Park	PLANTEFRY	3448100	<109	<109	<109	<109	<109	<109	<109	<109	<109	<120	<109
Spokane R at Riverside State Park	NINEM SPM	3454105	<108	130	<108	<108	<108	<108	<108	<108	<108	<119	130

Detected values are in green highlight.
<: The analyte was not detected at or above the reported result.
REJ: Data are unusable for all purposes.

Figure 13 shows the two-day whole water PCB concentrations estimated from the suspended matter data and illustrates the relative importance of the dissolved PCB component, at least during low-flow conditions. Results also suggest that the analysis of whole surface water samples collected during particulate matter sampling underestimated actual PCB concentrations.

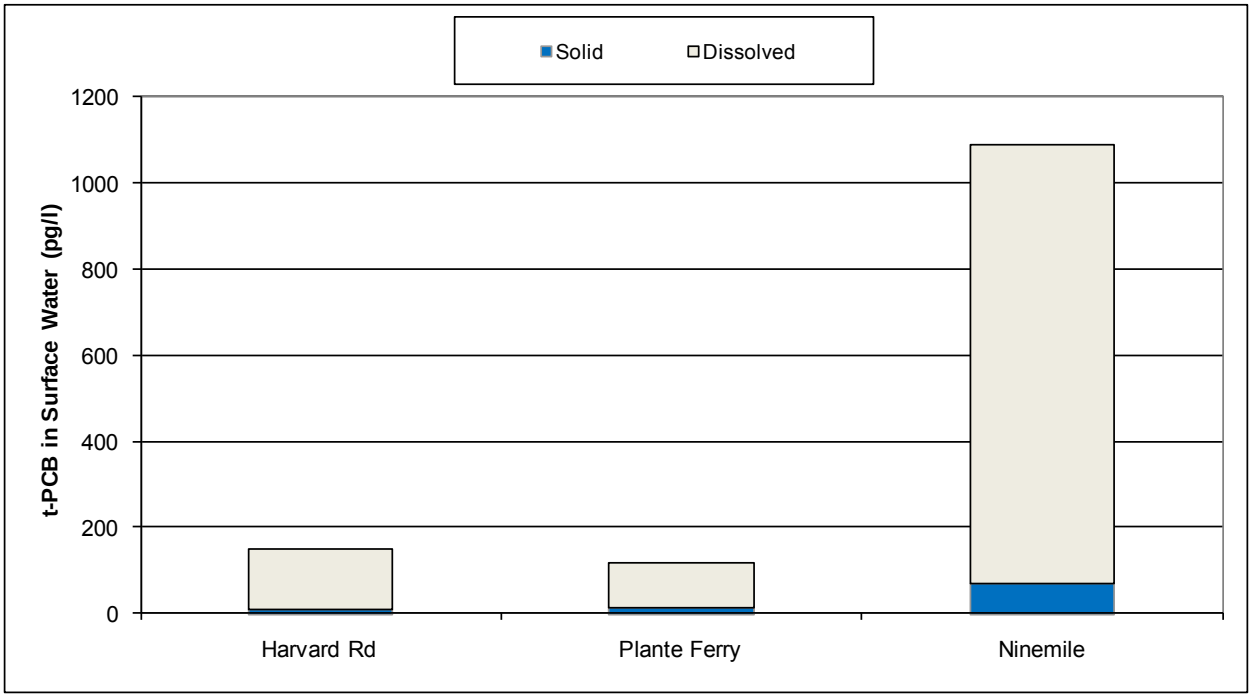


Figure 13. Measured Particle-Bound PCB Concentrations and Theoretical Dissolved PCB Concentrations Based on Suspended Particulate Matter Collected by Three 2-Day Centrifugation Sampling Events of Spokane River Water in October and November 2003.

PCBs in Industrial and Municipal Effluents Discharged to the Spokane River

In late 2003, Kaiser Trentwood installed a black walnut shell filtration system for their process wastewater discharge. Results of 2004-2005 effluent sampling showed an order of magnitude decrease in PCB concentrations and loads compared to 2001, presumably due to the filter and other facility management improvements. Table 20 shows the results of effluent PCB monitoring by Kaiser in 2004-2005 (unpublished).

Table 20. Kaiser Trentwood Effluent Concentrations of Total PCBs (Kaiser, 2005).

Source	Date	Total PCBs (pg/l)*	Effluent Flow (ML/day)	PCB Load to River (mg/day)
Kaiser Trentwood	6/25/04	1,170	63.9	75
	7/7/04	1,230	64.6	79
	7/23/04	1,340	66.2	89
	8/9/04	914	62.4	57
	4/20/05	669	56.2	38
	5/7/05	928	56.1	52
	5/19/05	1,370	59.7	82
	6/11/05	971	56.5	55
	6/14/05	1,130	55.4	63

*sum of detected congeners.

PCBs monitored by Ecology in effluents from four industrial and municipal facilities during three periods – October 2003, February 2004, and April 2004 – are shown in Table 21. Descriptions of the station names and sampling dates were listed in Table 10.

Spokane WWTP was the only facility where PCBs were detected in effluent during all three sampling collections, with an average PCB concentration of 940 pg/l.

Total PCBs in the Kaiser Trentwood effluent were generally <110 pg/l except during October when 330 pg/l was detected on 10/21/2003. Total PCBs were undetected at the 100 pg/l detection limit the following day. Samples from the treatment lagoon at Kaiser showed much higher PCBs (110 – 7,400 pg/l), but these concentrations were reduced substantially by the bed filtration system prior to discharge.

Liberty Lake WWTP had variable concentrations, as did Inland Empire to a lesser degree. Total PCB concentrations at Liberty Lake WWTP were an order of magnitude higher during April than during October and February, while Inland Empire had only one sample with PCBs detected, 670 pg/l total PCBs in October.

Overall, it appears that PCB concentrations in the effluents of the four facilities have decreased substantially since previous sampling. The smallest decrease occurred at the Spokane WWTP where 2003-04 average concentrations were about one-half those during 2001. However, the bulk of this apparent decrease may be due to higher detection limits used for the 2003-2004 samples compared to earlier samples. Effluent samples analyzed by Golding (2002) and SAIC (2003a) typically had detection limits <5 pg/l for individual congeners, and nearly all detected congeners were found at concentrations <100 pg/l. Therefore, the 2003-2004 results are likely all biased low due to the omission of these detections.

The reason for the relatively high level of monochloro-biphenyls in the 2004 Liberty Lake and Spokane WWTP replicate samples is unknown. The poor agreement between the Spokane WWTP replicate samples suggests contamination either from the field or laboratory. These values do not have a significant impact on the PCBs loading scenarios presented later in the report.

Table 21. PCB Concentrations Grouped by Homologues in Industrial/Municipal Effluent (pg/l).

Station Name	Sample ID	TSS mg/L	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
October 2003													
LIBLAKE	3434025	7	<98	161	<98	<98	<98	<98	<98	<98	<98	<98	161
KaiserEff	3434020	1	<100	100 J	228	<100	<100	<100	<100	<100	<100	<110	328 J
KaiserEff	3434023	1	<101	<101	<101	<101	<101	<101	<101	<101	<101	<112	<101
KaiserLag	3434021	3	<102	292 J	911	1,350	<102	<102	<102	<102	<102	<112	2,550 J
KaiserFilt	3434022	1	<100	167 J	104	<100	<100	<100	<100	<100	<100	<110	271 J
Inland Emp	3434026	5	<101	670	<101	<101	<101	<101	<101	<101	<101	<111	670
SPOKWWTP	3434027	6	<99	143	<99	112	218	<99	<99	<99	<99	<108	473
February 2004													
LIBLAKE	4064113	31	<111	<111	<111	<111	<111	<111	<111	<111	<111	<122	<111
KaiserEff	4064105	1	<112	<112	<112	<112	<112	<112	<112	<112	<112	<123	<112
KaiserEff Rep.	4064106	1	<106	<106	<106	<106	<106	<106	<106	<106	<106	<116	<106
KaiserEff	4064107	1	<109	<109	<109	<109	<109	<109	<109	<109	<109	<119	<109
KaiserLag	4064110	5	<106	422	2,580	3,720	647 J	<106	<106	<106	<106	<117	7,370
KaiserFilt	4064109	1	<109	<109	307	125 J	<109	<109	<109	<109	<109	<120	432 J
Inland Emp	4064111	9	<109	<109	<109	<109	<109	<109	<109	<109	<109	<120	<109
SPOKWWTP	4064112	10	<108	<108	<108	123	259	122	<108	<108	<108	<119	504
April 2004													
LIBLAKE	4188205	43	999 NJ	<112	<112	265	<112	<112	<112	<112	<112	<123	1,260 NJ
KaiserEff	4188198	1	<112	<112	<112	<112	<112	<112	<112	<112	<112	<112	<112
KaiserEff	4188199	1	<107	<107	<107	<107	<107	<107	<107	<107	<107	<107	<107
KaiserLag	4188202	1	<104	112 J	<104	<104	<104	<104	<104	<104	<104	<104	112 J
KaiserFilt	4188201	1	<106	<106	<106	<106	<106	<106	<106	<106	<106	<106	<106
Inland Emp	4188203	2	<112	<112	<112	<112	<112	<112	<112	<112	<112	<112	<112
SPOKWWTP	4188204	5	<102	<102	<102	342	588	329	<102	<102	<102	<113	1,260
SPOKWWTP Rep.	4188206	6	865 NJ	<107	<107	360	826	358	<107	<107	<107	<117	2,410 NJ

Detected values are in green highlight.
<: The analyte was not detected at or above the reported result (U or UJ).
NJ: There is evidence that the analyte is present. The associated numerical result is an estimate.
J: The analyte was positively identified. The associated numerical value is an estimate.

PCBs in Stormwater Discharged to the Spokane River

Stormwater sampling during the 2003-04 PCB source assessment study was conducted by City of Spokane personnel during one runoff event on June 10, 2004. Only four locations were sampled, although the sampling plan proposed more sites and storm events. Samples were collected from manholes nearest the outfalls draining the particular stormwater conveyance systems.

Due to the limited data from 2004, a second and larger set of stormwater samples was collected in the spring of 2007 by Parsons, a consultant hired by Ecology. Locations are shown in Figure 14. Results from both the 2004 and 2007 efforts are presented in Tables 22 to 26. The location IDs that correspond to the location descriptions were shown in Tables 11 and 12.

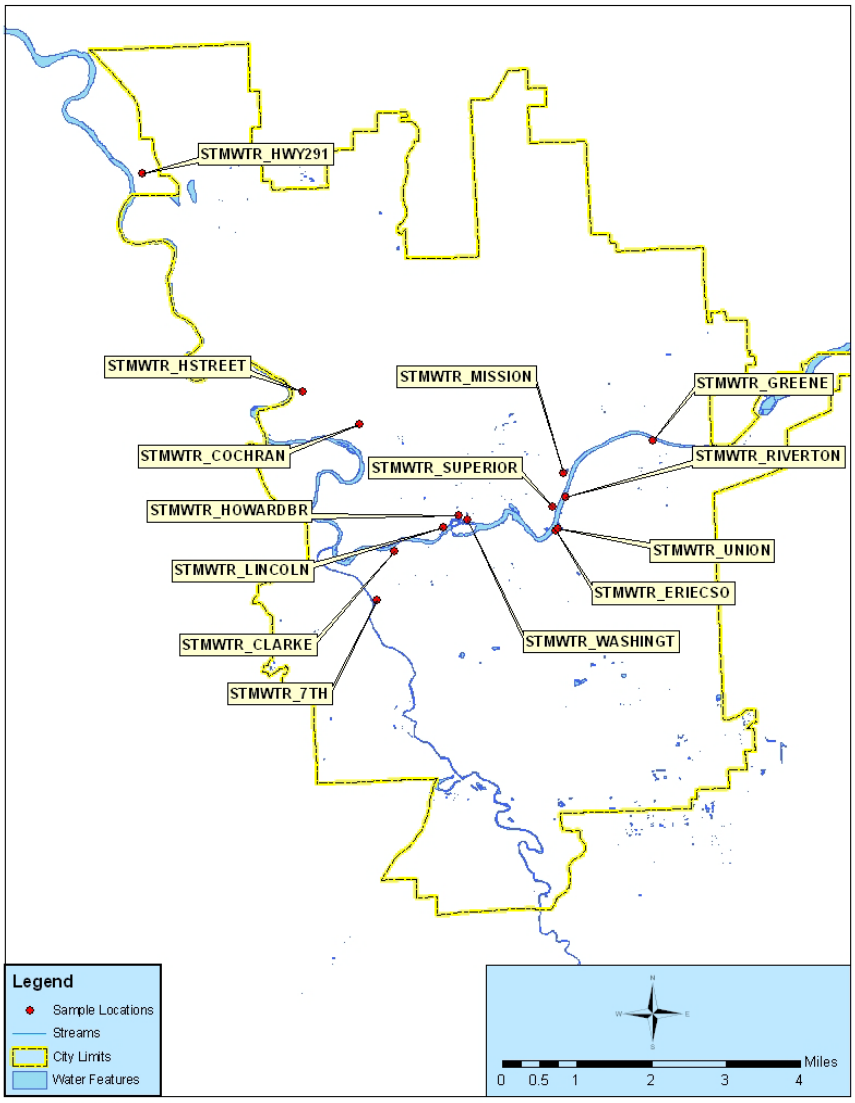


Figure 14. Stormwater Basins in the City of Spokane Sampled for PCBs During 2007 by Parsons.

Table 22. June 10, 2004 Stormwater PCB Concentrations Grouped by Homologues (pg/l).

Location ID*	Sample Number	TSS (mg/L)	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
Stmwtr_Mission (STMMISSBR)	4254001	58	<117	<117	117	5,490	28,800 J	19,200	6,660	1,600	283	254	62,400 J
Stmwtr_ErioeCSO (CSO 34)	4254000	126	<111	<111	685	3,120	10,200	28,500	32,400	7,800	678	<123	83,400
Stmwtr_Superior (STMSUPOUT)	4254003	26	<102	<102	<102	843	1,920	1,270	749	120	<102	<112	4,900
Stmwtr_Washingt (STMWASHBR)	4254002	91	<113	<113	285	2,560	8,380 J	5,290 J	2,530	690	198	<124	19,900 J

Detected values are in green highlight.
* Location ID in parentheses is presented for access to data in EIM. The Location IDs correspond to Table 12, which is the ID given for the 2007 stormwater sampling.
<: The analyte was not detected at or above the reported result (U or UJ).
J: The analyte was positively identified. The associated numerical value is an estimate.

Table 23. May 2, 2007 Stormwater PCB Concentrations Grouped by Homologues (pg/l).

Location ID*	Sample ID	TSS (mg/L)	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
HWY291	07184210	19	76	78	45	483 J	572	408	446	70	<20	<20	2180 J
7TH (CSO 26)	07184211	22	<80	<80	<80	<80	713 J	575	120	<80	<80	<80	1410 J
HSTREET (CSO 7)	07184212	63	<20	120	135	855 J	1,380	973	768	190	54	48	4520 J
COCHRAN	07184213	155	85	578	953	2,430 J	5,770	4,440	2,890	813	293	<20	18,250 J
LINCOLN	07184214	8	<20	<20	88	622 J	1,130	556	315	56	44	<20	2810 J
CLARKE (CSO 24A)	07184215	4	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80[1]
HOWARDBR	07184216	7	<20	102	194	849 J	734	408	309	29	27	42	2700 J
UNION	07184217	67	75	1,960	8,500	21,990	27,660	39,350	42,050	24,860	1,570	160	168,160
RIVERTON	07184218	27	23	336	919	6,570	17,200	10,050	6,050	1,900	99	<20	43,140
WASHINGT	07184221	26	57	295	408	1,700 J	2,800	1,330	1,110	514	82	<20	8,290 J
SUPERIOR	07184222	43	61	440	859	4,970 J	21,340	10,830	2,620	996	84	33	42,230 J
ERIECSO (CSO34)	07184223	40	115	2,960	13,650	29,140	48,120	85,070	78,890	20,190	2,000	296	280,430
MISSION	07184224	34	<100	319 J	381 J	2,990 J	9,720	6,690	2,220	452	<100	<100	22,770 J
SUPERIOR-Replicate	07184225	306	<100	342 J	527	2,350	9,250	6,670	1,410	690	<100	<100	21,230 J
SUPERIOR-Replicate	07184226	27	65	496	971	2,620	6,720	5,310	1,740	1,310	40	<20	19,260

Detected values are in green highlight.
*: In EIM these Locations IDs have the prefix STMWTR_; CSO number in parentheses is not part of the EIM Location ID.
[1]: The Clarke 07184215 Total PCB was revised from 0.062 to <80, post publication in the 2007 Parsons Report. The online report reflects the change.
<: The analyte was not detected at or above the reported result (U or UJ).
J: The analyte was positively identified. The associated numerical value is an estimate.

Table 24. May 21, 2007 Stormwater PCB Concentrations Grouped by Homologues (pg/l).

Location ID*	Sample ID	TSS (mg/L)	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
HWY291	07214210	8	110	105 J	<40	66 J	231	<40	<40	<40	<40	<40	512 J
7TH (CSO 26)	07214211	7	<40	158	51 J	296	342	144	<40	<40	<40	<40	991
HSTREET (CSO 7)	07214212	41	<40	137 J	<40	315 J	801 J	514	305	108	<40	<40	2,179 J
COCHRAN	07214213	12	43 J	135 J	<40	125 J	275 J	95 J	46 J	<40	<40	<40	719 J
LINCOLN	07214214	3	<40	164 J	<40	132 J	353 J	187	<40	<40	<40	<40	836 J
CLARKE (CSO 24A)	07214215	2	<40	101 J	<40	124	<40	<40	<40	<40	<40	<40	225 J
HOWARDBR	07214216	3	<40	122 J	57 J	302 J	317 J	42 J	<40	<40	<40	<40	839 J
UNION	07214217	18	142	373 J	645	1,795 J	3,006 J	4,325	4,631	1,121	62 J	<40	16,099 J
RIVERTON	07214218	14	52 J	<40	47 J	422 J	856 J	997	1,511	356	<40	<40	4,240 J
GREENE	07214219	38	54 J	233 J	828	2,367 J	3,033 J	2,254	2,238	403	<40	<40	11,409 J
WASHINGT	07214221	11	159	132 J	<40	<40	395 J	247	49 J	<40	<40	<40	981 J
WASHINGT-Replicate	07214225	8	108	136 J	<40	169 J	396 J	132	<40	<40	<40	<40	939 J
WASHINGT-Replicate	07214226	9	74 J	80 J	<40	156 J	402 J	239	65 J	<40	<40	<40	1,017 J
SUPERIOR	07214222		196	110 J	<40	155 J	304 J	202	185	<40	<40	<40	1,152 J

Detected values are in green highlight.
*: In EIM these Locations IDs have the prefix STMWTR_
<: The analyte was not detected at or above the reported result (U or UJ).
J: The analyte was positively identified. The associated numerical value is an estimate.

Table 25. June 5, 2007 Stormwater PCB Concentrations Grouped by Homologues (pg/l).

Location ID*	Sample ID	TSS (mg/L)	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
HWY291	07234710	6	<40	<40	<40	<40	98 J	143	<40	<40	<40	<40	241 J
7TH (CSO 26)	07234711	26	150	121	91 J	702 J	2,708 J	2,382	1,059	382	64 J	48 J	7,707 J
HSTREET (CSO 7)	07234712	46	<40	<40	<40	<40	422 J	266 J	62 J	<40	<40	<40	749 J
COCHRAN	07234713	298	65 J	552	724	2,458 J	5,257	6,301	2,535	1,078	518	110	19,598 J
LINCOLN	07234714	51	<40	215	378	1,187 J	3,163 J	2,818	852	495	255	61 J	9,423 J
CLARKE (CSO 24A)	07234715	92	<40	108	72 J	452 J	1,725 J	1,628	591	196	94 J	<40	4,867 J
HOWARD BR	07234716	67	<40	605	4,404	4,662	2,366 J	1,722	773	210	111	86 J	14,940 J
HOWARD BR-Replicate	07234725	63	<40	528	4,393	4,158	2,549 J	1,222	627	121	122	93 J	13,813 J
HOWARDBR-Replicate	07234726	46	<40	433	3,591	3,302	1,760 J	1,410	566	130	79 J	123	11,393 J
UNION	07234717	65	49 J	511	2,387	5,037	12,488	39,653	36,975	9,056	602	44 J	106,802
RIVERTON	07234718	82	<40	200	500	1,465 J	3,824 J	6,735	5,309	1,222	124	<40	19,380 J
GREENE	07234719	117	<40	295	1,770	3,631	5,599	9,275	5,463	1,315	232	43	27,622
WASHINGT	07234721	158	<40	216	404	1,947 J	2,726 J	2,489	681	318	171	80 J	9,031 J
SUPERIOR	07234222	55	<40	116	109	742 J	1,451 J	1,622	593	227	53 J	<40	4,912 J
ERIECSO (CSO34)	07234223	159	62 J	582	2,094	4,987	10,768	28,081	19,456	6,027	568	62 J	72,686
MISSION	07234224	30	<40	120	152	897 J	3,131 J	3,593	1,884	446	90 J	<40	10,311 J

Detected values are in green highlight.
*: In EIM these Locations IDs have the prefix STMWTR_
<: The analyte was not detected at or above the reported result (U or UJ).
J: The analyte was positively identified. The associated numerical value is an estimate.

Summary statistics for PCB concentrations in City of Spokane stormwater samples from 2004 and 2007 are shown in Table 26. Stormwater PCB concentrations ranged over two orders of magnitude in both data sets from 2004 and 2007. Individual total PCB concentrations varied widely from <80 to 280,000 pg/l in the 2007 Parsons study, and from 4,900 to 83,400 pg/l in 2004.

Table 26. Summary Statistics for Total PCB Concentrations in Spokane Stormwater (pg/l).

Statistic	Stormwater Sampling	
	Ecology in 2004	Parsons in 2007
minimum	4,900	240
10th	9,400	777
25th	16,150	1,118
mean	42,650	23,023
median	41,150	8,000
75th	67,650	19,290
90th	77,100	42,867
95th	80,250	101,684
maximum	83,400	280,430

Parsons provided an in-depth review of the 2007 data in their report (Parsons, 2007). They concluded that:

- Stormwater basins CSO 34 and Union Street showed the highest average concentrations for the three events.
- Total PCB concentrations showed a direct correlation with TSS.
- Sources of PCBs are similar in the stormwater systems, with the exception of the Howard Bridge site. The greater relative abundance of less chlorinated PCBs at Howard Bridge may indicate the presence of a different source.

Post publication of the Parsons report, Union Street was found to drain to the CSO34 (Erie Street) system. Their relative drainage areas are 109 and 1,951 acres, respectively. Thus, Union Street, at <6% of the CSO 34 area, may be largely responsible for the high PCB levels detected at CSO 34.

The Clarke 07184215 total PCB result was revised post publication of the Parsons (2007) report from 0.062 to <80 pg/l.

A wide range of PCB homologues was detected in Spokane stormwater (Tables 22-25) and in particulate samples from the Spokane River (Table 19). A similar homologue range was seen in Spokane River sediment samples (see Table 30). In contrast, a relatively narrow group of dichloro through pentachlorobiphenyl homologues was found in industrial and municipal effluents (Table 21). This finding, coupled with the loading analysis that follows, supports a conclusion that stormwater is a significant PCB source to the Spokane River.

Stormwater Discharges

Streamflow data were not collected during stormwater sampling. Therefore the discharge was estimated using calculations based on rainfall. The average annual stormwater discharge predicted by the Simple Method (www.stormwatercenter.net) was calculated by Parsons (2007). Briefly, the Simple Method uses the equation:

Equation 4. $R = P * Pj * Rv$

where R is annual runoff (inches), P is annual rainfall (inches), Pj is the fraction of annual rainfall events that produce runoff (assumed 0.9), and Rv is a runoff coefficient.

In this method, the runoff coefficient is calculated based on impervious area in the subwatershed (Ia). Watershed imperviousness is a reasonable predictor of Rv (Schueler, 1987), with the relationship best defined as:

Equation 5. $Rv=0.05+0.9Ia$

Geographical data were provided by the City of Spokane Wastewater Management Department. Annual rainfall was estimated to be 18 inches in Spokane, based on data from Ecology's Eastern Washington Stormwater Manual Precipitation Maps (Ecology, 2004 www.ecy.wa.gov/biblio/0410076maps.html). A value of 0.9 was used as the fraction of runoff.

The first step for developing flow estimates using the Simple Method was to determine the area draining to each of the sampling locations. To do so, a shapefile of stormwater boundaries provided by the City of Spokane was merged with the shapefile of areas contributing stormwater to the various CSOs (also provided by the City of Spokane) in a geographic information system. Figure 15 presents the combined stormwater-CSO boundaries for the entire city.

The second step was to determine the impervious areas. Pervious surfaces were determined in each drainage area based on 2007 geographic data. The total impervious area contributing was calculated as the sum of transportation and off-street impervious areas. Percent impervious for all the stormwater basins in the City of Spokane ranged from roughly 12 to 54% for the basins with any development (Parsons, 2007). This stormwater assessment did not take the Census-defined urban areas nor the Urban Growth boundary into account. The Spokane city limits were defined by the 2005 city boundary.

The total PCB average for each sampling station, as well as the calculated impervious fraction, area, and runoff, are shown in Table 27.

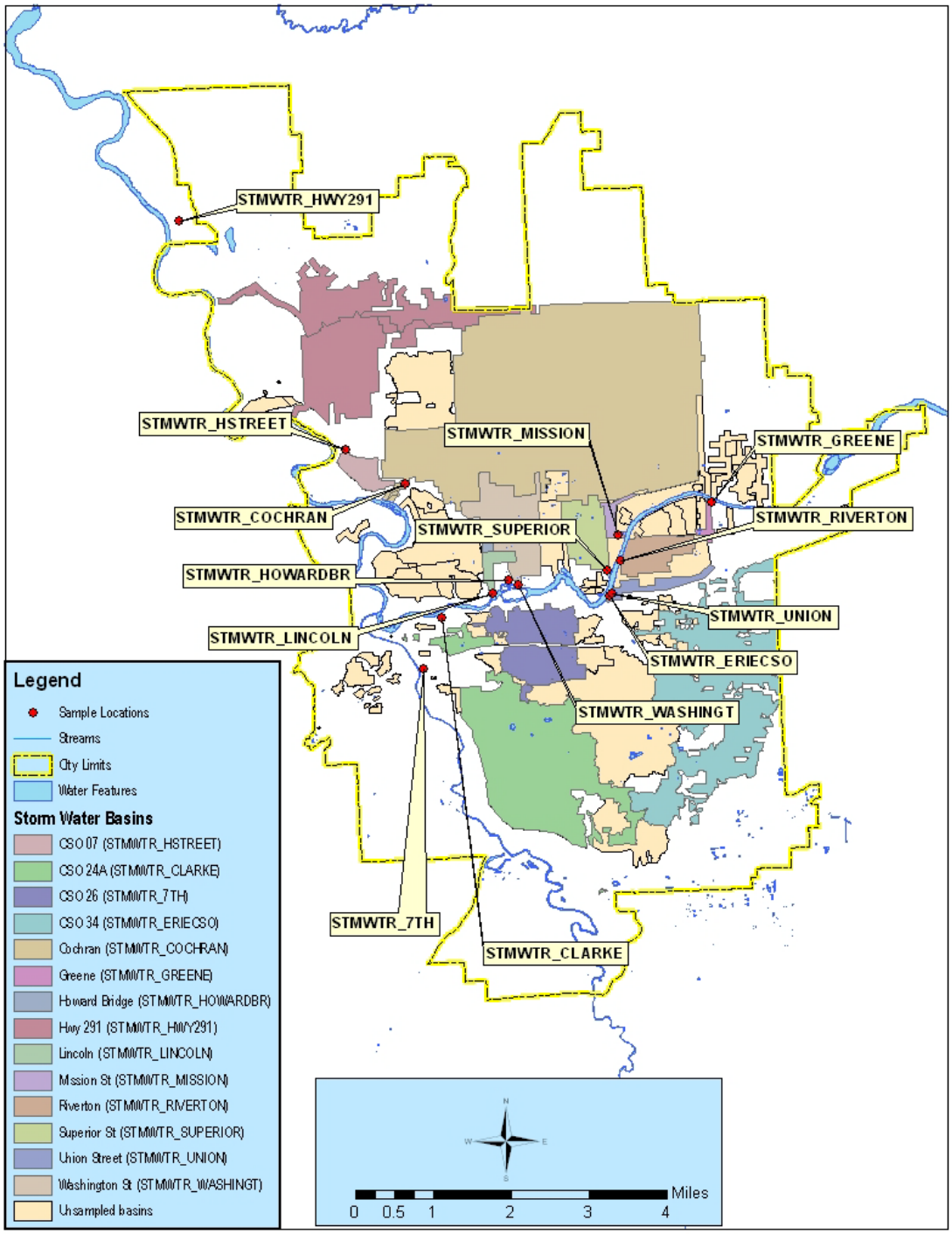


Figure 15. Stormwater Basins in the City of Spokane, Parsons, (2007).

Table 27. Total PCB Results, Impervious Fraction, and Runoff for Spokane Stormwater Basins.

Location_ID[1]	Total PCB (ng/L)[2]	Impervious Fraction	Drainage Area (acre)	Annual Runoff Volume (in)[3]
Sampled Stormwater Basins (High CSO Load Scenario)				
Above Monroe St Dam				
GREENE	19.5	0.365	34	6.1
MISSION	16.5	0.277	55	4.8
RIVERTON	22.3	0.217	233	4
SUPERIOR	17.8	0.376	294	6.3
UNION	97	0.323	109	5.5
ERIECSO (CSO 34)	177	0.24	2,060[4]	4.3
WASHINGT	4.05	0.417	465	6.9
HOWARDBR	8.74	0.407	57	6.7
Below Monroe St Dam				
LINCOLN	4.36	0.544	69	8.7
CLARKE (CSO 24A)	2.56	0.267	1,863	4.7
7TH (CSO 26)	3.38	0.439	609	7.2
COCHRAN	12.9	0.274	5,164	4.8
HSTREET (CSO 7)	2.49	0.247	121	4.4
HWY291	0.978	0.248	1,578	4.4
Totals			**12602**	**79**
29 Un-Sampled Stormwater Basins (Low CSO Load Scenario)				
Average Conc.	23			
Totals		**varied**	**4652**	**147**

Green shading represents CSO basins.
[1] In EIM these Locations IDs have the prefix STMWTR_; CSO number in parentheses is not part of the EIM Location ID.
[2] Average of all the samples collected in the 2007 Parsons study; the PCB average was updated by Ecology.
[3] Calculated for stormwater basins only, using Equations (6) and (7) and an annual rainfall amount of 18 inches.
[4] Includes Union area (109 acres).

PCB stormwater concentrations were found to be related to TSS concentrations in the Parsons study. TSS concentrations were substantial in stormwater (2-298 mg/L, Tables 22-25). Based on the high octanol-water partitioning coefficients (K_{ow}) for PCBs and the high TSS concentrations, it can be assumed that most of the PCBs were adsorbed to the solids fraction in stormwater. Approximately 85%-95% of the PCBs were estimated to be bound to the solid phase (i.e., attached to the suspended sediment) when the partitioning formula Eq. 3, described previously, was applied and an organic carbon fraction of 0.05 used. If this is the case, the suspended sediment carried in stormwater would have average dry weight t-PCB concentrations ranging from approximately 150 to 1,000 ng/g, or about two to 15 times the levels seen in suspended particulate matter in the Spokane River at Ninemile.

PCBs in Spokane River Bottom Sediments

Bottom sediment sampling site locations and dates are shown in Table 28. These sites were selected to investigate the possibility of PCB enriched sediments behind Monroe St. Dam, assess the longitudinal PCB concentration gradient in Lake Spokane, evaluate the potential of the un-surveyed Little Spokane River as a significant PCB source, and measure PCB concentrations in previously sampled Spokane River reaches downstream of Lake Spokane.

Table 28. Bottom Sediment Locations and Sampling Dates.

Station Location	Sample Name	RM	Dates
Spokane River above Monroe St.	MonroeSed	74.8	4/14/04
Upper Lake Spokane	LongLkUp	54.3	5/11/04
Middle Lake Spokane	LongLkMid	44.3	11/4/03
Lower Lake Spokane	LONGLKLOW	38.4	10/2/03 11/4/03 4/13/04
Spokane River above Little Falls Dam	Littlefls	29.9	11/4/03
Spokane River at Porcupine Bay	SPOK-1	11.3	11/06/03
Little Spokane River above SR291	LitlSpokSed	1.1	12/10/03
Buffalo Lake	BUFFALO REF	--	11/5/03

Due to the lack of bulk fine-grained deposits in the Spokane River, sampling was limited to a smaller number of sites than originally planned. Sampling the fine-grained sediment deposit behind Upriver Dam was deemed unnecessary due to the intensive investigation and cleanup being completed at this site.

Grain size composition and PCBs in surficial (top 2 cm) sediments from various Spokane River locations and one reference site (Buffalo Lake) are shown in Tables 29 and 30, respectively.

Table 29. Grain Size in Bottom Sediments (%).

Sample Name	Sample Number	Sand	Gravel	Silt	Clay
MonroeSed	04168149	47.1	52	0.8	0.0
LongLkUp	04208147	22	0.1	73.6	4.3
LongLkMid	03454111	3.6	0	76.3	20.2
LONGLKLOW	03454112/4*	7.0	0.1	59.1	34.0
Littlefls	03454113	88.2	0	9.4	2.3
SPOK-1	03458100	9.7	0	66.5	23.8
LitlSpokSed	03504060	84	0.2	13	2.8
BUFFALO REF	03458103	23.3	0.3	25.4	50.9

*Mean of replicate analysis.

Table 30. PCB Concentrations Grouped by Homologues in Surficial (top 2 cm) Bottom Sediments (ng/g, dw).

Station Name	Sample Number	TOC (%)	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
MonroeSed	4168149	0.36	<0.01	<0.01	0.04	0.15	3.00J	1.79	0.90	0.24J	0.05J	<0.02	6.17J
LongLkUp	4208147	2.8	0.17J	0.90	5.99	16.1	13.1J	8.52J	3.50	1.06	0.23	0.12	49.7J
LongLkMid	3454111	2.98	<0.24	0.30	3.05	7.31	5.54	5.23	1.76	0.86	0.27	0.08	24.4
LONGLKLOW	3454112/4*	2.81	0.09J	0.37	2.80	8.49	6.89	4.22	2.23	0.94	0.22	0.08	26.3
Littlefls	3454113	0.61	<0.05	0.10	0.24	0.52	0.62	0.35	0.05	<0.05	<0.05	<0.05	1.90
SPOK-1	3458100-S	1.71	<0.05	0.20	0.72	3.61	3.08	1.59	0.89	0.28	0.07	<0.05	10.4
LitlSpokSed	3504060	0.85	<0.05	<0.05	0.06	0.16	0.31	0.24	0.25	0.75	0.30	<0.05	2.06
BUFFALO REF	3458103-S	8.24	<0.05	0.06	0.07	0.30	0.82	0.81	0.30	0.12	0.23	0.16	2.88

*Mean of replicate analysis.
Detected values are in green highlight.
<: The analyte was not detected at or above the reported result.
J: The analyte was positively identified. The associated numerical value is an estimate.

Concentrations ranged from 50 ng/g total PCB at upper Lake Spokane to 1.9 ng/g at Little Falls. Upper Lake Spokane sediments have total PCB concentrations similar to suspended particulate matter concentrations at Ninemile, suggesting that this material is deposited in this reach. Surficial sediment PCB levels from the lower and middle reaches of Lake Spokane were one-half those in the upper reach.

The river sediments at Monroe St. had low PCB concentrations (6.2 ng/g total PCB) as did the Little Spokane River (2.1 ng/g) and Little Falls. The low concentrations probably reflected a lack of organic carbon-enriched fine material in these reaches. When PCB concentrations among sites were compared on an organic carbon normalized basis, the Lake Spokane stations retained the same relative PCB levels, Little Falls and the Little Spokane River were comparatively low, and Monroe St. total PCB concentrations were as high as those from upper Lake Spokane (Figure 16).

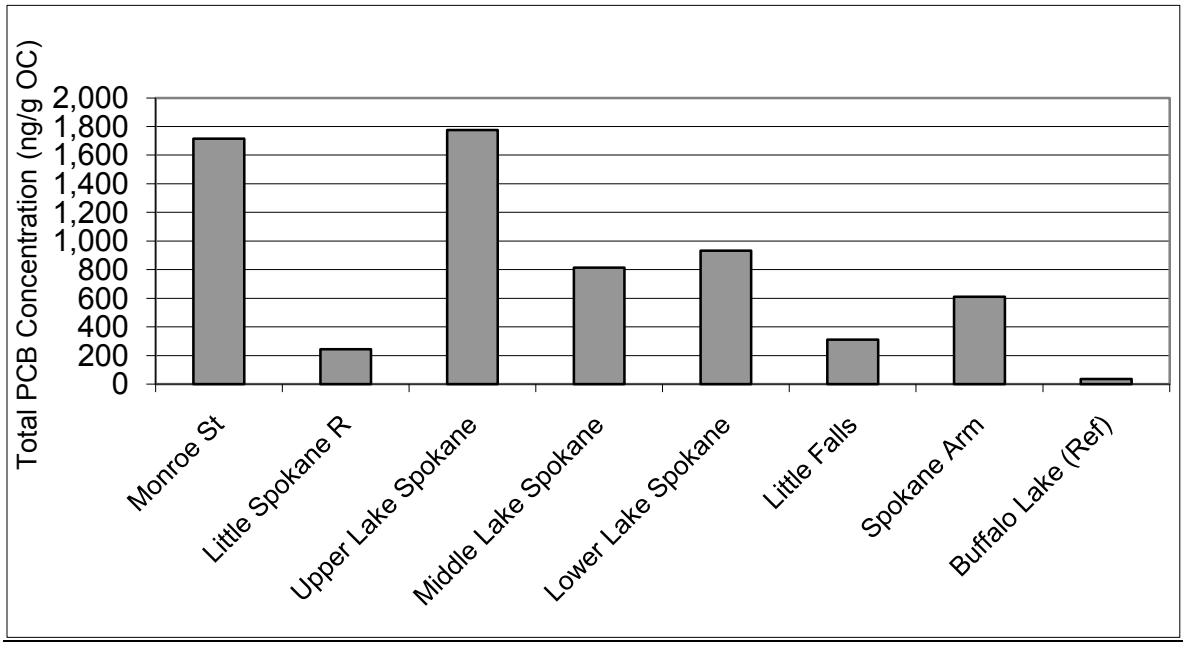


Figure 16. Surficial (Top 2 cm) Sediment PCB Concentrations in Spokane River and Little Spokane River Sediments Normalized to Organic Carbon (Buffalo Lake is a reference location).

TOC-normalized total PCB concentrations at Monroe St. and Upper Lake Spokane sediments were elevated 50 times the reference sediment from Buffalo Lake. Middle and lower Lake Spokane sediments were one-half that elevation. Little Spokane River and Little Falls sediments were more than nine times above PCBs in the reference sediments, while Spokane Arm (Porcupine Bay) levels were 18 times higher.

Temporal trends in sediment PCBs are difficult to establish due to the higher reporting limits in the Aroclor analysis of previous studies. For instance, Johnson and Norton (2001) found TOC-normalized total PCB concentrations of 400, 740, and 3,800 ng/g organic carbon at upper, middle, and lower Lake Spokane, respectively, but few Aroclors were detected and reporting limits were often >10 ng/g. In 1993, Ecology found 1,400 ng/g organic carbon at lower Lake

Spokane, using essentially the same analysis and near the same location (Ecology, 1995). Spokane Arm (Porcupine Bay) sediments from the same survey showed 770 ng total PCB/g organic carbon, representing the only other comparable data for sediments.

To more closely examine the historical record of PCB deposition in Spokane River sediments, PCBs were analyzed at various depths in a 30-cm core collected in upper Lake Spokane and in a 44-cm core from lower Lake Spokane. Table 31 shows total PCB concentrations at various depths in each core. Figures 17 and 18 show the chronology of PCB deposition based on radionuclide (^{210}Pb) decay in sediments (Appleby and Oldenfield, 1978).

Table 31. Total PCB Concentrations in Sediment Cores from Upper and Lower Lake Spokane (ng/g, dw).

Station/Sample ID	Depth (cm)	TOC (%)	Total PCB
LONGUP2			
04268382	0-1	2.82	8
04268383	1-2	2.38	14
04268384	3-4	2.27	16
04268385	5-6	1.81	16
04268386	7-8	1.94	19
04268387	9-10	1.79	33
04268388	11-12	1.85	32
04268389	14-15	1.85	28
04268390	24-25	2.01	51
04434079	28-29	1.87	32
04268391	29-30	2.58	30
LONGLOW2			
04268372	0-1	3.08	28
04268373	1-2	2.76	75
04268374	3-4	2.83	42
04268375	5-6	2.48	40
04268376	7-8	2.41	27
04268377	9-10	2.36	32
04268378	11-12	2.69	54
04268379	14-15	2.74	59
04268380	24-25	2.70	233
04268381	34-35	2.70	1,000
04434078	41-42	2.70	701

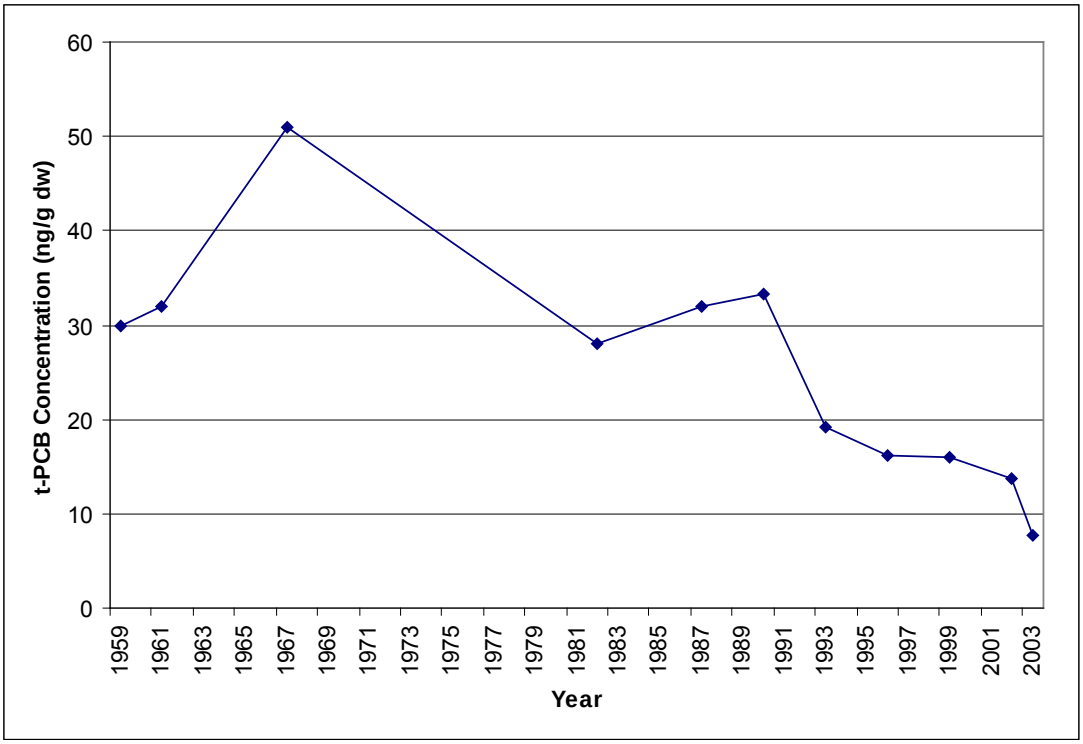


Figure 17. Chronology of PCB Concentrations in Upper Lake Spokane Sediments.

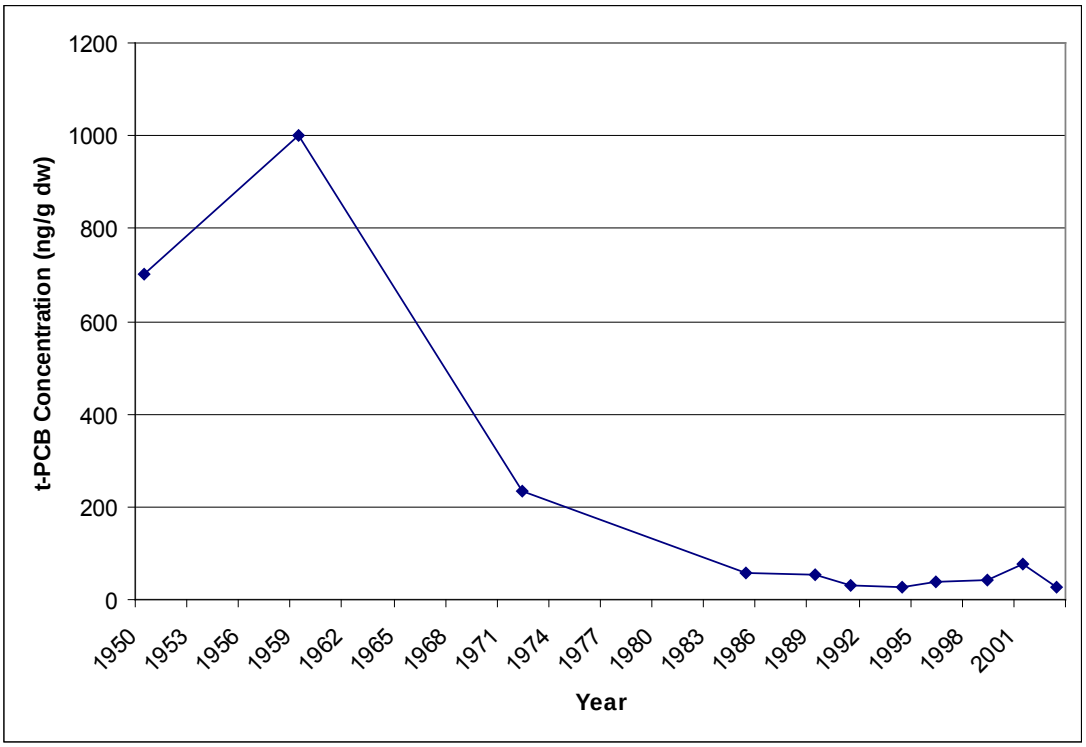


Figure 18. Chronology of PCB Concentrations in Lower Lake Spokane Sediments.

The sediment core from upper Lake Spokane was not as deep as desired due to coarser material preventing maximum corer penetration, and therefore PCB history could only be traced to circa 1959. The PCB profile showed a declining trend from 1959 to 2003, with a 1967 peak (51 ng/g), nearly coinciding with peak domestic PCB production in 1970.

The shape of the PCB profile from lower Lake Spokane had similarities to the upper lake. The peak occurred earlier with 1,000 ng/g circa 1959, but no horizons deposited between 1959 and 1972 were analyzed for PCBs, raising the possibility that the peak PCB concentration in this core was more than 1,000 ng/g and may have occurred later than 1959. PCB concentrations in sediment deposits have leveled off significantly in the past two decades, a pattern that has been observed at other locations in Washington (e.g., Serdar, 2003).

Cores from upper and lower Lake Spokane differ vastly in PCB levels, with peak years showing at least a 30-fold higher concentration at the lower lake. Lower Lake Spokane had post-peak total PCB concentrations 2-5 times higher than those deposited the same years in the upper lake, except during the early 1990s when PCB levels were nearly identical.

The surficial sediments and those normalized to TOC show upper Lake Spokane has higher PCBs. However, the sediment core samples and other studies indicate lower Lake Spokane historically had higher PCBs. This most likely has to do with the complex sedimentation history of the Lake Spokane Dam reservoir and sedimentation patterns from the tributaries to the lake.

The differences in PCB concentrations between upper and lower Lake Spokane and the apparent variability in PCB concentrations in upper lake sediments indicate that these locations receive sediments at proportionally different rates over time and possibly from different sources. The high level of PCBs historically deposited in the lower lake most likely originate from PCB contamination sources in and around Spokane, whereas the upper lake sediments are probably diluted with comparatively clean sediments from the Little Spokane River and Latah Creek, the latter providing large volumes of clean sediment (Johnson and Norton, 2001; SCCD, 2002).

The ^{210}Pb profile in the lower lake shows a steady input of newly formed material and little perturbation of sediments, while upper lake sediments appear to contain older material near the surface, presumably delivered from Little Spokane River and Latah Creek, and an inconsistent decay profile suggesting physical disturbance. Future analysis of upper lake sediments should be conducted with caution and consideration for the dynamics of sedimentation in this reach.

PCBs in Spokane River Fish

2003-2004

As part of the PCB source assessment, several species of fish were collected from multiple locations in the Spokane River from the state line through Lake Spokane. Table 32 shows concentrations of PCBs in rainbow trout fillets and in gut contents. Male rainbow trout from Plante Ferry had a somewhat higher PCB concentration than females, even though female fish were larger on average (391 vs. 363 mm). One possible explanation for the difference in concentrations at this location is that female fish may have mobilized PCBs along with lipids to egg production, since all female trout from this location were gravid. However, lipid content was nearly identical between sexes, suggesting other factors at play. Ninemile rainbow trout had slightly lower PCB concentrations than Plante Ferry possibly due to the smaller length (311 vs. 377 mm), exposure history, or lower lipids (1.3 vs. 1.7%) on average.

The Ninemile rainbow trout, having been analyzed individually, offer an opportunity to examine some of the factors determining PCB levels in tissue for fish collected from this location. Upon initial inspection, it appears that sex differences play a large role in PCB concentrations since females have twice the average PCB levels compared to males. However, the median age of the female fish was three years versus one year for the male fish, and the females were 20% longer on average. Another possible factor is the origin of the specimens; the larger females were all wild fish while the majority of male specimens were hatchery-raised based on the pattern of scale checking (John Sneva, WDFW, written communication). Differences in PCB levels of wild versus hatchery fish also may be due to foraging habits or prey selection.

PCB concentrations in rainbow trout gut contents were approximately 15%-30% those in tissue. Many of the specimens collected at both Plante Ferry and Ninemile were engorged with filamentous plant material. This material holds insects and other aquatic organisms, which are digested while the plant material remains undigested. Aquatic organisms extracted from Ninemile trout stomachs were mostly Corixidae (water boatman) adults, Chironomidae larvae, and Trichoptera larvae (probably Hydropsychidae). The gut contents of Plante Ferry rainbow trout were not examined closely, but casual observation suggested that contents were similar to Ninemile specimens; and PCB concentrations were similar as well. Crayfish or crayfish parts were also observed in the guts of some Plante Ferry trout.

Table 33 shows congener and total PCB concentrations (sum of detected congeners) in suckers analyzed whole and in gut contents. Crayfish from the Upriver Dam cleanup site are also included in Table 33. Suckers were composited by size to assess growth dilution as a potential factor in PCB concentrations. Growth dilution occurs when a fish grows faster than the accumulation rate of the contaminant of concern, lowering the contaminant concentration as the fish size increases.

Table 32. 2003-2004 PCB Concentrations in Rainbow Trout from Plante Ferry and Ninemile (ng/g, ww)

Station-Tissue	Sample ID	Composite	Sex	Lipid	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCB
Fillet															
PLANTE-F	4188308	Y	M	1.7%	0.004N	0.03	0.14	7.15	13.4	9.08J	10.2J	0.83	0.15J	0.02	40.9 J
	4188309	Y	F	1.7%	0.01J	0.06J	0.09	5.13J	6.35J	9.97J	5.82J	0.81	0.11	0.02	28.4 J
														mean=	**34.7**
Ninemile (WSTMP)[2]	084281	N	M	1.5%	<0.02	0.02	0.14	1.81	3.29	3.08	1.12	0.25	<0.02	<0.02	9.7
	084282/308 *	N	F	2.7%	0.02	0.03	1.01	6.45	19.8	20.4	6.45	1.73	0.16	0.02	56.0
	084283	N	M	1.3%	<0.02	0.03	0.13	2.35	5.04	4.25	1.41	0.26	0.03	<0.02	13.5
	084284	N	M	1.9%	<0.02	0.03	0.72	4.96	13.1	10.3	4.44	0.83	0.08	<0.02	34.4
	084285	N	F	1.1%	<0.02	<0.02	0.08	4.58	16.9	19.4	7.74	1.88	0.30	0.04	50.9
	084286	N	M	1.0%	<0.02	0.02	0.12	2.18	4.43	3.65	1.04	0.14	0.02	<0.02	11.6
	084287	N	M	0.4%	<0.03	<0.03	0.53	1.73	4.87	3.68	1.24	0.30	<0.03	<0.03	12.3
	084288	N	M	1.9%	<0.03	0.04	1.03	3.09	6.17	4.86	1.66	0.40	<0.03	<0.03	17.3
	084289	N	F	0.7%	<0.02	0.02	0.61	3.80	12.8	15.4	7.06	2.44	0.19	0.03J	42.4
	084290	N	M	3.3%	<0.02	0.04	1.70	9.48	31.2	19.0	10.7	2.20	0.15	<0.02	74.5
	084291	N	F	2.5%	<0.02	0.04	1.36	7.33	19.5	16.3	5.95	1.25	0.16	0.03	51.9
	084292	N	M	2.0%	<0.02	0.03	1.13	6.27	17.0	13.6	5.56	1.04	0.12	<0.02	44.8
	084293	N	M	1.8%	<0.02	0.03	0.39	3.75	9.98	8.96	3.23	0.65	0.09	<0.02	27.1
	084294	N	M	1.0%	<0.02	0.03	0.14	1.86	4.00	2.65	0.79	0.23	<0.02	<0.02	9.7
	084295	N	M	0.6%	<0.02	0.03	0.14	2.70	4.91	4.59	1.94	0.27	0.03	<0.02	14.6
	084296	N	M	0.4%	<0.02	0.03	0.11	2.20	4.18	2.72	1.16	0.25	0.02	<0.02	10.7
	084298	N	M	0.9%	<0.02	0.03	0.72	2.55	4.90	4.94	1.94	0.46	0.03	<0.02	15.6
	084299	N	M	0.2%	<0.02	0.03	0.07	2.62	7.16	4.67	1.84	0.39	0.02	<0.02	16.8
	084301	N	M	1.5%	<0.02	0.03	0.89	5.72	13.6	15.7	5.37	1.59	0.16	0.02	43.2
	084302	N	M	0.8%	<0.02	0.03	0.77	3.04	6.48	6.48	2.76	0.53	0.03	<0.02	20.1
	084303	N	F	0.9%	<0.02	0.03	0.60	3.29	9.30	10.7	3.28	1.35	0.11	0.02	28.7
	084304	N	M	0.3%	<0.02	<0.02	0.23	1.58	4.05	3.15	0.97	0.38	0.02	<0.02	10.4
	084305	N	M	0.5%	<0.03	0.04	0.55	1.89	4.29	3.35	1.66	0.33	<0.03	<0.03	12.1
	084306	N	M	1.6%	<0.02	0.03	1.00	4.32	11.9	12.8	3.38	1.03	0.10	<0.02	34.6
														mean of males =	**22.8**
														mean of females =	**46.0**
Gut Contents														**mean overall =**	**27.6**
PLANTE-F	4188311	Y			0.01N	0.03	0.06	0.11	1.77	0.97J	0.99J	0.14	0.02N	<0.02	4.1 J
NINEMILE-F	4188310	Y			<0.01	0.03	0.04	0.06	2.42	2.02J	1.35	0.21	0.03N	<0.01	6.2 J

[1] These Ninemile fish were collected under the station name "Spokane-F" as part of a concurrent WSTMP study and were analyzed as individuals.
*Mean of replicate analysis.
Detected values are in green highlight.
U: The analyte was not detected at or above the reported result.
J: The analyte was positively identified. The associated numerical value is an estimate.
NJ: There is presumptive evidence that the analyte is present. The associated numerical result is an estimate.

Table 33. 2003-2004 PCB Concentrations in Suckers and Crayfish Tissue from the Spokane River (ng/g, ww).

Station/Tissue	Sample ID	Size	Mean Length (mm)	Lip	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCB
Whole Body Suckers*															
STATELINE-F	4324442	Lg	513	4.5%	<0.02	<0.02	0.67	20.7	43.2	39.7	30.8J	5.78J	0.49	0.12	141.5 J
	4324443	Sm	445	3.4%	<0.02	<0.02	0.08	3.77	14.6	20.1J	16.8	3.02	0.40	0.10	59.0 J
														mean=	**100.2**
PLANTE-F	4324440	Lg	479	4.6%	<0.02	0.03	2.26J	30.2	52.4	25.0	25.9J	3.98	0.28	0.05	140.2 J
	4324441	Sm	453	3.3%	<0.02	0.02	0.76	9.71	19.0	12.7J	8.16	2.87J	0.24	0.04	53.5 J
														mean=	**96.9**
NINEMILE-F	4324447/8†	Lg	431	2.6%	<0.02	0.03	0.56J	3.33J	9.22J	11.0J	4.91J	1.27	0.21 J	0.05	30.6 J
	4324450	Sm	355	4.8%	<0.02	0.06	1.01J	3.86	8.77	9.66	3.49	0.79	0.16	<0.04	27.8 J
														mean=	**29.2**
LONGLOW-F	4324444	Lg	463	7.7%	<0.02	0.06	3.41J	43.4	59.7J	53.9J	25.5	8.17J	1.11	0.11	195.4 J
	4324446	Sm	433	9.1%	<0.02	0.06	4.08J	54.7	74.4J	78.0J	32.0	8.59	1.05	0.18	253.1 J
														mean=	**224.2**
Sucker Gut Contents															
PLANTE-F	4324445	--	485	na	<0.02	0.03	1.38	27.6	44.2	26.8J	14.1	3.40	0.28	0.04	117.8 J
NINEMILE-F	4324449	--	396	na	<0.02	0.02	0.03	0.29	1.13	1.48	0.28	0.05	0.02	<0.04	3.3
Crayfish Tail Muscle															
Upriver Dam	4208148	--	40	na	<0.006	0.02	0.01	0.03	0.036	0.05	0.54	0.18J	0.01	<0.01	0.87 J

*Largescale suckers except bridgelip suckers at NINEMILE-F.
†Mean of replicate analysis.
Detected values are in green highlight.
U: The analyte was not detected at or above the reported result.
J: The analyte was positively identified. The associated numerical value is an estimate.

Largescale suckers from Stateline and Plante Ferry had similar PCB concentrations. Composites of large fish had three times the PCB level of the smaller fish composites at both sites even though average lengths were not substantially different (513 vs. 445 mm at Stateline; 480 vs. 453 mm at Plante Ferry). The higher PCB concentrations in the large fish samples from these sites may be due to the 50% higher lipid content, yet even on a lipid-normalized basis, growth dilution does not appear to be a controlling factor in PCB concentrations.

The Lake Spokane largescale suckers had the highest PCB levels. Size disparity was similar (463 vs. 433 mm), and the sample of smaller fish had 30% higher PCB levels, but here again, the difference is not necessarily due to growth dilution since the sample composed of smaller fish had a 20% higher lipid content.

Bridgelip suckers from Ninemile had much lower PCB concentrations than suckers at other locations, possibly due to species difference or the smaller size of fish at Ninemile (large and small composites averaged 431 and 355 mm, respectively). However, PCB contamination of food items also appears to be a major factor since differences in PCB concentrations in whole fish from Plante Ferry and Ninemile reflect differences in PCB levels in gut contents.

Both rainbow trout and suckers appear to show drastic reductions in PCB concentrations compared to previous sampling. PCBs in rainbow trout fillet from Plante Ferry and Ninemile, when compared on a lipid-normalized basis to reduce covariability, have decreased an order of magnitude from 1999. Largescale suckers analyzed in 2003-2004 have approximately one-fifth the PCB concentrations compared to the previous sampling at Plante Ferry (1996) and lower Lake Spokane (2001). Bridgelip suckers collected from Ninemile in 2004 had much lower total PCB concentrations than the previous [largescale] sucker sampling at this location (880 ng/g lipid in 2004 vs. 31,000 ng/g lipid in 1999).

PCB concentrations in largescale suckers from Plante Ferry and lower Lake Spokane appear to be similar to "boundary conditions" at Stateline when compared on a lipid-normalized basis. This may suggest, generally, that PCB concentrations in certain Washington reaches of the Spokane River are in essence equilibrating to general conditions upstream in Idaho. A recent study of PCBs in Lake Coeur D'Alene fish (SAIC, 2003b) found a total PCB concentration of 1,580 ng/g lipid in whole largescale sucker, similar to the levels in Stateline suckers (2,440 ng/g lipid) as well as other locations analyzed during the present survey (2,340 ng/g lipid at Plante Ferry and 2,660 ng/g lipid at lower Lake Spokane).

An industrial or commercial legacy of PCB contamination is evident in the northern portion of Lake Coeur D'Alene. The SAIC study collected suckers (combined long-nose and large-scale) specifically around the area known as Blackwell Island, just outside the City of Coeur D'Alene. This location is the start of the Spokane River and has a long industrial history. The whole body sucker composites (combined long-nose and large-scale) ranged from 158 to 443 ug/Kg total PCBs. Large-scale sucker fillets collected more broadly from the north quadrant of the lake ranged from 52 to 124 ug/Kg. Much lower levels of 9 to 15 ug/Kg were found in kokanee and largemouth bass fillets more widely composited from the north quadrant of the lake.

Crayfish from the Upriver Dam fine-grained sediment site showed low levels of PCBs in tail muscle (0.87 ng/g total PCB). Previous analyses of muscle tissue from Spokane River crayfish also found mostly undetectable or low (≤ 7 ng/g total PCB) concentrations, indicating crayfish muscle is a poor sentinel of PCB contamination. Whole crayfish have not been analyzed and could have higher PCB concentrations due to gut contents or accumulation in hepatopancreas or other organs.

2005

Table 34 summarizes the data obtained on PCB levels in Spokane River fish during 2005, (Serdar and Johnson, 2006). Mean concentrations of total PCBs (sum of detected Aroclor-equivalents) ranged from 37-234 ug/Kg in sport fish fillets and 56-1,823 ug/Kg in whole largescale suckers.

Table 34. Summary of PCB Concentrations Measured in Spokane River Fish Collected in 2005.

Reach	Species	N* =	Total PCBs (ng/g, wet weight)	
			Mean	Range
Fillet Samples				
Plante Ferry	Rainbow Trout	3	55	48 - 68
Mission Park	Rainbow Trout	3	153	118 - 220
	Mountain Whitefish	3	234	203 - 280
Ninemile	Rainbow Trout	3	73	46 - 94
	Mountain Whitefish	3	139	86 - 172
Upper Lake Spokane	Mountain Whitefish	3	43	36 - 55
	Brown Trout	1	130	- -
	Smallmouth Bass	1	37	- -
Lower Lake Spokane	Mountain Whitefish	6	76	<9.6 - 190
	Smallmouth Bass	3	67	49 - 82
Whole Body Samples				
Stateline	Largescale Sucker	3	56	16 - 77
Plante Ferry	Largescale Sucker	3	122	91 - 180
Mission Park	Largescale Sucker	3	1,823	1,100 - 3,000
Ninemile	Bridgelip Sucker	3	69	52 - 94
Upper Lake Spokane	Largescale Sucker	3	327	160 - 510
Lower Lake Spokane	Largescale Sucker	3	254	109 - 396

*Composites of 4-5 individual fish each, except lower Lake Spokane mountain whitefish were analyzed individually.

In both types of samples, concentrations gradually increased between the Stateline and Mission Park reaches, then decreased from Mission Park down into lower Lake Spokane. The concentrations in Lake Spokane were higher than in the upper part of the river at Stateline and Plante Ferry.

Fish tissue studies often differ in sample size, use of composites vs. individual fish samples, and in other ways and are not appropriate for statistical testing for long-term trends. Therefore a qualitative, weight-of-evidence approach was taken for identifying long-term changes in PCB levels, coupled with a statistical test for significant differences for the limited instances where comparable data exist.

The data were examined to determine if it would be appropriate to normalize to the lipid content of the samples, since concentrations of PCBs and other organochlorines sometimes vary directly with lipid content. For the majority of species and locations, there was not a good correlation between total PCBs and percent lipids (Serdar and Johnson, 2006).

Serdar and Johnson (2006) identified seven data sets, by river reach, where the same fish species and tissues were analyzed for two or more time periods and where the sample size and type was sufficient for statistical analysis (Table 35). They found substantial decreases in fish tissue PCB concentrations for the following reaches:

- Plante Ferry
- Mission Park
- Ninemile
- Upper Lake Spokane

Table 35. Significant Changes Identified in Total PCB Concentrations in Spokane River Sportfish Fillets: Results from Analysis of Variance on Comparable Data Sets, 1994-2005.

Reach	Species	Sample Type	Time Period	*p* value (Probability)	Significant Change? ($p < 0.10$)
Plante Ferry	Rainbow Trout	composites	1994-1996	1.00	No
			1996-2005	0.34	
			1994-2005	0.01	Decrease
Mission Park	Rainbow Trout	composites	1994-2005	0.85	No
	Mountain Whitefish			0.02	Decrease
Ninemile	Rainbow	composites	1994-1996	0.07	Decrease
			1996-2005	1.00	No
			1994-2005	0.06	Decrease
		individuals	1996-2005	0.00	
	Mountain Whitefish	composites	1994-1996	0.01	Increase
			1996-2005	0.01	Decrease
Upper Lake Spokane	Mountain Whitefish	composites	2001-2005	0.05	Decrease

Appendices D and E of Serdar and Johnson (2006) have the total PCB data for all Spokane River fish tissue samples analyzed by Ecology from 1993 to 2005.

Results of this analysis suggest that, at least for these two species, there has been a significant decrease in PCB concentrations between 1994 and 2005. Evidence for a similar decrease in the Mission Park reach was equivocal. The general picture that emerges from the historical data on the Spokane River is one of decreasing PCB concentrations in fish from all areas of the river since 1994, except perhaps Mission Park.

The long-term declines in PCBs noted along the upper Spokane River both statistically and qualitatively are consistent with recent Ecology regulatory and investigatory actions that are yielding reductions in PCBs entering the river from NPDES discharges and remedial actions associated with cleanups at a major industrial facility. Lake Spokane may also be responding to the actions taken in the upper river. The apparent lack of a decline in PCB levels in fish from the Mission Park reach is consistent with stormwater discharge being the largest current source of PCBs to the river.

Table 36 compares the 2005 results with statewide data on PCBs in freshwater fish, based on fillet data reported by Seiders and Kinney (2004) and whole fish data reported by Davis et al. (1994, 1995, 1996, 1998). The fillet samples were primarily collected during 1995-2002; the whole fish samples are from 1992-1995. To avoid biasing the statewide results high, data for Spokane River fish were excluded. The statewide data do not represent "background" sampling from waters generally free of human influences, but are from various waters around the state including lakes, rivers, and streams also impacted by industrial and municipal discharges.

Table 36. Total PCB Concentrations in Spokane River Fish vs. Statewide Data (ug/Kg, wet weight).

Total PCBs	Spokane River 2005		Statewide	
	Fillet N=24	Whole Body N=24	Fillet N=98	Whole Body N=28
Mean	104	442	155	151
Median	78	135	28	87
Minimum	36	16	1.2	7.1
Maximum	280	3,000	1,943	622
90th percentile	213	1,181	297	334

For the most part, PCB concentrations in the 2005 Spokane River fillet samples are in the range of the statewide mean and median for fillets. The whole fish results for Mission Park and Lake Spokane are at or above the upper end of the range of whole fish statewide values.

Ecology recently completed an assessment of PCB levels in fish from background lakes, rivers, and streams throughout Washington (Johnson et al., 2010). Table 37 compares the results with the 2005 Spokane River edible fish tissue data. Whole body samples were not analyzed for the background study.

Statewide data obtained through the background study suggest that Spokane River fish are elevated by about an order of magnitude over other waterbodies with no obvious sources of contamination. It should be recognized, however, that the local background in the Spokane region may differ from these statewide results.

Table 37. Total PCB Concentrations in Spokane River Fish vs. Statewide Freshwater Background (ug/Kg, wet weight; fillet samples).

Total PCBs	Spokane River 2005 N=24	Statewide Background N=52
Mean	104	4.9
Median	78	1.4
Minimum	36	0.04
Maximum	280	88
90th percentile	213	6.5

Assessment of PCB Sources

The following section contains an assessment of PCB sources to the Spokane River, which include industrial and municipal effluents, stormwater, the Spokane River at the state line with Idaho, and the Little Spokane River. Loads from other sources are considered inconsequential (Ecology, 1995; Golding, 1996, 2001, 2002).

Deep Creek was initially considered for source assessment in the present study, but the lower section of the creek appears to be a hydraulically losing reach, and no water was present. Previous monitoring of Latah Creek detected no PCBs in the sediments (Johnson and Norton, 2001). The potential for other small tributaries to deliver PCBs to the Spokane River was considered low, and they were not sampled.

Other possible secondary sources to consider are groundwater and atmospheric deposition.

Groundwater has previously been monitored at the Kaiser Trentwood facility to assess its potential as a source of PCBs to the Spokane River, but Hart Crowser (1995) concluded that groundwater inflow was not a primary PCB transport pathway to the river from the facility. In addition, Ecology's Toxics Cleanup Program currently is overseeing the cleanup of PCBs at Kaiser Trentwood to ensure groundwater contamination will not impact the river.

Atmospheric deposition of PCBs is known to be pronounced in areas where cold condensation occurs, such as in the mountains of southern British Columbia and Alberta (Blais et al., 1998). This phenomenon holds the potential to deposit measurable quantities of PCBs in the mountains in the eastern portion of the Spokane River basin, eventually delivering PCBs to Lake Coeur D'Alene through the St. Joe, St. Maries, and Coeur D'Alene Rivers and, excluding industrial sources in Idaho, may partially explain higher than expected concentrations of PCBs in fish from Lake Coeur D'Alene. Delivery of PCBs to Washington from this source would be integrated to a single channel: the Spokane River at Stateline.

The Spokane River basin downstream of the Idaho border would not be ideal for atmospheric deposition due to aridity of the region, and PCBs that are deposited in the area would theoretically be integrated into delivery systems already considered, such as the Little Spokane River and urban stormwater. Deposition of PCBs directly to the surface of the Spokane River would be minimal due to its small surface area relative to the basin area. Atmospheric deposition is an un-quantified source of PCBs to the Spokane River.

Loss of PCBs to the atmosphere through volatilization has also not been quantified. PCB budgets for the Great Lakes area have shown atmospheric flux to be an order of magnitude greater than input and output through surface waters, with loss through volatilization approximately five times greater than atmospheric deposition (EPA, 1993).

PCB Loading Calculations

PCB loads calculated for the present 2003-07 study only include surface water inputs and outflow, generally using the following formula:

Equation 6. Daily Load (mg/day) = C_w x (10^{-9} mg/pg) x Q x (86,400 s/day)

Where:

- C_w (concentration in whole water) = concentration of PCBs in water (pg/l).
- Q (discharge) = flow of the delivery system being considered (L/sec).

To simplify the data presentation and maintain consistency with applicable criteria, loads are calculated for total PCBs only.

Industrial and Municipal Effluents

Table 38 shows PCB loads in effluents identified as PCB sources in this study. PCB loads from Liberty Lake WWTP, Inland Empire, and the Spokane WWTP were calculated using a combination of results from the present survey and previous sampling (Table 21). For the Liberty Lake and Spokane WWTPs, loads were calculated using the mean total PCB concentrations and instantaneous flows from 2001 and 2003-2004. For Inland Empire, loads were calculated using the mean total PCB concentrations and instantaneous flows from 2001, 2002, and 2003-2004. In samples where no PCBs were detected, reporting limits were used to calculate the average.

PCB loads from Kaiser were based on total PCB concentrations and instantaneous flows from nine samples collected during 2004 and 2005 (Table 20) since these represent the most current data on PCBs in Kaiser effluent.

Table 38. Estimated PCB Loads in Industrial and Municipal Effluents Discharged to the Spokane River.

Facility	RM	Total PCB (pg/l)	Discharge (ML/day)	Total PCB Load (mg/day)
Liberty Lake WWTP	92.7	1,121	2.5	2.9
Kaiser Trentwood	86.0	1,080	60	65
Inland Empire Paper	82.5	2,544	18	45
Spokane WWTP	67.4	1,364	143	194
			Total =	307

ML/day = megaliters/day [0.264 MGD (million gallons per day)].

Urban Stormwater Runoff

For the sampling conducted in 2004, PCB loads delivered to the Spokane River through stormwater were calculated using the "Simple Method" model to estimate runoff volume and calculate contaminant loads (www.stormwatercenter.net/).

For 2007, Parsons calculated the loads from sampled and un-sampled drains in the City of Spokane using two different discharge estimates: (1) calculated by the Simple Method to be consistent with the 2004 data, and (2) the reported discharge volumes from the City of Spokane's CSO Annual Report for fiscal year 2005. Both loading scenario calculations for the un-sampled drains used the average concentration from the sampled drains. Parsons concluded that the actual loading of PCBs to the river from stormwater is likely somewhere between the two estimates.

For the source assessment study, the loads from the stormwater sewer network were calculated as the sum of the load determined by the Simple Method for the sampled storm drains and the load using the 2005 discharge volumes for the un-sampled storm drains. The magnitude of stormwater discharge plays a large role in the loading calculations. Parsons stated that because direct untreated CSO discharges may occur only during large runoff events, the Simple Method was considered an upper bound.

The sum load from the sampled stormwater basins using the Simple Method was 557 mg/day total PCBs, and the un-sampled stormwater basins using the discharge records from the City of Spokane was 133 mg/day total PCBs.

The Simple Method uses the formula:

Equation 7 $L = 0.226 * R * C * A$

Where:
- L = Annual load (lbs).
- R = Annual runoff (inches).
- C = Pollutant concentration (mg/L).
- A = Area (acres).
- 0.226 = Unit conversion factor.

Annual runoff and runoff coefficient were previously presented as Equations 4 and 5.

Tables 39 and 40 show the estimated PCB stormwater loads in the sampled and un-sampled stormwater basins (data from Parsons, 2007).

The total stormwater load (691 mg/day) from the City of Spokane is considered to be the sum of the high load scenario for the sampled stormwater outfalls above and below Monroe St. Dam (557 mg/day) Table 39, and the low load scenario (133 mg/day) for the un-sampled stormwater outfalls, Table 40. The locations of the un-sampled stormwater outfalls were assumed to be half above and half below the Monroe St Dam.

Table 39. PCB Load from Sampled Stormwater Basins based on Simple Method Discharges, Parsons (2007).

Location_ID[1]	Average t-PCB (ng/L)[2]	Annual t-PCB Load (lb)[3]	Daily t-PCB Load (mg/day)[4]	Annual t-PCB Load/Acre (mg/acre)
Sampled Stormwater Basins (High CSO Load Scenario)				
Above Monroe St Dam				
GREENE	19.5	0.001	1	12.2
MISSION	16.5	0.001	1.2	8.2
RIVERTON	22.3	0.005	6	9.1
SUPERIOR	17.8	0.007	9	11.5
UNION	97	0.013	16	54.8
ERIECSO (CSO 34)	177	0.336	417	78
WASHINGT	4.05	0.003	3.6	2.9
HOWARDBR	8.74	0.001	0.9	6
Below Monroe St Dam				
LINCOLN	4.36	0.001	0.7	3.9
CLARKE (CSO 24A)	2.56	0.005	6	1.2
7TH (CSO 26)	3.38	0.003	4	2.5
COCHRAN	12.9	0.072	90	6.3
HSTREET (CSO 7)	2.49	<0.001	0.4	1.1
HWY291	0.978	0.002	2	0.4
Totals		0.45	**557**	198

[1] In EIM these Locations IDs have the prefix STMWTR_; and CSO # in parentheses is not part of Location ID.
[2] Average of all the samples collected in the 2007 Parsons study; the PCB average was updated by Ecology.
[3] Calculated using Equation (5).
[4] Daily PCB load (mg/day) = Annual load (lb/yr)*453000 mg/lb /365.
Rows highlighted in green correspond to CSO basins.

Table 40. PCB Load from Un-Sampled Stormwater Basins based on 2005 City Discharge Data, Parsons (2007).

Location_ID[1]	Average t- PCB (ng/L)[2]	Annual t-PCB Load (lb)[§]	Daily t-PCB Load (mg/day)[#]	Annual t-PCB Load/Acre (mg/acre)
29 Un-Sampled Stormwater Basins (Low CSO Load Scenario)				
I05 Upper	23	0.014	17.82	8.7
I04	23	0.007	8.57	18.0
I07	23	0.004	5.01	10.1
CSO 33B	23	0.022	27.80	9.2
CSO 06	23	0.012	14.90	11.3
CSO 12	23	0.010	13.02	12.4
I03	23	0.001	0.73	1.9
CSO 23	23	0.005	5.96	13.3
CSO 41	23	0.002	2.37	9.7
CSO 16B	23	0.002	2.41	7.4
CSO 25	23	0.001	1.08	18.7
CSO 33D	23	0.002	2.41	17.9
CSO 14	23	0.002	1.95	10.0
CSO 10	23	0.001	1.79	11.9
CSO 15	23	0.003	3.64	10.8
CSO 42	23	0.000	0.37	22.5
CSO 40	23	0.002	1.92	12.3
CSO 39	23	0.001	1.60	11.4
CSO 33A	23	0.001	1.77	9.7
CSO 38	23	0.002	2.19	11.2
CSO 24B	23	0.003	3.54	18.2
CSO 33C	23	0.001	0.85	19.3
CSO 20	23	0.005	6.65	9.6
CSO 02	23	0.002	1.95	11.1
CSO 19	23	0.001	0.99	10.6
CSO 16A	23	0.001	0.76	10.7
CSO 03C	23	0.000	0.34	12.3
CSO 18	23	0.000	0.22	6.1
CSO 34TOSVI	23	0.000	0.15	10.9
Totals		0.11	133	347

[1] In EIM these Locations IDs have the prefix STMWTR_; and CSO # in parentheses is not part of Location ID.
[2] Average of all the samples collected in the 2007 Parsons study; the PCB average was updated by Ecology.
[3] Calculated using Equation (5).
[4] Daily PCB load (mg/day) = Annual load (lb/yr)*453000 mg/lb /365.
Rows highlighted in green correspond to CSO basins.

Parsons found the largest stormwater PCB loads to the Spokane River originate from the Cochran, CSO 34, Union Street, and I05 Upper stormwater basins under both discharge scenarios.

Instream Loads

Harmonic Mean Flow

The harmonic mean flow is recommended by EPA (1991a) for use in assessing a river's loading capacity for long-term exposure to carcinogens such as PCBs. Harmonic mean is the appropriate measure of central tendency when dealing with rates, in this case rates of flow. The harmonic mean is less than the arithmetic mean and is expressed as $Q_h = n/\sum(1/Q_i)$, where n is the number of recorded flows and $\sum(1/Q_i)$ is the sum of the reciprocals of the flows.

As noted by EPA (1991b), the harmonic mean "provides a more reasonable estimate than the arithmetic mean to represent long-term average river flow. Flood periods in rivers bias the arithmetic mean above the flows typically measured. This overstates available dilution. The calculation of the harmonic mean, however, dampens the effect of peak flows. As a result, bias is reduced. The harmonic mean is also an appropriate conservative estimate of long-term average flow in highly regulated river basins, such as the Columbia. In a regulated river basin, the harmonic mean and the arithmetic average are often much closer numerically."

PCB Loads in the Spokane River at the Idaho Border

PCB loads at the Idaho border were calculated using the average dissolved total PCB concentration from 2003-2004 Stateline SPMD data and historic harmonic mean flow at USGS Gage 12419500 (Spokane River above Liberty Bridge). Two methods were used to calculate the whole water PCB concentrations: (1) extrapolation using the dissolved fraction estimated from Equation 3 and (2) addition of the solid component measured in Harvard Rd. suspended particulate matter (Table 41). Both methods yield an estimated total PCB load of approximately 480 mg/day. Results using the two methods are nearly identical since the theoretical dissolved fraction (0.92) is similar to the measured dissolved fraction (0.91).

Table 41. PCB Loads in Spokane River at Idaho Border.

Station	RM	Harmonic Mean Flow (L/sec)	Method for Calculating C_w	Component	Mean Total PCB C_w (pg/l)	Total PCB Load (mg/day)
Stateline	96.1	52,151*	Stateline SPMD (C_d) /diss fraction (0.92) from Equation 3	**C_w=**	**106**	**477**
Harvard	92.8	52,151*	Stateline SPMD (C_d) + Harvard suspended particulate matter (C_s)	Diss. (C_d)	97	439
				Solid (C_s)	10	43
				Total (C_w)=	**107**	**482**

* Flow from USGS Station 12419500: Spokane River above Liberty Br (RM 93.9).

C_w Concentration in whole water.

PCB Loads in the Little Spokane River

PCB loads in the Little Spokane River were calculated using the average Little Spokane SPMD data from 2003-2004 and historic flows at USGS Gage 12431000 (Little Spokane River at Dartford). Equation 3 was used to estimate dissolved and solid-phase fractions based on TSS concentrations in the Little Spokane River.

The estimated average total PCB load in the Little Spokane River is 97 mg/day (Table 42). Approximately 74% of this load is in the dissolved phase, based on estimation using Equation 3 and an average TSS of 5 mg/L.

Table 42. PCB Loads in the Little Spokane River.

Location	RM	Harmonic Mean Flow (L/sec)	Mean Total PCB C_d (pg/l)	Fraction C_d	Mean Total PCB C_w (pg/l)	Total PCB Load (mg/day)
Little Spokane R.	56.3	5,619*	147	0.74	199	96.6

* Flow from USGS Station: 12431000 Little Spokane River @ Dartford.

PCB Loads in the Mainstem Spokane River

PCB loads estimated from the 2003-2004 monitoring are shown in Table 43. Loads were calculated as described previously, i.e., using harmonic mean flows (from Figure 3), mean data collected using SPMDs, and application of Equation 3 to estimate total PCB concentrations from the dissolved fraction.

Table 43. Instream PCB Loads in Spokane River Reaches and the Little Spokane River.

Location	RM	Harmonic Mean Flow (L/sec)	Mean Total PCB C_d (pg/l)	Fraction C_d	Mean Total PCB C_w (pg/l)	Total PCB Load (mg/day)
Stateline	96.1	52,151[a]	97	0.92	106	477
Upriver Dam	80.3	53,081[b]	68	0.88	77	354
Upriver Dam (bottom)	80.3	53,081[b]	138	0.88	157	721
Monroe St.	74.8	82,239[c]	179	0.90	199	1,413
Ninemile	63.6	82,758[d]	265	0.85	311	2,281
Lower Lake Spokane	38.4	106,329[e]	332	0.83	399	3,664
Little Spokane R.	56.3	5,619[f]	147	0.74	199	97

[a] Flow from USGS Station 12419500: Spokane River above Liberty Br. (RM 93.9).
[b] Flow from USGS Station 12419500: Spokane River above Liberty Br. (RM 93.9) plus sum of flows from municipal and industrial facilities.
[c] Flow from USGS Station 12422500: Spokane River at Spokane (RM 72.9).
[d] Sum of Flows from USGS Station 12422500: Spokane River at Spokane (RM 72.9) and Station 12424000 – Latah (Hangman) Creek at Spokane (RM 72.2).
[e] Flow from USGS Station 12433000: Spokane River at Lake Spokane (RM 33.8).
[f] Flow from USGS Station 12431000: Little Spokane River at Dartford (RM 56.3).

In the mainstem Spokane River, PCB loads spanned an order of magnitude, from 350 mg/day at Upriver Dam to 3,700 mg/day at lower Lake Spokane (Figure 19). Higher PCB concentrations occurred in reaches with higher flows, compounding the increase in estimated loads traveling downstream. One exception to this pattern occurs at Upriver Dam (mid-depth), where all of the PCB loading can be attributed to loads moving downstream from the Idaho border (Stateline). Although PCB loads estimated at the bottom of the water column are twice those in the middle column, the mid-column loads are probably more representative of the actual river conditions whereas the bottom loads are influenced by localized conditions as discussed previously. With successful completion of the Upriver Dam cleanup, lower bottom-water concentrations of PCBs would be expected.

Loads were not calculated for Little Falls reservoir or the Spokane Arm due to the absence of PCB data from these reaches. However, it is reasonable to assume that instream loads at Little Falls are identical to those at Lake Spokane since there are no known additional PCB sources to the Little Falls reservoir, flow contributions or losses to the reservoir are minor, and residence time is short since Little Falls is a run-of-the-river dam.

These conditions are also true for the upstream half of the Spokane Arm which is free-flowing. The assumption of identical loads in the lower half of the Spokane Arm (approximate delineation at Porcupine Bay [RM 13]) is tenuous due to the influence of Lake Roosevelt which backs up the water in this reach during most of the year and has an undetermined effect on PCB concentrations and loads. Limited evidence suggests that Lake Roosevelt itself contributes at most a small portion of the PCBs to the Spokane Arm and more likely has a diluting effect. PCB concentrations in Lake Roosevelt fish tissues have been low compared to fish from the lower reaches of the Spokane River (EVS, 1998; Munn, 2000).

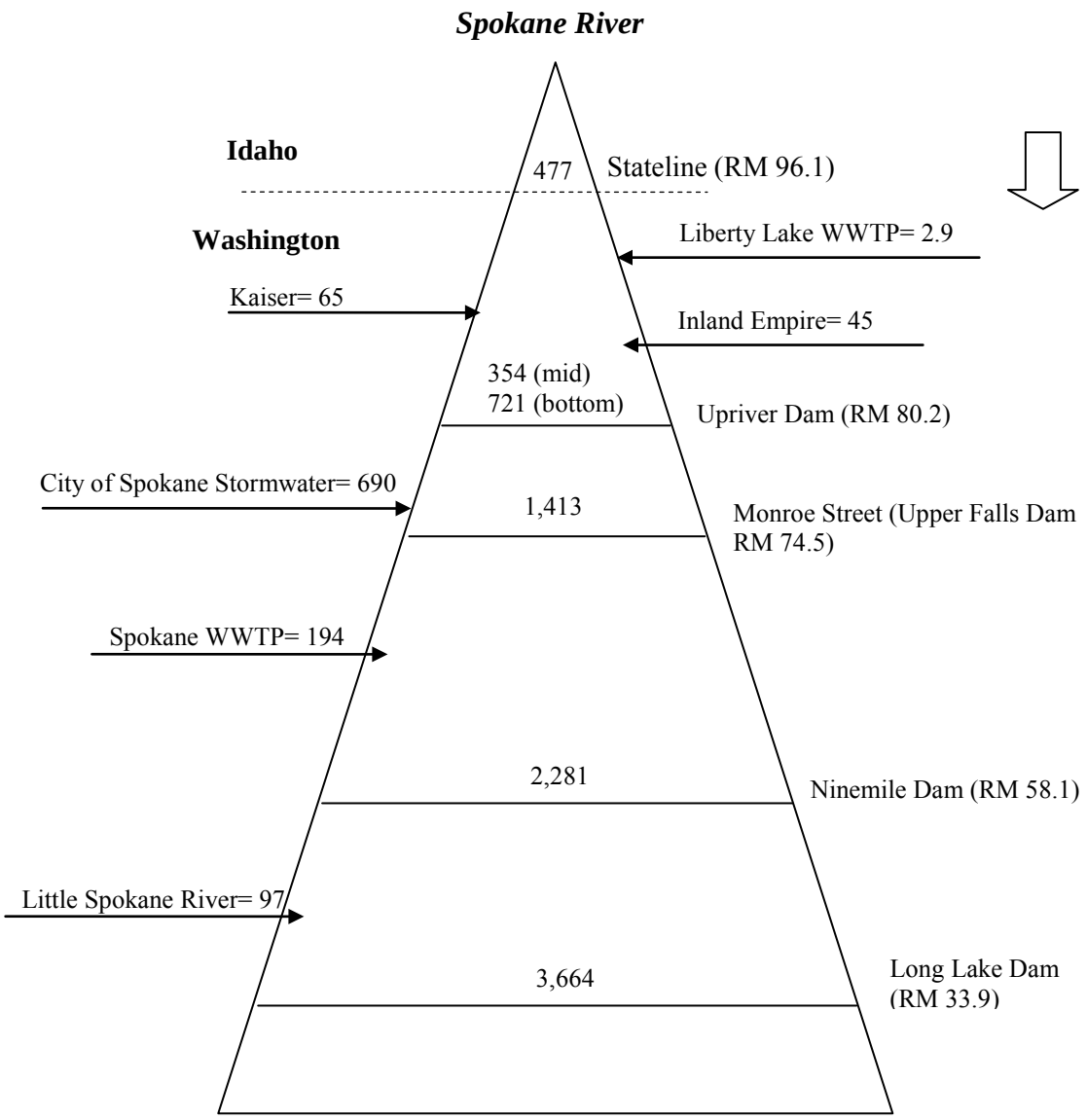


Figure 19. Schematic of PCB Sources and Instream Loads in the Spokane River (total PCB, mg/day).

Load Reductions Needed to Meet Human Health Criteria

Table 44 shows estimates of the reduction in PCB loads that would be needed to meet NTR and Spokane Tribe human health water quality criteria in the mainstem Spokane River and Little Spokane River. The "current" PCB loads were calculated in the preceding section of this report.

Table 44. Estimates of PCB Load Reductions Needed to Meet Human Health Water Quality Criteria in the Spokane River (based on 2003-04 water column data).

Location on Spokane River	Harmonic Mean Flow[a] (l/d)	Current t-PCB Conc.[a] (pg/l)	Current t-PCB Load (mg/day)	Target t-PCB Load (mg/day) at Water Quality Criterion		t-PCB Load Reduction Required to Meet Water Quality Criterion	
				NTR (170 pg/l)	Spokane Tribe (3.37 pg/l)	NTR	Spokane Tribe
Stateline	4.51E+09	106	477	766	15	none required	97%
Upriver Dam	4.59E+09	117	537	780	15		97%
Monroe St.	7.11E+09	199	1,413	1,208	24	15%	98%
Ninemile	7.31E+09	311	2,281	1,243	25	46%	99%
Little Spokane River	4.85E+08	199	97	83	2	15%	98%
Lake Spokane (lower)	9.19E+09	399	3,664	1,562	31	57%	99%
Little Falls	9.19E+09	399	3,664	1,562	31	57%	99%
Spokane Arm	9.19E+09	399	3,664	1,562	31	57%	99%

[a] From Table 43

During 2003-04, the Spokane River was meeting the NTR criterion for water (170 pg/l) between Stateline and Upriver Dam but not further downstream. Load reductions of 15-57% would be required to meet this criterion throughout the river, with the largest reductions needed in and below the Ninemile reach. A 15% reduction is called for in the Little Spokane River.

Very large reductions in loading would be required to meet the much more restrictive Spokane Tribe criterion (3.37 pg/l). These range from 97% at Stateline to 99% by Ninemile.

In order for the Spokane River to achieve compliance with human health water quality criteria, reduction of similar magnitude may be needed in loading from municipal and industrial discharges that have been identified as PCB sources. In the Washington reaches of the river, stormwater carries the largest PCB load and is thus the most important source to reduce.

Food Web Bioaccumulation Model

Fish accumulate PCBs through a variety of pathways including bio-concentration (direct uptake of dissolved PCBs in water through the gills and skin), diet, and, in some cases, direct ingestion of sediment. Both the NTR and Spokane Tribe water quality criteria may underestimate the PCB concentrations that will result in a fish because bio-concentration is the only accumulation mechanism considered in the NTR. Previous studies in the Spokane River have found the bio-concentration factor (BCF) of 31,200 L/kg used to derive this criterion to be a poor link between PCB concentrations in water and fish tissue. For instance, Jack et al. (2003) estimated that the BCF explained no more than 23% of the PCB accumulated in Spokane River fish tissue. To accurately relate water concentrations to fish tissue, all pathways must be considered including direct and indirect contributions from sediments.

It is widely recognized that bioaccumulation factors (BAFs) describe a much more meaningful relationship between water and tissue concentrations than BCFs (EPA, 2000b). Like BCFs, BAFs numerically describe the link between water concentrations and accumulation in tissue, but they integrate all exposure pathways (bio-concentration, diet, other sources) and therefore more accurately reflect the water-tissue relationship. Using a simplified computation method, BAFs for the Spokane River were estimated to be in the range of 10^5 - 10^6 L/kg (Jack et al., 2003).

In some cases, sediment may be a more important pathway for PCB exposure in fish, either through consumption of benthic organisms as prey or through direct ingestion of sediments. In instances where sediment exposure is important, the relationship is described as the biota-sediment accumulation factor (BSAF), a tissue concentration divided by a sediment concentration and usually normalized to lipid in tissue and organic carbon in sediment. If a BSAF is much better than a BAF at describing the link between contaminants in the aquatic environment and fish tissue concentrations, then sediment recovery rates (either natural or through cleanup actions) applied to BSAFs may be used to predict contaminant declines in fish tissues. In Lake Spokane, the sediment BSAF calculated from mean sediment and fish tissue concentrations was 10.9 (Jack et al., 2003).

Neither the BAF nor the BSAF by themselves can accurately describe the link between PCBs in the aquatic environment and fish tissue. Because of the interactions among water, sediments, and biota (prey items), it is impossible to account for fish tissue concentrations resulting from exposure to these sources when they are considered independently. Therefore, a mathematical food web bioaccumulation model was used to estimate PCB concentrations in fish tissue and prey items from concentrations in water and sediment.

Water or sediment quality targets based on the model have no regulatory standing without first meeting procedural requirements of site-specific criteria development. However, model development may be a useful exercise to determine if the existing numerical approach is adequate and if site-specific criteria are warranted.

The Model

A food web bioaccumulation model developed by Arnot and Gobas (2004) was selected to predict the PCB concentrations in fish tissues. This model calculates site-specific concentrations of hydrophobic organic chemicals in multiple aquatic ecosystem compartments and is a refinement of a widely used model previously developed by Gobas (1993). The model cannot only be used to predict PCB concentrations in fish tissue, BAFs, and BSAFs using relatively few input parameters, but more importantly, the model can be used to back-calculate PCB concentrations in water and sediment from target PCB concentrations in fish tissue.

A model such as this has potential value for affirming targets for both tribal and non-tribal fish consumers in specific localized areas of the river. In this way, local targets can be set to guide immediate efforts at improving conditions nearer sources, within the realm of practicability.

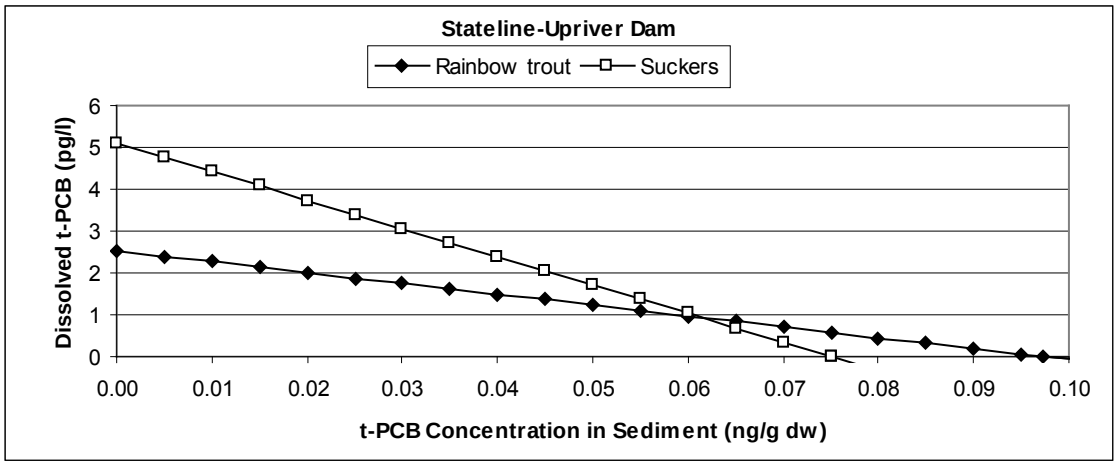
Details of the Arnot/Gobas model are in Appendix H.

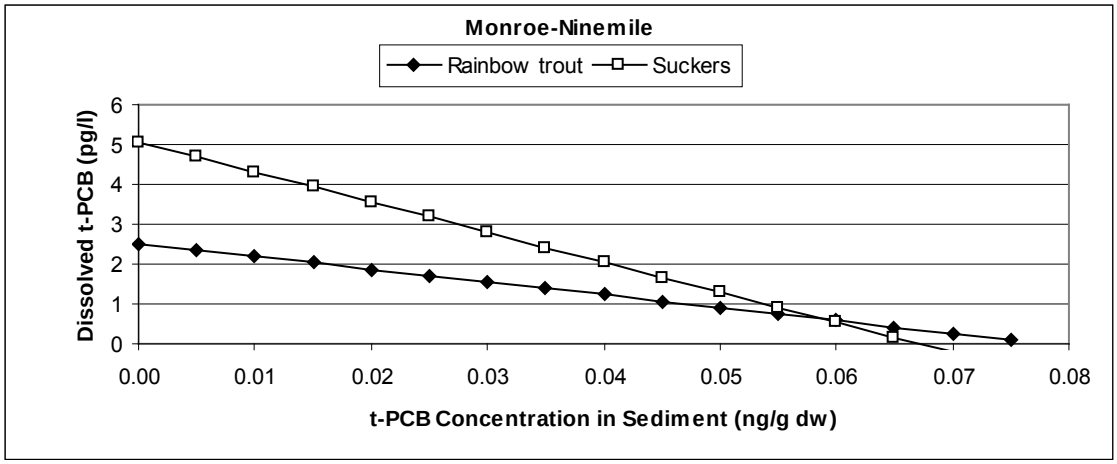
Target Water and Sediment Concentrations

The Spokane Tribe fish tissue criterion for PCBs (0.1 ng/g) was used to calculate target PCB concentrations in water and sediment. The study area was divided into five reaches to establish target PCB loads: Stateline-Upriver Dam, Monroe Street-Ninemile, Lake Spokane, Little Falls, and Spokane Arm. The four reaches upstream of Lake Spokane were collapsed into two – Stateline-Upriver Dam and Monroe Street-Ninemile – due to the lack of input parameters for individual reaches. The Monroe Street-Ninemile reach includes the section from Upriver Dam to Monroe Street dam. Some of the input parameters for Little Falls and Spokane Arm were out-of-date; Lake Spokane input parameters were used for these reaches with the exception of sediment TOC data which were collected at all locations for the present study. Table H-1 shows input parameters used in the model.

Dissolved water and sediment total PCB concentrations predicted to yield the Spokane Tribe criterion of 0.1 ng/g for total PCB in rainbow trout and sucker fillet are shown in Figures 20 and 21. Results show that PCB concentrations in water and sediment one to four orders of magnitude lower than present would be required to achieve the Spokane Tribe fish tissue criterion. The model illustrates the influence of PCBs in sediments on fish tissue, either through the food web or through direct ingestion, and offers a striking contrast to the simple BCF model which ignores PCBs in sediments and diet. When sediment PCB concentrations are set to zero, effectively reducing the food web model to the BCF model, rainbow trout fillet is predicted to have 0.1 ng/g total PCB at whole-water concentrations similar to the BCF model (3.37 pg/l).

Selection of water concentration targets for PCBs is subjective because it depends on sediment PCB concentrations, and conversely, target levels of PCBs in sediments depend on water PCB concentrations. In essence, both water and sediment critical values for PCBs are “moving targets” at an established tissue concentration. This is further complicated by differences in the two fish species being considered at each reach. As a practical matter, the recommended approach to establish target values is to select water and sediment concentrations where lines for rainbow trout and suckers intersect on each of the water-sediment plots in Figures 20 and 21.





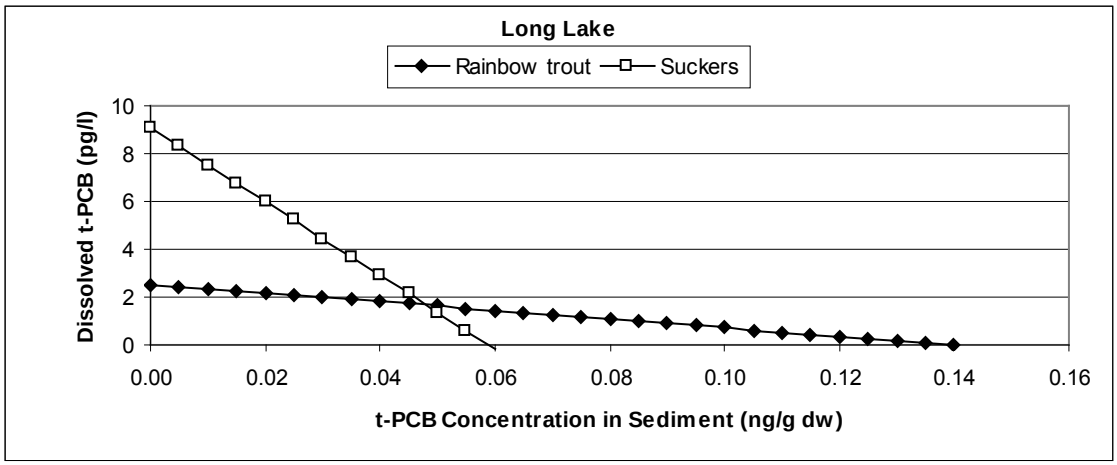
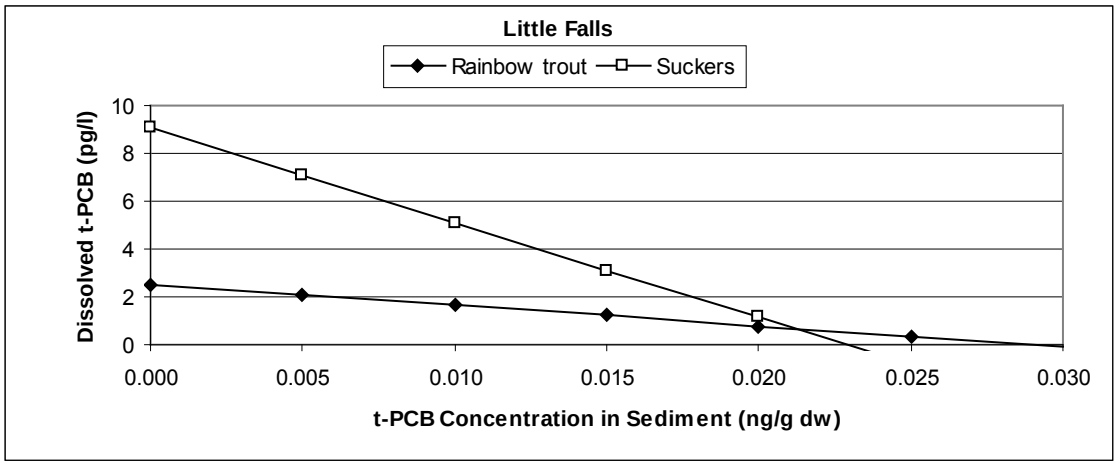


Figure 20. Dissolved Water and Sediment Total PCB Concentrations Predicted to Yield 0.1 ng/g in Rainbow Trout and Sucker Fillet (Stateline to Lake Spokane).



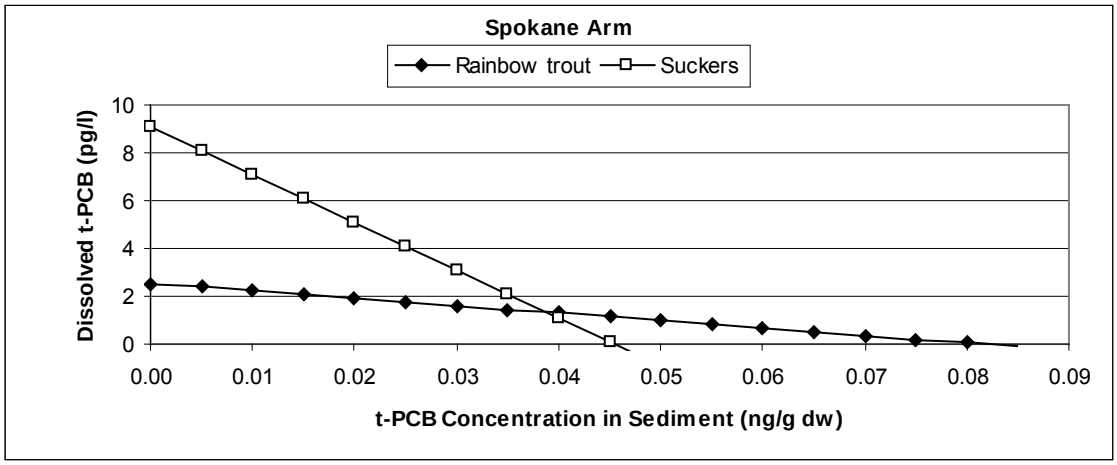


Figure 21. Dissolved Water and Sediment Total PCB Concentrations Predicted to Yield 0.1 ng/g in Rainbow Trout and Sucker Fillet (Little Falls and Spokane Arm).

By using the intersection of two disparate species, the resulting targets will likely be protective of other species that might be consumed. The target water and sediment values may then be computed by setting the equations for each line equal to one another ($[m \times C_s + b]_{Rainbow} = [m \times C_s + b]_{Sucker}$) and solving first for sediment concentration (C_s) and then for water concentrations ($C_d = m \times C_s + b$). This approach effectively halves the number of target values required.

Table 45 shows water and sediment targets for PCBs in the Spokane River, calculated using the food web bioaccumulation model. The targets for water are two to five times lower than those established using the Spokane Tribe water criterion.

Here again, the reductions needed in PCB concentrations and loads to meet the model-based targets would be very large. All discharges would require PCB load reductions of ≥99%. In addition, concurrent reductions of ≥99% are indicated for sediment PCB concentrations.

Table 45. Target Sediment and Water Total PCB Concentrations Needed to Yield the Spokane Tribe Fish Tissue Criterion (0.1 ng/g) in the Spokane River, Based on the Arnot-Gobas Food web Bioaccumulation Model.

Reach	Target Tissue Total PCB Conc. (ng/g)	Target Sediment Total PCB Conc. (ng/g dw)	Target Dissolved Water Total PCB Conc. (pg/l)	Dissolved PCB Fraction	Target Whole Water Total PCB Conc. (pg/l)	Target Total PCB Load (mg/day)
Stateline-Upriver Dam	0.1	0.06	0.9	0.90	1.0	4.5
Monroe-Ninemile	0.1	0.06	0.6	0.88	0.7	4.9
Lake Spokane	0.1	0.05	1.7	0.83	2.0	18.7
Little Falls	0.1	0.02	0.7	0.83	0.8	7.7
Spokane Arm	0.1	0.04	1.3	0.83	1.6	14.3

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Conclusions

The overall goal of the Spokane River PCB Source Assessment was to gather representative data to quantify PCB contamination in Washington reaches of the Spokane River. Data were collected in a series of studies conducted between 2003 and 2007. The information collected is being used to (1) identify necessary reductions in PCB sources to meet applicable water quality criteria and (2) develop a strategy for reducing sources to the river.

Specific components of the study included:

- Obtain representative data on PCB concentrations and ancillary parameters in the Spokane River water column, NPDES- permitted discharges, bottom sediments, and fish tissue.
- Assess trends and recovery rates for PCBs in Spokane River sediments.
- Determine the Spokane River's loading capacity for PCBs.
- Evaluate a food web bioaccumulation model to predict the PCB concentrations in Spokane River fish.

Results of sampling during 2003 and 2004 indicate that average PCB concentrations in river water increase with successive reaches from the Idaho border (106 pg/l) to lower Lake Spokane (399 pg/l), with a corresponding eight-fold increase in loads (477-3,664 mg/day). Overall, PCB loading to Washington reaches of the river can be divided into the following source categories: City of Spokane stormwater (44%), municipal and industrial discharges (20%), and Little Spokane River (6%). In addition, PCB loading from Idaho at the state line represented 30% of the overall loading.

Current PCB concentrations in fish tissue are lower than they have been historically. This may be due in part to natural attenuation and significant reductions in point-source PCB contributions over the past 10 to 15 years. The lack of decline in PCB levels in fish from the Mission Park reach of the river supports the conclusion about the importance of stormwater as a PCB source. A food web bioaccumulation model was used to predict PCB concentrations in fish tissue from PCB levels in water and sediments. This model indicates that significant reductions in sediment PCB concentrations would be required to reduce fish tissue to a Spokane Tribe target concentrations at their reservation.

Analysis of sediment cores suggests that PCB concentrations at the sediment surface will decrease by one-half approximately every ten years in upper Lake Spokane, although patterns of material deposition upstream of Lake Spokane require further evaluation. Lower Lake Spokane may be the ultimate sink for fine sediments. In lower Lake Spokane, PCBs have decreased by one-half over two decades after steep declines during the 1960s to mid-1980s.

A load-reduction scenario exercise was developed to show the reductions in water PCB concentrations that would be required to meet the Spokane Tribe's target criterion of 3.37 pg/l at the point where the river runs through the Spokane Tribe's reservation. The scenario requires a 95% PCB load reduction in the Spokane River at the Idaho border. Industrial and municipal discharges between the Idaho border and Lake Spokane require PCB load reductions greater than

99%. Stormwater from the City of Spokane also requires a load reduction of >99%. A 97% PCB load reduction is required in the Little Spokane River.

The food web bioaccumulation model is a useful tool to back-calculate water and sediment concentrations that will result in a target fish tissue PCB concentration. This model was used to develop alternative water and sediment quality goals. The model predicts target PCB concentrations in water and sediment after a target PCB concentration in fish tissue has been established, which in this exercise was the Spokane Tribe PCB tissue criterion of 0.1 ng/g. Based on model-derived targets, all discharges would require PCB load reductions of ≥99% to meet target loads.

According to the food web model, water reductions of PCBs may not be enough to achieve the tribal goal. Large PCB reductions in sediments would also be required to meet a fish tissue target of 0.1 ng/g. Even with large reductions in PCBs, it seems unlikely that the Spokane Tribal target of 0.1 ng/g is achievable. This concentration is approximately an order of magnitude lower than the median level (1.4 ng/g) reported in fish tissue from background areas in a 2010 statewide study conducted by Ecology (Johnson et al., 2010). Despite the extremely low tribal criteria, it is clear that further reductions in PCB loading are probably achievable.

Recommendations

Even though significant reductions in PCB levels have been measured in the Spokane River since the 1980s, achieving further reductions in PCBs and other toxic chemicals will be a challenging long-term process. This process requires a comprehensive strategy which uses a combination of activities to reduce toxic chemical loading to the river. To start meeting this challenge, Ecology has drafted a long-term strategy for reducing PCBs and other toxic chemicals in the Spokane River watershed. This plan is called *Reducing Toxics in the Spokane River Watershed* (Ecology, 2009). This strategy can be found at the following link: www.ecy.wa.gov/geographic/spokane/images/clean_up_strategy_toxics_in_srws_82009.pdf.

The Spokane River Toxics Reduction Strategy requires coordination across several Ecology programs, including the Spokane River Urban Waters Program (UWP) which was formed in 2007, to identify and eliminate toxic chemicals at their source. The UWP also works cooperatively with local governments including the City of Spokane and the Spokane Regional Health District.

Under the reduction strategy, PCB source identification and control will largely be carried out by the UWP. The strategy uses a three-pronged approach (prevention, management, and cleanup) to reduce sources. Priority is placed on using a systematic step-wise process to identify potential PCB sources within a conveyance system; then reducing or eliminating sources as they are located. This approach has been used successfully by other cities on the West Coast including San Francisco and Portland.

The conceptual approach to reduce PCBs discharged to the Spokane River should continue to focus on:

5. Identifying PCB sources and reducing or eliminating them from stormwater and wastewater effluents.
6. Examining treatment alternatives for effluent PCB removal.
7. Implementing necessary treatment plant controls.
8. Characterizing PCB transport through groundwater.

In addition, PCB source reduction efforts should be coupled with an ongoing effectiveness monitoring program to evaluate progress in reaching water quality targets. Effectiveness monitoring data will be useful in implementing an adaptive management framework for the watershed.

Future Characterization Activities

Extensive work to characterize PCBs in the Spokane River has been conducted since 1999. Future sampling should consider how the data will be used to either reduce PCB concentrations in fish tissue or to determine how and where PCB reductions may occur. Several activities to consider include the following:

Source Tracing

The UWP and other groups should continue systematic PCB source tracing activities in high-priority conveyance systems (stormwater and municipal/industrial) to identify and eliminate sources where possible. Implementation of an adaptive management approach using narrative limits in NPDES permits should be explored as an option to establish a set of achievable targets for toxic chemical reductions.

Effectiveness Monitoring

Design and implement a coordinated effectiveness monitoring program to track progress in meeting water quality targets. This program should include periodic assessment of PCB concentrations both instream (in water, sediments, and fish tissue) and in discharges to the river.

Food Web Modeling

Refinement of the Arnot-Gobas food wed bioaccumulation model is needed to predict conditions necessary to reach PCB target outcomes in priority reaches of the river. Specifically, the model should be examined to determine if modifications to the organism component (both benthic and fish) of the model would yield more accurate outcomes.

The model should be examined to identify critical input parameters that need refinement. Fish diet is a particular area where data refinement is needed. Site-specific field data are preferred to literature values where available.

Output parameters (i.e., fish tissue) should also be analyzed concurrently to assess the model's accuracy. This appears to be particularly important considering the apparent rapid change in fish tissue PCB concentrations.

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Appendices

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Appendix A: Spokane River Basin NPDES Permits

Table A-1. Spokane River Basin NPDES Permits (active during Ecology's 2003-2007 PCB studies).

Facility Name	Permit Type	Permit Number	WRIA
Industrial Facilities			
Newman Lk Flood Control Zone Dist	Minor	WA0045438A	57
B F Goodrich	POTW	ST0008068A	57
Columbia Lighting Inc	POTW	ST0005222B	57
Group Photo	POTW	ST0005378A	57
Johnson Matthey Electronic	POTW	ST0005350B	57
Novation Inc	POTW	ST0005355B	57
Inland Empire Paper Co	Major	WA0000825B	57
Kaiser Trentwood	Major	WA0000892B	57
Dawn Mining Company	State	ST0005230C	54
Avista Corp Headquarters	Minor	WA0045195B	57
Johnson Matthey (Cheney)	POTW	ST0008055A	56
Key Tronic Corp (Spokane)	POTW	ST0005284B	57
Olympic Foods	POTW	ST0008051A	57
Spokane Co Util. (Mica Landfill)	POTW	ST0005356B	56
Wilcox Farms Inc. (Milk Plant)	POTW	ST0005399A	56
Municipal Facilities			
Badger Lake Estates	State	ST0008057B	56
Clayton Sewer District	State	ST0005392A	55
Freeman School District #358	Minor	WA0045403A	56
Liberty School District #362	State	ST0005397A	56
Mullen Hill Terrace Properties	State	ST0008041A	57
Snowblaze Condominiums	State	ST0008039A	57
Spokane Co Util. (Hangman Hills)	State	ST0008045A	56
Upper Columbia Academy	State	ST0008034A	56
Deer Park WWTP	State	ST0008016B	55
Diamond Lake WWTP	State	ST0008029C	55
Medical Lake RWTP	Minor	WA0021148A	54
Liberty Lake Sewer Dist #1	Minor	WA0045144B	57
Spokane AWWTP	Major	WA0024473A	54
Cheney WWTP	Minor	WA0020842B	56
Tekoa WWTP	Minor	WA0023141B	56
Fairfield Town of WWTP	Minor	WA0045489B	56
Rockford Town of WWTP	Minor	WA0044831B	56
Spangle Town of WWTP	Minor	WA0045471A	56

WRIA: Water Resource Inventory Area.
POTW: Publicly-Owned Treatment Works.
WWTP: Wastewater Treatment Plant.
RWTP: Rural Wastewater Treatment Plant.
AWWTP: Advanced Wastewater Treatment Plant.

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Appendix B: Sampling Locations for Spokane River PCB Source Assessment Study

Table B-1. Sampling Locations.

Station ID[1]	Sampling Dates	Sample Type	Location Description	RM	Latitude North					Longitude West				
Stateline	10/1-29/2003	SPMD	Just downstream of the I-90 bridge at the Idaho state line	96.1	47°	41'	52	"		117°	2	'	29	"
	1/28-2/24/2004			"	"	"	"	"		"	"	"	"	"
	4/14-5/12/2004			"	"	"	"	"		"	"	"	"	"
STATELINE-F	7/14/2004	Fish	Idaho state line boundary to first downstream riffle (coordinates at midpont)	96.0	47°	41'	54	"		117°	2	'	33	"
Harvard	10/20-22/2003	SPM/Water	Near right bank below Harvard Road Bridge	92.8	47°	41'	2	"		117°	6	'	34	"
LIBLAKE	10/21/2003	Effluent	Liberty Lake Wastewater Treatment Plant effluent*	92.3	47°	40'	40	"		117°	6	'	44	"
KaiserEff	10/21-22/2003	Effluent	Kaiser effluent before discharge to river	86.0	47°	41'	5	"		117°	13	'	16	"
	2/2-3/2004			"	"	"	"	"		"	"	"	"	"
	4/26-27/2004			"	"	"	"	"		"	"	"	"	"
KaiserFilt	10/21/2003	Effluent	Kaiser at Filter Outlet	86.0	47°	41'	6	"		117°	13	'	17	"
	2/2/2004			"	"	"	"	"		"	"	"	"	"
	4/26/2004			"	"	"	"	"		"	"	"	"	"
KaiserLag	10/21/2003	Effluent	Kaiser Lagoon	86.0	47°	41'	6	"		117°	13	'	16	"
	2/2/2004			"	"	"	"	"		"	"	"	"	"
	4/26/2004			"	"	"	"	"		"	"	"	"	"
PLANTE-F	9/15/2003	Fish	⅛ mi. upstream of RR bridge to riffle at lava boulders below park (coordinates at midpoint)	85.0	47°	41'	41	"		117°	14	'	18	"
PLANTEFRY	10/28-30/2003	SPM/Water	Off right bank at Plante Ferry Park	84.8	47°	41'	52	"		117°	14	'	41	"
Inland Emp	10/21/2003	Effluent	Inland Empire effluent*	82.6	47°	41'	13	"		117°	17	'	2.8	"
	2/2-3/2004			"	"	"	"	"		"	"	"	"	"
	4/26/2004			"	"	"	"	"		"	"	"	"	"
Upriver Dam	10/1-29/2003	SPMD	⅛ mi. upstream of Upriver Dam, off right bank	80.3	47°	41'	13	"		117°	19	'	29	"
	1/28-2/25/2004			"	"	"	"	"	"	"	"	"	"	"
	4/14-5/12/2004			"	"	"	"	"	"	"	"	"	"	"
	5/13/2004	Crayfish		"	"	"	"	"	"	"	"	"	"	"

Table B-1 (Cont'd). Sampling Locations.

Station ID[1]	Sampling Dates	Sample Type	Location Description	RM	Latitude North					Longitude West				
UPRIVER BOT	10/1-29/2003	SPMD	Above Upriver Dam, off right bank, 2 feet from bottom of riverbed	80.3	47°	41'	13	"		117°	19	'	29	"
	1/28-2/25/2004			"	"	"	"	"	"	"	"	"	"	"
	4/14-5/12/2004			"	"	"	"	"	"	"	"	"	"	"
STMMISSBR	6/10/2004	Stormwater	Stormwater pipe near intersection of Mission and Perry on right bank	76.5	47°	40'	20	"		117°	23	'	20	"
STMSUPOUT	6/10/2004	Stormwater	Stormwater pipe at Superior Street near Cataldo on right bank	75.7	47°	39'	36	"		117°	23	'	32	"
CS034	6/10/2004	CSO	Combined sewer overflow (CSO) outfall at Erie Street	75.8	47°	39'	41	"		117°	23	'	30	"
MonroeSed	4/14/2004	Sediment	Approximately 60 feet off left bank at first bend upstream of Monroe Street Dam	74.9	47°	39'	52	"		117°	24	'	22	"
Monroe St	10/2-29/2003	SPMD	Upstream of Monroe Street Dam	74.8	47°	39'	48	"		117°	24	'	31	"
	1/28-2/25/2004			"	"	"	"	"	"	"	"	"	"	"
	4/14-5/12/2004			"	"	"	"	"	"	"	"	"	"	"
STMWASHBR	6/10/2004	Stormwater	Stormwater pipe at west side of Washington Street Bridge on right bank	74.3	47°	39'	51	"		117°	25	'	0.8	"
SPOKWWTP	10/21/2003	Effluent	Spokane Wastewater Treatment Plant effluent*	67.4	47°	41'	51	"		117°	28	'	32	"
	2/2/2004			"	"	"	"	"	"	"	"	"	"	"
	4/26/2004			"	"	"	"	"	"	"	"	"	"	"
Ninemile1	10/1-29/2003	SPMD	Ninemile reservoir above Plese Flats boat launch	63.6	47°	43'	15	"		117°	30	'	29	"
	1/28-2/24/2004			"	"	"	"	"	"	"	"	"	"	"
NINEM SPM	11/3-5/2003	SPM/Water	Off of right bank at Plese Flats, Riverside State Park	63.2	47°	43'	35	"		117°	30	'	43	"
Ninemile2	4/14-5/12/2004	SPMD	Ninemile Pool, downstream of boat launch at Plese Flats	62.4	47°	44'	9	"		117°	30	'	40	"
NINEMILE-F	9/16/2003	Fish Gut Contents	Ninemile reservoir near Seven Mile Bridge	61.7	47°	44'	35	"		117°	31	'	14	"
	7/13/2004	Fish		"	"	"	"	"	"	"	"	"	"	"
Spokane-F	9/16/2003	Fish		"	"	"	"	"	"	"	"	"	"	"
LongLkUp	5/11/2004	Sediment	Upper Long Lake (Lake Spokane)	54.3	47°	47'	38	"		117°	34	'	11	"

Table B-1 (Cont'd). Sampling Locations.

Station ID[1]	Sampling Dates	Sample Type	Location Description	RM	Latitude North					Longitude West				
LONGUP2	6/9/2004	Sediment Core	Upper Long Lake (Lake Spokane)	49.2	47°	50'	6	"		117°	39	'	3	"
LongLkMid	11/4/2003	Sediment	Middle Long Lake (Lake Spokane)	44.3	47°	53'	10	"		117°	41	'	28	"
Tum Tum	1/29-2/24/2004	SPMD	Long Lake right bank near Tum Tum	44.2	47°	53'	10	"		117°	41	'	38	"
Littlefls	11/4/2003	Sediment	Spokane River at pool above Little Falls Dam	29.9	47°	50'	10	"		117°	54	'	38	"
LONGLOW-F	7/13-14/2004	Fish	Lower Long Lake (Lake Spokane) off left bank approx. 1 mi. upstream of DNR launch	39.4	47°	49'	40	"		117°	44	'	39	"
LongLkLow	10/2-11/4/2003	SPMD	Lower Long Lake (Lake Spokane)	38.4	47°	49'	44	"		117°	46	'	8.2	"
	4/13-5/11/2004			"	"	"	"	"	"	"	"	"	"	"
	11/4/2003	Sediment		"	"	"	"	"	"	"	"	"	"	"
LONGLOW2	11/4/2003	Sediment Core	Lower Long Lake (Lake Spokane)	36.0	47°	48'	56	"		117°	48	'	25	"
SPOK-1	11/6/2003	Sediment	Porcupine Bay - NE of boat launch (upstream)	12.6	47°	53'	3	"		118°	8	'	59	"
LitlSpokSed	12/10/2003	Sediment	Little Spokane River approximately 1 mi. above SR291 bridge[2]	2.3	47°	46'	45	"		117°	31	'	0.9	"
LitlSpokBr	1/29-2/24/2004	SPMD	Little Spokane River @ SR291 bridge[2]	1.1	47°	46'	59	"		117°	31	'	44	"
	4/14-5/12/2004			"	"	"	"	"	"	"	"	"	"	"
LitlSpokR	10/2-30/2003	SPMD	Little Spokane River left bend in river, adjacent to SR291[2]	0.5	47°	47'	13	"		117°	31	'	38	"
BUFFALO REF	11/5/2003	Sediment	Buffalo Lake near lake center east of boat launch		48°	3'	56	"		118°	53	'	20	"

* Location coordinates in North American Datum 1983 (NAD83).
[1] Site identification as used in Ecology's Environmental Information Management System (EIM).
[2] The mouth of Little Spokane River is at Spokane River mile 56.3.
SPM: suspended particulate matter.
SPMD: semipermeable membrane device.
RM: river mile.

The additional fish collection locations and stormwater stations can be found in Tables 12 and 15 and the original reports, Serdar and Johnson (2006) and Parsons (2007) respectively.

Appendix C: Method Used to Convert PCB Concentrations in SPMD to Water

Background on SPMDs

Semipermeable membrane devices (SPMDs) are used to concentrate dissolved hydrophobic contaminants from the water column. Each SPMD consists of a 91 x 2.5 cm lay-flat, low-density polyethylene tube filled with 1 mL of highly purified triolein. The tube is thin-walled and generally considered nonporous except for small (≤ 10 Å) cavities created by the random thermal motions of the polymer chains (see Figure D-1). Freely dissolved hydrophobic contaminants are able to pass through the pores and are sequestered and concentrated in both the triolein and the polyethylene itself.

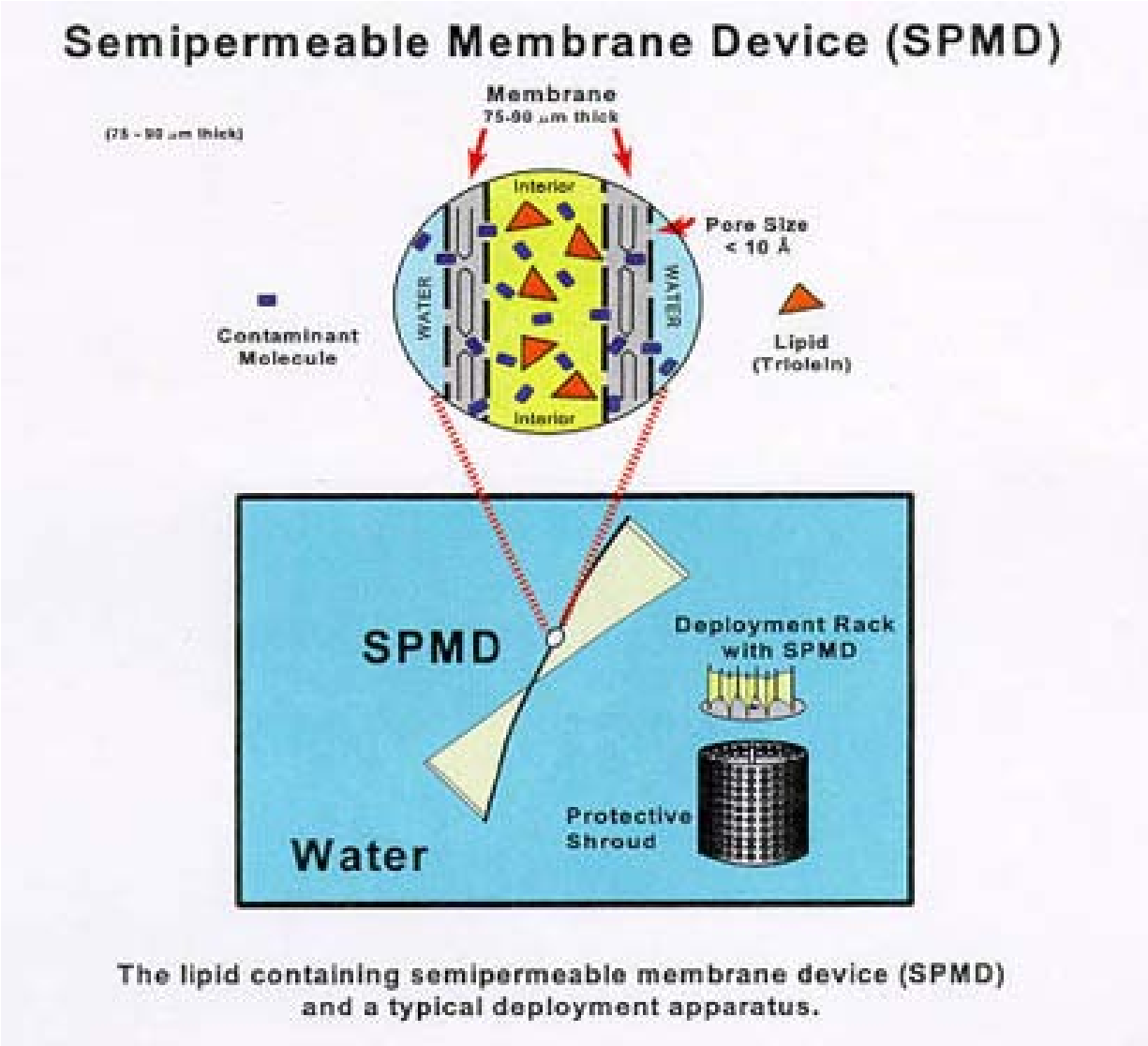

Figure C-1. Illustration of SPMD theory and mechanical design (*from* Duane Chapman, USGS Columbia Environmental Research Center, www.aux.cerc.cr.usgs.gov/spmd/index.htm)

The SPMDs are mounted on deployment racks (a.k.a. spider carriers) which permit nearly full exposure to surface water. From one to five spider carriers are then mounted inside a protective mesh-skinned stainless steel canister which is placed in the water column for approximately one month.

After removal from the water column, SPMDs are sent to a laboratory for dialytic extraction of the solutes. Prior to dialysis, material coating the SPMD (e.g., periphyton, sediments) is removed, and the membrane is inspected for holes and tears. The dialysate is concentrated to approximately 4 mL in a hexane solvent and stored in an ampule until it is ready for chromatographic or other analysis.

SPMDs are potent samplers of atmospheric organics which present major challenges in avoiding contamination while preparing, deploying, and dialyzing these samplers. To minimize contamination due to air exposure, SPMDs are stored in argon-filled cans following preparation except during their water deployment. Field blank SPMDs are also used to assess the degree of on-site contamination by exposing them to the atmosphere for the same duration as the inevitable exposure of the water sampling SPMDs. Laboratory blank SPMDs are also prepared and analyzed to assess the degree of contamination from the lab environment.

Performance reference compounds (PRCs) are spiked into each membrane prior to deployment to assess sampling rates. The recovery of PRCs, along with other factors such as temperature, water velocity, degree of biofouling, and exposure duration, is used to adjust the site/event-specific sampling rate from sampling rates determined in a laboratory setting. This adjustment factor, commonly referred to as the exposure adjustment factor (EAF), can be applied to the algorithms used to translate chemical concentrations in membrane extract to concentrations in the waterbody sampled.

Methods Used for the 2003-2004 Spokane River PCB Source Assessment Study

Field Blanks

Field (air) blanks were used to adjust SPMD results to account for laboratory and field contamination. The field blank was used for this purpose because it integrates contamination stemming from the field as well as the laboratory. Results for field blanks used during each round of sampling were subtracted (on a per membrane basis) from the sample results.

Exposure Adjustment Factors

PRCs were spiked into all membranes prior to deployment. Selection of PCB congeners for PRCs was based on the congeners found during recent effluent and fish tissue sampling in the Spokane River (Golding, 2002; Jack and Roose, 2002). Four congeners, which were absent or only present in very small amounts in these previous analyses, were used for the spiking solution: PCB-23, 55, 106, and 161. A total of 50 ng of each PRC was spiked into each membrane.

Average PRC recovery was higher than anticipated at 94%. More than a quarter of the PRCs were recovered at ≥100%. Subsequent consultation with Dr. David Alvarez and Dr. Jim Huckins of the USGS Columbia Environmental Research Center indicated that the fugacity of these congeners is too low to be suitable for calculation of EAFs (PCB-4 and 23 were recommended). Instead, they proposed using laboratory-derived sampling rates to calculate water concentrations.

Calculation of PCB Concentrations in Water

The following equation is the formula, in its simplest form, used to translate chemicals in SPMDs to water column concentrations:

$$C_W = C_{SPMD} / K_{SPMD} (1\text{-exp} [-k_e t])$$

Where:
C_W = analyte concentration in water
C_{SPMD} = analyte concentration in the SPMD
K_{SPMD} = equilibrium SPMD-water partition coefficient
k_e = first-order loss rate constant
t = time

Derivation of each term is beyond the scope of the present report but can be found at:

wwwaux.cerc.cr.usgs.gov/spmd/SPMD-Tech_Tutorial.htm#MODELING

or in:

Huckins, J.N. Petty, J.D., Priest, H.F., Clark, R.C., Alverez, D.A., Orazio, C.E., Lebo, J.A., Cranor, W.L., and Johnson, B.T, 2000. A Guide for the Use of Semipermeable Membrane Devices (SPMDs) as Samplers of Waterborne Hydrophobic Organic Contaminants. Report for the American Petroleum Institute (API), Washington, D.C. API Publication No. 4690.

To facilitate translation of SPMD analyte concentrations to water, David Alvarez has developed a spreadsheet which requires relatively few input parameters to make the necessary calculations. Necessary input parameters are temperature, exposure duration, volume and mass of SPMD, total mass of analyte in SPMD, and EAF if PRCs are used to adjust sampling rates. The spreadsheet includes default values for Log K_{ow} and for laboratory sampling rates in cases where EAFs are not used (Table C-1). All calculations are made using the input parameters and the default values in Table C-1 and using the river conditions and exposure periods described earlier in this report. Total analyte mass by PCB homologue group is shown in Table C-2.

Table C-1. Log K_{ow} and Sampling Rates Used to Calculate PCB Concentrations in Water.

Individual PCB Congeners	Log K_{ow}		Laboratory Sampling Rate (L/d)
4	5.1	k,m	12.8
5	5.1	k,m	12.8
6	5.1	g	12.8
7	5.1	k,m	12.8
8	5.1	k,m	12.8
9	5.1	k,m	12.8
10	5.1	k,m	12.8
11	5.1	k,m	12.8
15	5.1	k,m	12.8
16	5.5	k,m	6.7
17	5.5	k,m	6.7
18	5.2	g	9.2
19	5.0	g	5.3
20	5.5	k,m	6.7
22	5.6	g	5.7
24	5.5	k,m	6.7
25	5.7	g	5.7
26	5.7	g	5.7
27	5.5	k,m	6.7
28	5.7	g	8.4
31	5.7	g	7.0
32	5.5	k,m	6.7
33	5.5	k,m	6.7
34	5.5	k,m	6.7
35	5.5	k,m	6.7
37	5.5	k,m	6.7
40	5.7	g	6.6
41	5.7	g	6.2
42	5.8	g	6.2
43	5.8	g	6.2
44	5.8	g	7.5
45	5.5	g	7.9
46	5.5	g	4.4
47	5.8	g	7.5
48	5.8	g	3.5
49	5.8	g	5.3
51	5.6	g	4.8
52	5.8	g	6.2
53	5.6	g	4.8
54	5.9	k,m	5.7

Table C-1 (Cont'd). Log K_{ow} and Sampling Rates Used to Calculate PCB Conc. in Water.

Individual PCB Congeners	Log K_{ow}		Laboratory Sampling Rate (L/d)
55	5.9	k,m	5.7
56	5.9	k,m	5.7
57	5.9	k,m	5.7
58	5.9	k,m	5.7
59	5.9	k,m	5.7
60	5.9	k,m	5.7
63	6.2	g	5.3
64	6.0	g	7.5
66	6.2	g	5.3
67	6.2	g	5.3
69	5.9	k,m	5.7
70	6.2	g	7.0
71	5.9	k,m	5.7
72	5.9	k,m	5.7
74	6.2	g	6.2
75	5.9	k,m	5.7
77	6.2	a, h	2.9
78	6.4	a, h, k	4.4
79	6.4	a, h, k	5.1
81	6.4	g, h	4.3
82	6.2	g	4.4
83	6.3	g	4.8
84	6.0	g	4.4
85	6.3	g	4.8
86	6.4	k,m	4.7
87	6.3	g	5.3
90	6.4	g	6.2
91	6.1	g	4.4
92	6.4	g	5.3
95	6.1	g	6.2
96	6.4	k,m	4.7
97	6.3	g	4.4
99	6.4	g	4.4
101	6.4	g	6.2
102	6.4	k,m	4.7
105	6.6	g	4.0
107	6.7	g	5.3
109	6.4	k,m	4.7
110	6.5	g	5.7
112	6.4	k,m	4.7
113	6.4	k,m	4.7

Table C-1 (Cont'd). Log K_{ow} and Sampling Rates Used to Calculate PCB Conc. in Water.

Individual PCB Congeners	Log K_{ow}		Laboratory Sampling Rate (L/d)
114	6.6	g	4.4
115	6.4	k,m	4.7
117	6.4	k,m	4.7
118	6.7	g	4.8
119	6.6	g	4.4
122	6.4	k,m	4.7
123	6.4	k,m	4.7
126	6.7	a, h, k	2.2
127	6.7	a, h, k	1.6
128	6.7	g	4.4
129	6.7	g	3.5
130	6.8	g	4.0
131	6.8	k,m	4.1
132	6.8	k,m	4.1
133	6.8	k,m	4.1
134	6.6	g	4.8
136	6.2	g	5.3
137	6.8	g	3.5
138	6.8	g	4.8
139	6.8	k,m	4.1
141	6.8	g	4.8
144	6.8	k,m	4.1
146	6.9	g	4.8
147	6.8	k,m	4.1
149	6.7	g	5.7
151	6.6	g	5.3
153	6.9	g	3.2
156	7.2	g	2.6
157	7.2	g	2.6
158	7.0	g	3.5
163	6.8	k,m	4.1
164	6.8	k,m	4.1
166	6.8	k,m	4.1
167	6.8	k,m	4.1
169	7.4	a, h	2.1
170	7.1	k,m	2.6
171	7.1	k,m	2.6
172	7.3	g	1.3
173	7.1	k,m	2.6
174	7.1	g	3.1
175	7.1	k,m	2.6

Table C-1 (Cont'd). Log K_{ow} and Sampling Rates Used to Calculate PCB Conc. in Water.

Individual PCB Congeners	Log K_{ow}		Laboratory Sampling Rate (L/d)
176	6.8	g	2.2
177	7.1	k,m	2.6
178	7.1	g	3.1
179	6.7	g	2.2
180	7.4	g	2.6
183	7.2	g	3.1
185	7.1	k,m	2.6
187	7.2	g	3.5
189	7.1	k,m	2.6
190	7.1	k,m	2.6
191	7.1	k,m	2.6
193	7.1	k,m	2.6
194	7.8	g	1.3
195	7.6	k,m	1.6
196	7.6	k,m	1.6
197	7.6	k,m	1.6
198	7.6	k,m	1.6
199	7.6	g	1.6
200	7.6	k,m	1.6
201	7.3	g	1.6
202	7.6	k,m	1.6
203	7.6	k,m	1.6
205	7.6	k,m	1.6
206	7.7	k,m	1.6
207	7.7	g	1.6
208	7.7	k,m	1.6
Total PCB [g, h]	6.4	g, h	4.8

Compounds are listed in general order of their chromatographic elution on a DB-35MS and a DB-5 GC-column for the organochlorine pesticides and PAHs respectively.

The linear model of estimation was used in cases where a compound's log K_{ow}>6.

This calculator applies only to SPMDs which conform to the surface area-to-volume ratio of a standard SPMD.

If multiple log K_{ow} values were found in the literature, a mean value was selected using the t test at 95% Confidence for rejection of outliers.

[a] Mackay, D.; Shiu, W-Y; Ma, K-C. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals. Volume V, Lewis Publishers, Boca Raton, 1997.

[g] Meadows, J.C.; Echols, K.R.; Huckins, J.N.; Borsuk, F.A.; Carline, R.F.; Tillit, D.E. Environ. Sci. Technol., 1998, 32, 1847-1852.

[h] Rantalainen, A.L.; Cretney, W.; Ikonomou, M.G. Chemosphere, 2000, 40, 147-158.

[k] Log K_{ow} values estimated from similar congeners.

[m] R_s values estimated as the average of known R_s values of similarly substituted congeners

Table C-2. PCB homologue groups in SPMDs (pg per membrane)

Station Name	Sample Number	1-Cl	2-Cl	3-Cl	4-Cl	5-Cl	6-Cl	7-Cl	8-Cl	9-Cl	10-Cl	Total PCBs
October												
STATELINE	474155	42	729	2,117	2,557	7,628	2,173	602	108	0	0	15,957
UPRIVER DAM	474156	74	2,385	4,787	4,196	4,194	970	237	0	0	0	16,843
UPRIVER DAM(REP)	474157	71	2,301	5,208	4,272	4,565	1,324	323	0	0	0	18,063
UPRIVER BOT	474158	35	1,994	6,125	7,974	5,888	1,476	365	35	0	0	23,891
MONROEST	474159	64	4,159	6,224	9,594	9,033	4,940	1,312	128	0	0	35,454
NINEMILE	474160	39	6,847	12,144	10,254	13,492	5,864	1,605	144	0	0	50,389
LONGLOW	474161	80	7,395	14,935	51,689	32,233	10,102	2,747	484	30	0	119,693
LITTLSPOK	474162	0	634	3,605	5,814	5,191	2,321	849	514	69	0	18,998
LITTLSPMS	474163	41	154	1,336	3,217	4,352	1,415	989	450	74	0	12,030
February												
STATELINE	194130	0	24	359	767	1,982	1,007	373	0	0	0	4,511
UPRIVER DAM	194131	7	337	1,126	2,089	2,025	441	1,384	0	0	0	7,409
UPRIVER DAM(REP)	194132	0	125	86	271	338	62	6	0	0	0	888
UPRIVEBOT	194133	2	176	2,087	6,796	3,158	486	69	0	0	0	12,774
MONROEST	194134	0	561	1,903	3,596	2,873	1,552	841	0	0	0	11,326
TUMTUM	194135	4	698	2,317	3,834	2,368	988	895	6	0	0	11,109
LSPOKBR	194136	10	274	2,323	6,929	7,818	2,096	1,146	598	84	0	21,278
LSPOKBRMS	194137	14	83	1,063	4,342	5,711	1,388	639	477	60	0	13,778
April												
STATELINE	208134	0	61	1,564	2,781	8,261	3,737	2,022	88	0	0	18,513
UPRIVER DAM	208135	0	0	411	2,663	2,001	748	350	36	0	0	6,208
UPRIVER BOT(REP)	208137	75	432	5,345	11,499	6,211	1,898	758	48	0	0	26,266
UPRIVER BOT	208136	343	184	4,330	14,517	9,800	2,144	902	0	0	0	32,219
MONROE ST	208138	17	815	4,211	8,830	11,189	4,663	2,299	176	0	0	32,198
NINEMILE2	208139	49	1,202	4,870	9,609	9,742	4,747	2,079	174	0	0	32,470
LONGLKLOW	208133	62	3,086	5,083	15,707	12,072	4,026	1,211	143	0	0	41,389
LITLSPOKBR	208140	0	261	3,560	8,285	9,617	2,779	1,424	720	131	0	26,778
LSPOKBRMS	208141	65	367	3,491	4,126	5,386	1,464	2,071	581	91	70	17,712

REP: replicate.

Appendix D: Ancillary Parameters for Suspended Particulate Matter Sampling

Table D-1. Ancillary Data Taken at Centrifuge Locations During Suspended Particulate Matter Sampling (mg/L).

Station Name	Sample Number	Collection Date	TOC		DOC		TSS	
			inlet	outlet	inlet	outlet	inlet	outlet
Harvard								
	3438100	10/20/03	1.2	---	---	---	2	---
	3438101	10/21/03	1.1	---	---	---	1 U	---
	3438102		1.2	---	---	---	1	---
	3438103		1.1	---	---	---	1	---
	3438104		---	1.2	---	---	---	1 U
	3438105	10/22/03	1.1	---	---	---	1	---
	3438106		1.2	---	---	---	1 U	---
	3438107		---	2.3	---	---	---	1 U
PLANTEFRY								
	3448100	10/28/03	1.1	---	1.1	---	1	---
	3448101	10/29/03	1.1	---	1	---	3	---
	3448102		1.1	---	1	---	1	---
	3448103		---	1.1	---	1 U	---	1 U
	3448104		1.1	---	1	---	2	---
	3448105	10/30/03	---	1	---	1 U	---	1 U
	3448106		1.1	---	1	---	2	---
NINEM SPM								
	3454105	11/3/03	1	---	1 U	---	1	---
	3454106	11/4/03	1 U	---	1 U	---	1	---
	3454107		1 U	---	1 U	---	1	---
	3454108		---	1 U	---	1 U	---	1 U
	3454109		1 U	---	1 U	---	2	---
	3454128	11/5/03	1 U	---	1 U	---	1	---
	3454129		---	1 U	---	1 U	---	1 U

U: Undetected at value shown.

Appendix E: Biological Data for Fish and Crayfish Specimens Used for PCB Analysis

Table E-1. Biological Data for Plante Ferry Rainbow Trout Fillet Specimens.

Fillet Sample No.	Field ID	Date Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Fillet Weight (g)	Sex	Age (yrs)	Comments on Sex
188308	PF6	9/15/03	404	387	640	206	M	nd	
	PF8		365	350	552	190	M	nd	
	PF11		407	394	714	214	M	4	
	PF14		359	342	454	206	Imm. M?	3	
	PF15		323	308	363	126	M	3	
	PF16		300	284	291	106	M	2	
	PF17		380	364	582	212	M	3	
	PF18		422	401	782	202	M	3	
	PF23		345	328	452	126	Imm. M?	2	
	PF27		321	301	332	136	Imm. M?	2	
		Mean=	**363**	**346**	**516**	**172**		**3**	
188309	PF4	9/15/03	385	363	551	196	F	3	eggs visible
	PF5		410	387	670	208	F	4	eggs visible
	PF13		388	369	585	238	F	3	eggs visible
	PF19		412	385	667	210	F	4	eggs visible
	PF20		427	408	760	258	F	3	eggs visible
	PF21		376	356	583	178	F	3	eggs visible
	PF22		387	366	560	178	F	4	eggs visible
	PF24		378	359	517	220	F	3	eggs visible
	PF25		401	387	663	216	F	3	eggs visible
	PF26		345	325	427	202	F	2	eggs visible
		Mean=	**391**	**371**	**598**	**210**		**3**	

Imm. = Immature

Table E-2. Biological Data for Plante Ferry Rainbow Trout Gut Content Specimens.

Gut Content Sample No.	Field ID	Date Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Gut Contents (g)*	Sex	Age (yrs)
188311	PF4	9/15/03	385	363	551		F	3
	PF5		410	387	670	7	F	4
	PF6		404	387	640	1	M	nd
	PF8		365	350	552	15	M	nd
	PF11		407	394	714	1	M	4
	PF13		388	369	585	9	F	3
	PF14		359	342	454	5	Imm. M?	3
	PF15		323	308	363	1	M	3
	PF16		300	284	291	4	M	2
	PF17		380	364	582	3	M	3
	PF18		422	401	782	19	M	3
	PF19		412	385	667	12	F	4
	PF20		427	408	760	11	F	3
	PF21		376	356	583	14	F	3
	PF22		387	366	560	nm	F	4
	PF23		345	328	452	1	Imm. M?	2
	PF24		378	359	517	nm	F	3
	PF25		401	387	663	empty	F	3
	PF26		345	325	427	nm	F	2
	PF27		321	301	332	nm	Imm. M?	2
		Mean=	**373**	**355**	**546**			**3**

* Total sample weight = 16 g.

Table E-3. Biological Data for Ninemile Rainbow Trout Fillet Specimens.

Fillet Sample No.	Field ID	Date Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Lipids (%)	Sex	Age (yrs)	Origin
084281	NM1	9/16/03	334	321	413	1.5	Imm. M?	1	hatchery
084282	NM2		357	340	454	2.6	F	2	wild
084283	NM3		320	307	306	1.3	Imm. M?	1	hatchery
084284	NM4		308	290	306	1.9	M	1	wild
084285	NM5		350	332	471	1.1	F	3	wild
084286	NM6		300	282	289	1.0	Imm. M?	1	hatchery
084287	NM7		290	272	290	0.4	Imm. M?	1	hatchery
084288	NM8		333	321	425	1.9	M	1	hatchery
084289	NM9		377	365	483	0.7	F	3	wild
084290	NM10		328	315	380	3.3	M	3	wild
084291	NM11		333	316	376	2.5	F	3	wild
084292	NM12		342	325	421	2.0	Imm. M?	1	hatchery
084293	NM13		296	281	266	1.8	Imm. M?	1	wild
084294	NM14		289	273	257	1.0	M	1	hatchery
084295	NM15		283	273	268	0.6	Imm. M?	1	hatchery
084296	NM16		295	280	251	0.4	Imm. M?	1	hatchery
084298	NM18		296	285	320	0.9	M	1	hatchery
084299	NM19		275	261	227	0.2	Imm. M?	1	hatchery
084301	NM21		297	282	255	1.5	Imm. M?	1	wild
084302	NM22		282	269	250	0.8	Imm. M?	1	hatchery
084303	NM23		362	352	503	0.9	F	2	wild
084304	NM24		265	251	231	0.3	Imm. M?	1	hatchery
084305	NM25		286	270	244	0.5	Imm. M?	1	hatchery
084306	NM26		268	252	201	1.6	M	1	wild
		Mean=	**311**	**296**	**329**	**1.3**		**1**	

Table E-4. Biological Data for Ninemile Rainbow Trout Gut Content Specimens.

Gut Content Sample No.	Field ID	Date Collected	Total Length (mm)	Fork Length (mm)	Weight (g)	Gut Contents (g)*	Sex	Age (yrs)
188310	NM3	9/16/03	320	307	306	1	Imm. M?	1
	NM5		350	332	471	2	F	3
	NM6		300	282	289	4	Imm. M?	1
	NM9		377	365	483	1	F	3
	NM11		333	316	376	1	F	3
	NM13		296	281	266	3	Imm. M?	1
	NM14		289	273	257	5	M	1
	NM17		260	245	190	1	Imm. M?	
	NM18		296	285	320	5	Imm. M?	1
	NM19		275	261	227	5	Imm. M?	1
	NM23		362	352	503	2	F	2
	NM25		286	270	244	2	Imm. M?	1
	NM26		268	252	201	1	M	1
		Mean=	**309**	**294**	**318**			**2**

* Total sample weight = 22 g.

Table E-5. Biological Data for Stateline Largescale Sucker Whole Body Analysis Specimens.

Whole Body Sample No.	Field ID	Date Collected	Total Length (mm)	Weight (g)	Age (yrs)
328442	SL-5	7/14/04	556	1584	13
	SL-6		566	1618	18
	SL-7		483	984	11
	SL-8		521	1168	13
	SL-12		492	1070	8
	SL-15		499	1028	10
	SL-16		476	979	8
		Mean=	**513**	**1204**	**12**
328443	SL-4	9/17/03	460	909	9
	SL-9	7/14/04	459	940	11
	SL-10		457	973	11
	SL-11		427	707	7
	SL-13		433	765	7
	SL-14		471	868	9
	SL-17		408	731	6
		Mean=	**445**	**842**	**9**

Table E-6. Biological Data for Plante Ferry Largescale Sucker Whole Body Analysis Specimens.

Whole Body Sample No.	Field ID	Date Collected	Total Length (mm)	Weight (g)	Age (yrs)
328440	PF-32	9/15/03	463	1093	10
	PF-33		515	1325	8
	PF-38		458	1099	8
	PF-40		485	1117	7
	PF-42		502	1210	7
	PF-43		465	1061	7
	PF-46		440	981	6
	PF-47		501	1250	9
	PF-50		476	1095	9
	PF-51		489	1097	8
		Mean=	**479**	**1133**	**8**
328441	PF-28	9/15/03	475	1094	11
	PF-31		454	1082	8
	PF-35		477	992	7
	PF-36		435	903	5
	PF-41		416	797	6
	PF-48		433	800	7
	PF-49		442	843	9
	PF-52		454	1127	7
	PF-53		460	1043	8
	PF-54		482	963	7
		Mean=	**453**	**964**	**8**

Table E-7. Biological Data for Plante Ferry Largescale Sucker Gut Content Specimens.

Gut Content Sample No.	Field ID	Date Collected	Total Length (mm)	Weight (g)	Gut Contents (g)*	Age (yrs)
328445	PF-29	9/15/03	443	775	5	8
	PF-34		506	1205	17	10
	PF-37		460	893	8	9
	PF-39		424	704	2	6
	PF-44		532	1599	12	10
	PF-45		544	1379	9	8
		Mean=	**485**	**1093**		**9**

* Total sample weight = 53 g.

Table E-8. Biological Data for Ninemile Bridgelip Sucker Whole Body Analysis Specimens.

Whole Body Sample No.	Field ID	Date Collected	Total Length (mm)	Weight (g)	Age (yrs)
328447/8	NM-31	7/13/04	475	980	15
	NM-33		414	820	6
	NM-34		442	693	10
	NM-40		432	881	7
	NM-41		406	673	9
	NM-47		427	616	9
	NM-51		421	826	8
		Mean=	**431**	**784**	**9**
328450	NM-36	7/13/04	358	466	5
	NM-42		356	468	5
	NM-43		351	476	5
	NM-44		358	511	6
	NM-48		355	426	6
	NM-49		357	486	6
	NM-50		351	460	5
		Mean=	**355**	**470**	**5**

Table E-9. Biological Data for Ninemile Bridgelip Sucker Gut Content Specimens.

Gut Content Sample No.	Field ID	Date Collected	Total Length (mm)	Weight (g)	Gut Contents (g)*	Age (yrs)
328449	NM-32	7/13/04	393	695	3	5
	NM-35		401	631	8	5
	NM-37		411	665	6	7
	NM-38		408	732	16	6
	NM-39		408	626	4	6
	NM-45		366	533	6	6
	NM-46		385	536	12	7
		Mean=	**396**	**631**		**6**

* Total sample weight = 55 g.

Table E-10. Biological Data for Lake Spokane Largescale Sucker Whole Body Analysis Specimens.

Whole Body Sample No.	Field ID	Date Collected	Total Length (mm)	Weight (g)	Age (yrs)
328444	LL-2	7/13-14/2004	463	950	10
	LL-7		475	897	10
	LL-14		458	1155	11
	LL-17		445	1003	7
	LL-18		444	897	7
	LL-19		457	934	6
	LL-21		501	1335	9
	LL-23		466	986	5
	LL-24		473	1004	9
	LL-25		450	966	8
		Mean=	**463**	**1013**	**8**
328446	LL-1	7/13-14/2004	440	733	8
	LL-4		425	707	7
	LL-5		439	895	8
	LL-9		416	742	8
	LL-10		433	950	8
	LL-11		442	881	9
	LL-15		439	856	6
	LL-16		458	939	11
	LL-20		415	700	6
	LL-22		425	799	5
		Mean=	**433**	**820**	**8**

Table E-11. Biological Data for Crayfish Tail Muscle Analysis Specimens.

Sample No.	Field ID	Carapace Length (mm)	Date Collected	Weight (g)	Tail Muscle Weight (g)	Sex
208148	1	37	5/12-13/2004	41	5	F
	2	42		53	5	M
	3	39		53	4	M
	4	36		46	4	M

Appendix F: Fish Tissue Preparation, 2003-2005

Whole Body

Suckers for whole body analysis were prepared by removing them from the freezer and allowing them to partially thaw. Plans to composite specimens by sex were abandoned after numerous specimens were opened and gonads were either not found or of indeterminate type. As an alternative, specimens were grouped by length to form a small composite sample and a large composite sample, although size did not vary appreciably among fish. This allowed composites to be formed according to EPA recommendations where the smallest fish in the composite was at least 75% of the length of the largest fish (EPA, 2000a).

Scales and opercula were removed from suckers and mounted or stored for subsequent aging according to Washington Department of Fish and Wildlife (WDFW) protocols. The partially thawed fish were chopped or sawed into pieces on aluminum foil, then ground one at a time in a Hobart commercial meat grinder. After each individual was ground, tissue was mixed well using a stainless steel bowl and spoon. A 50 g aliquot from each specimen was combined to form the composite samples. The combined tissue was then passed twice more through the grinder and thoroughly mixed after each pass.

Composites of Plante Ferry and Lake Spokane suckers consisted of ten specimens each, and composites of Stateline and Ninemile suckers were made from seven specimens each. Homogenized tissue was placed in an appropriate sample container and returned to -20ºC until analysis.

Fillet

Rainbow trout fillets were prepared by removing specimens from the freezer and allowing them to partially thaw. Scales and otoliths were removed and mounted or stored for subsequent aging according to WDFW protocols. Specimens were scaled, rinsed with deionized water, and sex was determined by visual inspection of gonads.

Plante Ferry rainbow trout were prepared as ten-fish composite samples, grouped by sex. Ninemile rainbow trout were analyzed individually. Tissue was prepared by removing a skin-on fillet from one side of the fish while on aluminum foil. Composite samples were formed in the same manner as described for whole body samples except that a Kitchen Aid® food processor was used to homogenize tissue rather than a Hobart grinder. Homogenized tissue was placed in an appropriate sample container and returned to -20ºC until analysis.

Gut Contents

Gut contents were obtained from suckers other than those used for whole body analysis and from rainbow trout used for fillet samples. Thawed specimens were opened, and the entire gastrointestinal tract was removed, rinsed with deionized water, gently patted dry with a paper towel, and the contents of the stomach was extruded into a pre-cleaned glass jar. In some cases,

rainbow trout stomach contents could only be obtained by slicing open the stomach wall and removing the contents. For suckers, the gut did not have distinctive anatomical components (stomach, intestine), were extremely long (approximately 3 m), and narrow. Therefore, contents from the upper half of the gut were removed for analysis.

Once removed, gut contents were weighed and visual observations were made. Approximately one-half of the rainbow trout had large masses of filamentous plant material in the stomach. In these cases, bugs, mucous bolus, or other food-like material was extracted, and plant material was discarded. Entire gut contents from each specimen were combined for a composite sample, since total mass of material was small and near the minimum amount of material required for analysis. Several grams of material from each species were placed in 20% formalin for subsequent stereoscopic evaluation. The remainder of the collected material was frozen at -20ºC until analysis.

Crayfish Tail Muscle

Crayfish (*Pacifastacus leniusculus*) collected from Upriver Dam were allowed to partially thaw. Sex was determined and the entire tail muscle (4-5 g) was removed from the exoskeleton. All tissue from the four specimens obtained were placed together in a pre-cleaned jar, finely chopped and mixed using a clean scalpel, and frozen at -20ºC until analysis.

Equipment Cleaning

Prior to sampling, all sampling implements and equipment were cleaned by sequentially:

1. Washing in Liquinox detergent and hot tap water.
2. Rinsing with hot tap water.
3. Rinsing with deionized water.
4. Rinsing with pesticide grade acetone.
5. Air-drying.
6. Rinsing with pesticide grade hexane.
7. Air drying.

After drying, equipment was wrapped in aluminum foil (dull side in) until used in the field. Sampling equipment was dedicated to each station or each sample. Fish processing and tissue homogenization equipment was cleaned between each sample using the described procedure. Persons preparing tissue samples wore non-talc polyethylene or nitrile gloves and worked on aluminum foil. Gloves and foil were changed between samples.

All sample containers were pre-cleaned according to EPA (1990) quality assurance/quality control specification. Samples for PCB analysis were placed in glass jars with Teflon-lined lids. All samples were cooled on ice immediately after collection and transported under chain-of-custody protocols.

Appendix G: Results on Quality Control Samples for 2003-2005

Results of quality control samples analyzed to estimate precision and accuracy are shown in Tables G-1- G-3. Laboratory duplicate analysis of PCB congeners and Aroclors show generally good precision, with relative percent differences (RPDs), the difference as a percentage of the mean, less than 20% when detected.

Equation:

$$\boldsymbol{RPD} = \left(\frac{\boldsymbol{difference\ of\ 2\ results}}{\boldsymbol{mean}}\right) \times \mathbf{100}$$

Table G-1. Precision of Laboratory Duplicates (Mean RPD of Individual PCB Congeners or Aroclors*).

Station	Sample type	Sample number	RPD
Harvard	Surface water	3438100	ND
LIBLAKE	Water (effluent)	4064113	ND
Litlfls	Sediment	3454113	19%
LONGUP2 *		4268384	8%
Spokane-F	Tissue fillet	03084282	5%

ND: not detected at the reporting limit.

Precision of field replicates, which integrates environmental, sampling, and laboratory variability, is shown in Table G-2. Results show that there is substantial variability in SPMD results (average RPD of 28%). Other matrices show lower variability and can be largely accounted for by variation in laboratory analysis.

Table G-2. Precision of Field Replicates (Mean RPD of Individual PCB Congeners).

Station	Sample type	Sample number	Replicate sample number	RPD
Upriver Dam	SPMD	3474156	3474157	9%
		4194131	4194132	55%
UPRIVER BOT		4208136	4208137	20%
LitlSpokR		3474162	3474163	26%
LitlSpokBr		4194136	4194137	25%
		4208140	4208141	35%
SPOKWWTP	Water (effluent)	4188204	4188206	6%
KaiserEff		4064105	4064106	ND
NINEMILE-F	Tissue fillet	4324447	4324448	8%
Spokane-F		3084282	3084308	20%
LongLkLow	Sediment	3454112	3454114	20%

ND: not detected at the reporting limit.

Replicate samples for conventional parameters showed little variation in most cases (Table G-3). Instances of high RPD results were due to small absolute differences at low concentrations which have the effect of amplifying RPDs.

Table G-3. Precision of Field Replicates for Conventional Analytes.

Station	Sample type	Parameter	Sample number	Replicate sample number	RPD
Ninemile 1	Surface water	TOC DOC TSS	4058115	4058114	0% 17% 0%
PLANTEFRY		TOC DOC TSS	3448102	3448101	0% 0% 100%
Upriver Dam		TOC DOC TSS	4208136	4208135	0% 10% 0%
Harvard		TOC TSS	3438103	3438102	9% 0%
Upriver Dam		TOC DOC	3408967	3408972	22% 8%
NINEM SPM		TSS	3454107	3454106	0%
Upriver Dam		TOC DOC	4094045	4094044	15% 0%
		TOC DOC TSS	4164043	4164042	12% 18% 0%
SPOKWWTP	Water (effluent)	TSS	4188204	4188206	18%
KaiserEff		TSS	4064105	4064106	0%
LongLkLow	Sediment	Grain size TOC % solids	3454112	3454114	8%* 0% 1%
NINEMILE-F	Tissue fillet	% Lipids	4324447	4324448	8%

*Mean RPD of individual size fractions.

Accuracy of the PCB congener data in sediments was assessed through analysis of the National Institute of Standards & Technology (NIST) standard reference material (SRM) 1944 - New York/New Jersey Waterway Sediment. Results are shown for 12 of the 25 PCB congeners for which SRM 1944 is certified; other individual congeners in SRM 1944 match co-eluting congeners reported by Pace and were not compared (Table G-5). Five of the 12 congeners were within the 95% confidence level of the certified values. Other results were 20%-25% below the certified value, suggesting a low bias for PCB congener results in sediments.

Table H-5. Analysis of NIST 1944 Standard Reference Material (New York – New Jersey Waterway Sediment) by Pace Analytical Services, Inc. (ng/g, dw).

Analyte	Certified concentrations*	Pace Result	% Difference from mean
PCB-008	22.3. ± 2.3.	23.4	5%
PCB-031	78.7. ± 1.6	77.6	-1%
PCB-052	79.4. ± 2.0	80.3	1%
PCB-066	71.9 ± 4.3	57.1	-21%
PCB-095	65.0 ± 8.9	48.1	-26%
PCB-099	37.5 ± 2.4	29.7	-21%
PCB-105	24.5 ± 1.1	23.5	-4%
PCB-118	58.0 ± 4.3	52.9	-9%
PCB-194	11.2 ± 1.4	9.35	-17%
PCB-195	3.75 ± 0.39	3.91	4%
PCB-206	9.21 ± 0.51	7.09	-23%
PCB-209	6.81 ± 0.33	5.43	-20%

*Mean and range of 95% confidence levels.
Shading: Outside certified range of values.

Appendix H: Details of Arnot-Gobas Food Web Bioaccumulation Model

Overview of Arnot-Gobas Food Web Bioaccumulation Model

Models to track hydrophobic organic chemicals through the food web have increased in their accuracy and complexity as investigators have built upon previous models to make iterative improvements. One of the most recently available models, the food web bioaccumulation model developed by Arnot and Gobas (2004), was selected for the present study for several reasons:

1. The model was built upon a widely accepted kinetic model developed to predict bioaccumulation of hydrophobic organic compounds in the food web of Lake Ontario and other lakes (Gobas, 1993).
2. The model is programmed in Excel spreadsheets and is simple to use, make adjustments, and perform backward calculations (find values for input parameters needed to derive a defined model output).
3. Validation runs indicated the model could predict PCB concentrations in at least two Spokane River fish species with a fairly high degree of accuracy.

The model accounts for major routes of PCB accumulation through diet and the gills, while depuration occurs through elimination by the gills and feces and by metabolic transformation (Figure H-1). The model also accounts for decreases in contaminant concentration through growth dilution.

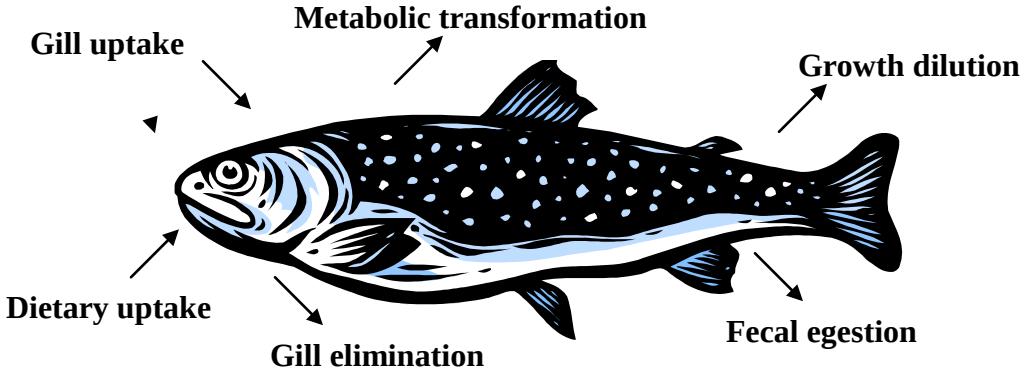

Figure H-1. Conceptual Diagram of the Major Routes of Contaminant Uptake and Depuration (Adapted from Arnot and Gobas, 2004).

The basic equation which describes the general model is:

$$dM_B/d_t = \left\{ W_B \bullet \left(k_1 \bullet [m_o \bullet \Phi \bullet C_{wT,0} + m_p \bullet C_{wD,S}] + K_D \bullet \Sigma(P_i \bullet C_{d,i}) \right) \right\} - (k_2 + k_E + k_M) \bullet M_B$$

Where:

M_B = mass of the chemical in the organism (g)
t = time (d)
dM_B/d_t = net flux of chemical in the organism at any point in time
W_B = weight of the organism at t (kg)
k_1 = clearance rate constant for the chemical uptake via gills and skin (L/kg • d)
M_o = fraction of respiratory ventilation in overlying water
M_p = fraction of respiratory ventilation in pore water
Φ = fraction of total chemical concentration that is freely dissolved in overlying water
$C_{wT,0}$ = total chemical concentration in water above sediments (g/L)
$C_{wD,S}$ = chemical concentration freely dissolved in pore water (g/L)
K_D = clearance rate constant for the chemical uptake via diet (kg/kg • d)
P_i = fraction of diet consisting of prey item i
$C_{d,i}$ = chemical concentration in prey item i (g/kg)
k_2 = rate constant for the chemical elimination via gills and skin (d^{-1})
k_E = rate constant for the chemical elimination via fecal egestion (d^{-1})
k_M = rate constant for metabolic transformation of the chemical (d^{-1})

The general equation can be simplified by assuming steady-state conditions (i.e., $dM_B/d_t = 0$), which results in a re-expression of the equation to:

$$C_B = \left\{ k_1 \bullet \left(m_o \bullet \Phi \bullet C_{wT,0} + m_p \bullet C_{wD,S}) + K_D \bullet \Sigma(P_i \bullet C_{d,i}) \right) \right\} / (k_2 + k_E + k_M + k_G)$$

Where:

C_B = chemical concentration in the organism (M_B/W_B)

The steady-state assumption necessitates a growth dilution term (k_G) which can be represented by a constant fraction of the organism's body weight. The reader is referred to Arnot and Gobas (2004) for detailed explanations of the sub-models used to derive all of the terms in the general equation. Assumptions and input parameters used to apply the model to the Spokane River are discussed below. All other environmental characteristics were those used for Lake Erie modeling and were supplied by J. Arnot.

Environmental characteristics

Environmental characteristic input parameters for the Spokane River model included mean annual water temperature, DOC, TSS, particulate organic carbon (POC), and sediment TOC. Table H-1 shows the values used. Mean annual temperatures, DOC, and TSS were mean values of the reaches modeled from data collected during SPMD deployment and recovery. One-half the detection limits were used for non-detects. Since January-February data for temperature

were lost at Ninemile, the Monroe-Ninemile model was run using mean temperature data only from Monroe St. POC was calculated as the fraction organic carbon (f_{oc}) in suspended particulate matter (0.15, see Eq. 3) multiplied by TSS.

Table H-1. Input Parameters for the Arnot-Gobas Food Web Bioaccumulation Model.

	Reach				
	Stateline-Upriver	Monroe-Ninemile	Long Lake	Little Falls	Spokane Arm
Water					
Mean annual water temperature (°C)	9.2	8.9	10.0	10.0	10.0
DOC (mg/L)	1.2	1.0	1.1	1.1	1.1
TSS (mg/L)	1.6	2. 2	2.8	2.8	2.8
Particulate organic carbon (mg/L)	0.24	0.33	0.42	0.42	0.42
Sediment					
TOC (%)	2.0	1.6	2.9	0.6	1.7
Zooplankton					
Diet	100% phytoplankton				
Benthic Species					
Diet	50% phytoplankton, 50% sediment				
Rainbow Trout					
Weight (kg)	0.5				
Lipid (%)	5.6				
Diet	50% zooplankton, 12.5% each may-fly larvae, chironomid larvae, *Gammarus*, crayfish				
Sucker					
Weight (kg)	0.918				
Lipid (%)	3.8				
Diet	33% phytoplankton, 33% chironomids, 34% sediment		50% chironomids, 50% sediment		
Chemical (Total PCBs)					
Log K_{ow}	6.4				
Henry's Law Constant (Pa. m^3/mol)	3.9				

OC = organic carbon.
Pa = Pascals

Sediment TOC concentrations were more difficult to estimate due to lack of depositional material in the upstream reaches. For the Stateline-Upriver model run, the TOC was the mean of five sediments from RM 81.5-94.8 analyzed by Ecology (1994). Sediments from the Upriver Dam PCB "hot spot" were not used to derive this value. For the Monroe-Ninemile model run, the TOC value was the mean TOC of five Monroe St. (RM 74.9-78.7) sediments collected during 1994 averaged with a single Ninemile sediment collected during 1993 (Ecology, 1994).

Species characteristics

Fish species used for target PCB concentrations were rainbow trout and suckers. The model has output parameters built in for rainbow trout. The sucker species built into the model is white sucker (*Catostomus commersoni*). This species has similar habits and foraging characteristics as

largescale and bridgelip suckers, and may even interbreed with largescale suckers where their ranges overlap (Wydoski and Whitney, 1979), and was therefore deemed a suitable substitute.

The model also allows for yellow perch, smallmouth bass, and largemouth bass as target endpoints (criteria). These species are found in Lake Spokane and the Spokane Arm, with limited populations of smallmouth bass in upstream reaches. However, these species were not selected to establish critical PCB concentrations because they generally have much lower PCB concentrations than lipid-rich species such as trout and sucker (e.g. Ecology, 1995; Jack and Roose, 2002). For these species, the target tissue concentration of 0.1 ng/g would be achieved with much higher water and sediment PCB levels.

Rainbow trout lipid content used in Table H-1 was the average of rainbow trout analyzed whole from four Spokane River locations. Weight was an approximation of present and historical Spokane River rainbow trout collected for analysis. For largescale suckers, lipid fraction in Table H-1 was an average of whole bodies from all available Spokane River samples, historic and present. Weight was the average of all suckers analyzed whole for the present study.

Diet of target fish species in Table H-1 was based on observations of gut contents. Diet composition of fish prey items (zooplankton and benthic species) was based on likelihood rather than site-specific observations.

Whole body to fillet conversion

The model produces a whole organism output for PCB concentrations in fish, which assumes that the chemical is distributed homogeneously among tissues of an organism. This limitation of the model may be an over-simplification when applied to complex organisms such as fish. To achieve the target concentration in fillet tissue, a conversion factor of 1.47 was applied based on the work of Amrhein et al. (1999). Limited data on paired whole fish-fillet data from the Spokane River (Johnson, 2000) yielded a conversion factor of 1.18 for rainbow trout and 2.73 for largescale suckers. This indicates that the water and sediment PCB concentrations used in the model along with the published conversion factor may be conservative for predicting target concentrations in suckers, while those used to predict rainbow trout targets may contain a slightly high bias.

Chemical characteristics

Total PCB was analyzed as the chemical of interest in the model to provide a simplified method of calculating PCB endpoints. The log K_{ow} and Henry's Law constant for total PCB used for the model were the same as those used to translate SPMD concentrations to water concentrations (Table H-1). For SPMDs, these parameters yield values similar to total PCBs calculated by summing individual congeners separately.

Validation and sensitivity

Prior to use, the model was validated using input parameters representative of the Spokane River and reach-specific fish weight and lipid data from recent sampling. Predicted and observed tissue concentrations were similar (Table H-2).

Table H-2. PCB Concentrations in Fish Tissue Predicted Using the Arnot-Gobas Food Web Bioaccumulation Model vs. Observed PCB Concentrations.

	Reach				
	Stateline-Upriver	Monroe-Ninemile	Lake Spokane	Little Falls	Spokane Arm
Measured PCB concentrations in water and sediment					
Dissolved total PCB conc. in water (pg/l)	83	222	332	na	na
total PCB conc. in sediment (ng/g dw)	54	78	33	1.9	10
Total PCB concentrations in whole rainbow trout (ng/g ww)					
Predicted	87	31**	55	--	--
Observed*	51	40**	na	na	na
Total PCB concentrations in whole suckers (ng/g ww)					
Predicted	110	26**	98	--	--
Observed*	99	29**	224	na	na

*PCB concentrations in fillet converted to whole fish by multiplying by 1.47.
**Ninemile only. Recent tissue data not available for Monroe St.
na: not available.

The model was not calibrated by adjusting the algorithms to match predicted and observed results. The decision to apply this model was made only after sampling had been completed. However, the necessary input parameters were easily obtained from current or historical data, and default values for physical, chemical, and species characteristics – originally used to model PCBs in the Lake Ontario food web – are applicable to the Spokane River.

A cursory assessment of model sensitivity was done by inserting ranges of values for the input parameters discussed in previous sections. The model is somewhat sensitive to changes in POC, sediment TOC, percent lipid in target fish, and prey composition for target fish. A 50% change in these model parameters results in an approximate 15% change in the target fish PCB concentrations when other model parameters are held at values typical for the Spokane River.

The model is particularly sensitive to log K_{ow} values, which can be expected due to the log K_{ow} as one of the most important factors driving the partitioning of PCBs between water and lipid soluble compartments. The response to changes in log K_{ow} is an approximate 10% decrease in target fish PCB concentrations with each 0.1 decrease in log K_{ow} around the value used for the Spokane River (log K_{ow} = 6.4). Increases of 0.1 in log K_{ow} result in approximately 10% increases in fish PCB concentrations. Of course, these responses are not linear, and the limited information provided here cannot be used to calculate target fish PCB concentrations, but they offer a glimpse at how the model output responds to certain input parameters.

Appendix I: Glossary Acronyms, Symbols, and Units

Ambient: Surrounding environmental condition (for example, surrounding air temperature).

Benthic: Bottom-dwelling organisms.

Best Management Practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Clean Water Act: Federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act identifies water quality impaired waterbodies.

Composite sample: A representative sample created by the homogenization of multiple fish.

Congener: In chemistry, congeners are related chemicals. For example, polychlorinated biphenyls (PCBs) are a group of 209 related chemicals that are called congeners.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each waterbody or segment, regardless of whether or not the uses are currently attained.

Discharge: The rate of streamflow at a given instant in terms of volume per unit of time, typically cubic feet per second.

Effluent: An outflowing of water from a natural body of water or from a man-made structure. For example, the treated outflow from a sewage treatment system.

Exceeded criteria: Did not meet criteria.

Harmonic mean flow: One of several methods of calculating an average rate of flow. The harmonic mean is defined as $Q_h = n/\Sigma(1/Q_i)$ where n is the number of recorded flows Q_i. The harmonic mean is never larger than the geometric mean or the arithmetic mean.

Grab: A discrete sample from a single point in the water column or sediment surface.

Homologue: A chemical compound from a series of compounds that differs only in the number of repeated structural units.

Legacy pesticides: Banned pesticides no longer used but that persist in the environment.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Parameters: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Reach: A specific portion or segment of a stream.

Sediment: Solid fragmented material (soil and organic matter) that is transported and deposited by water and covered with water (example, river or lake bottom).

Stormwater: The portion of precipitation that does not naturally percolate into the ground or

evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands, and all other surface waters and water courses within the jurisdiction of Washington State.

Suspended particulate matter (SPM): Particulates suspended in the water column.

Total Maximum Daily Load (TMDL): A distribution of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Total suspended solids (TSS): The suspended particulate matter in a water sample as retained by a filter.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Acronyms, Symbols, and Units of Measurement

303(d):	Section 303(d) of the federal Clean Water Act
BAF:	bioaccumulation factor
BCF:	bioconcentration factor
BSAF:	biota-sediment accumulation factor
BW:	body weight
CFR:	Code of Federal Regulations
CSO:	combined sewer overflow
DOC:	dissolved organic carbon
dw:	dry weight
Ecology:	Washington State Department of Ecology
EIM:	Environmental Information Management (Ecology database accessible through internet)
EPA:	U.S. Environmental Protection Agency
FS:	feasibility study
GC/ECD:	gas chromatography/electron capture detection
GC/MS:	gas chromatography/mass spectrometry
MTCA:	Model Toxics Control Act
N:	number of samples
NIST:	National Institute of Standards and Technology
NPDES:	National Pollutant Discharge Elimination System
NTR:	National Toxics Rule
PCB:	polychlorinated biphenyl
RF:	risk factor
RI:	remedial investigation
RM:	river mile
RPD:	relative percent difference
SPM:	suspended particulate matter
SPMD:	semi-permeable membrane device
SRM:	standard reference material
SV:	screening value
TMDL:	Total Maximum Daily Load
Total PCB:	the sum of PCB congeners or Aroclors (also t-PCB)
TOC:	total organic carbon
TSS:	total suspended solids
UWP:	Spokane River Urban Waters Program
USGS:	U.S. Geological Survey
WAC:	Washington Administrative Code
WC:	water consumption
WDFW:	Washington Department of Fish and Wildlife
WDOH:	Washington State Department of Health
WQS:	water quality standard(s)
WRIA:	Water Resource Inventory Area

WSTMP:	Washington State Toxics Monitoring Program
ww:	wet weight
WWTP:	waste water treatment plant
C_d :	concentration in the dissolved phase
C_s :	concentration in sediment or solids
C_t :	concentration in tissue
C_w:	concentration in whole water
f_{oc}:	fraction of organic carbon
f_s:	fraction of solid in water
K_{oc}:	sediment-water partition coefficient normalized for organic carbon
K_{ow}:	octanol-water partitioning coefficient
Q:	discharge
q1*:	cancer slope factor
Pb:	lead
g:	gallon
cm:	centimeter
kg/day:	kilograms per day
L/kg:	liters per kilogram
MGD:	million gallons per day
mg/day:	milligrams per day
mg/L:	milligrams per liter (parts per million)
ML:	megaliter (one million liters)
mm:	millimeter
ng/g:	nanograms per gram (parts per billion)
ng/L:	nanograms per liter (parts per trillion)
pg/g:	picograms per gram (parts per trillion)
pg/l:	picograms per liter (parts per quadrillion)
Pa m3/mol:	Pascals cubic meter/mole

Prepared in cooperation with
WASHINGTON STATE DEPARTMENT OF ECOLOGY

Ecological Indicators of Water Quality in the Spokane River, Idaho and Washington, 1998 and 1999

Background

Urban and mining activities have affected the Spokane River that flows out of Coeur d'Alene Lake from Idaho into Washington. This large river (more than 150 feet wide) flows through the city of Spokane to the 7 Mile bridge site and is impounded by three dams used to generate hydroelectric power. From Spokane, the river continues west and joins the Columbia River 63 miles downstream. Historical and current mining activities in the Coeur d'Alene River Basin in Idaho have contributed large quantities of metals to Coeur d'Alene Lake (Grosbois and others, 2001). The USGS has documented elevated concentrations of cadmium, lead, and zinc entering the river from Coeur d'Alene Lake (Woods, 2000). The WDOE has placed the Spokane River on its 303(d) impaired water list (Clean Water Act) for high concentrations of trace metals that violate Washington's water-quality criteria (Washington State Department of Ecology, accessed May 1, 2003, at **http://www.ecy.wa.gov/programs/wq/303d/1998/1998_by_wrias.html**. In addition, studies done by the WDOE (1995) and USGS (MacCoy, 2001) have identified elevated concentrations of PCBs in fish and sediments.

Overview

A water-quality investigation of the Spokane River was completed during summer low-flow conditions in 1998 and 1999 as part of the USGS NAWQA Program, in cooperation with the WDOE. (Abbreviations used in this report are defined on the last page.)

Samples for analyses of water chemistry; bed sediment; aquatic communities (fish, macroinvertebrates, and algae); contaminants in tissue (fish and macroinvertebrates); and associated measures of habitat were collected at six sites downstream from Coeur d'Alene Lake between river miles 63 and 100. These data provided baseline information to evaluate the water-quality status of the Spokane River and can be used to determine the ecological risk to aquatic organisms from contaminants.

The USGS, in cooperation with WDOE, sampled six sites along the Spokane River during the summers of 1998 and 1999 to evaluate urban and mining impacts on aquatic organisms (fig. 1). This study of the Spokane River was conducted as part of the NROK NAWQA Program to evaluate the status and trends in surface- and ground-water quality in parts of western Montana, northern Idaho, and eastern Washington (Tornes, 1997).

Ecological indicators were evaluated to determine the effects of multiple stressors on aquatic organisms. The ecological data collected at these sites are outlined in the sampling matrix table (table 1). The purpose of this study was to:

- Identify surface-water-quality and sediment-quality constituents of concern and determine whether those constituents were affecting aquatic organisms.
- Conduct a baseline aquatic community assessment at selected Spokane River sites.
- Compare aquatic community measures and metrics with those at least-impacted sites.
- Analyze contaminants in aquatic organisms and sediment and compare the results with established criteria.

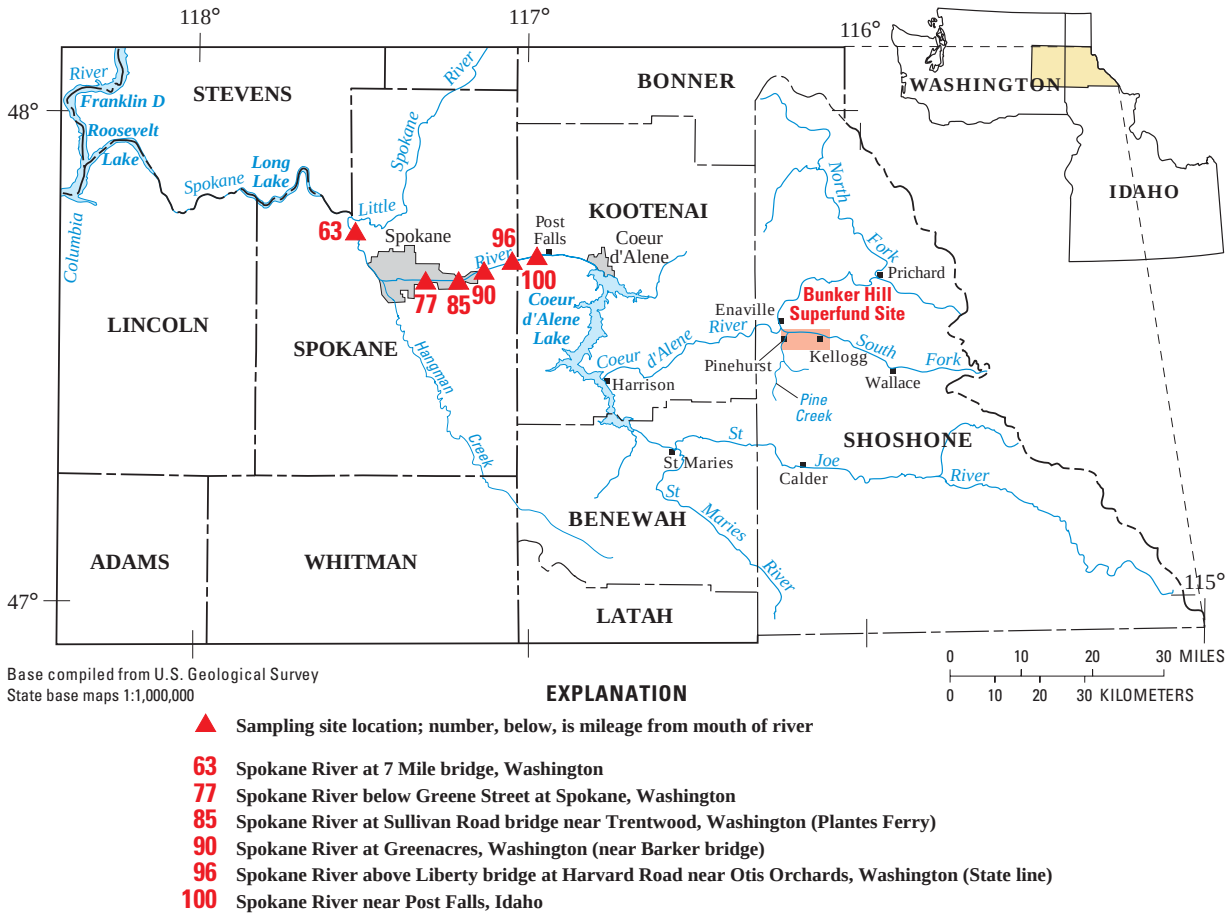

Figure 1. Locations of sampling sites, Bunker Hill Superfund site, and the Spokane River Basin, Idaho and Washington.

Figure 2. Periphyton (algae attached to bottom substrate) were collected from riffle areas using protocols described by Porter and others (1993).

Periphyton

Samples of periphyton (algae attached to bottom substrate) were collected at all sites for analysis of CHLA (fig. 2). The concentration of CHLA in a sample indicates the level of nutrients in the river that are available to promote algal growth. Concentrations of CHLA between 100 and 150 milligrams per square meter (mg/m^2) have been suggested as an indicator of nuisance algal conditions (Welch and others, 1989; Watson and Gestring, 1996).

The Spokane River did not appear to be water-quality limited as a result of excessive algal growth at sites sampled during this study; however, the downstream CHLA concentration approached the nuisance level. At the upstream sites in the Spokane River, CHLA concentrations were between 2 and 10 mg/m^2, far below levels of nuisance algal growth. At the downstream site at the 7 Mile bridge, below sewage-treatment facilities and other industrial inputs, the CHLA concentration was 94 mg/m^2, which is approaching the nuisance level.

Table 1. Sampling matrix of ecological data collected by the USGS during 1998 and 1999 from selected sites on the Spokane River, Idaho and Washington, for a cooperative study with WDOE and for the NROK NAWQA Program.

[Locations of sampling sites shown in figure 1; O, samples collected in 1998; X, samples collected in 1999; X, data analyzed by WDOE[1]. Data analyzed by USGS for this study can be accessed at **http://idaho.usgs.gov/projects/spokane/index.html**]

	Site name					
	Post Falls	Otis Orchards (State line)	Greenacres	Sullivan Road bridge	Greene Street	7 Mile bridge
River mile	100	96	90	85	77	63
USGS site ID	12419000	12419500	12420500	12420800	12422000	12424500
Latitude Longitude	47°42'11" 116°58'37"	47°40'56" 117°05'05"	47°40'45" 117°09'25"	47°40'40" 117°11'43"	47°40'40" 117°22'20"	47°44'25" 117°31'10"
Periphyton (chlorophyll- *a* and biomass)	X	X	X	X	X	X
Macroinvertebrate community	OX	X	X	X	X	X
Fish community	OX	X		X	X	OX
Habitat assessment	X					X
Continuous (hourly) summer water temperature	OX	X			X	X
Trace metals–macroinvertebrates	X	X	X	X	X	X
Trace metals–fish tissue	X	X		X		OX
Organochlorines–fish tissue	X	X		X		O
Trace metals–sediment	OX					OX
Organochlorines–sediment	OX					OX
Trace metals and PCBs–whole rainbow trout, largescale suckers, and mountain whitefish[1]		X		X	X	X

[1]See the WDOE home page (**http://www.ecy.wa.gov/**) for further details about their sampling effort on the Spokane River.

Figure 3. Macroinvertebrates were sampled at all sites in the Spokane River using protocols described by Cuffney and others (1993).

Macroinvertebrate Community

Macroinvertebrates were collected from riffle habitats for community assessment and analysis of metal concentrations in caddisflies (fig. 3). Even though the total abundance of macroinvertebrates collected in 1999 at the Spokane River sites was higher than at least-impacted sites (sites upstream from urban and mining impacts sampled as part of the NROK NAWQA) on the North Fork Coeur d'Alene River at Enaville and the St. Joe River near Calder (Maret and others, 2001), the number of individual taxa (indicating biological diversity) was much lower. In fact, the number of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), referred to as EPT taxa, was 2 to 3 times lower at Spokane River sites than at least-impacted sites (fig. 4). Stoneflies that are found at most least-impacted sites in

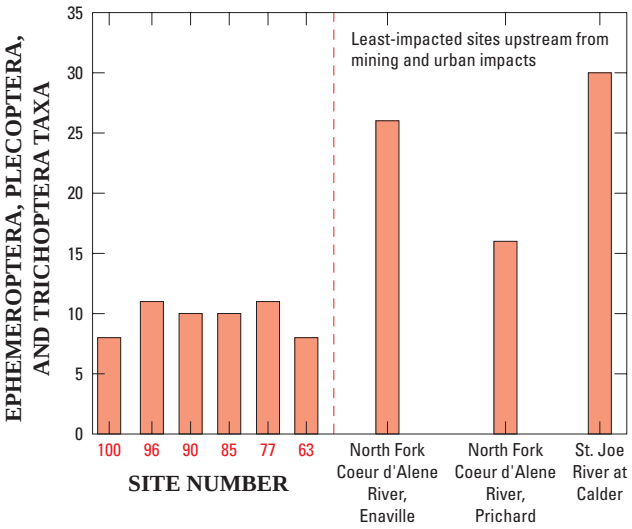

Figure 4. Ephemeroptera, Plecoptera, and Trichoptera taxa collected in the Spokane River, Idaho and Washington, compared with taxa collected at least-impacted sites, Idaho. (Site numbers shown in figure 1; data for least-impacted sites are given in report by Maret and others, 2001)

Idaho were absent from the Spokane River. On the basis of regional collections by Maret and others (2001), the Spokane River should be able to support at least five taxa of stoneflies. Even though measures of substrate (bottom material such as gravel or cobbles) size and percent embeddedness (amount of fine substrate surrounding larger substrate) did not indicate habitat degradation and were very low (less than 10 percent) for riffle habitats at all sampling sites, the low numbers of EPT taxa in the Spokane River indicated impaired water quality.

Fish Community

Fish were collected at each site as indicated in table 1. The fish were weighed, measured, and examined for anomalies (such as deformities, eroded fins, lesions, and tumors) using protocols described by Meador and others (1993). The fish species collected from the Spokane River are listed in table 2.

Salmonids will experience adverse health effects when exposed to temperatures outside their optimal range (U.S. Environmental Protection Agency, 2002) because they are coldblooded and their survival depends on external water temperatures. The Spokane River historically supported a strong native salmonid population (Youngs, 1996). The State of Washington has classified the Spokane River as "excellent" between river miles 58 and 96 (below the 7 Mile bridge site to the Idaho/Washington State line), meaning that water quality in this reach must meet or exceed goals for all uses, including salmon migration, rearing, spawning, and harvesting. In an effort to meet these goals, a temperature criterion of 20 degrees Celsius has been set for protection of coldwater species in this reach of the river (Washington State Department of Ecology, 1997). Idaho's criterion for the protection of coldwater aquatic organisms is 22 degrees Celsius (Idaho Department of Environmental Quality, accessed January 28, 2003, at **http://www2.state.id.us/adm/adminrules/rules/idapa58/58index.htm)**.

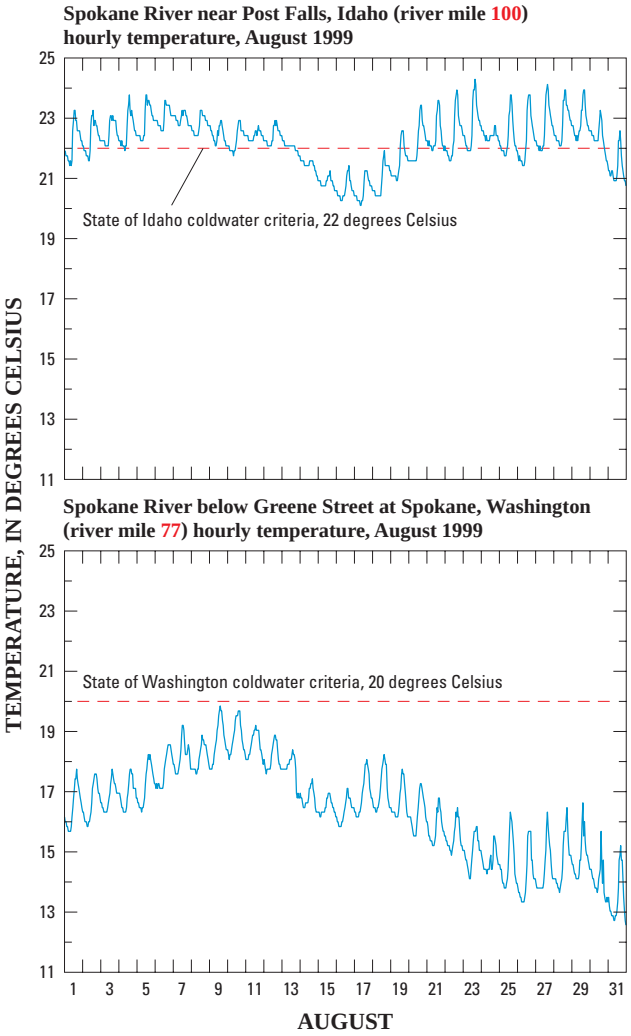

Figure 5. Hourly temperature measurements at Spokane River near Post Falls, Idaho, and Spokane River below Greene Street at Spokane, Washington, August 1999.

The upstream part of the Spokane River receives water from the surface of Coeur d'Alene Lake that is warmer than the river water. Coeur d'Alene Lake is a natural lake and outflow is controlled by Post Falls Dam. During the summer months, water temperature in the

Table 2. Number of fish species collected at selected reaches on the Spokane River, Idaho and Washington, 1998 and 1999

[Samples collected in 1998 unless otherwise indicated]

Family	Site name						
	Post Falls	Post Falls (1999)	Otis Orchards (State line)	Sullivan Road bridge	Greene Street	7 Mile bridge	7 Mile bridge (1999)
Salmonidae (trout and whitefish)			1	4	2	2	2
Cottidae (sculpins)		1	1			1	
Catostomidae (suckers)	1	1	1	2	1	2	2
Cyprinidae (minnows and carp)	3	3	3	3	2	4	2
Centrarchidae (sunfish)	4	1			1		
Ictaluridae (catfish and bullheads)	2	1					
Percidae (perch)	1						

river downstream from Post Falls Dam exceeds Idaho's and Washington's coldwater criteria (fig. 5). The fishery at this site consists mostly of warmwater species such as sunfish, minnows, and bullheads. During the summer, the Spokane River loses water to the SVRP aquifer in the upper parts of the study reach and receives cooler water from the SVRP aquifer in the downstream reach (Box and Wallis, 2002). Near river mile 85 at Sullivan Road bridge, cool SVRP aquifer water with temperatures between 8 and 10 degrees Celsius (Rod Caldwell, U.S. Geological Survey, written commun., 2002) flows into the river, providing habitat for coldwater salmonids such as chinook salmon, cutthroat, brown, and rainbow trout (table 2).

Figure 6. Sculpin (a bottom-feeding native fish), which are especially sensitive to metals (Maret and MacCoy, 2002), were found at only a few sites and in low numbers in the Spokane River.

Fish abundance was analyzed for individuals and species, and a population summary was calculated using 10 fish metrics (Mebane and others, 2003) that are useful for evaluating river conditions in the Pacific Northwest. The metrics are number of coldwater native species, number of cottid (sculpin) age classes (fig. 6), percent sensitive native individuals, percent coldwater individuals, percent tolerant individuals, number of alien species, percent common carp individuals, number of salmonid age classes, catch per unit effort (fish per minute of electrofishing), and percent selected anomalies. Each metric is given a value and all are summed to provide an IBI score ranging from 0 to 100 for each site. According to Mebane and others (2003), sites with IBI scores between 75 and 100 exhibit high biotic integrity with minimal disturbance and possess an abundant and diverse assemblage of native coldwater species. Sites with scores between 50 and 74 exhibit somewhat lower quality where alien species occur more frequently and the assemblage is dominated by coolwater, native spe-

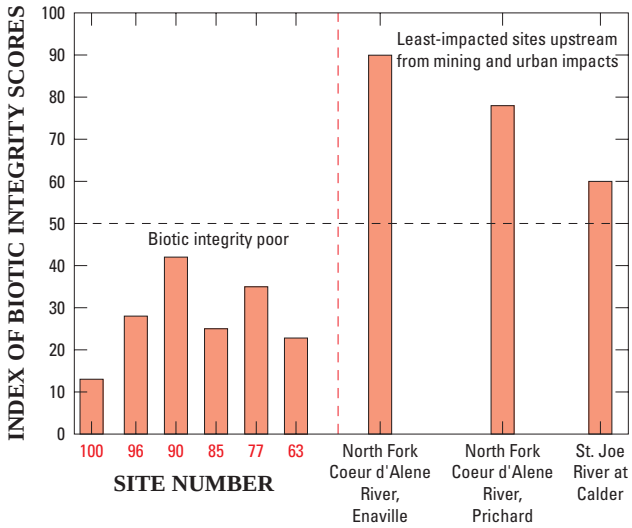

Figure 7. IBI scores for sites where fish were collected, Spokane River, Idaho and Washington, and for least-impacted sites, Idaho. (Site numbers shown in figure 1; data for least-impacted sites are given in report by Maret and others, 2001; scores based on 10 fish metrics given in report by Mebane and others, 2003)

cies. Sites with scores less than 50 indicate poor biotic integrity where coldwater and sensitive species are rare or absent, and where tolerant fish predominate. Sites with scores below 50 generally do not support a coldwater fishery. The Spokane River fish index scores indicate poor biotic integrity at all sites and sculpins were rare or absent. Index scores for the Spokane River, as well as those for least-impacted sites, are shown in figure 7.

Contaminants

Metals and organic contaminants have been measured at varying concentrations in water, sediment, and tissue of fish in the Spokane River. Elevated zinc has been measured in surface water between Post Falls and 7 Mile bridge at concentrations above the acute water-quality criteria of 35 micrograms per liter in water with a hardness value of 25 milligrams per liter (U.S. Environmental Protection Agency, 1987; Clark, 2003). Low concentrations of pesticides and VOCs also have been measured in surface water at the 7 Mile bridge site (Craig Bowers, U.S. Geological Survey, written commun., 2002).

Historical mining in the Coeur d'Alene River Basin has caused increased metal concentrations downstream in the Spokane River water, sediment, and fish tissue (Kadlec, 2000; Grosbois and others, 2001; Box and Wallis, 2002). Metals such as lead and zinc in streambed sediment can be harmful to aquatic organisms (Maret and others, in press). The PEL at which lead exposure would cause frequent adverse effects to aquatic organisms is 91.3 milligrams per kilogram, or ppm dry weight (Washington State Department of Ecology, 2002). The concentration of lead measured in 1998 in sediment smaller than 63 microns at Post Falls was 1,620 ppm dry weight, which exceeded the PEL. A lead concentration of 47.3 ppm measured in sediment at the 7 Mile bridge site that same year was below the PEL but still considered elevated. In 1998, the concentration of zinc in sediment at Post Falls (3,210 ppm) and 7 Mile bridge (319 ppm) exceeded the PEL of 315 ppm (Washington State Department of Ecology, 2002).

Concentrations of lead and zinc in tissue of caddisflies (the main diet of many fish species) from the Spokane River were 5 times the average concentrations in tissue of caddisflies from least-impacted sites. The concentrations in caddisflies collected in the Spokane River in 1999 were 3 micrograms per gram for lead and 180 micrograms per gram for zinc (Maret and others, in press) (figs. 8 and 9).

Elevated concentrations of metals from mining and PCBs from industrial and urban sources have been measured in tissue of fish from the Spokane River over the past 10 years (Johnson and others, 1994; Johnson, 1999; Johnson, 2000; Kadlec, 2000; MacCoy, 2001; Maret and MacCoy, 2002). Metal concentrations in whole fish were elevated compared with concentrations in fish measured during national surveys (Johnson and others, 1994).

Figure 8. Collection trays for caddisfly (*Hydropsyche* sp.) tissue analyzed for metals.

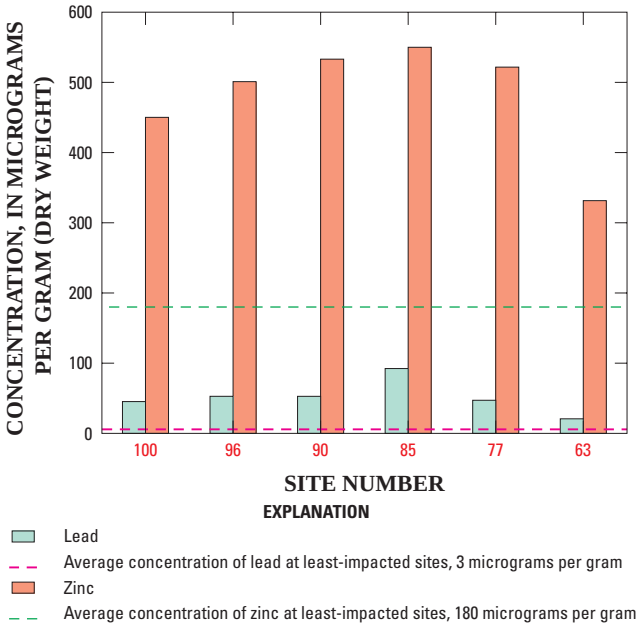

Figure 9. Concentrations of lead and zinc measured in tissue of caddisflies collected from sites on the Spokane River, Idaho and Washington, 1999, compared with average concentrations in tissue of caddisflies collected from least-impacted sites, Idaho. (Site numbers shown in figure 1; data for least-impacted sites are given in report by Maret and others, 2001)

Concentrations of lead and PCBs in fish tissue pose a threat to the public who eat fish caught between the Idaho/Washington State line and 7 Mile bridge site. PCBs in sportfish ranged from 70 to 1,610 micrograms per kilogram, or ppb (MacCoy, 2001), during this study and exceeded the human consumption criterion of 5 ppb for edible fish tissue (U.S. Environmental Protection Agency, 1999). In response to these high concentrations of lead and PCBs in fish tissue, a fish advisory for sections of the Spokane River was issued by the Washington State Departments of Ecology and Health (1999).

PCB concentrations in tissue of whole fish from the Spokane River near Post Falls (270 ppb) and Otis Orchards (500 ppb) ranked in the top 25 percent of concentrations in the 205 fish collected from streams in mixed land-use areas across the Nation but ranked far below the highest concentrations (in excess of 10,000 ppb) in tissue of fish from rivers in the Northeast (Lisa Nowell, U.S. Geological Survey, written commun., 2002, NAWQA data from 1991 and 1994 study units).

Conclusions

- Aquatic organisms in the Spokane River are affected by multiple stressors (metals, PCBs, and temperature).
- Exposure risk of aquatic organisms to elevated temperature and contaminants, such as metals and PCBs, depends on where impairment occurs in the river and the type of organism exposed.
- Major groups of native aquatic fauna, such as stoneflies and sculpins, are rare or absent in the Spokane River.
- The brevity of sampling for this study did not allow adequate determination of the extent or permanence of contamination or impairment, nor did it allow for determination of the most important stressors. Further studies targeting specific ecological indicators of various pollutants are needed to identify those stressors that are most limiting to aquatic organisms.

—Dorene E. MacCoy and Terry R. Maret

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ABBREVIATIONS USED IN THIS REPORT:

CHLA	chlorophyll-*a*
IBI	Index of Biotic Integrity
NAWQA	National Water-Quality Assessment
NROK	Northern Rockies Intermontane Basins
PCBs	polychlorinated biphenyls
PEL	Probable Effect Level
ppb	parts per billion
ppm	parts per million
SVRP	Spokane Valley-Rathdrum Prairie
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOCs	volatile organic compounds
WDOE	Washington State Department of Ecology

THE DEPARTMENT OF ECOLOGY
Environmental Assessment Program

November 17, 2011

TO: Ted Hamlin, Water Quality Program, ERO
Dave Moore, Water Quality Program, ERO
Arianne Fernandez, Hazardous Waste & Toxics Reduction Program, ERO
Dave George, Toxics Cleanup Program, ERO

THROUGH: Will Kendra, Environmental Assessment Program, Statewide Coordination Section Manager WK
Dale Norton, EAP, Toxics Studies Unit Supervisor

FROM: Patti Sandvik, EAP Toxics Studies Unit, Project Manager PS

SUBJECT: **Baseline Summary of a Long-term Monitoring Effort in the Spokane River for PCBs, PBDEs, and Metals**

Background

The Spokane River in eastern Washington contains elevated levels of polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), dioxins/furans, and metals. These contaminants are prevalent in water, sediment, and fish tissue. There are numerous studies and clean-up activities addressing contamination in the Spokane River. Information about the Spokane River, water quality, research studies, clean-up efforts, and resources can be found on Washington State Department of Ecology's (Ecology) website for the Spokane River Basin at www.ecy.wa.gov/geographic/spokane/spokane_river_basin.htm.

The Spokane River has been part of several statewide monitoring efforts for some years. These statewide efforts increased sampling in the Spokane River in 2009 and 2010 in order to help develop a long-term effectiveness monitoring program (Era-Miller, 2009) for the Spokane River Urban Waters Initiative (www.ecy.wa.gov/urbanwaters/spokaneriver.html). This initiative focuses on urban waterbodies and aims to prevent contamination or re-contamination of waterways by identifying and eliminating toxic chemicals at their source.

The goal of the 2009 and 2010 supplemental monitoring was to help establish a baseline characterization of PCBs, PBDEs, arsenic, cadmium, lead, and zinc as part of the beginning efforts of the Urban Water Initiative. The supplemental monitoring was conducted as part of three long-term statewide efforts, with extra sites and analytes added for the Spokane River sites:

- The River and Stream Water Quality Monitoring program samples for metals and conventional parameters (Hallock and Ehinger, 2003; Hallock, 2007; Hopkins, 1995).

- Monitoring for PBTs using Suspended Particulate Material (SPM). Lead is the main target analyte; arsenic, cadmium, and zinc were added for the Spokane River sites (Meredith and Furl, 2008).

- Monitoring for Persistent, Bioaccumulative and Toxic (PBT) chemicals using semi-permeable membrane devices (SPMDs). Target chemicals included pesticides, PCBs, PBDEs, and PAHs (Johnson, 2007a; Sandvik, 2010a).

A description of the long-term monitoring programs, access to historical data and previous annual reports can be found on Ecology's Internet web site at www.ecy.wa.gov under the "Environmental Assessment" program. Water quality monitoring information is listed under "River and Stream Water Quality Monitoring" at www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html and the PBT Trends can be found listed under "Toxics Monitoring by Ecology" in the "Washington State Toxics Monitoring Program" (WSTMP) at www.ecy.wa.gov/programs/eap/toxics/wstmp.htm.

Methods and results are summarized below.

Monitoring Design

Sites and Timeframes

Two locations were sampled for the baseline characterization effort (Figure 1). These sites are currently being used in the PBT studies and in the River and Stream Water Quality Monitoring program although additional sampling and analytes were added for the baseline project. Descriptions of the monitoring sites are in Appendix A.

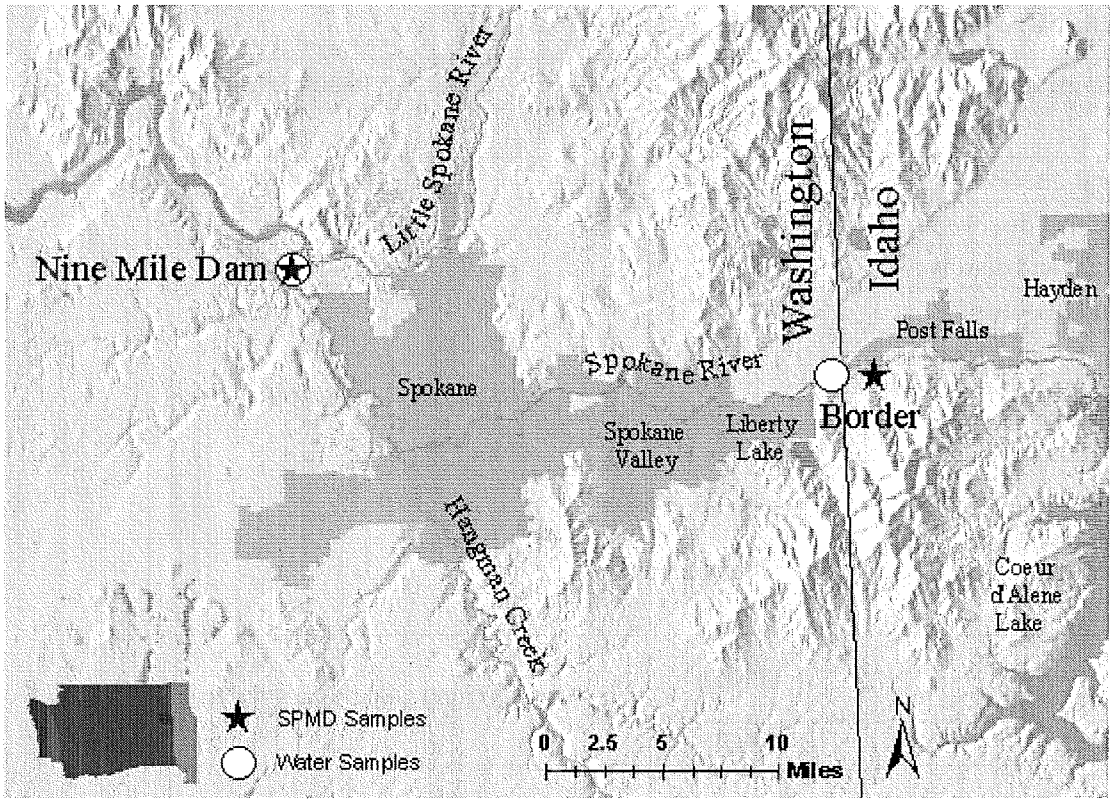


Figure 1. Site Locations in the Spokane River.

Sampling took place in fall 2009 (September) and spring 2010 (May and June). Sampling during these periods captured typical seasonal low-flow (fall) and high-flow (spring) conditions for the river. Sample collection by the various methods usually overlapped in time. SPM collection was taken twice during each of the SPMD deployments. Water samples were taken during one SPMD deployment, and after one SPMD deployment.

Methods

Chemicals Monitored

Table 1 shows analytes monitored by collection method for each sampling period.

Table 1. Chemical, Metal, and Ancillary Parameters Analyzed.

Parameters	Collection Method	Sampling Timeframe		
Water				
Lead, total and dissolved	Grab	9/22/2009 and 6/14/2010		
Arsenic, total and dissolved				
Cadmium, total and dissolved				
Zinc, total and dissolved				
Hardness				
TOC				
TSS				
Flow				
Conductivity	Field measurement			
Water temperature				
pH				
PBDEs	SPMDs[1]	9/3-30/2009 and 4/28 - 5/27/2010		
PCB congeners				
Water temperature	TidbiTs[1,2]			
TOC	Grab	9/3/2009 and 4/28/2010	9/21/2009 and 5/14/2010	9/30/2009 and 5/27/2010
TSS				
Water temperature	Field measurement			
Conductivity				
Particulates				
Lead, particulates	SPM	9/3/2009 and 4/28/2010	-	9/30/2009 and 5/27/2010
Arsenic, particulates				
Cadmium, particulates				
Zinc, particulates				
TSS, particulate fraction				
pH	Field measurement			

1. Passive monitoring: continuous or near continuous sample collection.
2. TidbiTs: Onset Computer Corporation Hoboware temperature loggers.
SPM: suspended particulate matter.
SPMD: semipermeable membrane devices.
TOC: total organic carbon.
TSS: total suspended solids.

Whole water samples for metals were collected once during each sampling period. SPM and SPMD samples were collected near each other and during the same sampling time period.

Conventional parameters such as TOC, TSS, water temperature, pH, and conductivity were collected during all sampling efforts (i.e. metals, SPM, and SPMDs), which may have varying sampling timeframes.

Field Procedures

Sample collection and field measurements followed Ecology's standard operating procedures (SOPs). SOPs followed for this study are listed in Appendix B.

Brief descriptions of field procedures referenced to each project's Quality Assurance Project Plans (QAPPs) are:

- Water sample collections were single, near-surface grab samples from highway bridges (Hallock and Ehinger, 2003; Hallock, 2007; and Hopkins, 1995).
- SPM were collected using in-line filtration of river water taken from 0.5 - 3 feet below the surface (Meredith and Furl, 2008).
- Sample collection with SPMDs used a composite of 5 standard SPMD membranes and then deployed into the water for a one-month period. The SPMDs were deployed for approximately 28 days each sampling period (Johnson 2007a; Sandvik, 2010a).

Laboratory Procedures

Chemicals analyzed in the samples collected at each site are shown in Table 1 above.

Water and SPM samples were analyzed by Ecology's Manchester Environmental Laboratory (MEL). The SPMDs were prepared and processed by their manufacturer, Environmental Sampling Technology Laboratory (EST). The SPMD extracts were then analyzed by other laboratories: MEL performed PBDEs analyses while Analytical Perspectives Laboratory conducted PCB congener analyses.

Analytical methods, reporting limits, and a brief discussion on how final results are reported in this document can be found in Appendix C.

Detailed information regarding extraction, clean-up, analysis, and data reduction can be found in the QAPPs (referenced above). Annual reports with the Spokane River results discussed here include:

- River and Stream Water Quality Monitoring Report Water Year 2009 (Hallock, 2010b).
- River and Stream Water Quality Monitoring Report Water Year 2010 (Hallock, 2011).
- PBT Trend Monitoring: Measuring Lead in Suspended Particulate Matter from Washington State Rivers and Lakes, 2009 Results (Meredith and Furl, 2010).

- PBT Trend Monitoring: Measuring Lead in Suspended Particulate Matter from Washington State Rivers and Lakes, 2010 Results (Meredith and Roberts, 2011).

- Washington State Toxics Monitoring Program: Monitoring with SPMDs for PBTs in Washington Waters in 2009 (Sandvik and Seiders, 2011).

- Washington State Toxics Monitoring Program: Monitoring with SPMDs for PBTs in Washington Waters in 2010 (in draft).

Data Quality

The QAPP developed for each study established data quality requirements for accuracy, bias, and reporting limits with measurement quality objectives (MQOs). The project lead for each study compared results from field and laboratory QC samples to the MQOs to determine if the MQOs were met. Based on these assessments and reviews of laboratory data verification reports, the data were accepted, accepted with appropriate qualifications, or rejected. Results presented here were accepted and any qualifiers were retained. A summary of field and laboratory data quality are presented in Appendix D. For more discussion of specific data quality, refer to each project's annual report.

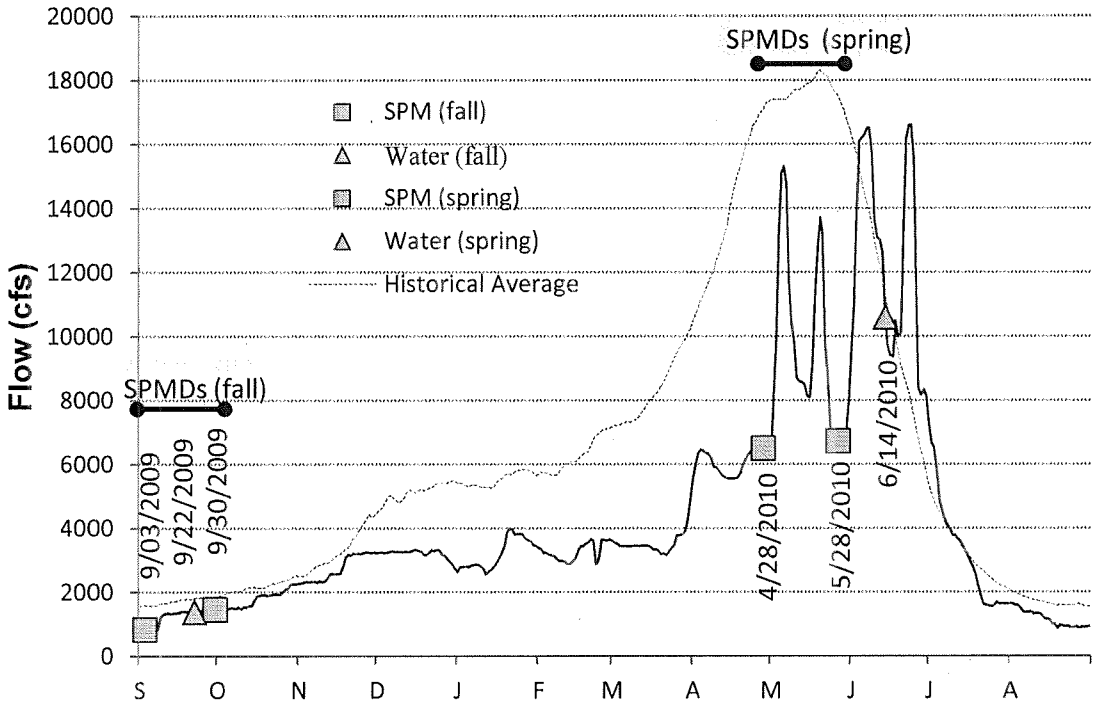
Results and Discussion

Data for this study is available at Ecology's Environmental Information Management (EIM) website www.ecy.wa.gov/eim/index.htm or by contacting Ecology. At the website, search EIM User Study ID, AMS001 (water results) or PbTrends09 and PbTrends10 (SPM results). Data for SPMDs are not stored in Ecology's EIM system. SPMD data can be obtained by contacting the Ecology project officer: Patti Sandvik at patti.sandvik@ecy.wa.gov.

Discussions of the chemistry results follow a description of the flow in the Spokane River during the sampling events.

Flow

The Spokane River flow was below historical average for both sampling periods (2009 fall and 2010 spring) (Hopkins, 2009; Hopkins, 2010) during SPMD, SPM, and metal (2009 fall only) collection. Flow was above historical average for the metals sampling event in spring of 2010 (Hopkins, 2010). Figure 2 shows sample collections in relation to flow.



Flows taken from USGS real-time water data station 12422500 Spokane River at Spokane (http://waterdata.usgs.gov/wa/nwis/rt).

Figure 2. Stream Flow Pattern and Sampling Events in 2009 (fall) and 2010 (spring).

In the summer of 2009, low precipitation events coupled with above normal temperatures during July and August kept the majority of statewide in-stream flow levels (including Spokane River) towards the lower end of their normal historical ranges. Although precipitation and temperatures returned to normal in September, river levels remained below normal during the sampling period for this project.

In May of 2010, a majority of Washington State rivers had above normal flows, but not the Spokane River. Below normal precipitation was experienced most of the winter months (December through March) resulting in below normal river levels in most rivers statewide. Increased precipitation near the end of April increased river levels.

When SPMD and SPM sampling began at the end of April 2010, the Spokane River was below its 20th percentile: only 20 percent of historical stream flow for this time period fell below this level. The flow increased to between the 20th and 50th percentile (median historical stream flow) by the end of May when sampling ended. Above normal precipitation in June increased flow in the Spokane River (as well as the majority of rivers statewide) to above historical levels. Metals were sampled in the middle of June and, therefore, they sampled at or above historical river levels.

Chemistry Results

Chemistry results are shown in Table 2 (fall 2009) and Table 3 (spring 2010). Results reported in bold are above the Washington State Water Quality chronic criteria for dissolved metals or the Lowest Apparent Effects Threshold (LAET) for particulates. Results are discussed further for each sampling type (water, SPM, and SPMDs) below.

Table 2. Results of Chemical and Metal Tests of Spokane River Collected Fall 2009.

2009 Fall	**Spokane R. at Nine Mile Dam**				**Spokane R. near Idaho Border**			
Metals	***SPM*** 9/3/2009	***Water*** 9/22/2009		***SPM*** 9/30/2009	***SPM*** 9/3/2009	***Water*** 9/22/2009		***SPM*** 9/30/2009
Parameter	particulates (mg/Kg)	dissolved (ug/L)	total (ug/L)	particulates (mg/Kg)	particulates (mg/Kg)	dissolved (ug/L)	total (ug/L)	particulates (mg/Kg)
Lead	135	0.083	0.37	143	**653**	0.142	1.49	**809**
Arsenic	20.7	2.98	2.79	17.2 U	29.4 U	0.48	0.46	50.0 U
Cadmium	16.7 U	0.053	0.10 U	17.2 U	29.4 U	0.065	0.12	50.0 U
Zinc	**1090**	8.9	12.4	**2800**	**3547**	22.9	27.8	**4420**
Organics	***SPMD*** 9/3-30/2009				***SPMD*** 9/3-30/2009			
Parameter	dissolved (pg/L)				dissolved (pg/L)			
Total PCBs	83				46			
Total PBDEs	240				33			
Conventionals	***SPM, SPMD*** 9/3/2009	***SPMD*** 9/21/2009	***Water*** 9/22/2009	***SPM, SPMD*** 9/30/2009	***SPM, SPMD*** 9/3/2009	***SPMD*** 9/21/2009	***Water*** 9/22/2009	***SPM, SPMD*** 9/30/2009
Flow (cfs)	-	-	1195	1300[a]	-	-	742	1037[a]
Water Temperature (C°)	16.8	-	13.3	13.1, 14.8[b]	22		19.2	17.5, 19.5[b]
Conductivity (us/cm)	276	218	290	215	51, 49	50	52	46, 48
pH	8.4	-	8.38	8.2	7.8		7.6	8.1
TSS (mg/L)	1, 2	2	2	2, 2	1, 1 U	1 U	2	1, 1 U
TOC (mg/L)	1.0 U	1.2	1.1	1.3	1.5	1.3	1.4	1.7
Hardness (mg/Kg)	-	-	131	-	-	-	20.6	-

SPM: suspended particulate matter.
SPMD: semipermeable membrane device.
Water: Water grab samples.
TSS: total suspended solids.
TOC: total organic carbon.

U = not detected above reporting limit.
a. geometric mean for sampling period 9/3-30/2009.
b. average temperature for sampling period 9/3-30/2009.
- No individual result. May be part of an average or not analyzed.

Table 3. Results of Chemical and Metal Tests of Spokane River Collected Spring 2010.

2010 Spring	Spokane R. at Nine Mile Dam				Spokane R. near Idaho Border			
Metals	***SPM*** 4/28/2010	***Water*** 6/14/2010		***SPM*** 5/27/2010	***SPM*** 4/29/2010	***Water*** 6/14/2010		***SPM*** 5/27/2010
Parameter	particulates (mg/Kg)	dissolved (ug/L)	total (ug/L)	particulates (mg/Kg)	particulates (mg/Kg)	dissolved (ug/L)	total (ug/L)	particulates (mg/Kg)
Lead	**338**	0.142	1.40	212	**1091**	0.145	1.28	**471**
Arsenic	23.7	0.68	0.66	22.7 U	62.5 U	0.35	0.33	41.7 U
Cadmium	20.8 U	0.158	0.20	22.7 U	62.5 U	0.183	0.22	41.7 U
Zinc	**2333**	40.6	45.0	**1391**	**4088**	**46.8**	51.0	**2942**
Organics	***SPMD*** 4/27 - 5/27/2010				***SPMD*** 4/27 - 5/27/2010			
Parameter	dissolved (pg/L)				dissolved (pg/L)			
Total PCBs	85 JK				140 JK			
Total PBDEs	30 JK				41 JK			
Conventionals	***SPM, SPMD*** 4/28/2010	***SPMD*** 5/14/2010	***Water*** 6/14/2010	***SPM, SPMD*** 5/27/2010	***SPM, SPMD*** 4/29/2010	***SPMD*** 5/14/2010	***Water*** 6/14/2010	***SPM, SPMD*** 5/27/2010
Flow (cfs)	-	-	10873	9696[a]	-	-	10300	9722[a]
Water Temperature (C°)	8.8	-	15	12.6, 10.9[b]	7.8	-	14.8	12.4, 10.4[b]
Conductivity (us/cm)	92	84	84	109	50, 50	51	52	50, 48
pH	7.5	-	7.88	7.7	7.4	-	7.71	7.4
TSS (mg/L)	3, 3	4	3	4, 2	1, 2	1	2	2, 1
TOC (mg/L)	1.5	1.6	1.5	1.6	1.6	1.6	1.5	1.9
Hardness (mg/Kg)	-	-	35.2	-	-	-	20.8	-

SPM: suspended particulate matter.
SPMD: semipermeable membrane device.
Water: Water grab samples.
TSS: total suspended solids.
TOC: total organic carbon.

U = not detected above reporting limit.
JK: the analyte was positively identified. Reported results are an estimate with unknown bias.
a. Geometric mean for sampling period 4/27 - 5/27/2010.
b. Average temperature for sampling period 4/27 - 5/27/2010.
- No individual result. May be part of an average or not analyzed.

Water

Results from fall 2009 and spring 2010 whole water samples ranged from 0.083 – 0.145 ug/L for lead (dissolved) and 8.9 - 46.8 ug/L for zinc (dissolved) at the Nine Mile Dam and Stateline sites. The Stateline dissolved zinc result (46.8 ug/L) exceeded the Washington State Water Quality chronic criteria for dissolved metals (27.63 ug/L based on hardness) by 69% in 2010. Furthermore, dissolved zinc at the Stateline site exceeded the criterion in all months for water year 2009 except August and September (Hallock, 2010b).

Dissolved cadmium was also higher in the Spokane River than typical for these two sampling periods (ranged 0.053 – 0.183 ug/L), but below the criteria for dissolved concentration based on hardness (ranged 0.32 – 1.36 ug/L). Many dissolved arsenic results were also elevated above the statewide median 0.55 ug/L, ranging from 0.35 to 2.98 ug/L, but lower than other sites statewide and considerably lower than the chronic water quality criteria (190 ug/L).

Overall, results for metals in water samples showed concentrations higher in the Spokane River when compared to other waterbodies (Hallock, 2010b; Hallock, 2011). In a statewide evaluation of concentrations of arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc in water samples, Hallock (2010b) found dissolved metals higher in eastern Washington than in western Washington. The Stateline Bridge samples from the Spokane River located at the Idaho border had dissolved metal concentrations, (all metals combined, median-normalized), above the 75th percentile of the body of ambient metals data and more than 75% of results were greater than reporting limits. Dissolved lead and zinc were much higher in the Spokane River than elsewhere making the comparison of metal concentrations more pronounced in the eastern Washington Rivers. The evaluation also found dissolved zinc appears to have a baseline concentration around 30 ug/L at the lowest flows.

Suspended Particulate Matter Samples

Results from fall 2009 and spring 2010 samples ranged from 135 – 1,091 mg/kg for lead and 1,090 – 4,088 mg/kg for zinc in the Nine Mile Dam and Stateline sites. Highest concentrations of lead and zinc were found at the Spokane River Idaho border site overall, which agreed with the water sample metal results above.

Concentrations of lead were high compared to other waterbodies (Meredith and Furl, 2010; Meredith and Roberts, 2011) and much higher than background levels found during a freshwater sediment reference study in Washington State. Zinc concentrations appear high also. The sediment reference study sampled bottom-sediments from nine lakes resulting in lead and zinc concentrations ranging from 3.18 – 55.4 mg/kg (average 13.6 mg/kg) and 23 – 110 (average 62.2 mg/kg), respectively (Sloan and Blakely, 2009).

Ecology developed guidelines to identify contaminant levels in sediments at which possible biological effects might occur by using the Lowest Apparent Effects Threshold (LAET) (Cubbage et al., 1997; Betts, 2003). The 2003 LAETs are 335 mg/kg for lead and 683 mg/kg for zinc. Comparing the results from the fall 2009 and spring 2010 sampling, one sample from the

Nine Mile Dam site and all samples from the Stateline site were above this threshold for lead and all samples for both sites were above the threshold for zinc.

Other SPM results (arsenic and cadmium) ranged from not detected to 23.7 mg/kg for arsenic and not detected in either sampling period for cadmium, falling near or below background levels. Two arsenic results, one from spring 2009 and one from spring 2010 sampled at the Nine Mile Dam site were above background bottom-sediment levels for Washington waterbodies (16.9 mg/kg). No cadmium results were above the 1.01 mg/kg background level. All arsenic and cadmium results fell below LAETs thresholds for arsenic (31.4 mg/kg) and cadmium (2.39 mg/kg).

Relationships

Previous monitoring efforts suggest existence of strong relationships among flow, metals concentrations, and TSS. During high flows, the dominant water in the Spokane River coming from the Coeur d'Alene system upstream of the Washington border is likely carrying re-suspended bank and bed sediment that are contaminated by historical mining (Hallock, 2010b). At low flow, the river contains a higher percent of groundwater (MacInnis et al., 2009). Seasonality, loading potential, and trends using these correlations have been reported where sufficient data is available (Hallock, 2010b; Meredith and Furl, 2010; Meredith and Roberts, 2011).

Meredith et al. (2010 and 2011) found lead concentrations by volume (particulate results divided by volume of filtered water (ug/L)) were significantly higher in the spring than in the fall ($p \leq 0.005$), likely driven by higher flows, which brought higher TSS (Table 4). Zinc was found higher in the spring than in the fall also. Arsenic and cadmium results were not detected in the spring but were found at low levels in the fall in some samples.

Table 4. Averaged Particulate Fraction Seasonal Comparison.

SPM by Volume (ug/L)	Spokane R. at Nine Mile Dam		Spokane R. near Idaho Border	
	2009 Fall	2010 Spring	2009 Fall	2010 Spring
Lead	0.1905	0.899	0.6	1.3605
Arsenic	0.0255 J	0.0795 J	0.0 U	0.0955 U
Cadmium	0.0235 U	0.076 U	0.0 U	0.0955 U
Zinc	2.865	6.05	3.4	6.495

Average results were qualified same as original results, except where one site had a mix of nondetects (U) and detected results, averaged results were qualified "J".

There appear to be strong indications that concentrations of total and dissolved cadmium, lead, and zinc are decreasing in the Spokane River. This observation is based on a review by Hallock (2010b) and a larger dataset than presented in this document, of which the 2009 water sample results are a part of. This decrease may be partially a result of declining trends in flow, though the trend in flow is not statistically significant. Variability in flow data and metal data as it relates to flow makes trend detection difficult.

Semipermeable Membrane Devices

PBDEs

Total PBDE results (dissolved) from SPMDs in the Spokane River ranged from 33 – 240 pg/L for 2009 fall and 2010 spring. Highest concentrations (240 pg/L) were found at the Nine Mile Dam site in the fall of 2009. Other waterbodies sampled for the PBT Trends Study generally had results below 50 pg/L. PBDE concentrations in the Spokane River at Nine Mile Dam have been consistently 5 to >10 times higher than other waterbodies statewide (Johnson et al., 2006; Sandvik, 2009; Sandvik, 2010b; Sandvik and Seiders, 2011). These elevated concentrations at this site are typically found in the fall samples. Statewide, seasonal patterns are not apparent at any of the other monitoring sites (Johnson et al., 2006; Sandvik, 2009; Sandvik, 2010b). There is insufficient data available to compare the seasonal observation with the Spokane River Idaho border sampling location, although concentrations remained lower (< 50 pg/L) for both fall (2009) and spring (2010) than at Nine Mile Dam.

PCBs

Results for total PCBs (dissolved) ranged from 46 – 140 pg/L for fall 2009 and spring 2010 SPMD samples in the Spokane River. Higher PCB concentrations were found in the spring 2010 samples for both Spokane River sampling sites. Previous PBT trend results from SPMDs (2007 – 2009), found total PCB concentrations in statewide waterbodies ranged from 5.4 – 130 pg/L (dissolved). The Spokane River and the Lower Columbia River generally had higher PCB levels than other sites.

Certain PCB congeners were identified as common contributors to field-trip blanks. Field samples also contained these same congeners at similar concentrations except for PCB-011. Several field samples showed levels of PCB-011 contributing greater than 20% to total PCBs (Sandvik and Seiders, 2011). Recent studies are reporting PCB-011 to be a global inadvertent pollutant from production of pigments or dyes (Dingfei and Hornbuckle, 2010; Muñoz, 2007; Rodenburg et al., 2010). In the Spokane River samples discussed here, PCB-011 contributed 6% and 32% in the Spokane River Nine Mile Dam samples and 2% and 3% in the Idaho border samples for 2009 and 2010 respectively for each site. All blanks had <2% contribution of PCB-011. The high contributions of PCB-011 found in field samples compared to the low contributions in field-trip blanks suggests PCB-011 may be from a current local source rather than part of the background PCBs.

Whole water concentration (sum of dissolved and particulate) PCB results ranged from 120 – 410 pg/L. For comparative purposes only since no SPMD data are used for regulatory action, whole water concentrations were compared to the Washington State and national human health criterion for PCBs. All total concentration results for both Spokane River sites in 2009 and 2010 except one (the 2009 fall Spokane River border site) did not meet the Washington human health criterion of 170 pg/L. All total concentration results from fall 2009 and spring 2010 samples for the Spokane River were above the EPA national recommended human health criterion of 64

pg/L. Like dissolved results, higher total concentrations were found in the spring 2010 samples likely as a result of higher TOC in the spring associated with higher TSS and flows.

Caution should be taken when comparing SPMD results among different studies or determining trends because of high variability found in the sampling system (Sandvik and Seiders, 2011).

Conventional Parameters

Table 5 shows result ranges for conventional parameters, which include temperature, conductivity, TSS, TOC, flow, and pH.

Table 5. Ranges of Ancillary Results Collected During Fall 2009 and Spring 2010 Sampling in the Spokane River.

Site	Sample Event	Parameter	Range
Spokane R. at Nine Mile Dam	2009 fall	Temperature (C°)	13.1 - 16.8
		Conductivity (us/cm)	215 - 290
		TSS (mg/L)	1 - 2
		TOC (mg/L)	nd - 1.3
		Flow (geometric mean cfs)	1,300
		pH	8.2 - 8.4
Spokane R. near Idaho Border	2009 fall	Temperature (C°)	17.5 - 22
		Conductivity (us/cm)	46 - 52
		TSS (mg/L)	nd - 2
		TOC (mg/L)	1.3 - 1.7
		Flow (geometric mean cfs)	1,036
		pH	7.6 - 8.1
Spokane R. at Nine Mile Dam	2010 spring	Temperature (C°)	8.8 - 15
		Conductivity (us/cm)	84 - 109
		TSS (mg/L)	2 - 4
		TOC (mg/L)	1.5 - 1.6
		Flow (geometric mean cfs)	9,696
		pH	7.5 - 7.88
Spokane R. near Idaho Border	2010 spring	Temperature (mean C°)	7.8 - 14.8
		Conductivity (us/cm)	48 - 52
		TSS (mg/L)	1 - 2
		TOC (mg/L)	1.5 - 1.9
		Flow (cfs)	9,722
		pH	7.4 - 7.71

TSS: total suspended solids.
TOC: total organic carbon.
nd: not detected.

Recommendations

- Monitoring for metals (lead, cadmium, and zinc), PBDEs, and PCBs in the Spokane River should be continued in water, SPM, and SPMDs.

- Sampling locations should include Nine Mile Dam and near the Idaho border. An additional sampling site(s) should be considered in-between these two locations for some parameters such as PBDEs and PCBs. The Spokane River aquifer interchange should be considered when selecting a site(s).

- Address potential use of PCB congener pattern matching techniques to help identify current local sources in the Spokane River. For example, a reduction of PCB-011 may have a favorable reduction to total PCBs.

- Use information from this monitoring to help design an effectiveness monitoring program for toxics in the Spokane River.

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Appendix A. Monitoring Site Descriptions

Table A-1. Monitoring Site Descriptions, Fall 2009 and Spring 2010.

Site Description	Sample	River Mile (RM)	Latitude[1] Decimal Degrees	Longitude[1] Decimal Degrees	WBID[2] WA-	Field ID[3]
Spokane River at Nine Mile Dam	SPMDs	RM 58.1	47.7747	-117.5444	WA- 54-1020	SPOK and REPSPOK
Spokane River at Nine Mile Dam	SPM	RM 58.1	47.7747	-117.5444	WA- 54-1020	SPOKNM-PB
Spokane River at Nine Mile Dam	Water	RM 58	47.7767	-117.5448	WA- 54-1020	54A090
Spokane River near Idaho Border	SPMDs	RM 98.3	47.6942	-117.0094	WA- 57-1010	SPOKBD
Spokane near Idaho Border	SPM	RM 96	47.6948	-117.0513	WA- 57-1010	SPOKBD-PB
Spokane River near Idaho Border	Water	RM 96.35	47.6985	-117.0446	WA- 57-1010	57A150

1 - North American Datum 1983 is horizontal datum for coordinates.
2 - Ecology's Water Body Identification Number (WBID).
3 - Site identification as used in Ecology's Environmental Information Management system.
SPM = suspended particulate matter.
SPMDs = semipermeable membrane devices.

Appendix B. Ecology SOPs

Table B-1. Ecology SOPs for Sample Collecting and Processing.

Collection Method	Parameters	Reference to Ecology's SOPs
Whole Water Grab Sample	total and dissolved metals: lead, arsenic, cadmium, zinc, hardness	Ward 2007a, Ward 2007b
SPM	lead, arsenic, cadmium, zinc	Meredith 2008
SPMDs	PBDEs, PCB congeners	Johnson 2007b
Whole Water Grab Sample	TOC, TSS	Ward 2007b
TidbiTs	water temperature	Bilhimer and Stohr 2008
Field Measurement	water temperature	Nipp 2006
Field Measurement	pH	Ward 2007b
Field Measurement	conductivity	Ward 2007b

Flow information and data were obtained from Ecology's Environmental Assessment Program Freshwater Monitoring Unit, USGS, and other sources.

Appendix C. Analytical Methods, Reporting Limits, and Final Results Reported.

Table C-1. Laboratory and Measurement Procedures.

Analysis	Sample Matrix	Sample Prep Method	Analytical Method	Reporting Limit
PBDEs	SPMD extract	dialysis/GPC[1]	EPA 8270[2]	2 ng/Sample
PCB congeners	SPMD extract	dialysis/GPC[1]	EPA 1668A[3]	0.1 ng/Sample
Lead	SPM	EPA 3050B	ICP/MS EPA 200.8	1 mg/Kg dw[4]
Arsenic	SPM	EPA 3050B	"	1 mg/Kg dw[4]
Cadmium	SPM	EPA 3050B	"	1 mg/Kg dw[4]
Zinc	SPM	EPA 3050B	"	1 mg/Kg dw[4]
Lead, dissolved	whole water	field filter	"	0.02 µg/L
Arsenic, dissolved	whole water	field filter	"	0.1 µg/L
Cadmium, dissolved	whole water	field filter	"	0.02 µg/L
Zinc, dissolved	whole water	field filter	"	1 µg/L
Lead, total	whole water	acid digest	"	0.1 µg/L
Arsenic, total	whole water	acid digest	"	0.1 µg/L
Cadmium, total	whole water	acid digest	"	0.1 µg/L
Zinc, total	whole water	acid digest	"	5 µg/L
Hardness	whole water	-	SM 2340B	0.3 µg/L
TOC	whole water	-	SM5310B	1 mg/L
TSS	whole water	-	SM2540D	1 mg/L

1. EST SOPs E14, E15, E19, E21, E32, E33, E44, E48.
2. GC/MS SIM = gas chromatography / mass spectrometry applying selective ion monitoring.
3. HRGC/HRMS = high resolution gas chromatography / high resolution mass spectrometry.
4. Assuming 0.5 g of field sample.

GPC = gel permeation chromatography.
dw = dry weight.

Results are reported as follows:

- Metal concentration results from water samples are reported in ug/L and hardness as mg/L. Water quality monitoring results are not considered finalized until the annual report is published, which is generally June of the following year. The 2009 fall and the 2010 spring results are finalized as of the printing of this report. These reports compare results to Washington Water Quality Criteria and are mentioned in this report.

- SPM laboratory results are reported in ug/filter. Final results are reported as mg/Kg dry weight. SPM results are also calculated based on volume as ug/L by dividing the laboratory-reported ug/filter value by the volume of water passed through the filter. SPM results (mg/Kg) were compared to the Lowest Apparent Effects Threshold (LAET) in freshwater sediments.

- The SPMD results are reported as total ng/sample as found in the entire extract; a 5-membrane composite. Residues are blank-corrected for background contamination as described in Appendix D before estimating water concentrations. Estimates of average water column concentrations are reported by using a USGS Estimated Water Concentration spreadsheet and PRCs. PRC loss rates are used to derive an exposure adjustment factor (EAF) to calibrate for the effects of temperature, water velocity, and biofouling. More information can be found through Huckins et al., 2006 and at wwwaux.cerc.cr.usgs.gov/SPMD/index.htm. Water concentration is reported as pg/L (dissolved).

- Total PCB is the sum of the individual congeners. Total PBDE is the sum of the 13 congeners analyzed in this study. Non-detect results were treated as zero when summing compounds. Summed compounds were calculated from water concentration values (as opposed to the residue concentration).

- Currently, SPMD and SPM data are not used for 303(d) listing purposes or other direct regulatory actions. Comparison with water quality standards and other threshold levels in this report are for comparative purposes only. SPMD total water concentrations results (dissolved plus particulate fractions) were compared to the Washington human health criterion and EPA national recommended human health criterion for PCBs. Total concentrations for SPMD results were estimated using the relationship from TOC developed by Meadows et al., 1998 and Karickhoff's (1981) estimation for K_{oc}. There are no criteria for PBDEs.

Appendix D. Data Quality Summary

Performance of laboratory analyses is governed by quality assurance and quality control (QA/QC) protocols. A QAPP developed for each study establishes a data quality guideline for accuracy, bias, and reporting limits with measurement quality objectives (MQOs) (See QAPP references listed in the Methods section).

Manchester's (MEL) quality assurance (QA) program includes the use of quality control (QC) charts, check standards, laboratory surrogates, in-house matrix spikes, laboratory replicates, and laboratory blanks, along with performance evaluation samples. For a more complete discussion of laboratory QA, see MEL's *Quality Assurance Manual* (MEL, 2006) and their *Lab Users Manual* (MEL, 2008).

To determine if MQOs were met, the project lead compared results on field and laboratory QC samples to the MQOs. Based on these assessments, a review of the laboratory data packages, and Manchester Laboratory's data verification reports, the data were either accepted, accepted with appropriate qualifications, or rejected. A summary of field and laboratory data quality are presented below. For more discussion of specific data quality, refer to each projects' annual report as mentioned above.

Field

Field Blanks

Field filter blanks were taken during each sampling period at one of the sample locations: one for SPMs and one for water samples. In the fall of 2009, a SPM field blank was taken at the Idaho border site and a whole water field blank at the Nine Mile Dam site. In the spring of 2010, a SPM field blank was taken at the Nine Mile Dam site and a whole water field blank at the Stateline border site. All results were below reporting limits except one water sample blank result. Dissolved zinc reported 1 ug/L in the water sample field blank taken during the 2010 spring sampling event. Since all results for this report are > 5ug/L, no qualifiers were applied (Hallock, personal communication, 2010a; Hallock, 2011).

A SPMD field trip blank was taken at the Nine Mile site during both sampling events. The field trip blank consisted of five membranes manufactured identically as for field samples. The blank was exposed to the site's ambient air for two minutes during deployment and again during retrieval of the field samples. Low levels of contaminants were found in both fall 2009 and spring 2010 field trip blanks. Sample results were evaluated and a blank-correction procedure used, where possible, before residue results were used for estimating water column concentrations (see below).

Field Replicates

There were no field replicates taken for SPM or water samples from the Spokane River. Field replicates for lead were taken from other sites during the routine sampling for SPM. High

variability was indicated by half the lead replicate results outside the MQOs (± 50% RPD) during the fall 2009 and spring 2010 sampling events.

A SPMD field replicate was deployed at the Nine Mile Dam location in the spring of 2010, but not during the fall of 2009. Results from the replicate were rejected due to a lab accident. Historical field replicates generally showed good precision having RPDs less than 20% for over 80% of the residue results (Sandvik 2009 and 2010b). Replicates deployed specifically at the Nine Mile Dam location in the spring of 2009 and fall of 2010 had good precision with over 90% of PBDE and PCB residue results having RPDs of 20% or less (Sandvik and Seiders 2011).

TidbiTs

To determine if SPMDs remained submerged throughout the sampling period, an Onset StowAway® TidbiTs™ temperature monitor was attached to each SPMD canister. Another TidbiT™ was secured out of the water near the site. These TidbiT™ recorded temperature every two minutes. Examination of data from TidbiTs™ showed that all samples remained submerged during deployment.

Laboratory

All samples were prepared and analyzed within the methods holding times for the various parameters. Most QC procedures and corresponding samples fell within the acceptable limits. Exceptions were qualified as estimates when necessary and are briefly discussed below. One 2010 spring SPMD sample was rejected due to a laboratory accident; sample 1006021-15. Laboratory case narratives are available upon request for the project officers.

Metals

Matrix Spikes

The matrix spike and matrix spike duplicate recoveries for hardness analysis in the 2009 fall samples were below the acceptable criteria. Since the spike was insufficient for the elevated concentration of analyte in the field sample, no action was taken. All other associated matrix spike recoveries were within the acceptable limits.

SPM

All QC results were within acceptable limits. No additional qualitative action was needed.

SPMDs

Laboratory Blanks

Analytical laboratory method blanks showed no significant contamination for any of the chemicals analyzed. Individual PCB and PBDE compounds were detected in processing blanks. Concentrations of individual target chemicals in the blanks were inconsistent. Some of these same compounds were found at similar levels in the field trip blanks, suggesting a combination

of laboratory and field sources. Although the contamination source is unclear, a certain background level appears to exist and has been documented in previous reports (Sandvik, 2009; Sandvik, 2010b, Sandvik and Seiders 2011). Blank correction for background contamination is briefly described below. WSTMP annual reports for monitoring PBTs with SPMDs describe the blank correction procedure used for each sampling period in more detail.

TSS and TOC

All results for TOC and TSS met QA limits except for two TSS samples. TSS results were qualified as estimates because the samples had fast settling sand.

PCBs

All calibration standards were within the QC limits with a few exceptions. However, as the OPR recoveries were acceptable, no action was taken.

Each congener reported as detected met the isotopic abundance ratio and retention time criteria for positive identification with several exceptions. These exceptions have been qualified to reflect tentative identification, and the associated numerical value represents its approximate concentration; qualified NJ. The values reported for these congeners were not included in the totals for the corresponding homolog.

A number of congeners were qualified as estimates (J) because the concentration was below the lowest calibration standard. Also, low levels of certain target compounds were detected in the laboratory blanks. All corresponding concentrations were qualified as nondetects with an estimated reporting limit (UJ) because the values were below the reporting limit (0.02 ng/sample) and less than 10 times that of the corresponding method blank.

Target analyte recoveries were within method QC of 50% to 150% with several exceptions. Also, certain unlabeled analytes that were not deliberately spiked into an on-going precision and recovery (OPR) or laboratory control sample (LCS) were detected. These results and analytes were also found in field and laboratory blanks indicating certain background contamination of PCBs.

PBDEs

Sampling periods, (2009 fall and 2010 spring), had excellent QA results for PBDEs. Only one QA result for PBDE-138 in the 2010 spring samples required qualification (J) because of slightly low surrogate responses; sample 1006021-19.

Correction for Background Contamination (or Blank-Correction)

The sample results were screened to determine if they could be blank-corrected. Results that were greater than the mean plus two standard deviations of the field trip blank were deemed correctable. Correctable results were adjusted by subtracting the mean of the field trip blanks from the result; the adjusted results were then qualified as an estimate with an unknown bias (JK). For detected compounds that did not meet the blank-correction criteria, the original result

was used as an estimated reporting limit and qualified as being below the method detection limit with an unknown bias (UJK). The detection limit was used where a compound was not detected.

The fall sampling event in 2009 provided only one field trip blank. This result was assumed to represent the mean background contamination for that period because the samples were in the same waterbody (the Spokane River) and reasonably close in proximity (approximately 26 miles apart). The standard deviation of the fall field trip blank was estimated using the proportion of the standard deviation to the mean of the 2009 spring field trip blanks, which consisted of seven blanks. The assumption was made that the proportion of standard deviation to mean for one sampling period is similar to another sampling period. Even though this approach limits representativeness, the assumption seems fair, based on the review of the spring and fall field trip blank results.

The impact of the correction process varied among the chemical groups. For the combined 2009 fall and 2010 spring PBDE results, 42% were detected, and of those detected, 59% were correctable. For 2009 fall and 2010 spring PCBs, 84% were detected with 67% of those correctable.

Some results fell below the original reporting limit after they were blank-corrected. These results were considered detected at the "new" corrected level in the remainder of this report.

PCBs, Dioxins, and Furans in Fish, Sediment, and Wastewater Treatment Plant Effluent from West Medical Lake

DEPARTMENT OF ECOLOGY
State of Washington

September 2010
Publication No. 10-03-038

Publication and Contact Information

This report is available on the Department of Ecology's website at
www.ecy.wa.gov/biblio/1003038.html.

Data for this project are available at Ecology's Environmental Information Management (EIM) website www.ecy.wa.gov/eim/index.htm. Search User Study ID, RCOO0008.

The Activity Tracker Code for this study is 08-099.

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Cover photo: West Medical Lake looking from south to north (photo by Randy Coots).

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by

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Table of Contents

Page

List of Figures and Tables....5

Abstract....7

Acknowledgements....8

Introduction....9
- 303(d) Parameters....9
  - PCBs....10
  - Dioxins and Furans....10
- Watershed Description....10
- Water Quality Standards and Guidelines....11
  - Fish Tissue and WWTP Effluent....11
  - Sediments....11
- Potential Sources of Contamination....12
  - Historical Discharges....12
  - Permit Holders....13
  - Nonpoint Sources....13

Methods....15
- Overview....15
  - Fish....17
  - Sediment....18
  - WWTP Effluent....18

Quality Assurance....19

Results and Discussion....21
- Fish....21
  - PCBs....21
  - Dioxins and Furans....22
  - Comparison to Previous Study....24
  - WDOH Human Health Evaluation....25
  - Fishery Management....25
- Sediment....26
  - PCBs....27
  - Dioxins and Furans....28
- WWTP Effluent....29
  - Discharge....29
  - PCBs....31
  - Dioxins and Furans....31
  - PCB and TCDD Loads....32

Conclusions and Recommendations....34

References....35

Appendices.....37
Appendix A. Glossary, Acronyms, and Abbreviations.....39
Appendix B. Study Tables.....43

List of Figures and Tables

Page

Figures

Figure 1. Structure and Numbering System of PCBs, Dioxins, and Furans. 9

Figure 2. Study Area. 14

Figure 3. Sediment Collection Sites and Fish Collection Areas. 16

Figure 4. Cumulative Frequency Distribution of Total PCBs in Rainbow Trout Fillets Collected in 2008 from West Medical Lake Compared to Statewide Data for 1993-2008. 22

Figure 5. Dioxin TEQs in Rainbow Trout Tissue from West Medical Lake. 23

Figure 6. Grain Size Distribution of West Medical Lake Sediments. 26

Figure 7. Total PCBs in West Medical Lake Sediments. 27

Figure 8. Dioxin TEQs in West Medical Lake Sediments. 28

Figure 9. Daily Effluent Discharge from Medical Lake WWTP, 2008. 29

Figure 10. Total PCBs in Medical Lake WWTP Effluent. 30

Tables

Table 1. Washington State Water Quality Criteria for PCBs and 2,3,7,8-TCDD. 11

Table 2. Recommended Numerical Guidelines for Total PCBs and TCDD in Freshwater Sediments from Washington State, Ontario, and Florida. 12

Table 3. Methods for Fish Tissue, Sediment, and WWTP Effluent Sample Analysis. 17

Table 4. Comparison of 2008 PCBs and PCDD/PCDF TEQs in fish tissue to WSTMP Data and NTR Criteria. 24

Table 5. Summary of PCB Data for Eastern Washington WWTP Effluents. 31

Table 6. Total PCB Loads Discharged and Allowable Loads from the Medical Lake WWTP. . 32

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Abstract

The Washington State Department of Ecology conducted a toxics study of West Medical Lake between February and October 2008. Six fish tissue, seven sediment, and four Medical Lake wastewater treatment plant (WWTP) effluent samples were collected. The toxics analyzed included polychlorinated biphenyls (PCBs), 2,3,7,8-tetrachlorodibenzodioxin (TCDD or dioxin), and other chlorinated dioxins and furans. Additional conventional parameters analyzed included lipids in fish tissue, total organic carbon and grain size in sediments, and total suspended solids and total organic carbon in WWTP effluent.

Total PCB concentrations in fish tissue were generally low compared to statewide levels. However the Environmental Protection Agency National Toxic Rule (NTR) human health criterion was still exceeded by a factor of 2 to 8. Tissue concentrations of dioxins/furans were low, and TCDD was not detected.

Total PCBs and dioxins/furans in sediment were below apparent effects thresholds for the protection of benthic infauna based on Washington State's proposed freshwater Sediment Quality Guidelines.

Total PCBs in WWTP effluent were low and below the NTR criterion for human health throughout the study period. In the April sample, TCDD was reported just above the reporting limit, exceeding the NTR criterion. The April results may be related to the WWTP upset in the de-nitrification system. No furans were reported above detection limits.

Recommendations include:

1. Consider changing the West Medical Lake 303(d) listing for TCDD from Category 5 (on the list) to Category 1 (meets standards) during the next water quality assessment (year 2012).
2. Re-analyze West Medical Lake rainbow trout in five years to assess levels of PCBs, dioxins, and furans.
3. Analyze PCBs, dioxins, and furans in rainbow trout at the time of planting to determine if there is contamination from hatchery sources prior to introduction to the West Medical Lake.

Acknowledgements

The authors of this report thank the following people for their contribution to this study:

- Steve Cooper, lead operator at the Medical Lake Wastewater Treatment Plant, was very helpful throughout the study especially with his historical knowledge and assistance with collecting samples.
- Washington State Department of Fish and Wildlife staff:
  - Chris Donley's knowledge of the lake and help with collecting fish was much appreciated.
  - Lucinda Morrow age dated the fish collected for the study.
- Washington State Department of Ecology staff:
  - Ken Merrill proposed and helped develop the study and also assisted in collecting sediment samples.
  - Karin Baldwin took over the project and was helpful in defining the final product.
  - Dale Norton and Art Johnson reviewed the document.
  - Joan LeTourneau and Cindy Cook prepared the final report.

Introduction

In 2002 the Washington State Toxic Monitoring Program (WSTMP) collected samples of rainbow trout from West Medical Lake. One composite of fillet from 10 fish was analyzed. Results from this sample were responsible for placing West Medical Lake on the 2004 303(d) list for total polychlorinated biphenyls (PCBs) [listing ID: 42173] and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) [listing ID: 42381].

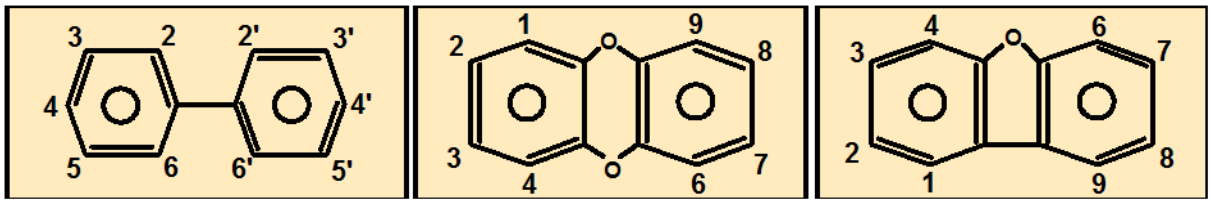
Since that time the 303(d) listing policy has changed resulting in using only the concentration of 2,3,7,8-TCDD. The WSTMP sample that justified the 303(d) listing in 2004 was based on 2,3,7,8-tetrachlorodibenzofuran (TCDF).

The federal Clean Water Act requires that waterbodies on the 303(d) list be cleaned up by pollution control programs or that a total maximum daily load (TMDL) be developed. A pollution-control program needs to address the sources of pollution and have a monitoring and enforcement component. A TMDL identifies pollution problems in the watershed and specifies how much pollution needs to be reduced or eliminated to achieve clean water. When developing a pollution-control program or a TMDL, Ecology will work with the local community and other relevant stakeholders to identify all actions that need to occur to address the sources of pollution. Monitoring to assess the effectiveness of those implementation actions will also be developed. That monitoring will be used to determine success or the next steps needed.

303(d) Parameters

PCBs, dioxins, and furans are similar in structure and are classes of organic chemicals that are persistent, bioaccumulative, and toxic. They can remain in the environment for many years and move between water, air, soil, and sediments. With the ability to move between these media, they threaten the food chain and can accumulate in animals and humans. Higher detection levels are typically reported from fish tissue and sediment (parts per billion) than water (parts per trillion or quadrillion) because of the hydrophobic nature of these contaminants.

Figure 1 shows the structure and numbering system of PCBs, dioxins, and furans. The numbered locations are chlorine bonding sites.



Polychlorinated biphenyls (PCBs) | Polychlorinated dibenzo-p-dioxin (PCDD) | Polychlorinated dibenzofuran (PCDF)

Figure 1. Structure and Numbering System of PCBs, Dioxins, and Furans.

PCBs

PCBs are synthetic organic compounds with no natural sources. PCBs enter the environment through their use and disposal. The commercial value of PCBs was based on their chemical stability and electrical insulating properties. Use largely focused around coolants and lubricants in transformers, capacitors, and other electrical equipment. Production of PCBs was banned by the Environmental Protection Agency (EPA) in 1979.

PCBs are normally analyzed as congeners or Aroclors. Congeners are individual chlorinated biphenyl molecules that are identified by the number and location of chlorine atoms around the biphenyl rings joined by a carbon-carbon bond. There are a total of 209 PCB congeners possible. Aroclors are commercial mixtures of congeners based on the application and the desired properties. Detection limits are higher for Aroclor analysis.

Dioxins and Furans

Dioxins and furans are the common names associated with polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF). These compounds are formed as an unintended byproduct during combustion of organic compounds in the presence of chloride. Sources are waste incinerators, pulp mills, industrial processes, and even backyard burn barrels. There is no commercial or domestic use for dioxins or furans. Ecological effects can occur because of their persistence and ability to biomagnify in the food chain.

There are a total of 210 possible dioxin and furan congeners. Like PCBs they are identified by the number and location of chlorine atoms around the biphenyl rings, but in this case, joined by oxygen atoms (Figure 1). The highest toxicity is associated with the 17 co-planar congeners (7 dioxin and 10 furan) that have chlorine atoms located in the 2,3,7, and 8 positions. The most toxic of these congeners is 2,3,7,8-TCDD.

Watershed Description

West Medical Lake is located within the Upper Crab Creek watershed in eastern Washington about 15 miles southwest of Spokane. Forming the western boundary of the City of Medical Lake, the shoreline surrounding the lake is largely natural. A picnic area is located on the east shore, and a large public access with boat rentals and docks is on the south shore (Figure 2). The land surrounding the lake is owned by the state with no near-shore residential development. The drainage area to West Medical Lake is mainly agriculture with wheat fields the major land use.

West Medical Lake is one of the few lakes in Washington State receiving a National Pollutant Discharge Elimination System (NPDES) permitted discharge. Nutrient levels in the lake are elevated, classifying it as “highly eutrophic”. It may be one of the most enriched lakes in the state (Smith et al., 2000). Aquatic plants are thick in most places. Zooplankton support one of the most productive trout fisheries in the state (Donley, 2008). The Washington Department of

Fish and Wildlife (WDFW) have operated aerators in the past to maintain adequate dissolved oxygen levels and prevent fish kills. West Medical Lake is not normally used for primary contact recreation.

Draining a relatively small basin of about 1.8 miles^2, West Medical Lake has approximately 4 miles of shoreline, a surface area of 220 acres, and an average depth of 22 feet. With no natural inflows or outflows, the hydraulic residence time of this seepage lake is very long, estimated at about 29 years (Willms and Pelletier, 1992).

The arid climate of eastern Washington averages about 80 degrees from June through August. From December through February the average high is about 35 degrees. Annual precipitation is slightly more than 16 inches per year. Elevation of West Medical Lake is 2,420 feet above sea level.

Water Quality Standards and Guidelines

Fish Tissue and WWTP Effluent

In 1992, EPA established water quality criteria for the protection of human health from the adverse effects of priority pollutants. The criteria are called the National Toxics Rule (NTR) (40 CFR 131). The Clean Water Act required states without sufficient human health criteria for priority pollutants to adopt the National Toxics Rule. Human health criteria are calculated for an increased lifetime cancer risk of one in one million (10^{-6}) from the consumption of fish or water. Water quality criteria for the toxic parameters addressed in this study for West Medical Lake are shown below in Table 1.

Table 1. Washington State Water Quality Criteria for PCBs and 2,3,7,8-TCDD.

Chemical	Criteria for Protection of Aquatic Life - Freshwater		Criteria for Protection of Human Health		
	Acute (ng/L)	Chronic (ng/L)	Water and Fish Consumption (ng/L)	Fish Consumption (ng/L)	Fish Tissue
Total PCBs	2,000	14	0.17	0.17	5.3 *u*g/Kg
2,3,7,8-TCDD			0.000013	0.000014	0.065 ng/Kg

Sediments

Washington State has not formally adopted regulatory numeric standards or EPA criteria for chemical contaminants in freshwater sediments. Instead, recommended numerical Freshwater Sediment Quality Values (FSQVs) are used as guidelines. The FSQVs are intended for the protection of sediment-dwelling organisms from toxic effects of chemical contaminants.

Avocet (2003) has developed FSQVs as both Sediment Quality Standards (SQS) and Cleanup Screening Levels (CSL) for Washington State. The SQS are concentration thresholds below which biological effects are not expected. The CSL estimates the concentration below which minor adverse effects can occur and above which more significant effects are likely.

The FSQVs presented below in Table 2 have been developed from field studies and laboratory data. The most recent SQS guidelines for use in Washington State are shown for PCBs (Avocet, 2003) and TCDD (Cubbage et al., 1997). In addition, two other sets of FSQVs for total PCBs from the state of Florida (Florida DEP, 2003) and Ontario, Canada (Jaagumagi and Persaud, 1999) are shown. The Florida value is consensus-based and developed using five threshold effect guidelines developed by MacDonald et al. (2000). Differences in proposed guideline values lie in the different chemical mixtures present in sediments and the biological effect from them.

Table 2. Recommended Numerical Guidelines for Total PCBs and TCDD in Freshwater Sediments from Washington State, Ontario, and Florida.

Guideline		Reference
Total PCBs (*ug*/Kg, dw)		
Washington State [1]	62	Avocet, 2003
Ontario [2]	70	Jaagumagi and Persaud, 1999
Florida [3]	60	Florida DEP, 2003
TCDD (ng/Kg, dw)		
Washington State [4]	8.8	Cubbage et al., 1997

[1] - Reported as LAET, "Lowest Apparent Effects Threshold".
[2] - Reported as LEL, "Lowest Effect Level".
[3] - Reported as TEC, Consensus-based "Threshold Effects Concentration".
[4] - Reported as AET, "Apparent Effects Threshold".

Potential Sources of Contamination

Historical Discharges

Historically, two facilities discharged treated wastewater directly to West Medical Lake:

- Eastern State Hospital and Lakeland Village, operated by the Washington State Department of Social and Health Services.
- Pine Lodge Corrections Center for Women, operated by the Washington State Department of Corrections.

Discharges from these state facilities were rerouted in October 2000 and connected to the City of Medical Lake's new wastewater treatment plant (WWTP).

Permit Holders

Under the NPDES Waste Discharge Permit and Reclaimed Water Permit No. WA-0021148, the City of Medical Lake is authorized to discharge reclaimed water to West Medical Lake. The effective date of the permit was June 1, 2005 and expiration was April 27, 2010. A new permit is expected by the end of summer 2010.

The current NPDES permit does not address discharge limits for total PCBs or TCDD. The design flow is for an average maximum discharge per month of 1.85 million gallons per day (mgd).

The Medical Lake WWTP provides tertiary treatment by activated sludge, coagulation, and filtration. Following tertiary treatment, effluent is divided and discharged to a tributary of Deep Creek and West Medical Lake. The West Medical Lake portion is discharged by way of a manifold extending from the eastern shoreline at the historical WWTP to almost the center of the lake as reclaimed water for augmentation and maintenance of the lake's water level. During the dry season WWTP discharge to West Medical Lake averages between 0.4 and 0.5 mgd, and during the wet season the discharge averages between 0.7 and 1.0 mgd (Cooper, 2007).

Nonpoint Sources

There are a number of possible nonpoint (diffuse) sources of PCBs and TCDD to West Medical Lake. Air deposition is a likely contributor from both local and global sources. Entering the air during manufacture, use, and disposal, airborne contaminants such as PCBs and TCDD can travel long distances before being deposited back to the earth's surface.

Waste burning of materials containing PCBs and TCDD contributes to the airborne pool of contaminants available as fallout to land and water surfaces. Uncontrolled combustion is thought to be a major source of PCBs and TCDD today. Anything from backyard trash burning to industrial incinerators can be considered a potential source. A recent EPA study (EPA, 2006) found that residential burning of household trash is a leading source of dioxins to the air. Agricultural burning and forest fires are also thought to contribute dioxins.

Because of the persistent nature of PCBs, contaminant levels found in West Medical Lake today could be partly a result of past improper or illegal handling as well as disposal of transformers and other electrical equipment containing PCBs.

Stormwater runoff from Eastern State Hospital, Lakeland Village, other facilities within the drainage area, and agricultural lands may also be playing a role as a source of PCBs and TCDD to the lake. In addition to direct deposition from the air, PCBs and TCDD can bind to soils and wash off to surface waters during storm events.

Lake sediments may also play a role as an internal source of pollutants to the food chain. Historical discharges to the lake from the state facilities, in addition to other ambient sources, have likely contributed to sediment contamination.

Figure 2. Study Area.

Methods

Overview

This study was conducted under the guidance of the Quality Assurance Project Plan (QAPP) entitled *West Medical Lake Total PCBs and Dioxin (2,3,7,8-TCDD) Total Maximum Daily Load* (Coots, 2008), which can be found at: www.ecy.wa.gov/pubs/0803104.pdf . Sampling locations for the study are shown below on Figure 3. Analytical methods, reporting limits, and sample preparation are presented in Table 3.

Study objectives included:

- Evaluating current levels of total PCBs and TCDD in fish tissue, sediment, and WWTP effluent.

- Providing the fish tissue data to the Washington State Department of Health to evaluate the need of a fish consumption advisory.

These objectives were met through characterizing the current levels of PCBs and TCDD in edible fish tissue and sediments from West Medical Lake. Seasonal loads of PCBs and TCDD were also monitored for the Medical Lake WWTP discharge to the lake.

The current West Medical Lake 303(d) listings for PCBs and TCDD are based on rainbow trout tissue, so they were targeted for collection and analysis. Rainbow trout are the dominant species in the lake. WDFW stocks the lake with 150,000 to 300,000 rainbow trout annually (Donley, 2008). The planting consists of catchable size fish, as well as some brood stock and triploids. Carry-over fish two or more years of age were targeted for collection.

The Washington State Department of Health was consulted during study development to ensure the number of fish targeted for collection would meet the needs of a fish consumption advisory evaluation.

Medical Lake WWTP loads of total PCBs and TCDD discharged during the 2008 study year were calculated from results reported for seasonal effluent samples and the flow rate from the WWTP at the time of sampling. Maximum loads for total PCBs and TCDD were also developed using the water quality criteria for each contaminant and sample time flows for the Medical Lake WWTP facility.

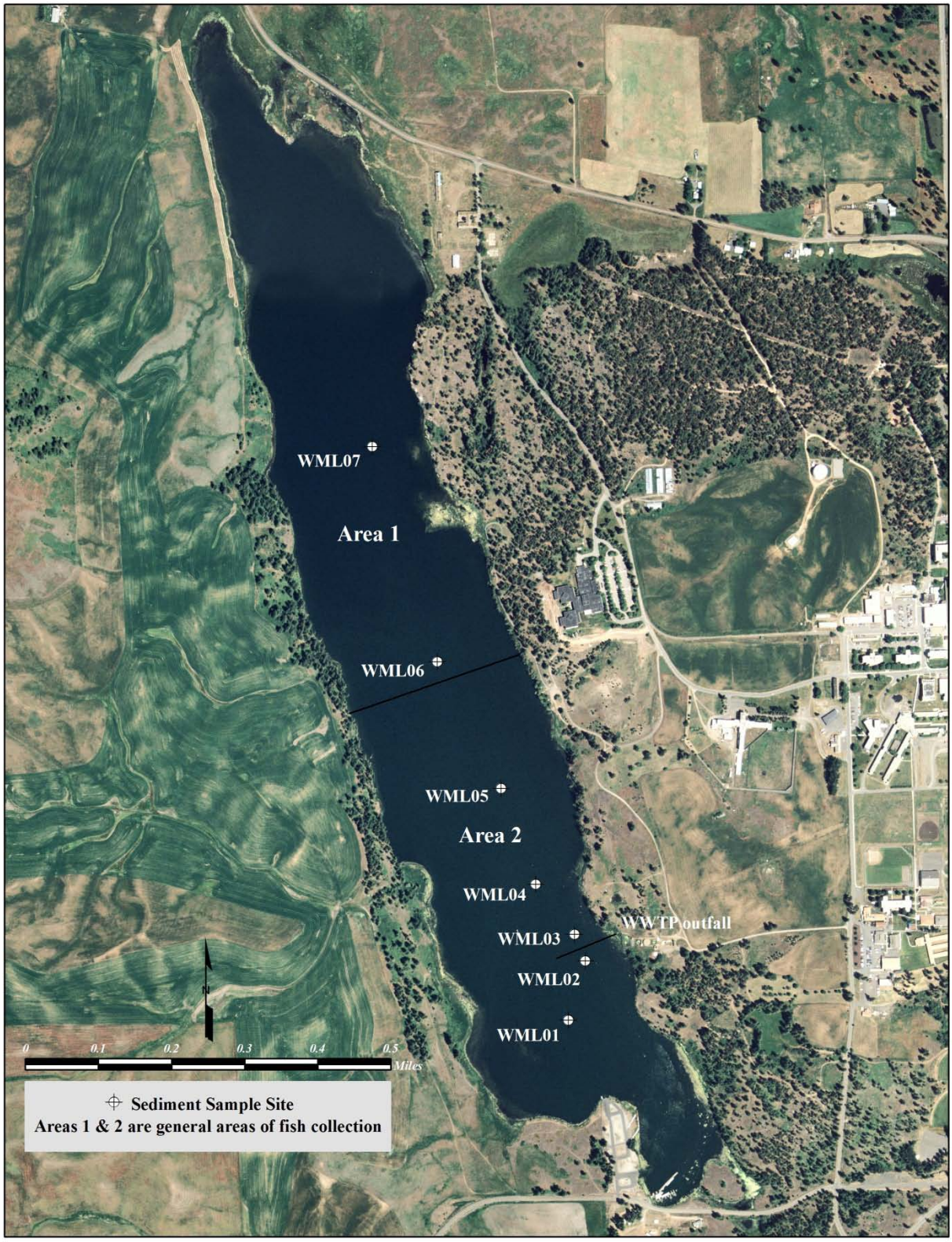


Figure 3. Sediment Collection Sites and Fish Collection Areas.

Table 3. Methods for Fish Tissue, Sediment, and WWTP Effluent Sample Analysis.

Analysis	Reporting Limit	Sample Preparation Method	Analytical Method
Fish Tissue			
PCB Aroclors	5 *u*g/kg, wet	EPA 3541	EPA 8082
Dioxins/Furans	0.07 ng/Kg, wet	Silica-gel if needed	EPA 1613B
Percent Lipids	0.10%	Extraction	EPA 1613 B
Sediment			
PCB Aroclors	5 *u*g/kg, dry	EPA 3541	EPA 8082
Dioxins/Furans	0.05 ng/Kg, dry	Silica-gel if needed	EPA 1613B
Total Organic Carbon	0.10%	Combustion/NDIR	PSEP-TOC
Grain Size	0.10%	Sieve and Pipette	PSEP-1986
Effluent/Water			
PCB Congeners	10 pg/L	EPA 1668A	EPA 1668A
Dioxins/Furans	1 pg/L	EPA 1613B	EPA 1613B
Total Organic Carbon	1 mg/L	NA	SM 5310B
Total Suspended Solids	1 mg/L	NA	SM 2540D

NDIR – non-dispersive infrared detector.
NA – not applicable.
PSEP-TOC – Puget Sound Estuary Program – Total Organic Carbon.
SM – Standard Methods.

Fish

WDFW biologists routinely collect fish from West Medical Lake so Ecology took the opportunity to coordinate fish sampling for the project. Fish were collected by gill net in April 2008. The two fish collection areas are shown on Figure 3. Biological information for the individual fish collected for the study is presented in the Appendix, Table B1.

The lake was divided into two areas based on its general configuration and location of the NPDES discharge: (1) North lake (Area 1) and (2) South lake (Area 2) where the WWTP discharge is located (Figure 3). Rainbow trout (*Oncorhynchus mykiss*) were collected from each area for analysis.

A total of six composite fish tissue samples were collected from the lake, three from each of two sampling areas. Two of the three composites from each area were from the year-one age class, hold-overs from the previous year. These composites were made of five fish each. The third composite from each area was of larger fish ranging in age from two to three years. The larger fish composite from the north area was made from four fish, while the south area composite was made from two fish.

Composite fish tissue samples were made from equal weight portions of individual fish. The samples were homogenized to a uniform color and consistency. The composites were divided into the appropriate sample containers for PCB aroclor equivalents, dioxins and furans, and lipid analysis.

Sediment

A survey of West Medical Lake surface sediments was conducted to establish baseline conditions for PCBs, dioxins, and furans. The spatial extent and levels of these pollutants in sediment were previously unknown. A total of seven sediment samples were collected during April 2008. Two samples were collected adjacent to the WWTP outfall, with the remainder as transect collected at increased distances from the outfall (Figure 3). Coordinates of sample locations and general descriptions of sediment grabs are included in Appendix B, Table B2.

Sediment samples were collected from a Wooldridge 16-foot aluminum jet sled using a 0.05 m^2 stainless-steel Ponar grab and hand-crank davit. Samples were composites made from three separate grabs. A grab sample was considered acceptable if it was not overfilled, overlying water was present but not overly turbid, the sediment surface appeared intact, and the grab reached the desired sediment depth. When the grab was considered acceptable, overlying water was siphoned off and sub-sampling was initiated. Equal volumes of the top 2-cm of each grab was used as the sample.

Each composite sample was homogenized to a uniform color and consistency using dedicated stainless-steel spoons and bowls. Debris on the surface or sediment contacting the sides of the Ponar grab was not retained. Composites were divided into the appropriate sample containers for PCB aroclor equivalents, dioxins and furans, total organic carbon (TOC), and grain size.

WWTP Effluent

Effluent samples from the Medical Lake WWTP were collected on four occasions: once each in February, April, July, and October of 2008. Collection locations for sampling were the same as for NPDES requirements, just prior to effluent discharge. The July and October samples were collected from a sample port on the effluent line entering the lake at Eastern State Hospital's remnant WWTP. The February and April samples were collected as final effluent from the WWTP disinfection chamber. A temporary upset in the WWTP de-nitrification system in February and the lake level peaking in April required all effluent to be discharged to Deep Creek, as required in the NPDES permit.

The WWTP samples were collected as composites of the final effluent. To avoid the possibility of contamination by automatic samplers, grab samples were hand composited. Effluent composites consisted of four grabs, two collected in the morning (8:00 AM) and two collected in the afternoon (4:00 PM), during two consecutive days. The composite samples were analyzed for PCB congeners, dioxins and furans, TOC, and total suspended solids. Flow data were obtained from WWTP records.

Quality Assurance

Ecology's Manchester Environmental Laboratory prepared quality assurance reviews for all chemical data. Data are reviewed for qualitative and quantitative accuracy following the EPA National Functional Guidelines for Organic Data Review. Data were evaluated for adherence to sample holding times, instrument calibration, results for process blanks, duplicate analysis, recovery of surrogates, labeled compounds and matrix spikes, and laboratory control samples analyses.

Overall, a review of the data quality control and quality assurance from laboratory case narratives indicates the data are usable as qualified by Manchester Laboratory (MEL, 2008). Most data met measurement quality objectives established in the Quality Assurance Project Plan (Coots, 2008).

MEL performed all analyses within recommended holding times.

Results reported from analysis of quality control samples for PCB Aroclors in fish tissue and sediment met established quality control limits. No target analytes were detected in laboratory blanks.

Due to weathering and metabolic breakdown, PCB Aroclor patterns can differ from the analytical reference standards used for identification. If the relative standard deviation (RSD) between peaks used to quantify Aroclors exceeds 40%, results are reported as estimates ("J"). All results for Aroclor 1254 and 1260 in fish tissue were "J" flagged as estimates.

Sediment samples 08144050 and 08144051 had recovery of the surrogate decachlorobiphenyl reported just below the 50-150% limit. Aroclors detected in these sediment samples were qualified as estimates ("J").

A number of PCBs, dioxins, and furans were positively identified in effluent below the lowest calibration standard. When this occurred, these results were qualified as estimates ("J"). Recoveries for target analytes in laboratory control samples, calibration standards, and labeled reference compounds were within method specified quality control limits.

A field transfer blank was analyzed for dioxins and furans. None of the seventeen 2,3,7,8-chlorine substituted congeners were detected.

Several PCB, dioxin, and furan congeners were detected in method blanks. When analytes were also detected in the sample at less than 10 times the blank level, the sample result was qualified as not detected at an estimated concentration ("UJ").

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Results and Discussion

Fish

Biological statistics for fish collected during the study can be found in Appendix B, Table B1. Information for fish weight, length, sex, age, and field and laboratory identification of samples is presented. Figure 3 shows the two general areas where fish were collected.

Rainbow trout were targeted for sampling because they are the dominant species in West Medical Lake, the basis of the 303(d) listings, and a popular sport fish. Results from the analysis of fillets are shown in the Appendix B, Table B3 for PCB Aroclors and Table B4 for dioxins and furans. Three composite samples from each of the two collection areas of the lake were analyzed. Two of the three composites were comprised of layover fish planted the previous year. The third composite was of larger fish made up of hatchery brood stock or triploids, both routinely planted by WDFW.

PCBs

Total PCB Aroclors in rainbow trout fillets were generally low, averaging 24 *u*g/Kg (parts per billion) wet weight and ranging from 12 to 44 *u*g/Kg for all samples. The NTR human health criterion for total PCBs is 5.3 *u*g/Kg which was exceeded by a factor of 2 to 8. Aroclor PCB-1254, the most common Aroclor reported in fish tissue, was detected in all samples. Only one other Aroclor was detected: PCB-1260 was found in the large fish composite from the south lake area (sample 08214015).

The two composites of larger fish (08214012 and 08214015) had roughly twice the total PCB concentration as the four composites of smaller fish. The mean total PCB concentration of the four composites of smaller fish was 16.5 *u*g/Kg, while the mean for the two composites of larger fish was 40 *u*g/Kg.

The total PCB results from rainbow trout samples collected for this 2008 study were compared to total PCB data from rainbow trout collected statewide from 1993 to 2008, by Ecology and EPA. These data are available from Ecology's Environmental Information Management (EIM) system. The database contains all data monitored by, or required by, Ecology or recipients of Ecology grants.

The EIM data represent total PCBs in rainbow trout fillet from 107 sites over 15 years. Only total PCB results reported above detection limits are presented. Figure 4 presents a cumulative frequency plot displaying data as percentiles. Units on the Y axis are micrograms per kilogram (*u*g/Kg – parts per billion) of total PCBs plotted on a logarithmic scale. Levels of total PCBs measured in West Medical Lake rainbow trout fall between the 23rd and 60th percentile for all rainbow trout collected between 1993 and 2008 in Washington State. Composites of the smaller fish fall between the 23rd and 45th percentiles, while composites of the larger fish (samples 08214012 and 08214015) were at the 56th and 60th percentiles.

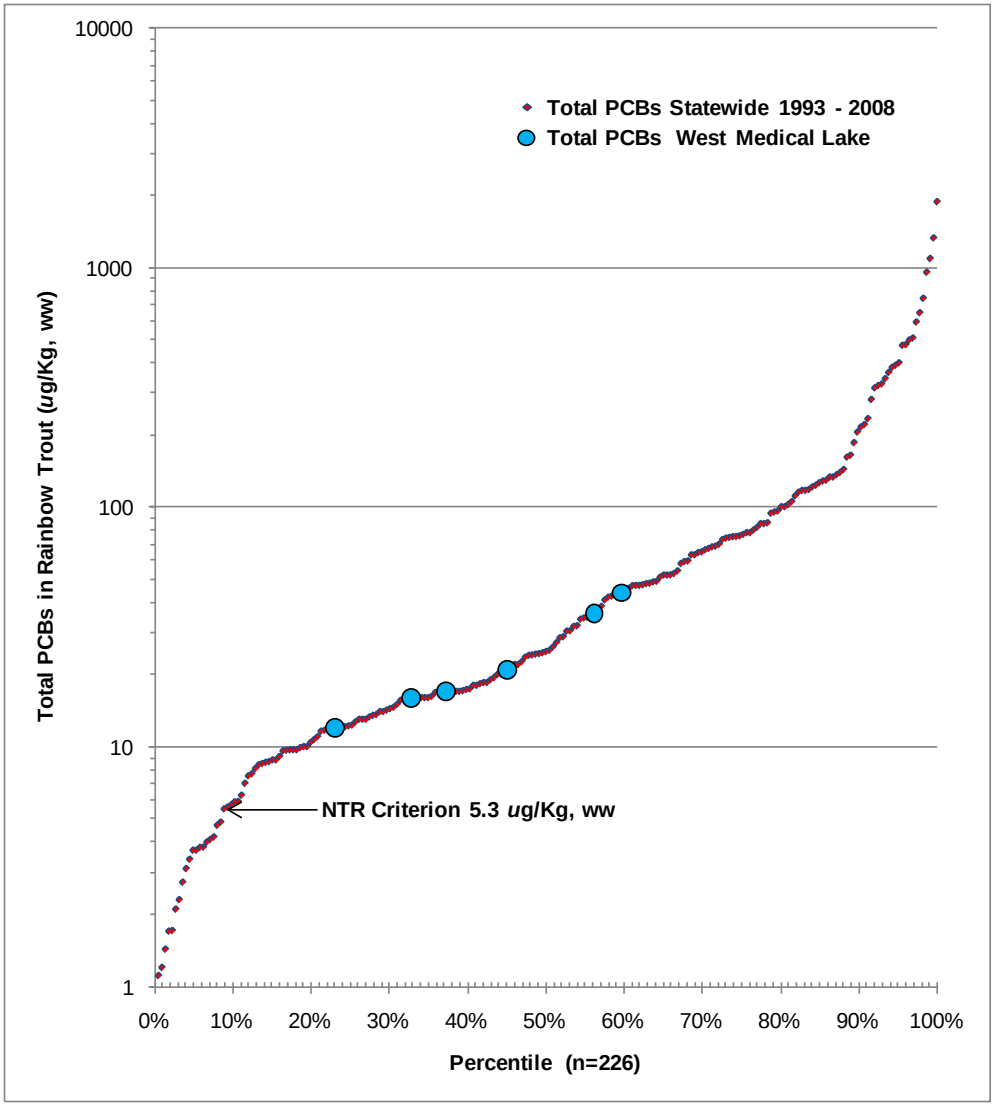

Figure 4. Cumulative Frequency Distribution of Total PCBs in Rainbow Trout Fillets Collected in 2008 from West Medical Lake Compared to Statewide Data for 1993-2008.

Fish food used at some WDFW hatcheries has recently been suspected of containing significant levels of PCBs and other persistent organic pollutants. A recent Ecology study reported some hatchery and planted fish contained concentrations of PCBs that may be above regulatory criteria (Serdar et al., 2006). West Medical Lake was not a part of the study, and it is not known if planted fish were affected by the contaminated fish food reported at some WDFW hatcheries (Donley, 2008).

Dioxins and Furans

The more highly chlorinated dioxins and furans were detected in the fish tissue samples. For dioxins, only the octa- congener was detected, while furans detected included the tetra-, penta-, hexa-, hepta-, and octa- congeners.

The levels of dioxins and furans were generally low in fish tissue, Appendix B (Table B4). TCDD the most toxic of the dioxins and furans, was not detected. The only dioxin congener reported above detection limits was octachlorodibenzo-p-dioxin (OCDD), the least toxic of the seven.

To assess the total potential toxicity of dioxins and furans in West Medical Lake fish tissue, toxic equivalent factors[1] (TEFs) were applied to study data (WHO, 2005). The toxicity of each detected congener is determined based on TEFs. Summing the TEF values for all the detected congeners gives a toxicity equivalent quotient (TEQ) which can be compared to TCDD criteria.

Figure 5 shows dioxin TEQs in the rainbow trout samples. TEQs averaged 0.090 ng/Kg (parts per trillion) wet weight, ranging from 0.039 to 0.130 ng/Kg. The NTR human health criterion for TCDD is 0.065 ng/Kg. The largest contributor to the TEQ was TCDF, which has a TEF of 0.1. The TCDF contribution to the total TEQ of each fish composite ranged from 71 to 93%.

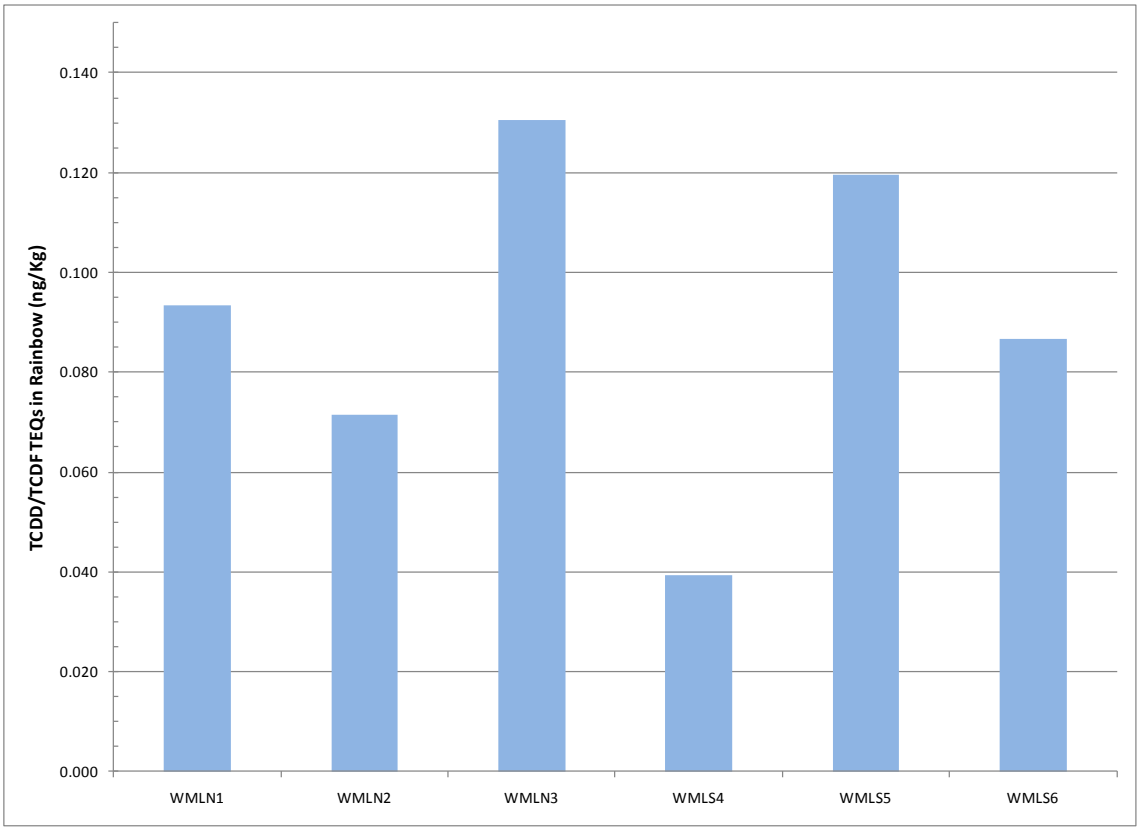

Figure 5. Dioxin TEQs in Rainbow Trout Tissue from West Medical Lake.

[1] 2,3,7,8-TCDD is the most toxic of the dioxin or furan congeners and is given a TEF of 1. Each of the other 16 dioxin/furan congeners of concern are given a TEF that is a decimal fraction of 1 based on the relative toxicity compared to 2,3,7,8-TCDD. TEFs are multiplied by the congener concentrations and summed to give a TEQ which can be compared to criteria for 2,3,7,8-TCDD.

Comparison to Previous Study

The WSTMP study results, responsible for the 303(d) listings for PCBs and dioxins/furans, (Seiders and Kinney, 2004) are compared to the results from this study in Table 4. The mean total PCBs in fish reported for this study was about a third less than the levels reported for the WSTMP fish. The composites of smaller fish from this study were lower in concentration, averaging less than one half the levels reported in the larger fish composites. The dioxin/furan TEQs were similar between studies, and no 2,3,7,8-TCDD was detected. Current 303(d) listing policy is to use the concentration of TCDD only, as the other dioxins and furans or TEQs are not addressed in the standards.

Table 4. Comparison of 2008 PCBs and PCDD/PCDF TEQs in fish tissue to WSTMP Data and NTR Criteria.

Study	Total PCBs (*u*g/Kg, ww)	PCDD/PCDF TEQ (ng/Kg, ww)	2,3,7,8-TCDD (ng/Kg, ww)	Lipids (percent)
Present study 2008	24.0[1]	0.090[1]	0.03 UJ	2.4[1]
Small/large fish composites from 2008	16.5/40.0[2]	0.081/0.11[2]	0.03 UJ/0.03 UJ	2.1/3.2[2]
WSTMP 2002	36.0	0.084	0.52 UJ[3]	2.4
NTR criteria	5.3	-	0.065	-

[1] = Study mean (six composites).
[2] = Mean of four small fish composites/mean of two large fish composites.
[3] UJ = Not detected at the estimated detection limit shown.

Two important factors that drive levels of toxics such as PCBs and TCDD in fish tissue are (1) biomagnification of contaminants through the food chain and (2) water column concentrations. Fish species, size, and age are also important in concentrating persistent toxic chemicals. The PCB and dioxin results reported by WSTMP, placing the rainbow trout on the 303(d) list, were from fish averaging 660 grams (Seiders and Kinney, 2004). The four composites of smaller fish collected for this study averaged only 164 grams, while the two composites of larger fish averaged 736 grams. These larger fish had similar concentrations of PCBs and dioxins as the samples collected by WSTMP that resulted in the 2008 303(d) listing.

West Medical Lake may not be the only source of PCBs and dioxins found in fish. As previously discussed, WDFW hatchery fish have been shown to have significant levels of PCBs from food (Serdar et al., 2006). In addition to the 150,000 to 300,000 catchable-sized rainbows stocked yearly, WDFW also plant brood stock and triploids. It is not known what levels of PCBs or TCDD were in the fish prior to planting or the residence time of the larger fish. So it is not clear what fraction of the PCB and TCDD load was acquired from the lake.

WDOH Human Health Evaluation

The Washington State Department of Health (WDOH) evaluates the human health risk of chemical contaminants in fish and issues advisories when levels of pollutants are a concern. WDOH conducted a Consumption Advisory Assessment of West Medical Lake rainbow trout collected during the 2008 study for total PCBs and TCDD. The assessment was completed in April 2009.

WDOH concluded that, "No restrictions are necessary due to either PCB or dioxin/furan levels in West Medical Lake rainbow trout. Recommended meal consumption rates are based in part on contaminant levels but also incorporate other factors such as background concentrations in rainbow trout or other species in Washington State, levels of contaminants in other foods, nutritional and cultural benefits. Rainbow trout from West Medical Lake would be a good choice for anglers" (McBride, 2009).

This consumption assessment is specifically for rainbow trout from West Medical Lake. Other species of fish that reside in the lake could have different levels or types of contaminants.

Fishery Management

WDFW applied the pesticide, rotenone, to West Medical Lake in October 2009 with the goal of restoring the lake to a trout fishery. Removal of competing populations of undesirable fish allows the WDFW to stock the lake with fry at almost a tenth the cost of planting catchable-sized trout. The beneficial effects are expected to last for six to eight years.

Tench, pumpkinseed sunfish, and possibly gold fish were targeted for removal. These exotic species were illegally planted in West Medical Lake. Following the rotenone treatment, the dead fish were not removed from the lake.

The fish community that this study reports results for no longer exists. Additional sampling would be required to determine current levels of PCBs or dioxins/furans in West Medical Lake fish.

Between March and May of 2010, the lake was replanted with over 160,000 rainbow trout. Four size classes of fish made up the plant: 125,000 fry at about 100 per pound; 35,000 catchable at about five per pound; 1650 triploids at about one and a half pound each; and 600 broodstock at about three pounds each.

Sediment

Surface sediments were collected from seven locations within West Medical Lake along a north to south transect (Figure 3). Two samples bracketed the WWTP outfall, with the remainder collected at increasing distances from the outfall. The sample coordinates, relative location within the lake, water depth at the collection site, and sediment description are presented in Table B2 in Appendix B. The complete set of results for PCBs, dioxins and furans, TOC, and percent fines from West Medical Lake sediments can be found in Tables B5 and B6.

West Medical Lake has been reported as one of the most enriched lakes in the state (Smith et al., 2000). Levels of TOC in surface sediments were high, averaging 6.9% and ranged from 6.1% to 8.0%. Field logs consistently noted sediment grabs had a black color, pudding-like texture, and the odor of hydrogen sulfide (Table B2). The most recent Washington State sediment quality guideline for TOC (Avocet, 2003) recommends TOC no greater than 9.8%.

Grain size results are presented in Figure 6. Particle distribution from site to site was fairly uniform. Samples were comprised largely of fines ranging from 66.4% to 97.2% (fines consist of silts and clays - particle sizes < 62.5 microns). Only the most southern sample (WML01) reported fines less than 75%.

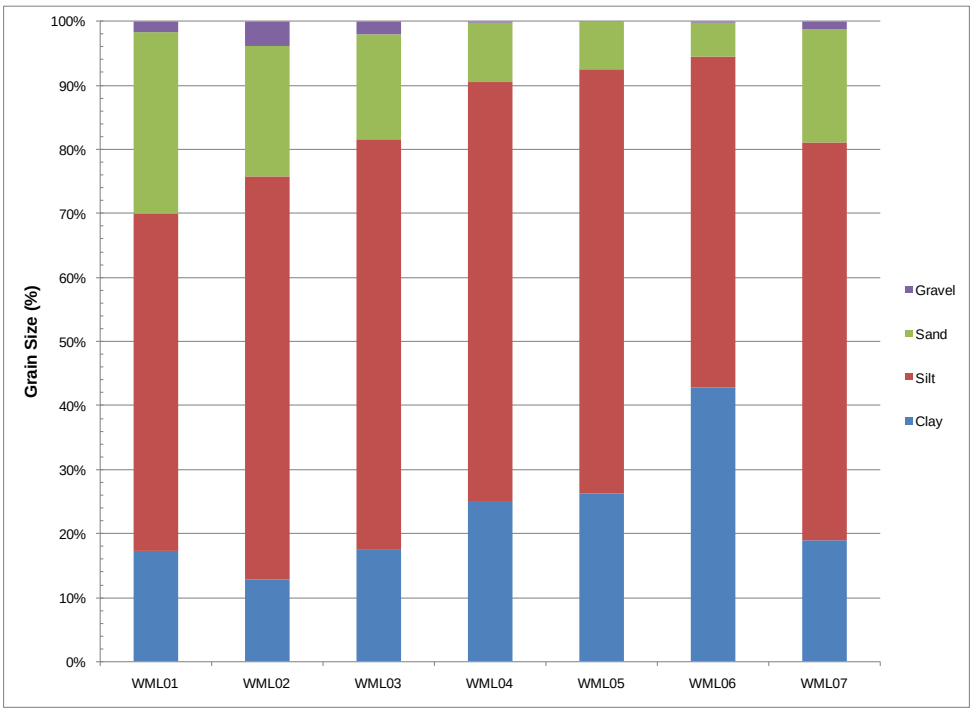

Figure 6. Grain Size Distribution of West Medical Lake Sediments.

PCBs

Sediment PCBs were analyzed as Aroclors. The most frequently detected Aroclors in sediment are PCB-1254 and PCB-1260. In this study only PCB-1254 was detected, in all samples. Levels of PCB-1254 were fairly low, ranging from 9.0 to 19 *u*g/Kg dry weight (dw) and averaging 14 *u*g/Kg dw (Table B5).

PCB levels were similar in sediment collected throughout the lake. Only small differences were found between samples collected adjacent to the WWTP outfall and samples from other sites. The maximum concentration reported from all samples was only twice the minimum. The highest level of PCB-1254 was reported from WML07, the northern most sample site (Figures 7 and 3). This site represented the farthest sample point from the WWTP discharge, suggesting the possibility there may be a source of PCBs entering the north lake area. These results also show WWTP effluent is not creating a PCB hot spot in the area adjacent to the outfall.

The lowest AET for total PCBs in the recommended freshwater sediment quality values for use in Washington State is 62 *u*g/Kg, dw (Avocet, 2003). The total PCB levels found in West Medical Lake's surface sediments average less than a fourth of the AET. This suggests a low probability of harm from PCBs to sediment-dwelling organisms in the top 2 cm of sediments.

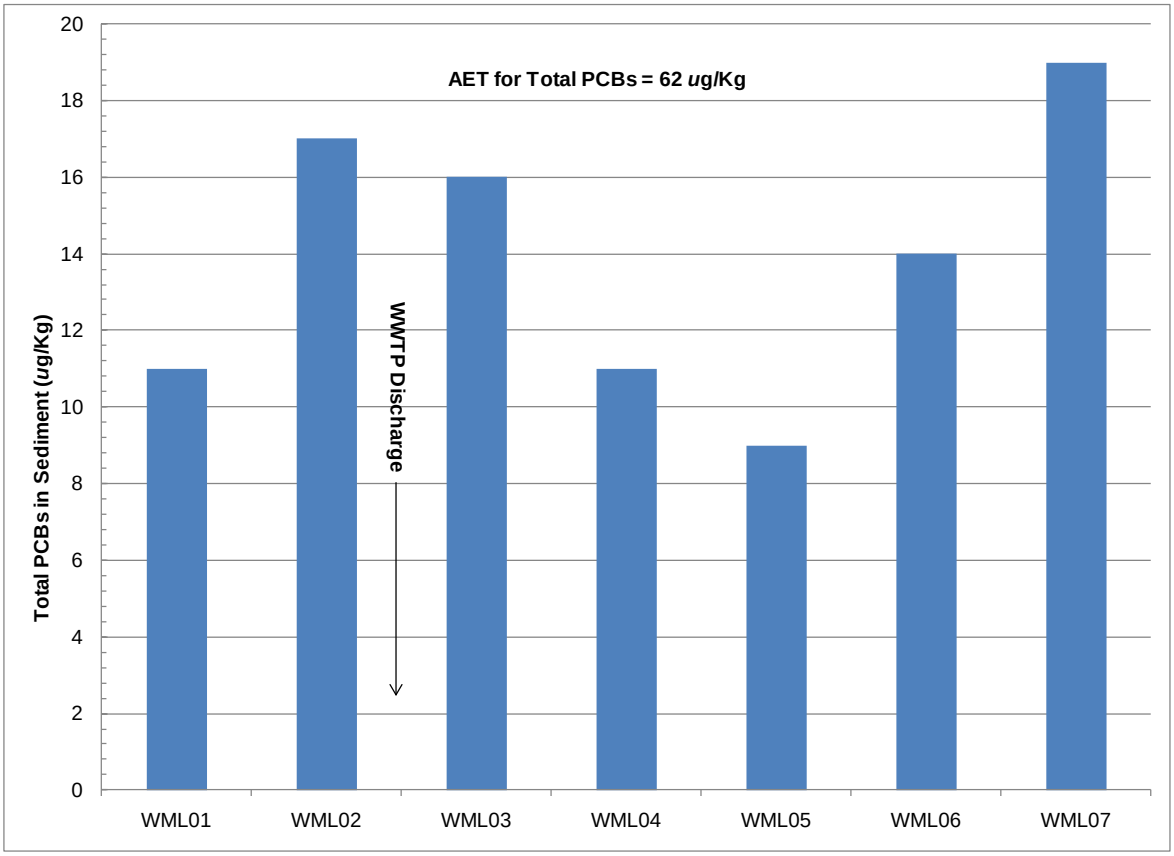

Figure 7. Total PCBs in West Medical Lake Sediments.

At times predictable relationships are identified between results from high-cost analysis for organic analytes and low-cost conventional parameters such as TOC or percent fines. For West Medical Lake, sediment PCBs were found to be only moderately correlated to TOC ($r^2 = 0.61$) and poorly correlated to percent fines ($r^2 = -0.19$).

Dioxins and Furans

Concentrations of dioxins and furans in sediment were generally low (Figure 8 and Table B6). 2,3,7,8-TCDD was reported above detection in all samples with a mean of 0.46 ng/Kg dw and ranging from 0.29 to 0.76 ng/Kg. The most recent freshwater sediment quality guideline for 2,3,7,8-TCDD, based on the AET for benthic infauna, is 8.8 ng/Kg dw (Cubbage et al., 1997). Levels of 2,3,7,8-TCDD reported for this study averaged more than an order of magnitude below the guideline concentration. Sediment TEQs ranged from 2.9 to 5.2 ng/Kg and averaged 4.2 ng/Kg, suggesting a low probability of causing harm to sediment-dwelling organisms.

Tetra- to octa-chlorinated dioxins and furans were detected in sediments. The highest concentrations of dioxins were reported in the more chlorinated homologs of the hepta- and octa- groups. The average 2,3,7,8-TCDD contribution to the total TEQ was 11%, and ranged from 8 to 15% (Figure 8). For furans, homologs from the tetra-, hepta- and octa-chlorinated groups were reported having the highest concentrations. The percent contribution of the seven 2,3,7,8-chlorine-substituted PCDDs and ten 2,3,7,8-chlorine-substituted PCDFs to the total TEQ was generally consistent, being about 60% and 40%, respectively (Table B6).

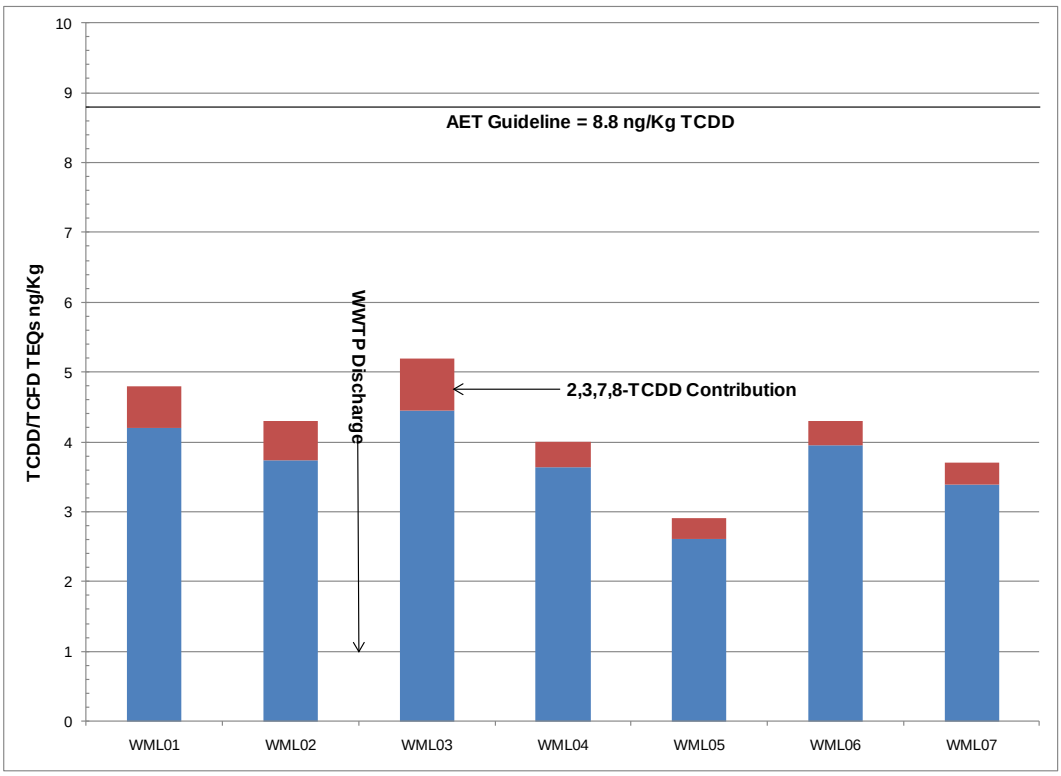

Figure 8. Dioxin TEQs in West Medical Lake Sediments.

WWTP Effluent

Discharge

During 2008 the Medical Lake WWTP discharge ranged between 0.334 and 1.303 million gallons per day (mgd). Flows for the January through June period were variable, ranging between 0.395 and 1.303 mgd. Discharge exceeded 1.0 mgd for a brief period from February 29 to March 17, averaging 1.13 mgd. July through December discharge was more stable, ranging from 0.334 to 0.503 mgd.

The discharge fluctuated seasonally (Figure 9). Influent volumes often increase in the winter and spring, caused by inflow and infiltration from water entering the collection system through joints, breaks, or cracks. Improper domestic connections like roof or foundation drains are other sources that can increase influent flows to the WWTP during winter and spring.

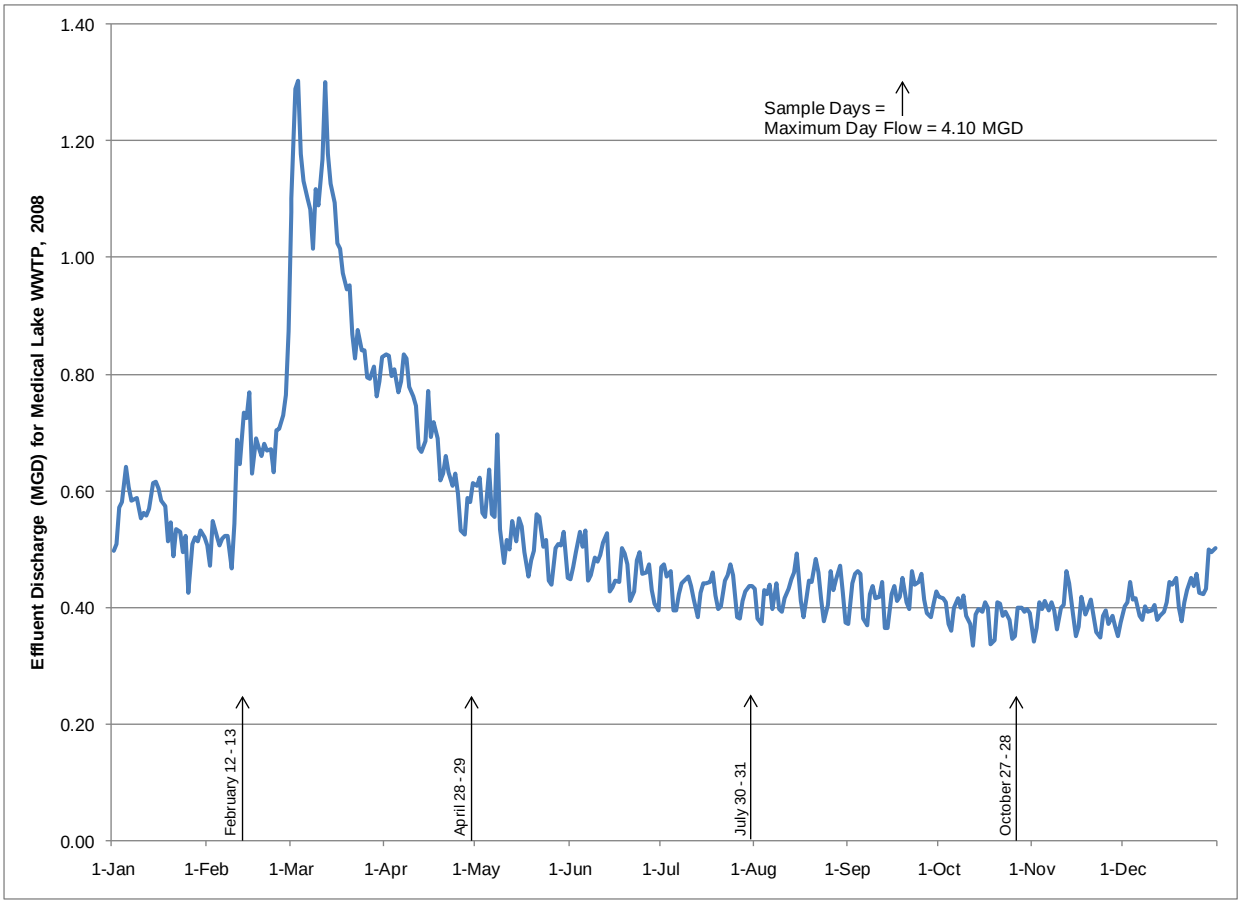

Figure 9. Daily Effluent Discharge from Medical Lake WWTP, 2008.

The Medical Lake NPDES permit (No. WA-0021148) requires effluent to be discharged to three possible locations. The primary outfall is to an intermittent unnamed tributary to Deep Creek. Throughout the year, effluent is discharged down the Deep Creek tributary with a NPDES permit required minimum of 0.10 mgd. The other two discharge locations are Use Area #1, West Medical Lake, for lake level augmentation, and Use Area #2, the City of Medical Lake reclaimed water system uses, such as landscape irrigation. During 2008 the City used reclaimed water between May 8 and October 13, averaging 0.012 mgd.

West Medical Lake has no natural surface inputs or outflows. Evaporation and seepage through the lake bottom or side walls accounts for the majority of lake water loss. Water levels are maintained by receiving effluent as reclaimed water from the Medical Lake WWTP. Effluent is discharged through a manifold located at the remnant Eastern State Hospital WWTP located on the eastern shore (Figure 2). The discharge limit is based on the lake stage. When the lake level reaches the defined maximum, all effluent is discharged to the Deep Creek tributary.

Table B7 in Appendix B presents information on effluent collection times, dates, and locations where samples were collected, in addition to results for TOC and TSS. Results for PCB congeners are shown in Figure 10, and results for dioxins/furans are in Tables B8 and B9.

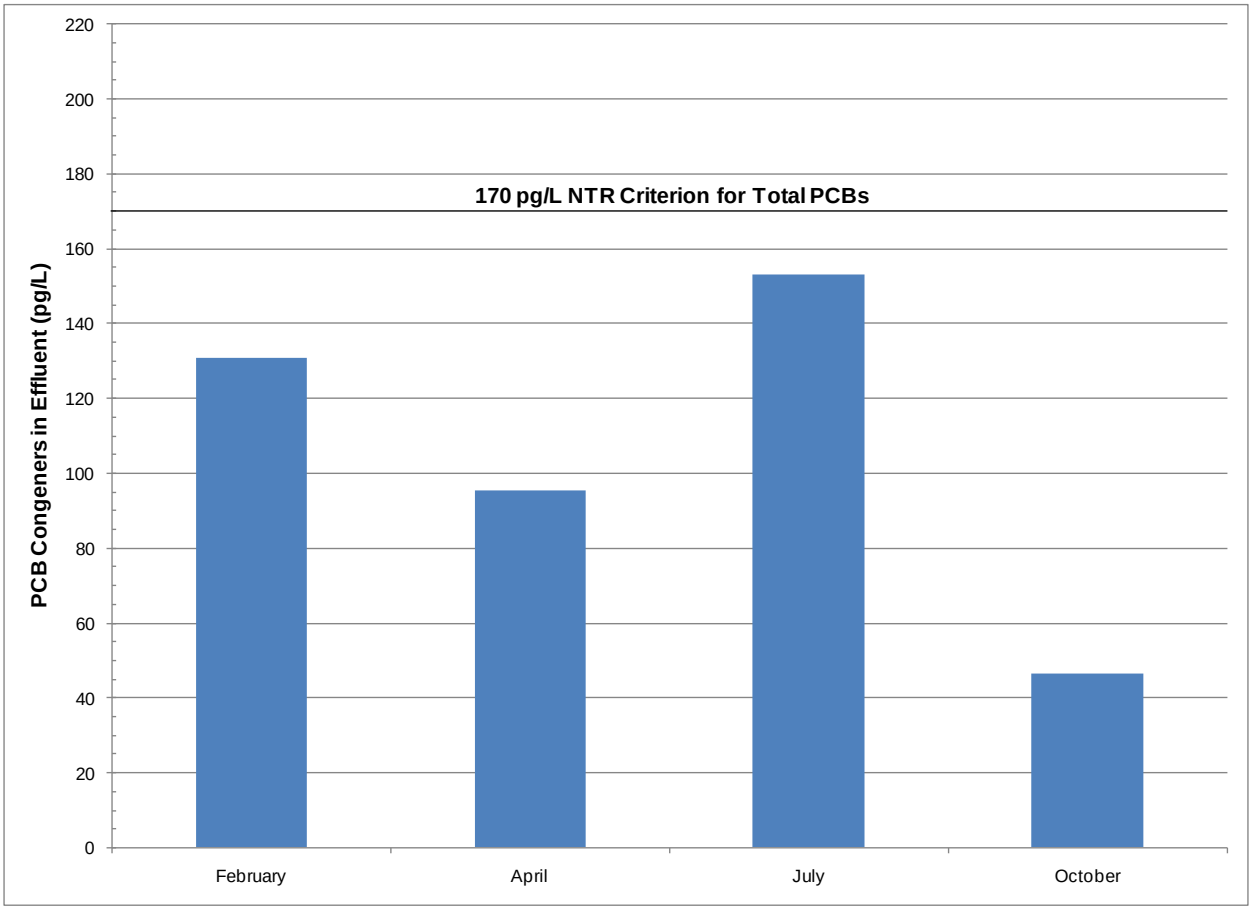

Figure 10. Total PCBs in Medical Lake WWTP Effluent.

PCBs

Table B8 summarizes the results for the PCB homolog groups. Di-, tri-, tetra-, penta-, and hexa-chlorinated homolog groups were detected in effluent samples. Total PCBs averaged 106 pg/L and ranged from 46.6 to 153 pg/L (parts per quadrillion) throughout 2008. This is below the 170 pg/L NTR human health criterion for total PCBs in water. The highest concentration was reported for the sample collected in July, while the lowest concentration was from October. There was no obvious seasonal trend.

Table 5 summarizes the PCB data that have been reported for eastern Washington WWTP effluents since 2001. Concentrations found in seasonal effluent samples from the Medical Lake WWTP are low compared to other WWTPs from areas that include agriculture and urban environments such as the Palouse, Walla Walla, Spokane, and Yakima.

Table 5. Summary of PCB Data for Eastern Washington WWTP Effluents.
(pg/L, parts per quadrillion; mean values)

Receiving Water/ WWTP	Year	N=	Total PCBs	Reference
Palouse River				
Pullman	2007-08	3	1400	Lubliner (2009)
Colfax	2007-08	3	330	
Albion	2007-08	1	1500	
Walla Walla River				
Walla Walla	2002-03	4	790	Johnson et al. (2004)
	2006-07	3	380	
College Place	2002-03	4	1300	Lubliner (2007)
	2006-07	3	300	
Spokane River				
Spokane	2001	2	1800	Golding (2002)
Liberty Lake	2001	2	1700	
Yakima River 18 facility mean	2007-08	72	580	Johnson et al. (2010)
West Medical Lake Medical Lake	2008	4	106	Present study

Dioxins and Furans

Few dioxins and no furans were reported above detection limits (Appendix B, Table B9). The sample collected in April had 2,3,7,8-TCDD reported at an estimated concentration of 0.56 pg/L (parts per quadrillion), just above the 0.50 pg/L reporting limit. This is about 43 times the 0.013 pg/L NTR human health criterion for 2,3,7,8-TCDD. Currently analytical capabilities are not able to reach the 2,3,7,8-TCDD NTR human health criterion. For this study the 2,3,7,8-TCDD reporting limit was 0.50 pg/L or about 38 times the NTR criterion. The large difference between the NTR criterion for 2,3,7,8-TCDD of 0.013 pg/L and the reporting limit of 0.50 pg/L suggests the possibility dioxins could be a concern.

During December 2007 through April 2008, the Medical Lake WWTP suffered an upset in their de-nitrification system. As a result this treatment process was taken off-line. The detection of 2,3,7,8-TCDD in effluent may be related to the upset. The de-nitrification system did not return to normal function until ambient temperatures started increasing in the spring when it was put back on-line.

The only other dioxin compound detected in effluent was OCDD at an estimated concentration of 3.03 pg/L. OCDD is the least toxic of the dioxin congeners, with a TEF of 0.0003 (OCDD TEQ = 0.00091 pg/L).

PCB and TCDD Loads

Chapter 173-201A WAC specifies inflows to West Medical Lake must meet water quality criteria at the point of discharge. This is particularly important to West Medical Lake, a seepage lake without the benefit of a clean natural inflow or outflow to shorten residence time, estimated at 29 years (Willms and Pelletier, 1992).

Water quality criteria are based on the concentration of a contaminant, expressed as a unit measure per volume of water: for example, micrograms per liter (ug/L). Determining a contaminant load removes the effects of dilution which can fluctuate throughout the year. Loads are calculated and expressed as a unit measure over a period of time: for example, milligrams per day (mg/day).

During the December and April sample events, all effluent from the WWTP was discharged to the Deep Creek tributary, averaging 0.638 mgd. For the July and October sample events, effluent was split with portions going to both West Medical Lake and the Deep Creek tributary. Total WWTP discharge averaged 0.412 mgd for the July and October periods, with 0.268 mgd going to West Medical Lake and 0.143 mgd to the Deep Creek tributary.

Table 6 presents calculated loads based on concentrations reported for samples collected during the study and effluent flows at the time of sampling. Loads discharged to West Medical Lake and the Deep Creek tributary are shown separately, along with allowable maximums based on the NTR human health criterion and total effluent discharge.

Table 6. Total PCB Loads Discharged and Allowable Loads from the Medical Lake WWTP.

Sample Date – 2007-08	Effluent Discharge to Deep Crk (mgd)	Effluent Discharge to WML[1] (mgd)	Total PCB Congeners in Effluent (pg/L)	Total PCB Load to Deep Crk (mg/day)	Total PCB Load to WML (mg/day)	Total PCB Load Discharged (mg/day)	Total Allowable PCB Load (mg/day)[2]	Percent of Allowable Load
Dec 12-13	0.691	0	131	0.343	0	0.343	0.445	77.1
Apr 28-29	0.584	0	95.3	0.211	0	0.211	0.376	56.1
Jul 30-31	0.120	0.304	153	0.0695	0.176	0.246	0.273	90.1
Oct 27-28	0.167	0.233	46.6	0.0295	0.0411	0.0706	0.257	27.5

[1] - West Medical Lake.
[2] - Allowable load is the WWTP flow rate at the time of sampling and the NTR criterion for total PCBs (170 pg/L).

The percent of total PCBs discharged compared to maximum allowable loads for the sample events ranged from 27.5 to 90.1%. The December sample period discharged the largest total PCB load (0.343 mg/day), and the October event discharged the smallest (0.0706 mg/day).

Only in the April sample was 2,3,7,8-TCDD detected. The maximum allowable load of 2,3,7,8-TCDD based on WWTP discharge at the time of sampling and the human health criterion was 0.029 *u*g/day. The 2,3,7,8-TCDD load discharged to the Deep Creek tributary during April was 1.24 *u*g/day. As previously discussed, sampling occurred during a WWTP upset and this upset is likely related to the sampling results.

Conclusions and Recommendations

Conclusions

The 303(d) listing for total PCBs in edible tissue of West Medical Lake fish should be retained based on data from this 2008 study. The NTR human health criterion for total PCBs was exceeded by a factor of 2 to 8. Although dioxins and furans were also detected, the current policy is to list for TCDD exceedances only. Fish tissue samples from this study did not have TCDD levels above detection limits. On this basis, West Medical Lake no longer qualifies for a 303(d) listing under Category 5 for TCDD.

Based on the WDOH assessment, no fish consumption restrictions are necessary due to either PCBs or dioxin/furan levels. Rainbow trout were found to be a good choice for anglers.

Levels of PCBs, dioxins, and furans in sediment were generally low and below recommended effects thresholds for benthic infauna. It does not appear the WWTP discharge has created a toxic hotspot adjacent to the outfall. The highest PCBs reported in sediments were from a northern site farthest away from the outfall, suggesting a source in the northern area of the lake.

Effluent from the Medical Lake WWTP show total PCBs were low and within the NTR human health criterion. Dioxins and furans were generally not detected except for the sample collected in April when TCDD and OCDD were present just above the limit of detection. From December 2007 through April 2008, the WWTP suffered a process upset in the de-nitrification system. Until warmer weather returned, the de-nitrification system did not return to normal operation and was off-line. These April results may be related to the WWTP upset in the de-nitrification system.

Recommendations

The results of this study support the following recommendations.

- The current West Medical Lake 303(d) listing for 2,3,7,8-TCDD in rainbow trout tissue should be revisited in the 2012 listing cycle for proper category placement based on this study's data.

- West Medical Lake rainbow trout should be analyzed for PCBs, dioxins, and furans in five years for comparison to this study's data.

- Catchable-sized rainbow trout planted by the Washington Department of Fish and Wildlife should be analyzed just prior to planting in West Medical Lake. This should be done to determine contaminant levels in the trout prior to planting in the lake.

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Appendices

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Appendix A. Glossary, Acronyms, and Abbreviations

Glossary

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

Ambient: Background (environmental). Away from point sources of contamination.

Benthic infauna: Tiny sediment-dwelling invertebrates (e.g., aquatic insects, worms).

Bioaccumulative pollutants: Pollutants that build up in the food chain.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Dioxins and furans: Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans.

Eutrophic: Nutrient rich and high in productivity resulting from human conditions such as fertilizer runoff and leaky septic systems.

Grab sample: A discrete sample from a single point in the water column or sediment surface.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will,

or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Sediment: Solid fragmented material (soil and organic matter) that is transported and deposited by water and covered with water (example, river or lake bottom).

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): Water cleanup plan. A distribution of a substance in a water body designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

AET	Apparent effects thresholds
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
NPDES	(See Glossary above)
NTR	National Toxics Rule
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
PCBs	polychlorinated biphenyls
PCDD	polychlorinated dibenzo-p-dioxins
PCDF	polychlorinated dibenzofurans
TCDD	2,3,7,8-tetrachlorodibenzodioxin
TEF	toxic equivalency factor
TEQ	toxic equivalent quotient (or concentration)
TMDL	(See Glossary above)
TOC	Total organic carbon

WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOH	Washington State Department of Health
WSTMP	Washington State Toxics Monitoring Program
WWTP	Wastewater treatment plant

Units of Measurement

dw	dry weight
ft	feet
g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams.
mg	milligrams
mgd	million gallons per day
mg/d	milligrams per day
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mL	milliliters
ng/Kg	nanograms per kilogram (parts per trillion)
ng/L	nanograms per liter (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
ug/Kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
ww	wet weight

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Appendix B. Study Tables

Table B1. Biological Data on West Medical Lake Rainbow Trout, April 11, 2008.

Site ID	Composite ID	Laboratory ID	Length (mm)	Weight (g)	Fillet Weight (g)	Sex[1] M, F, U	Age
RBT17	WMLN1	08214010	235	132	70	U	1
RBT15	WMLN1	08214010	263	173	87	U	1
RBT10	WMLN1	08214010	254	165	91	U	1
RBT9	WMLN1	08214010	261	158	97	U	ND
RBT1	WMLN1	08214010	281	194	105	U	ND
RBT6	WMLN2	08214011	262	163	85	U	ND
RBT7	WMLN2	08214011	253	162	97	U	1
RBT8	WMLN2	08214011	242	140	84	U	1
RBT12	WMLN2	08214011	276	198	114	M	2
RBT13	WMLN2	08214011	265	165	96	F	1
RBT33	WMLN3	08214012	383	702	183	F	2
RBT34	WMLN3	08214012	438	830	240	M	3
RBT35	WMLN3	08214012	385	701	170	F	2
RBT36	WMLN3	08214012	415	885	233	F	3
RBT21	WMLS4	08214013	253	181	94	U	ND
RBT23	WMLS4	08214013	235	137	80	U	ND
RBT24	WMLS4	08214013	269	178	106	U	ND
RBT27	WMLS4	08214013	250	154	89	U	1
RBT29	WMLS4	08214013	264	179	103	U	ND
RBT22	WMLS5	08214014	263	181	108	U	ND
RBT25	WMLS5	08214014	260	168	94	U	ND
RBT26	WMLS5	08214014	253	160	89	U	1
RBT28	WMLS5	08214014	245	169	96	U	ND
RBT30	WMLS5	08214014	233	130	68	U	ND
RBT31	WMLS6	08214015	375	600	276	F	2
RBT32	WMLS6	08214015	477	782	309	F	3

1 = Male, Female, Unable to determine visually.
ND = Not able to determine age.

Table B2. West Medical Lake Sediment Sample Coordinates and General Description.

Site ID	Latitude	Longitude	General Locations	Water Depth	Sediment Description
WML01	47.56538	-117.70521	Approx. 520' south of outfall	31 Feet	Fine black organic material - H_2S
WML02	47.56656	-117.70465	Approx. ≤ 100' south of outfall	27 Feet	Fine black organic material - H_2S
WML03	47.56709	-117.70494	Approx. ≤ 100' north of outfall	31 Feet	Fine black organic material – H_2S
WML04	47.56811	-117.70602	Approx. 550' north of outfall	32 Feet	Fine black organic material – H_2S (replicate site)
WML05	47.57003	-117.70694	Approx. 1300' north of outfall	33 Feet	Fine black organic material with brown surface
WML06	47.57257	-117.70867	Approx. 2300' north of outfall	33 Feet	Fine black organic material With brown surface
WML07	47.57687	-117.71035	Approx. 4000' north of outfall	30 Feet	Fine black organic material - H_2S

See Figure 3 for station locations.
H_2S = Hydrogen sulfide.

Table B3. PCB Aroclor Results from West Medical Lake Fish Tissue, April 2008 (*u*g/Kg, ww–ppb).

Site ID:	WMLN1	WMLN2	WMLN3	WMLS4	WMLS5	WMLS6	Human Health NTR (Total PCBs)
Sample ID (08):	214010	214011	214012	214013	214014	214015	
Lipids (%):	2.0	2.2	3.5	2.3	1.9	2.8	
PCB - 1016	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.7 U	5.3 *u*g/Kg
PCB - 1221	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.7 U	
PCB - 1232	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.7 U	
PCB - 1242	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.7 U	
PCB - 1248	4.4 UJ	3.3 UJ	5.5 UJ	2.8 U	3.3 UJ	4.4 UJ	
PCB - 1254	**12**	**21 J**	**36 J**	**16 J**	**17 J**	**30 J**	
PCB - 1260	2.7 U	4.4 UJ	11 UJ	3.3 UJ	3.3 UJ	**14 J**	
PCB - 1262	2.7 U	2.8 U	5.5 UJ	2.8 U	2.7 U	8.7 UJ	
PCB - 1268	2.7 U	2.8 U	2.7 U	2.8 U	2.7 U	2.7 U	
Total PCBs	**12**	**21 J**	**36 J**	**16 J**	**17 J**	**44 J**	

U = Not detected at the detection limit shown.
UJ = Not detected at the estimated detection limit shown.
J = The result is an estimate.
Bold = Analyte was detected.

Table B4. Dioxin and Furan Results from West Medical Lake Fish Tissue, April 2008 (ng/Kg, ww; pptr).

Site ID:	TEF[1]	WMLN1		WMLN2		WMLN3		WMLS4		WMLS5		WMLS6	
Sample ID (08):		214010		214011		214012		214013		214014		214015	
Parameter													
Lipids (%)		2.0		2.2		3.5		2.3		1.9		2.8	
Dioxins													
2,3,7,8-TCDD	1	0.03	UJ	0.03	UJ	0.03	UJ	0.03	UJ	0.03	UJ	0.03	UJ
1,2,3,7,8-PeCDD	1	0.033	UJ	0.033	UJ	0.033	UJ	0.033	UJ	0.033	UJ	0.033	UJ
1,2,3,4,7,8-HxCDD	0.1	0.1	UJ	0.1	UJ	0.1	UJ	0.1	UJ	0.1	UJ	0.1	UJ
1,2,3,6,7,8-HxCDD	0.1	0.082	UJ	0.082	UJ	0.082	UJ	0.082	UJ	0.082	UJ	0.082	UJ
1,2,3,7,8,9-HxCDD	0.1	0.064	UJ	0.064	UJ	0.064	UJ	0.064	UJ	0.064	UJ	0.064	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0.085	UJ	0.085	UJ	0.085	UJ	0.085	UJ	0.085	UJ	0.085	UJ
OCDD	0.0003	**0.189**	**J**	**0.329**	**J**	**0.245**	**J**	**0.376**	**J**	**0.671**	**J**	**0.592**	
Furans													
2,3,7,8-TCDF	0.1	**0.678**		**0.503**		**1.06**		**0.364**		**0.866**		**0.708**	
1,2,3,7,8-PeCDF	0.03	**0.086**	**J**	**0.106**	**J**	**0.21**	**J**	**0.096**	**J**	**0.245**	**J**	**0.094**	**J**
2,3,4,7,8-PeCDF	0.03	0.039	UJ	**0.047**	**J**	0.039	UJ	0.039	UJ	0.039	UJ	**0.04**	**J**
1,2,3,4,7,8-HxCDF	0.1	**0.131**	**J**	**0.084**	**J**	0.075	UJ	0.075	UJ	0.075	UJ	**0.116**	**J**
1,2,3,6,7,8-HxCDF	0.1	0.075	UJ	0.075	UJ	0.075	UJ	0.075	UJ	0.075	UJ	0.075	UJ
2,3,4,6,7,8-HxCDF	0.1	**0.085**	**J**	**0.079**	**J**	**0.18**	**J**	0.05	UJ	**0.254**	**J**	0.05	UJ
1,2,3,7,8,9-HxCDF	0.1	0.056	UJ	0.056	UJ	0.056	UJ	0.056	UJ	0.056	UJ	0.056	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.094	UJ	0.052	UJ	0.052	UJ	0.055	UJ	0.065	UJ	0.052	UJ
1,2,3,4,7,8,9-HpCDF	0.01	**0.128**	**J**	0.085	UJ	0.085	UJ	0.085	UJ	0.085	UJ	0.085	UJ
OCDF	0.0003	**0.284**	**J**	**0.329**	**J**	**0.157**	**J**	**0.179**	**J**	**0.232**	**J**	0.2	UJ
NTR = 0.065 ng/Kg													
TEQ[2]		0.093	J	0.071	J	0.130	J	0.039		0.120	J	0.087	J

[1] = Toxic Equivalent Factor - WHO, 2005.
[2] = Toxic Equivalent Quotient - total toxicity equivalent to 2,3,7,8 TCDD.
UJ = Not detected at the estimated reporting limit shown.
J = Reported result is an estimate.
Bold = Analyte was detected.

Table B5. PCB Results from West Medical Lake Surface Sediment Samples, April 2008 (ug/Kg, dw - parts per billion).

Site ID:	WML01	WML02	WML03	WML04[1]	WML05	WML06	WML07
Date:	4/3/08	4/2/08	4/2/08	4/3/08	4/3/08	4/3/08	4/3/08
Sample ID (08):	144050	144051	144052	144053/7	144054	144055	144056
TOC 70°C (%):	7.3	6.8	6.8	6.3	6.1	7.2	8.0
Fines (%):	66.4 J	75.8	84.4	94.6	95.1	97.2	80.4
PCB - 1016	13 UJ	12 UJ	13 UJ	6.8 U	6.7 U	8.1 U	9.4 U
PCB - 1221	51 UJ	194 UJ	128 UJ	192 UJ	135 UJ	258 UJ	187 UJ
PCB - 1232	51 UJ	73 UJ	51 UJ	6.8 U	54 UJ	8.1 U	9.4 U
PCB - 1242	13 UJ	24 UJ	6.4 U	6.8 U	27 UJ	8.1 U	9.4 U
PCB - 1248	13 UJ	6.1 UJ	6.4 U	6.8 U	13 UJ	8.1 U	9.4 U
PCB - 1254	**11 J**	**17 J**	**16**	**11**	**9.0**	**14**	**19**
PCB - 1260	6.3 UJ	6.1 UJ	6.4 U	6.8 U	6.7 U	8.1 U	9.4 U
PCB - 1262	6.3 UJ	6.1 UJ	6.4 U	6.8 U	6.7 U	8.1 U	9.4 U
PCB - 1268	6.3 UJ	6.1 UJ	6.4 U	6.8 U	6.7 U	8.1 U	9.4 U

1 = The value reported is the mean of a replicate pair.
J = Analyte is positively identified; the result is an estimate.
UJ = Analyte was not detected at the estimated detection limit shown.
U = Analyte was not detected at the detection limit shown.

Table B6. Dioxin and Furan Results from West Medical Lake Sediments, April 2008 (ng/Kg, dw - pptr).

Site ID:	TEF[1]	WML01	WML02	WML03	WML04	WML05	WML06	WML07
Sample ID (08):		144050	144051	144052	144053	144054	144055	144056
Sample Dates:		4/3/08	4/2/08	4/2/08	4/3/08	4/3/08	4/3/08	4/3/08
Parameter								
Dioxins								
2,3,7,8-TCDD	1	**0.60**	**0.56**	**0.76**	**0.37**	**0.29**	**0.35**	**0.32**
1,2,3,7,8-PeCDD	1	**0.71 J**	**0.84**	**0.91**	**0.90**	**0.55 J**	**0.86**	**0.66 J**
1,2,3,4,7,8-HxCDD	0.1	**0.74 J**	**0.48 J**	**0.84**	**0.79**	**0.44 J**	**0.68 J**	**0.45 J**
1,2,3,6,7,8-HxCDD	0.1	**2.5**	**2.0**	**2.6**	**1.9**	**1.6**	**2.1**	**1.9**
1,2,3,7,8,9-HxCDD	0.1	**3.2**	**2.0**	**3.1**	**2.5**	**2.3**	**3.4**	**1.8**
1,2,3,4,6,7,8-HpCDD	0.01	**83**	**74**	**88**	**62**	**45**	**58**	**53**
OCDD	0.0003	**710**	**649**	**745**	**501**	**336**	**420**	**375**
Furans								
2,3,7,8-TCDF	0.1	**10.5**	**8.30**	**9.79**	**7.78**	**5.75**	**10.5**	**10.4**
1,2,3,7,8-PeCDF	0.03	**1.17**	**1.03**	**1.29**	**0.94**	**0.75**	**1.34**	**1.11**
2,3,4,7,8-PeCDF	0.3	**1.48**	**1.05**	**1.42**	**1.21**	**1.00**	**1.35**	**1.24**
1,2,3,4,7,8-HxCDF	0.1	1.47 UJ	1.02 UJ	1.09 UJ	1.01 UJ	0.74 UJ	0.99 UJ	1.05 UJ
1,2,3,6,7,8-HxCDF	0.1	**0.82**	**0.78**	**0.97**	**0.63 J**	**0.5 J**	**0.80 J**	**0.71 J**
2,3,4,6,7,8-HxCDF	0.1	**0.76 J**	**0.91**	**1.06**	**0.79**	**0.41 J**	**0.93**	**0.87**
1,2,3,7,8,9-HxCDF	0.1	**0.13 J**	**0.12 J**	**0.088 J**	**0.098 J**	0.074 UJ	**0.14 J**	**0.075 J**
1,2,3,4,6,7,8-HpCDF	0.01	**13.3**	**13.2**	**15.2**	**10.8**	**7.54**	**7.52**	**7.70**
1,2,3,4,7,8,9-HpCDF	0.01	**0.61 J**	**0.61**	**0.66**	**0.3 J**	**0.40 J**	**0.53 J**	**0.48 J**
OCDF	0.0003	**38.6**	**30.2**	**33.1**	**25.2**	**17.7**	**19.1**	**15.2**
TEQ[2]		4.8	4.3	5.2	4.0	2.9	4.3	3.7
% 2,3,7,8-TCDD		13%	13%	15%	9%	10%	8%	9%
% Dioxins		60%	63%	64%	62%	61%	58%	54%
% Furans		40%	37%	36%	38%	39%	42%	46%

[1] = Toxic Equivalent Factor; WHO, 2005.
[2] = Toxic Equivalent Quotient - total toxicity equivalent to 2,3,7,8-TCDD.
J = The result is an estimate.
UJ = Analyte was not detected at or above the estimated reporting limit shown.
Bold = Analyte was detected.

Table B7. TOC and TSS Results from West Medical Lake Effluent, February, April, July, and October 2008.

Sample ID (08)	Sample ID	Sample Location	Sample Collection[1]		TOC (mg/L)	TSS (mg/L)
			Date	Time		
074000	WMLEFF	Medical Lake WWTP	2/12/08 2/13/08	0820-1500 0820-1510	**3.6**	1 U
184025	WMLEFF	Medical Lake WWTP	4/28/08 4/29/08	0850-1515 0810-1515	**4.3**	1 U
314050	WMLEFF	At old Eastern State Hospital WWTP	7/30/08 7/31/08	0800-1605 0805-1600	**4.5**	1 U
444050	WMLEFF	At old Eastern State Hospital WWTP	10/27/08 10/28/08	0805-1605 0800-1555	NAF	1 U

1 = Effluent samples are composites of AM and PM aliquots collected over two consecutive days.
U = Not detected at the reporting limit shown.
NAF = Not analyzed for. Laboratory instrument malfunctioned - no result.

Table B8. PCB Congener Concentrations in Medical Lake WWTP Effluent, February, April, July, and October 2008 (pg/L, parts per quadrillion).

Sample Dates:		2/12-13/08	4/28-29/08	7/30-31/08	10/27-28/08
Sample ID (08):		074000	184025	314050/1[1]	444050/1[1]
PCB Homolog Groups	Mono-	44.5 UJ	71 UJ	41.3 UJ	36.9 UJ
	Di-	**68.5**	**39.7**	**27.4 J**	10 U
	Tri-	**46.6 J**	**35.8 J**	**75.8**	**22.1**
	Tetra-	**16.1**	**19.8**	**9.7 J**	12.7 UJ
	Penta-	10 U	31.6 UJ	**28.2 J**	**11.5 J**
	Hexa-	10 U	15.2 UJ	**11.8 J**	**13.0 J**
	Hepta-	10 U	10 U	10 U	10 U
	Octa-	10 U	10 U	10 U	10 U
	Nona-	10 U	10 U	10 U	10 U
	Deca-	10 U	10 U	10 U	10 U
Total PCBs		**131 J**	**95.3 J**	**153 J**	**46.6 J**

1 = Results are a mean of a replicate pair. Where one sample analyte was detected and the companion result was not detected, one-half of detection was used in the mean.
Bold = Analyte was detected.
UJ = Not detected at the estimated detection limit shown.
J = The result is an estimate.
U = Not detected at the detection limit shown.

Table B9. Dioxin and Furan Results for the Medical Lake WWTP Effluent, February, April, July, and October 2008 (pg/L, parts per quadrillion).

Sample Date:	TEF[2]	2/13/08		4/29/08		7/31/08		10/28/08	
Sample ID (08):		74000		184025		314050/1[1]		444050/1[1]	
Parameter									
Dioxins									
2,3,7,8-TCDD	1	0.5	UJ	**0.56**	**J**	0.5	UJ	0.5	UJ
1,2,3,7,8-PeCDD	1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,4,7,8-HxCDD	0.1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,6,7,8-HxCDD	0.1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,7,8,9-HxCDD	0.1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,4,6,7,8-HpCDD	0.01	1	UJ	1	UJ	1	UJ	1	UJ
OCDD	0.0003	2	UJ	**3.03**	**J**	2	UJ	2	UJ
Furans									
2,3,7,8-TCDF	0.1	0.5	UJ	0.5	UJ	1.17	UJ	1.39	UJ
1,2,3,7,8-PeCDF	0.03	1	UJ	1	UJ	1	UJ	1	UJ
2,3,4,7,8-PeCDF	0.3	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,4,7,8-HxCDF	0.1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,6,7,8-HxCDF	0.1	1	UJ	1	UJ	1	UJ	1	UJ
2,3,4,6,7,8-HxCDF	0.1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,7,8,9-HxCDF	0.1	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,4,6,7,8-HpCDF	0.01	1	UJ	1	UJ	1	UJ	1	UJ
1,2,3,4,7,8,9-HpCDF	0.01	1	UJ	1	UJ	1	UJ	1	UJ
OCDF	0.0003	2	UJ	2	UJ	2	UJ	2	UJ
TEQ[3]		2	UJ	**0.56**	**J**	2	UJ	2	UJ

[1] = Results are for a replicate pair. Where detection limits are different, the higher is shown.
[2] = Toxic Equivalent Factor; WHO, 2005 (Van de Berg et al.).
[3] = Toxic Equivalent Quotient - total toxicity equivalent to 2,3,7,8-TCDD.
UJ = Analyte was not detected at or above the estimated reporting limit shown.
J = The result is an estimate.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
WATER

JUN 25 2004

Ms. Maxine I. Lipeles, J.D.
Director, Interdisciplinary Environmental Clinic
Washington University in St. Louis
1 Brookings Drive #1120
St. Louis, MO 63130

Dear Ms. Lipeles:

Thank you for your letter of February 25, 2003, to Administrator Whitman transmitting a petition on behalf of the Ozark Chapter of the Sierra Club requesting that the U.S. Environmental Protection Agency (EPA) set consistent and adequate water quality standards for defined portions of the Mississippi and Missouri rivers. EPA has carefully considered your petition and our formal response is enclosed.

In summary, EPA agrees with the Sierra Club that the Mississippi and Missouri Rivers are valuable resources that must be protected. After evaluating the currently approved water quality standards applicable to the petition area waters, the existing scientific knowledge for each pollutant at issue, and whether the affected states are working to establish or revise water quality standards in a manner that would address potential concerns, EPA is denying the Sierra Club's specific request but committing to further action.

In our discussions with you and the Sierra Club, you specified that two of your highest priority issues are numeric criteria for nutrients and bacteria. You also indicated that if federal promulgation of numeric nutrient criteria was not an option, you would like to see more federal leadership on nutrient issues in the petition area. In response to the petitioners' request to promulgate numeric nutrient criteria, we do not believe it is appropriate to promulgate numeric criteria for these specific waters until the science and the development of numeric nutrient criteria in the big rivers are better understood. However, in response to your request for more federal leadership, in addition to the ongoing work to address hypoxia in the Gulf of Mexico, EPA is committing to convene a multi-day national workshop to bring together states and others to discuss the development and adoption of appropriate ambient water quality criteria for nutrients for the Mississippi and Missouri Rivers to protect the rivers as well as the Gulf of Mexico. Following the workshop, EPA will publish a report that will summarize the results of the workshop, identify next steps, and establish a roadmap for how EPA would work with its partners to address nutrients in the Mississippi and Missouri Rivers. EPA has identified the necessary funds and will begin planning the workshop immediately with the intent to hold the

workshop in 2005. EPA hopes that the Sierra Club and other stakeholders will actively participate in this effort to help ensure success. In the interim, EPA will continue to assist the states and invest additional resources in the development and adoption of nutrient criteria for the rivers' tributaries, with the expectation that state adoption and implementation of nutrient criteria for tributaries of the Mississippi and Missouri Rivers will lead to an overall reduction of nutrient loadings entering the petition area and thus flowing to the Gulf of Mexico.

With regard to the petitioners' request to promulgate bacteria criteria in the petition area, we are pleased to inform you that both Illinois and Missouri have sent EPA formal letters committing to adopt *E. coli* criteria for the petition area (among other waters) within their states. Missouri has committed to adopt *E.coli* criteria (as well as appropriate recreation uses) by July of 2005. Illinois has committed to initiate its rulemaking process to adopt *E. coli* criteria by September 30, 2004. The remaining six states have either adopted *E. coli* criteria or have proposed *E. coli* criteria in their state rulemaking process and are moving forward to adopt it into state regulation. If any state does not follow through on its commitment, EPA will, if necessary, promulgate water quality standards for the petition area within these states.

The Agency expects states to protect their waters consistent with the requirements of the Clean Water Act and the federal regulations. While EPA is not promulgating water quality standards for the petition area in response to the petition at this time, EPA is committed to continue to work with states and others to ensure these valuable waters are adequately protected.

We understand the Sierra Club's concern regarding the consistency, adequacy, and effective monitoring of water quality standards for the Mississippi and Missouri Rivers. I want to assure you EPA carefully considered the petition and the additional information you provided in our decision making process. If you would like to discuss your concerns further, please feel free to contact me at (202) 564-5700 or Geoffrey Grubbs, Director of the Office of Science and Technology at (202) 566-0430.

Sincerely,

[Signed by Ben Grumbles, June 25, 2004]

Benjamin H. Grumbles
Acting Assistant Administrator

Enclosure

cc. J. I. Palmer, Jr, Regional Administrator, Region 4
Bharat Mathur, Acting Regional Administrator, Region 5
Richard Greene, Regional Administrator, Region 6
James B. Gulliford, Regional Administrator, Region 7

DECISION ON PETITION FOR RULEMAKING TO PUBLISH WATER QUALITY STANDARDS FOR THE MISSISSIPPI AND MISSOURI RIVERS WITHIN ARKANSAS, ILLINOIS, IOWA, KANSAS, KENTUCKY, MISSOURI, NEBRASKA AND TENNESSEE

On February 26, 2003, the Ozark Chapter of the Sierra Club (hereafter Sierra Club or petitioner) submitted a petition to the United States Environmental Protection Agency (hereafter "EPA" or Agency) requesting that EPA publish water quality standards for the Mississippi and Missouri Rivers within the petition area. As described below, EPA has given careful consideration to the issues raised in the petition and its request but is HEREBY DENYING the petition for the reasons set forth below.

Petition for Rulemaking

On February 26, 2003, the Ozark Chapter of the Sierra Club submitted a petition requesting that EPA set consistent and adequate water quality standards for defined portions of the Mississippi and Missouri Rivers ("petition area"). The petition area includes portions of the Mississippi and Missouri Rivers in Arkansas, Illinois, Iowa, Kansas, Kentucky, Missouri, Nebraska, and Tennessee ("the petition states"). The Sierra Club submitted this petition pursuant to Paragraph 9 in the Settlement Agreement in American Canoe Ass'n v. Browner, 98-1195-CV-W and 98-482-CV-W (W.D. Mo.) (Effective date 2-27-01).

The petitioner summarizes its request as follows:

> Pursuant to the Settlement Agreement[1], the Ozark Chapter requests that, within one year of receipt of this petition, the EPA publish water quality standards for the Mississippi and Missouri Rivers within the petition area states. Such standards should be:
>
> 1) Consistent among the states on each river, such that no state impairs the ability of any other affected state (whether across-stream or downstream) to achieve its water quality standards; and
> 2) Adequate:
> a) Including numeric criteria for chlordane, atrazine, polychlorinated biphenyls, *E. coli*, enterococci, conventionals (including dissolved oxygen and ammonia), nutrients, sediments, and an index of biological integrity for the aquatic community ("the petition pollutants"), among other criteria; and
> b) Reflecting criteria sufficient to achieve and maintain fishable/swimmable water quality criteria.
> *3)* In addition, such standards should include monitoring requirements sufficient to support a uniform, statistically based method for determining whether the rivers are meeting their water quality standards. Petition at 2 – 3.

[1] Settlement Agreement. American Canoe Ass'n v. Browner, 98-1195-CV-W and 98-482-CV-W (W.D.M.o). Effective date 2-27-01. The Settlement Agreement provides that EPA will "grant or deny" the petition within a year of its receipt. On February 26, 2004, the parties to the settlement agreed to extend the date by which EPA would respond to the petition to June 25, 2004.

Statutory and Regulatory Background

The Clean Water Act (CWA) establishes a comprehensive program "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." CWA section 101(a). The interim goal of the CWA is to attain water quality that provides for the protection and propagation of fish, shellfish, and wildlife. CWA section 101(a)(2).

The CWA section 303 requires states to adopt (subject to federal approval) water quality standards. The principle components of states' water quality standards are: (a) designated uses for waters, such as water supply, recreation, fish propagation, agriculture, and navigation; (b) water quality criteria, which define the amounts of pollutants the waters may contain without impairing their designated uses; and (c) antidegradation requirements, which protect existing uses and otherwise limit degradation of waters. CWA section 303(c)(2)(A) and 303(c)(2)(B), and 40 C.F.R. §§131.3(b), 131.3(f), 131.3(i), 131.6, 131.10-.11 (uses and criteria); and 40 C.F.R. §131.12 (antidegradation).

Designated Uses

Pursuant to CWA section 303(c)(2)(A) and 40 C.F.R. §131.10(a), states must designate appropriate water uses to be achieved and protected taking into consideration the use and value of water for public water supplies, protection and propagation of fish, shellfish, and wildlife, recreation in and on the water, agricultural, industrial, and other purposes including navigation. Where existing water quality standards specify designated uses less than those that are presently being attained, the state shall revise its standards to reflect the uses actually being attained. 40 C.F.R. §131.10(i). A state must conduct a use attainability analysis (UAA) where a state designates or has designated uses that do not include uses specified in section 101(a)(2) (sometimes referred to as "fishable/swimmable"), or where the state wishes to remove designated uses specified in section 101(a)(2), or to adopt subcategories of uses specified in section 101(a)(2) which require less stringent criteria. 40 C.F.R. §131.10(j).

Water Quality Criteria

The CWA section 304(a)(1) provides that EPA shall develop (and from time to time thereafter, revise) recommended water quality criteria based on current data and scientific judgment regarding the relationship between pollutant concentrations and environmental and human health effects. EPA's recommended section 304(a) criteria serve as guidance for states to use in deriving criteria to protect states' adopted designated uses.

EPA currently derives its section 304(a) water quality criteria for the protection of aquatic life using EPA's *Guidelines for the Derivation of Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* ("Guidelines") (Stephan et al. 1986. NTIS: PB85-227049). The Guidelines provide that each criterion is derived from the

evaluation of toxicological data from a representative universe of species, allows for the inclusion of site-specific considerations, and results in a chemical concentration expected to be protective of aquatic life and their uses.

EPA currently derives its section 304(a) water quality criteria for the protection of human health using the *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)* ("Methodology") (EPA-822-B-00-004, www.epa.gov/waterscience/humanhealth/method). The Methodology details the necessary components of the risk assessment: hazard (cancer and non-cancer effects), exposure (from drinking water and fish consumption rates), and bioaccumulation (from measured or calculated bioaccumulation factors). The exposure component of criteria is based on consumption of contaminated aquatic organisms and drinking water. Many of the hazard identification and dose response assessments can be found in EPA's Integrated Risk Information System (IRIS)[2], a database that summarizes available toxicity data and contains EPA's assessment of the data. EPA establishes criteria at a recommended risk level for carcinogens; however, selection of a specific risk level is a risk management decision and EPA believes adoption of either a 10^{-6} or a 10^{-5} risk level represents an acceptable range of discretion for states and tribes[3].

The scientific efforts that lead to the publication of a final ambient water quality criterion for protection of either aquatic life or human health typically need 18 months or more to complete. EPA follows the procedures described in EPA's *Guidelines for the Derivation of Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* and the *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)*, as well as Agency policy and procedures governing the development of scientific data and documents. This process includes an extensive search of peer reviewed literature, data quality evaluation, criterion and supporting documentation derivation, public scientific input, and peer review. Both the derivation process and the public and peer participation are critical to ensuring that the final section 304(a) criteria meet the clarity, transparency, and scientific rigor standards of the Agency. These steps ensure that the final criteria are scientifically defensible and that risk management decisions based on the criteria are legally defensible.

Ultimately, water quality criteria provide a basis for controlling discharges or releases of pollutants into surface waters. In establishing criteria, EPA's regulations require states to adopt water quality criteria to protect designated uses by adopting EPA's section 304(a) criteria recommendations, modifying EPA's section 304(a) criteria recommendation to reflect site-specific conditions, or deriving and adopting criteria based on other scientifically defensible methods. 40 C.F.R.§131.11. In addition, states may establish narrative criteria where numeric criteria cannot be established or to supplement numeric criteria.

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[2] U.S. Environmental Protection Agency. Integrated Risk Information System. < http://www.epa.gov/iriswebp/iris/index.html>

[3] U.S. Environmental Protection Agency. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000).* Office of Water, Washington D.C., EPA-822-B-00-004. October 2000.

Under the regulations[4], narrative criteria have the same force and effect as numeric criteria. The National Pollutant Discharge Elimination System (NPDES) regulations require that the permitting authority establish water quality-based effluent limits for any parameters in the discharge of a point source that the permitting authority determines are or may be discharged at a level which will cause, have reasonable potential to cause, or contribute to an excursion above any applicable state water quality standards, including narrative criteria. 40 C.F.R. §122.44(d)(1)(i). EPA regulations specify three options for deriving a numeric effluent limitation for a particular parameter designed to implement a narrative criterion: (1) use a calculated numeric water quality criterion; (2) use EPA's section 304(a) water quality criteria on a case-by-case basis, supplemented by other relevant information; or (3) use an indicator parameter (see 40 C.F.R. §122.44(d)(1)(vi)). CWA section 303(d) requires states to identify water quality limited segments (i.e. impaired waters) that do not meet applicable water quality standards. For those water quality limited segments identified under 40 C.F.R. § 130.7, the CWA and EPA's regulations require states to develop Total Maximum Daily Loads (TMDLs) which specify the maximum pollution loads the water body can assimilate and still meet water quality standards. TMDLs also allocate these loads among the various pollution sources. For the purposes of CWA section 303(d), "applicable water quality standards refers to water quality standards established under CWA section 303 "…including numeric criteria, narrative criteria, [and] water body uses…" 40 C.F.R. §130.7(b)(3).

Protection of Downstream Uses

The federal regulations state, "In designating uses of a water body and the appropriate criteria for those uses, the State shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters." 40 C.F.R. §131.10(b). The regulations do not compel states to adopt the same criteria and uses, nor do they suggest that this is the only way a state can meet these requirements. The water quality program is structured to provide states with flexibility to determine the best way to meet their obligations under § 131.10(b).

Under the NPDES permitting regulations, no permit may be issued "when the imposition of conditions cannot ensure compliance with applicable water quality requirements of all affected States[.]" 40 C.F.R. §122.4(d). To obtain approval of a state NPDES program, the CWA requires the state to have the authority to notify other affected states of applications for permits and provide an opportunity for a hearing. CWA section 402(b)(3). Further, the state must allow any state whose waters may be affected by the discharge to submit recommendations. If the permitting state rejects the recommendations, it must notify the affected state and EPA Administrator. CWA section 402(b)(5). Where EPA determines the permitting state rejected the recommendations for inadequate reasons, EPA may exercise its discretionary authority to object to the permit. If the objection is not resolved, EPA may issue a federal permit. 40 C.F.R. §123.44 (c)(2).

[4] 40 C.F.R. §122 and 40 C.F.R. §130

EPA's Authority and Role

Whenever a state adopts new or revised water quality standards, the state is required under the CWA section 303(c) to submit such standards to EPA for review and approval or disapproval. EPA reviews and approves or disapproves the water quality standards based on whether the standards meet the requirements of the CWA and federal regulations as discussed above.

If EPA determines that a new or revised water quality standard submitted for its review is consistent with the CWA's requirements, the standards "shall thereafter be the water quality standard for the applicable waters" of the state. If EPA determines that a new or revised water quality standard is inconsistent with the CWA's requirements, EPA is to notify the state of the relevant shortcomings (i.e. EPA will "disapprove" the state's water quality standards) and specify the changes needed to meet the CWA's requirements. The state then has ninety days to adopt the changes specified. CWA Section 303(c)(3). If such changes are not adopted, EPA is then required to promulgate a federal standard. In doing so, EPA shall "promptly prepare and publish proposed regulations setting forth a revised or new water quality standard for the navigable waters involved" and promulgate ninety days thereafter if the state still has not adopted water quality standards in accordance with the CWA. CWA Section 303(c)(4).

In addition to EPA's authority to review and approve new and revised water quality standards, EPA also has a separate, discretionary authority to promulgate federal water quality standards for a state if the Administrator determines that new or revised water quality standards are necessary to meet the requirements of the CWA. CWA Section 303(c)(4)(B), 40 C.F.R. §§131.5(b), 131.22(b). In its petition to EPA, the Sierra Club asks that the EPA Administrator exercise his discretionary authority under the Clean Water Act to correct the perceived deficiencies identified by the Sierra Club in its petition. Therefore, in deciding if promulgation of water quality standards is "necessary to meet the requirements of the CWA," EPA has evaluated whether the minimum requirements of the Act and the federal regulations (i.e., designated uses consistent with sections 101(a)(2) and 303(c)(2)(A) and criteria protective of those uses), are satisfied by the existing state water quality standards. Below, each of the specific issues raised by the Sierra Club are reviewed against this standard.

The structure of the Water Quality Standards program, as described, reflects Congress' intent to "recognize, preserve, and protect the primary responsibilities and rights of states to prevent, reduce, and eliminate pollution [and] to plan the development and use (including restoration, preservation and enhancement) of … water resources[.]" CWA Section 101(b). Accordingly, the CWA confers to the states primary authority for setting water quality standards. EPA's role is largely one of oversight, in which it reviews a state's new or revised water quality standards as they are adopted by the states and submitted to EPA. CWA Section 303(c). EPA exercises its discretionary authority under CWA section 303(c)(4)(B) only when the Administrator has determined that the

existing state water quality standards are insufficient to meet the requirements of the CWA.

EPA's approach to evaluating the petition, state standards, and the need for Federally promulgated water quality standards

In determining how to respond to the petition, EPA considered the following:

(1) What are the currently approved water quality standards that apply to the petition area and what are the apparent differences in state water quality standards that the petitioner identifies?

EPA reviewed the petition and the addenda in the petition, which contain multiple tables comparing uses and criteria within the petition area. After reviewing this information, EPA conducted its own independent analysis of the currently approved state water quality standards.[5, 6]

(2) Are the water quality standards of the petition states inconsistent with the CWA? Do any differences in water quality standards among the petition states indicate the standards are inconsistent with the CWA?

As discussed earlier, the federal regulations do not compel states to adopt the same criteria and uses to meet the requirements of the Act. Therefore, differing water quality standards do not necessarily indicate that the water quality standards are inconsistent with the CWA. Where differences in water quality standards were confirmed in EPA's analysis, EPA examined whether the various state water quality standards nonetheless provided protection for the petition area waters. Such protection could be afforded in a number of ways. EPA looked to see if a state applies ambient water quality criteria, either as part of general standards that apply to all waters or criteria to protect another designated use that would protect the designated uses applicable to the petition area. EPA looked to see if a state might have implementation procedures outside of EPA approved water quality standards (e.g., procedures to derive numeric criteria) that would further describe how the state implements its water quality standards and whether this information would resolve any apparent inconsistencies/inadequacies. EPA also reexamined the state water quality standards to determine why the differences might exist. To do so, EPA compared state water quality criteria to EPA's previous section 304(a) criteria recommendations and looked at the assumptions/policy decisions that states used to determine if the criteria were derived using scientifically defensible methods.

(3) Are the differences in water quality standards a basis for environmental concern?

[5] See Attachment A
[6] See Attachment B

Where EPA confirmed states have different designated uses and/or criteria for the petition area, EPA evaluated the degree of environmental concern linked to those specific differences. EPA evaluated the petition data to determine whether the petitioner identified any specific information to indicate where the differences were causing an environmental problem of concern. EPA then reviewed states' section 303(d) impaired waters lists for 2002 to see whether the states themselves identified segments within the petition area to be impaired by the petition pollutants. If a state identified the pollutant on the section 303(d) list, EPA then investigated whether any documented evidence exists to show that water from an upstream state or across stream state was the leading cause of the impairment even if that water body was meeting the upstream or across stream states' water quality standards.

(4) Is the current level of scientific knowledge sufficient to determine the criteria appropriate to adequately protect designated uses?

EPA investigated the current status of scientific knowledge for each pollutant identified by the petitioner. EPA first identified its most current section 304(a) criteria recommendation. EPA then considered where it is in the process to either revise its section 304(a) criteria recommendations or to derive a section 304(a) criteria recommendation for pollutants where one does not exist. EPA also evaluated the scientific understanding of these pollutants to determine whether the science is sufficient at this time to support federal or state development of numeric ambient water quality criteria for the petition area.

(5) Are the states working to revise their water quality standards in a way that would address the concerns of this petition?

Development and implementation of water quality standards to protect state waters are primarily the state's responsibilities. CWA section 101(b). EPA identified the instances where adjacent states adopted different ambient water quality criteria for pollutants that EPA has provided section 304(a) criteria recommendations and determined if these differences have the potential to cause adverse effects. In these cases, EPA evaluated whether the states are making a good faith effort to revise their water quality standards to address these concerns and incorporate the latest scientific knowledge.

Issues Identified by Petitioner and EPA's Response

1) Designated Uses

Petitioner's Position - The Sierra Club claims that while variations in designated uses are acceptable in some circumstances, states have designated uses throughout the petition area that vary inappropriately. The petitioner maintains that as a result of these inconsistencies, "when downstream states designate these interstate rivers for uses such as drinking water, fishing, and

contact recreation, but upstream states do not protect for those uses, downstream states may be unable to achieve their water quality standards." Petition at 12. In the petition, the Sierra Club specifically identifies that, unlike their surrounding states, Kentucky does not designate the Mississippi River for drinking water, Iowa does not designate the Mississippi or Missouri Rivers for a fishing use, and Missouri does not designate the Mississippi or Missouri Rivers for primary contact recreation. The Sierra Club also claims that Iowa designates one portion of the Missouri River for non-contact recreation whereas stretches above and below that portion of the river are classified for primary contact recreation. Petition at 10 – 11. The petitioner requests that EPA use its authority under the CWA section 303(c)(4) to promulgate water quality standards applicable to the Mississippi and Missouri Rivers in the eight state region around the rivers' confluence. Such standards should be consistent among the states on each river, such that no state impairs the ability of any other affected state (whether across-stream or downstream) to achieve its water quality standards. Petition at 1 and 3.

EPA Response – For the reasons provided below, EPA concludes that it is unnecessary to federally promulgate, at this time, any designated uses for the petition area to meet the requirements of the CWA section 303(c) or the federal water quality standards regulations at 40 C.F.R. Part 131.

a) Aquatic life Use

In the petition, the Sierra Club did not discuss any specific concerns regarding the designated aquatic life uses within the petition area. However, tables contained in the petition's addenda (see addenda 6 and 7), showed that some petition states designate aquatic life uses for the petition area differently from their neighboring states.

The Sierra Club's addenda show that all states within the petition area designate an aquatic life use to these waters but label the uses differently. To understand the significance of these differences, EPA evaluated the currently approved state water quality standards to determine whether the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of aquatic life uses is necessary. EPA found that while the specific terms used by each state may differ (e.g., Significant Resource Warm Water (IA), Warm Water Aquatic Habitat (KY), Perennial Delta Fishery (AR))[7], each state designates uses to protect aquatic life consistent with the CWA and federal regulations. Based on this information, EPA determined that each state designates a use to provide for the protection and propagation of fish, shellfish, and wildlife. Therefore, EPA does not believe it is necessary to federally promulgate, at this time, aquatic life uses for the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B).

b) Drinking water supply

The Sierra Club points out in the designated use section of the petition that Kentucky does not designate the Mississippi River for drinking water uses whereas surrounding states have

[7] See Attachment B

made such a designation. Petition at 10. Addendum 6 of the petition also indicates that Tennessee does not designate a drinking water use for the segment of Mississippi River from the upstream end of the Loosahatchie Bar to the Mississippi/Tennessee state line. The petitioner did not provide any specific evidence of adverse impacts on drinking water uses resulting from these differences. EPA evaluated the information contained in the petition and the currently approved state water quality standards to determine if the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of drinking water uses is necessary. To assess the potential for human health impacts, EPA also identified the drinking water intake locations and assessed whether there is any evidence that the drinking water use at these intakes is impaired as a result of different water quality standards within the petition area.

EPA found that where segments of the Mississippi and Missouri Rivers in the petition area are used for drinking water (i.e., drinking water intakes exist) states have designated those segments for a drinking water use. Kentucky does not designate its portion of the Mississippi River for drinking water supply because the state does not use the Mississippi River as a source of drinking water. Tennessee does not designate the segment of the Mississippi River from the upstream end of Loosahatchie Bar to the Mississippi/Tennessee state line as drinking water because they do not use this segment for drinking water. This Tennessee segment, however, while identified in addendum 6, is not within this petition area as defined in the petition. Therefore, EPA will not address this segment further in its response.

Since Kentucky does not designate the Mississippi River for a drinking water source, EPA evaluated whether an across stream or downstream state's drinking water uses are impaired by Kentucky's lack of designated drinking water use. While it is true that Missouri and Tennessee designate the Mississippi River located within the petition area for a drinking water use, EPA confirmed that Missouri does not have any drinking water intakes along the Mississippi River located across from Kentucky (Cape Girardeau south to Kentucky/Tennessee border) and Tennessee (which is downstream of Kentucky) does not have any drinking water intakes at all along the Mississippi River. In addition, neither Missouri nor Tennessee lists the drinking water uses on the Mississippi River within their jurisdiction as impaired. Therefore, EPA concludes that Kentucky's lack of a drinking water use is not preventing a downstream or across stream state from attaining and maintaining a drinking water use since there are no drinking water intakes or drinking water use impairments downstream or across stream from Kentucky. Therefore, Kentucky's lack of a public water supply designated use is consistent with the CWA and federal regulations at 40 C.F.R. §131.10(b). EPA concludes it is unnecessary to federally promulgate, at this time, drinking water uses for Kentucky within the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B).

c) Fish Consumption

The Sierra Club asserts that Iowa does not designate the Mississippi and Missouri Rivers for fish consumption although its waters are adjacent to Illinois, which the Sierra Club indicates has designated a fish consumption use. Petition at 10 – 11. Addenda 6 and 7, however, show that Illinois does not designate the Mississippi River for fishing. EPA evaluated this information

and the currently approved state water quality standards to determine if the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of fish consumption uses is necessary.[8] EPA first looked to see which states explicitly designate fish consumption as a use applicable to the petition area. For those states that do not, EPA evaluated the states' water quality standards to determine whether the criteria applicable to the petition area protect fish consumption uses in the petition area.

Missouri's aquatic life use is labeled Warm Water and Human Health Fish Consumption. Kansas designates the Missouri River for Food Procurement which is defined as "the use of surface waters other than stream segments for obtaining edible forms of aquatic or semiaquatic life for human consumption"[9], thus protecting human health for fish consumption. The remaining six states (Kentucky, Tennessee, Iowa, Nebraska, Illinois and Arkansas) do not explicitly designate fish consumption as a use within the petition area; however, all six of these states apply ambient water quality criteria to the petition area applicable to all surface waters or to protect another designated use that were derived to protect humans from possible risks posed by fish consumption. For example, Kentucky's minimum criteria applicable to all surface waters includes water quality criteria for the protection of human health from the consumption of fish tissue (See 401 KAR 5:031 Surface Water Standards, Section 2 Minimum Criteria Applicable to Surface Waters, Table 1 Water Quality Criteria for the Protection of Human Health from the Consumption of Fish Tissue).[10]

With regard to the Sierra Club's specific concern that Iowa lacks a fish consumption use, Iowa's Class B (WW) or Warm Water Aquatic Life use, which applies to both the Mississippi and Missouri Rivers within the petition area, includes a narrative provision (see Iowa State Standards at 567 IAC 61.3(1)(b)(4)) to prohibit the contamination of fish tissue which would present a hazard to human health as well as numeric water quality criteria for specific pollutants intended to protect human health from possible risks posed by fish consumption (See Iowa State Standards, 567 IAC 61.3(3) Table 1).

EPA concludes that while all the petition states do not specifically designate the petition area for fish consumption, all petition states apply human health criteria to protect humans from possible risks posed by fish consumption and therefore effectively protect fish consumption uses consistent with the CWA and federal regulations at 40 C.F.R. Part 131. Therefore, it is unnecessary for EPA to federally promulgate, at this time, a fish consumption use for any state within the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B).

d) Recreation

The Sierra Club points out that Missouri designates the Mississippi and Missouri Rivers for secondary contact recreation use while surrounding states designate the waters for primary contact recreation use. The petition further states that one portion of the Missouri River in Iowa's jurisdiction is designated for non-contact recreation instead of primary contact recreation

[8] See Attachment B
[9] See Attachment A
[10] See Attachment A

uses. Petition at 10 – 11. Addenda 6 and 7 reiterate this information. EPA evaluated this information and the currently approved state water quality standards to determine if the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of recreation uses is necessary.[11] EPA first reviewed each state's water quality standards to determine what recreation uses and associated criteria apply to protect these uses. Where EPA found a primary contact recreation use and/or the associated ambient water quality criteria absent, EPA discussed its findings with the state to determine whether the state intended to revise its water quality standards in the near future, and if that revision would resolve the issue identified in this petition.

EPA's analysis shows that Illinois, Kentucky, Tennessee, Arkansas, Nebraska, Kansas, and Iowa have all adopted primary contact recreation uses and the water quality criteria to protect a primary contact recreation use for all segments of the Mississippi and/or Missouri Rivers within the petition area. While the petitioner identifies Iowa as not applying a primary contact use to one segment along the Missouri River, EPA's analysis showed that Iowa has designated all portions of the Missouri River within the petition area for primary contact recreation. The stretch of the Missouri River within Iowa's jurisdiction flows from the confluence with the Big Sioux River to the Iowa/Missouri state line. Iowa's water quality standards specifically state that the Missouri River from the Iowa/Missouri state line to the confluence with the Big Sioux River is designated for Class A (waters "to be protected for primary contact recreation"), among other uses (See Iowa State Standards, 567 IAC 61.3(5)(e)).

On October 14, 2003, the Missouri Coalition for the Environment filed a lawsuit against EPA alleging that EPA has a duty to promulgate water quality standards for Missouri. One of the issues raised in the lawsuit is Missouri's lack of primary contact recreation uses. The state of Missouri has provided EPA a letter committing to adopt a primary contact use (labeled "whole body contact" by the state of Missouri) for the waters within the petition area (among others in the state). Missouri has committed to completing its rulemaking process to adopt such uses by July of 2005.

To summarize, seven of the eight petition states have adopted primary contact recreation uses for the petition area consistent with the CWA and federal regulations at 40 C.F.R. Part 131 and Missouri has initiated a rulemaking process to adopt primary contact uses for the petition area by January 2005, for the petition area. For this reason, EPA concludes that it is unnecessary for EPA to federally promulgate, at this time, a primary contact use for Missouri or Iowa within the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B) in response to this petition.

e) ***Agriculture, Aesthetics, Irrigation, Livestock & Wildlife watering, Navigation, Industrial uses***

In the petition, the Sierra Club did not identify any specific instances where states designated agriculture, aesthetic, irrigation, livestock and watering, navigation or industrial uses to the petition area differently. However, tables contained in the petition's

[11] See Attachment B

addenda (see addenda 6 and 7), showed some differences in how petition states designate these uses for the petition area.

The addenda show differences among the states' designations for agriculture, aesthetics, irrigation, livestock and wildlife watering, navigation, and industrial uses. For example, while Iowa, Illinois, Arkansas and Tennessee designate the Mississippi River within the petition area for agricultural uses, Missouri does not. To understand the significance of these differences, EPA evaluated the currently approved state water quality standards to determine whether the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of any of these uses is necessary. Based on a review of the petition states' approved water quality standards[12], the criteria adopted to protect aquatic life uses are more stringent than the criteria that are or would be applied to protect agriculture, aesthetics, irrigation, livestock and wildlife watering, navigation, or industrial uses within the petition area. Therefore, EPA concludes that the most stringent criteria that the states apply to the petition area to protect aquatic life will also protect agriculture, aesthetics, irrigation, livestock and wildlife watering, navigation and industrial uses wherever they have been designated in the petition area. Accordingly, it is not necessary for EPA to promulgate, at this time, any of these uses for the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B).

2) Water Quality Criteria

Petitioner's Position – In addition to the concerns regarding designated uses, the Sierra Club asserts that the problems in the petition area are compounded by states applying different criteria or no criteria to protect designated uses even in the situations where the underlying designated uses are equivalent. The Sierra Club specifically identifies the following pollutants at issue: chlordane, atrazine, polychlorinated biphenyls, *E. coli*, enterococci, dissolved oxygen, ammonia, nutrients, and sediments. They also identify the need for an index of biological integrity for the aquatic community. Petition at 3. The petitioner requests that EPA exercise its authority under section 303(c)(4) of the CWA to promulgate water quality standards applicable to the Mississippi and Missouri Rivers in an eight state region around the rivers' confluence. EPA should set standards that are adequate to achieve the CWA's fishable/swimmable requirements.

EPA's Response – EPA evaluated the currently approved water quality criteria within the petition area for chlordane, atrazine, polychlorinated biphenyls, *E. coli*, enterococci, dissolved oxygen, ammonia, nutrients, sediments, and an index of biological integrity for the aquatic community to determine if the criteria are consistent with the requirements of the CWA section 303(c) and the federal water quality standards regulations at 40 C.F.R. Part 131. These criteria were identified in Paragraph 9 of the Settlement Agreement in American Canoe Ass'n v. Browner, 98-1195-CV-W (W.D. Mo.) (effective date 2-27-01), as well as in the Sierra Club's petition. EPA finds that the petitioner has not demonstrated that a federal promulgation of new or revised water quality criteria for the

[12] See Attachment A

petition area is needed to meet the requirements of the CWA and the federal regulations. Therefore, EPA denies the petitioner's request to promulgate any numeric water quality criteria, at this time, for the pollutants specifically identified by the petitioner, to apply to the petition area. EPA's detailed rationale for its conclusions regarding each of the pollutants is discussed in greater detail in the following paragraphs.

a) Atrazine

Aquatic Life Protection. The petition does not identify any specific concerns with the petition states' atrazine criteria for the protection of aquatic life. Addendum 8 of the petition describes the atrazine criteria that the states have adopted for the Mississippi River. It shows that none of the states along the Mississippi River have adopted numeric atrazine criteria to protect aquatic life uses (or any other use, except drinking water, as discussed below). Neither the petition nor the addenda contain any information or discussion of atrazine criteria to protect aquatic life uses on the Missouri River.

EPA evaluated this information as well as the currently approved state water quality standards to determine if the state water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric atrazine criteria for the protection of aquatic life is necessary for the petition area. EPA first reviewed the states' currently adopted and approved water quality standards to validate the petitioner's findings. Specifically, EPA looked to see whether any states have adopted numeric or narrative atrazine criteria to protect aquatic life. EPA also reviewed the petition states' 2002 section 303(d) lists[13] to determine if any state identified atrazine as a pollutant responsible for impairing an aquatic life use. Finally, EPA evaluated the scientific understanding of atrazine to determine if the science is sufficient at this time to support EPA or state development of numeric ambient water quality criteria for the protection of aquatic life.

According to EPA's evaluation of the states' water quality standards, all eight of the petition states currently have narrative criteria related to toxic pollutants that may be used for establishing NPDES permits, listing waters as impaired by atrazine on section 303(d) lists and developing TMDLs, if necessary. As discussed earlier in the "Statutory and Regulatory Background" section, narrative criteria may form the regulatory basis for these purposes. While the petition's addendum 8 indicates that no state has adopted numeric atrazine criteria, EPA found that three states, Illinois, Nebraska and Kansas, have numeric aquatic life criteria for atrazine.[14] Illinois has an EPA approved procedure for implementing their narrative criteria at Title 35, Subtitle C, Chapter 1, Section 302.210 in Illinois' water quality standards. This procedure derives numeric values to be used as ambient water quality criteria for toxic pollutants, including atrazine.[15] Nebraska

[13] See Attachment G
[14] See Attachment B
[15] Derived Water Quality Criteria, Illinois Environmental Protection Agency <http://www.epa.state.il.us/water/water-quality-standards/water-quality-criteria.html>

and Kansas have explicitly adopted ambient water quality criteria for atrazine.[16] However, these states adopted criteria at the state's own initiative without the benefit of a final EPA CWA section 304(a) criteria recommendation. These states exercised their discretion to adopt a numeric criterion for atrazine based on other scientifically defensible methods. None of the petition states identified (nor has EPA proposed to identify) atrazine as an impairing pollutant within the petition area on their 2002 section 303(d) impaired waters list.[17]

On November 7, 2003, EPA released and requested scientific views on a revised draft ambient water quality criteria document for atrazine to protect aquatic life. This document provides EPA's draft acute and chronic criteria recommendations for atrazine designed to protect aquatic life in both freshwater and saltwater. The revised draft criteria incorporate toxicity information for atrazine that had not been available at the time EPA published its 2001 draft recommendations (see EPA's website at http://www.epa.gov/waterscience/criteria/atrazine/). In addition to revising the 2001 draft criteria recommendations to reflect scientific views EPA received from the public during the comment period, the Office of Water has been closely coordinating with the Office of Pesticide Programs (OPP) to ensure that the draft ambient water quality criteria recommendation is consistent with OPP's ecological risk assessment. OPP used its ecological risk assessment for atrazine to ensure that its decision to reregister atrazine did not result in unreasonable adverse effects.

Since EPA is currently in the process of developing a final numeric atrazine water quality criterion to protect aquatic life and atrazine may be controlled, if necessary, in all petition states based on narrative criteria where numeric atrazine criteria to protect aquatic life uses do not exist, EPA concludes that it is not necessary for EPA to promulgate numeric atrazine criteria to protect aquatic life for the petition area, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B). Once EPA's recommendations are finalized, it is EPA's policy to allow states an appropriate amount of time to incorporate EPA's newest recommendations into their water quality standards. When EPA's section 304(a) atrazine criterion to protect aquatic life is final and states have had appropriate time to incorporate the updated science into their water quality standards, EPA will evaluate the need for a federal promulgation where it is determined that atrazine criteria are necessary to protect designated uses in the petition area.

Human Health Protection. The Sierra Club's addendum 8 shows that Iowa, Missouri and Tennessee have adopted an ambient water quality criterion for atrazine of 3 µg/L to protect drinking water supplies along the Mississippi River while Arkansas, Illinois and Kentucky have not adopted numeric criteria for atrazine. In the petition's water quality criteria section, the Sierra Club specifically expresses a concern that Kentucky, the only state that does not designate the Mississippi River for a drinking water use, does not have a numeric criterion for atrazine to protect public health. The petition does not discuss atrazine criteria to protect human health on the Missouri River.

[16] See Attachment B
[17] See Attachment G

EPA evaluated this information as well as the currently approved state water quality standards to determine if the state water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric atrazine criteria for the protection of human health is necessary for the petition area. EPA first reviewed the states' currently adopted and approved water quality standards to validate the petitioner's findings. Specifically, EPA looked to see if any states have adopted numeric atrazine criteria to protect human health. EPA also reviewed the 2002 section 303(d) lists[18] to determine if any state identified atrazine as a pollutant responsible for impairing human health uses. Finally, EPA evaluated the scientific understanding of atrazine to determine if the science is sufficient at this time to support EPA or state development of numeric ambient water quality criteria to protect human health.

According to EPA's evaluation of the states' water quality standards, all of the petition area states along the Missouri River (Iowa, Nebraska, Missouri, and Kansas) apply 3 µg/l to protect public water supplies. Iowa, Missouri, and Tennessee have adopted 3 µg/l into their water quality standards to protect public water supplies on the Mississippi River. Kentucky, Illinois, and Arkansas have not adopted numeric water quality criteria for atrazine to protect human health. All eight of the petition states currently have narrative criteria related to toxic pollutants that may be used for establishing NPDES permits and TMDLs, if necessary. As discussed earlier in the "Statutory and Regulatory Background" section, narrative criteria can form the regulatory basis for these purposes. No state within the petition area has included atrazine as a pollutant on their section 303(d) impaired waters list nor did the petitioner raise any specific instances of concern in the petition.

The ambient water quality criterion of 3 µg/l that five of the eight petition area states have adopted to protect public water supplies is based on EPA's maximum contaminant level (MCL) published under § 1412(b)(4) of the Safe Drinking Water Act that applies to treated drinking water, not to ambient surface waters. EPA has not yet developed ambient water quality criteria recommendations for atrazine to protect human health under section 304(a) of the CWA because the science necessary to develop appropriate criteria for surface waters is not yet complete. Currently, the Agency is reassessing the available toxicity information on atrazine (OPP recently conducted a human health risk assessment for atrazine and concluded that there was a reasonable certainty of no harm from the reregistration of atrazine). Once this scientific evaluation is completed, EPA will consider developing ambient water quality criteria for atrazine. In the interim, states continue to have the discretion to adopt a numeric criterion for surface waters to protect human health based on other information, such as MCLs.[19]

In response to the petitioner's specific concern with respect to Kentucky, EPA concludes that since Kentucky does not use the Mississippi River as a drinking water

[18] See Attachment G

[19] U.S. Environmental Protection Agency. 1994. *Water Quality Standards Handbook: Second Edition.* Office of Water, Washington, D.C. EPA-823-B-94-005a.

source, there are no drinking water intakes across or immediately downstream from Kentucky, and Kentucky could use narrative criteria to control atrazine if necessary, Kentucky's water quality standards are consistent with the CWA and federal regulations. Therefore, it is unnecessary for EPA to federally promulgate numeric atrazine criteria for Kentucky to protect human health uses, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B).

With regard to Illinois and Arkansas, EPA concludes that a federal promulgation is unnecessary, at this time, to meet the requirements of the CWA CWA section 303(c)(4)(B). This conclusion is based on the following facts: The science is currently under review in preparation for criteria development; the states have not specifically identified atrazine as a pollutant impairing human health uses on their impaired waters list; the petitioner has not identified any specific concerns; and the petition states' current narrative criteria provide a basis for pollutant control in the absence of numeric criteria to protect local and downstream water quality standards (40 C.F.R. §131.10(b)), if necessary. However, once EPA issues section 304(a) criteria recommendations for atrazine for the protection of human health and EPA has provided states appropriate time to incorporate the latest science into water quality standards, EPA will reevaluate the need for a federal promulgation where it is determined that atrazine criteria are necessary to protect designated uses in the petition area.

b) PCBs

The Sierra Club identifies a specific concern regarding PCB criteria for two states, Iowa and Nebraska, both of which are upstream of Missouri on the Mississippi River and the Missouri River, respectively. The Sierra Club points out that Iowa's and Nebraska's PCB criteria are nearly ten times less stringent than Missouri's PCB criteria. Petition at 13 - 14. Addenda 10 and 11 of the petition provide tables describing the PCB criterion that each petition state applies to the petition area, as evaluated by the Sierra Club, and shows that the petition states have adopted varying criteria to protect their designated uses.

EPA evaluated the information provided by the petitioner as well as the currently approved state water quality standards for all petition states to determine if the PCB criteria in the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric PCB criteria is necessary. EPA first reviewed the states' currently adopted and approved water quality standards to validate the petitioner's findings. Specifically, EPA identified exactly what numeric and/or narrative PCB criteria states have currently adopted to apply to the petition area.[20] EPA then investigated the basis for these criteria to determine if the states had adopted criteria based on EPA's recommendations or on other scientifically defensible methods. Finally, EPA looked for any documented evidence that may suggest the differences in criteria are preventing a downstream or across stream state from attaining and maintaining its water quality standards.

[20] See Attachment B

Adverse human health effects are expected at much lower concentrations of PCBs than in aquatic life. As a result, EPA's CWA section 304(a) criteria recommendations for PCB to protect human health have generally been more stringent than those to protect aquatic life. In the case where states have adopted PCB criteria to protect both human health and aquatic life, the criteria to protect human health are more likely to drive regulatory decisions. Therefore, in its evaluation of currently approved PCB criteria, EPA focused on whether the states have adopted numeric criteria for PCBs to protect human health-related designated uses. EPA acknowledges there are variations in the numeric PCB criteria adopted by the petition states. There are four legitimate reasons why the numeric PCB criteria vary within the petition area:

(1) EPA published section 304(a) criteria recommendations several times over the past 20 years. EPA's revised section 304(a) criteria recommendations reflect the most current scientific knowledge but do not always result in more stringent criteria recommendations (e.g., EPA's 1999 section 304(a) recommendations for PCB were less stringent than its 1986 section 304(a) recommendations.)[21,22] States have adopted and revised PCB criteria at different points in time. The criteria the petition states adopted depended on the recommendations and information available at that time. For example, Kentucky and Kansas adopted human health criteria based on EPA's 1986 section 304(a) criteria recommendation while Nebraska (which evaluates the aquatic life and human health criteria and adopts whichever one is most stringent) adopted human health criteria based on EPA's 1992 National Toxics Rule (See 40 C.F.R. §131.36). These values were also published as section 304(a) criteria in 1999. On the Missouri River, even though Kansas' human health criterion for PCB is more stringent than Nebraska's (the upstream state), Nebraska's criterion is in fact based on more recent science. Therefore, comparing stringency of criteria is not an adequate method of determining whether states have appropriate criteria to protect the designated uses or whether they are providing for the attainment and maintenance of downstream water quality standards as required under 40 C.F.R. §131.10(b).

(2) While EPA did not publish revised section 304(a) criteria for PCBs between 1986 and 1999, EPA updated toxicity information for PCBs in EPA's IRIS[23] database in 1989. As a result, Iowa, Missouri, Arkansas, and Tennessee took EPA's 1986 section 304(a) criteria recommendations and incorporated the new toxicity information from IRIS to derive a revised ambient water quality criterion for PCBs. States have the discretion to derive criteria based on other scientifically defensible

[21] U.S. Environmental Protection Agency. *Quality Criteria for Water*. Office of Water, Washington, D.C. < http://www.epa.gov/waterscience/criteria/goldbook.pdf > EPA 440/5-86-001. May 1986
[22] U.S. Environmental Protection Agency. *National Recommended Water Quality Criteria – Correction*. Office of Water, Washington, D.C. < http://www.epa.gov/waterscience/pc/1999table.pdf> EPA 822-Z-99-001. April 1999
[23] [23] U.S. Environmental Protection Agency . Integrated Risk Information System. < http://www.epa.gov/iriswebp/iris/index.html>

methods (40 C.F.R. §131.11). These states used EPA's method to derive criteria but used more recent toxicity information to ensure their criteria incorporated the latest scientific information at the time of adoption.

(3) As discussed in the "Statutory and Regulatory Background" section, EPA publishes section 304(a) criteria based on a 10^{-6} risk level for carcinogens; states may select a specific risk level based on their own risk management decisions. EPA believes that adoption of criteria within a risk level of 10^{-6} (one in a million incremental risk for cancer) or 10^{-5} (one in one hundred thousand incremental risk for cancer) represents an acceptable range of risk management discretion for states and tribes.[24] Within the petition states, each state adopts criteria to protect human health based on risk management decisions. Iowa, Arkansas, Tennessee, and Nebraska have adopted PCB criteria based on a 10^{-5} risk level; Illinois, Kentucky and Missouri have adopted PCB criteria based on a 10^{-6} risk level; and Kansas chose to adopt a PCB criterion to protect human health at a 10^{-7} risk level.

(4) EPA's regulations provide that states may adopt EPA's section 304(a) criteria recommendations, modify EPA's section 304(a) criteria to reflect site-specific conditions, or derive and adopt criteria based on other scientifically defensible methods. (40 C.F.R. §131.11 (b)). Illinois developed a procedure to translate its narrative criteria and derive numeric values for certain pollutants. EPA determined that this procedure is scientifically defensible and considers the numeric values derived using this procedure to be within the acceptable range to protect designated uses. Illinois uses this procedure to derive numeric values for PCBs that may be used to issue NPDES permits, to determine if a waterbody is impaired for PCBs and thus listed under CWA section 303(d) listings, and/or to develop a TMDL.

As discussed above, Iowa and Missouri adopted a numeric PCB criterion to protect human health based on the toxicity information available in IRIS that was updated in 1989. With regard to the Sierra Club's specific concern about Iowa's PCB criterion as compared to Missouri's criterion, EPA found that Iowa's criterion is an order of magnitude greater than Missouri's because Iowa has chosen to protect human health at a 10^{-5} risk level while Missouri protects human health at a 10^{-6} risk level. With regard to the Sierra Club's specific concern about Nebraska's PCB criterion as compared to Missouri, EPA found that Nebraska adopted a numeric PCB criterion to protect human health based on EPA's section 304(a) criteria recommendations published in 1999 (Missouri used the updated 1999 IRIS data), but chose a 10^{-5} risk level. As a result, Nebraska's PCB criterion is greater than Missouri's criterion.

[24] U.S. Environmental Protection Agency. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000).* Office of Water. Washington, D.C. EPA-822-B-00-004. <http://www.epa.gov/waterscience/humanhealth/method > October 2000.

As described in the "Statutory and Regulatory Background" section, the regulations do not compel states to adopt the same criteria and uses in order to provide for attainment and maintenance of downstream water quality standards (40 C.F.R. §131.10(b)), nor do the regulations suggest that this is the only way a state can meet the requirements under § 131.10(b). The water quality program is structured to provide states with flexibility to determine the best way to protect their designated uses and meet their obligations under § 131.10(b). The petitioner has not provided any specific instances where the differences in PCB criteria are preventing a downstream or across stream state from attaining its designated uses as required by 40 C.F.R. §131.10(b).

The PCB criteria adopted by the petition states vary due to any one or a combination of the above reasons. EPA found that the petition states adopted criteria based on an EPA section 304(a) criteria recommendation or another scientifically defensible method and these criteria are within the scientifically acceptable range to protect designated uses consistent with 40 C.F.R. §131.11. In addition, since the production of PCBs have been banned in the United States, EPA believes it is unlikely that any differences in criteria will lead to future increases in the discharge of PCBs. While the petition states do apply different numeric PCB criteria to the petition area and some states have listed certain segments of the petition area waters as impaired for PCBs, EPA is unaware of any evidence that indicates the impairments are a result of anything but local water quality or sediment quality issues. Therefore, EPA has no reason to believe that an upstream or across stream state is causing the impairments. For example, on the Missouri River, while Missouri lists the Missouri River as impaired at the Iowa/Missouri state line due to PCBs, Iowa does not. EPA has no reason to believe that the mere listing of the Missouri River for PCBs is due to the different PCB criterion in Iowa instead of water quality issues wholly within the state of Missouri. Since the petition states have adopted PCB criteria based on EPA recommendations or other scientifically defensible methods, states have mechanisms available to them to ensure downstream water quality standards are attained and maintained, if necessary, and because the petitioner has not provided any specific instances (nor has EPA identified) where the differences in PCB criteria are preventing a downstream or across stream state from attaining its designated uses (40 C.F.R. §131.10(b)), EPA concludes that it is unnecessary for EPA to federally promulgate numeric PCB criteria for the petition states at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B).

c) Chlordane

The Sierra Club identifies a specific concern regarding chlordane criteria for two states, Iowa and Nebraska. The Sierra Club specifically points out that Iowa's and Nebraska's chlordane criteria are nearly ten times less stringent than Missouri's chlordane criteria. Petition at 13 – 14. Addenda 12 and 13 of the petition provide tables describing the chlordane criteria that each petition state applies to the petition area, as evaluated by the Sierra Club, and shows that the petition states have adopted varying criteria to protect their designated uses.

EPA evaluated the information provided by the petitioner as well as the currently approved state water quality standards for all petition states to determine if any of the chlordane criteria in the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric chlordane criteria is necessary. EPA first reviewed the states' currently adopted and approved water quality standards to validate the petitioner's findings. Specifically, EPA identified exactly what numeric and/or narrative chlordane criteria states have adopted to apply to the petition area.[25] Then EPA investigated the basis for these criteria to determine if states had adopted criteria based on EPA's recommendations or on other scientifically defensible methods. Finally, EPA looked for any documented evidence that may suggest the differences in criteria are preventing a downstream or across stream state from attaining and maintaining its water quality standards.

Adverse human health effects are expected at much lower concentrations of chlordane than in aquatic life. As a result, EPA's criteria recommendation for chlordane to protect human health is generally more stringent than those to protect aquatic life. In the case where states have adopted chlordane criteria to protect both human health and aquatic life, the criteria to protect human health are more likely to drive regulatory decisions. Therefore, in its evaluation of currently approved chlordane criteria, EPA focused on whether states have adopted numeric criteria for chlordane to protect human health-related designated uses. EPA acknowledges that there are variations in the numeric chlordane criteria adopted by the petition states. There are three legitimate reasons why the numeric chlordane criteria vary within the petition area:

(1) EPA published section 304(a) criteria recommendations several times over the past 20 years. EPA's revised section 304(a) criteria reflects the current scientific knowledge but does not always result in more stringent criteria recommendations (e.g., EPA's 1999 section 304(a) recommendations for chlordane were less stringent than its 1986 section 304(a) recommendations.)[26,27] States have adopted and revised chlordane criteria into their water quality standards at different points in time. The criteria the petition states adopted depended on the recommendations and information available at that time. For example, Missouri, Kansas, and Nebraska (Nebraska evaluates the aquatic life and human health criteria and adopt whichever one is most stringent) adopted human health criteria based on EPA's 1986 section 304(a) criteria recommendation while Iowa and Kentucky adopted human health criteria consistent with EPA's 1992 National Toxics Rule (see 40 C.F.R. §131.36). On the Mississippi River, even though Missouri's human health criterion for chlordane is more stringent than Kentucky's (the across stream state), Kentucky's criterion is, in fact, based on more recent science. Therefore, comparing stringency

[25] See Attachment B

[26] U.S. Environmental Protection Agency. *Quality Criteria for Water*. Office of Water, Washington, D.C. < http://www.epa.gov/waterscience/criteria/goldbook.pdf > EPA 440/5-86-001. May 1986

[27] U.S. Environmental Protection Agency. *National Recommended Water Quality Criteria – Correction*. Office of Water, Washington, D.C. < http://www.epa.gov/waterscience/pc/1999table.pdf> EPA 822-Z-99-001. April 1999.

of criteria is not always an adequate method of determining whether states have appropriate criteria to protect the designated uses or whether they are providing for the attainment and maintenance of downstream water quality standards as required under 40 C.F.R. §131.10(b).

(2) As discussed in the "Statutory and Regulatory Background" section, EPA publishes section 304(a) criteria based on a 10^{-6} risk level for carcinogens; states may select a specific risk level based on their own risk management decisions. EPA believes that adoption of criteria within the risk level of 10^{-6} (one in a million incremental risk for cancer) or 10^{-5} (one in one hundred thousand incremental risk for cancer) represents an acceptable range of discretion for states and tribes.[28] Within the petition states, each state adopts criteria to protect human health based on different risk management decisions. Iowa, Arkansas, Tennessee, and Nebraska have adopted chlordane criteria based on a 10^{-5} risk level while Illinois, Kentucky, Kansas and Missouri have adopted chlordane criteria based on a 10^{-6} risk level.

(3) EPA's regulations provide that states may adopt EPA's section 304(a) criteria recommendations, modify EPA's section 304(a) criteria to reflect site-specific conditions, or derive and adopt criteria based on other scientifically defensible methods. (40 C.F.R. §131.11 (b)). Illinois developed a procedure to translate its narrative criteria and derive numeric values for certain pollutants. EPA determined that this procedure is scientifically defensible and considers the numeric values derived using this procedure to be within the acceptable range to protect designated uses. Illinois uses this procedure to derive numeric values for chlordane that may be used to issue NPDES permits, to determine if a waterbody is impaired for chlordane and thus listed under CWA section 303(d) listings, and/or to develop a TMDL.

With regard to the Sierra Club's specific concern about Iowa's chlordane criterion as compared to Missouri's criterion, EPA found that Missouri adopted a numeric chlordane criterion to protect human health based on EPA's 1986 section 304(a) criteria recommendation, while Iowa adopted human health criterion consistent with EPA's National Toxics Rule. Iowa's chlordane criterion is an order of magnitude greater than Missouri's because Iowa has chosen to protect human health at a 10^{-5} risk level while Missouri protects human health at a 10^{-6} risk level. With regard to the Sierra Club's specific concern about Nebraska's chlordane criterion as compared to Missouri's criterion, EPA found that both Missouri and Nebraska adopted chlordane criteria based on EPA's 1986 section 304(a) criteria, however, Nebraska's policy is to evaluate the aquatic life and human health criteria and to adopt whichever is most stringent to protect both aquatic life and human health. In 1986, EPA's section 304(a) criteria

[28] U.S. Environmental Protection Agency. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000).* Office of Water, Washington, D.C. EPA-822-B-00-004. <http://www.epa.gov/waterscience/humanhealth/method > October 2000.

recommendation to protect aquatic life was slightly more stringent than the 10^{-5} human health recommendations. Nebraska adopted one criterion to protect for both aquatic life and human health by adjusting EPA's recommended human health criterion for chlordane to protect human health at a 10^{-5} risk level. Therefore, the magnitude of Nebraska's chlordane criteria is close to an order of magnitude greater than Missouri's criterion because while Nebraska has chosen to protect human health at a 10^{-5} level, Missouri protects human health at a 10^{-6} risk level.

As discussed earlier, the regulations do not compel states to adopt the same criteria and uses in order to provide for attainment and maintenance of downstream water quality standards (40 C.F.R. §131.10(b)), nor do the regulations suggest that this is the only way a state can meet the requirements under § 131.10(b). The water quality program is structured to provide states with flexibility to determine the best way to protect their designated uses and meet their obligations under § 131.10(b). The petitioner has not provided any specific instances where the differences in chlordane criteria are preventing a downstream or across stream state from attaining its designated uses (40 C.F.R. §131.10(b)).

The chlordane criteria adopted by the petition states vary due to any one or a combination of the above reasons. EPA found that the petition states adopted criteria based on an EPA section 304(a) criteria recommendation or another scientifically defensible method and these criteria are within the scientifically acceptable range to protect designated uses consistent with 40 C.F.R. §131.11. In addition, since the use of chlordane has been banned in the United States, EPA believes it is unlikely that any differences in states' criteria will lead to a future increase in discharge of the pollutants. While the petition states do apply different numeric chlordane criteria to the petition area and some states have listed certain segments of the petition area waters as impaired for chlordane, EPA is unaware of any evidence that indicates the impairments are a result of anything but local water quality or sediment quality issues. Therefore, EPA has no reason to believe that an upstream or across stream state is causing the impairments. For example, on the Missouri River, while Missouri lists the Missouri River as impaired at the Iowa/Missouri state line due to chlordane, Iowa does not. EPA has no reason to believe that the mere listing of the Missouri River for chlordane is due to the different chlordane criterion in Iowa instead of water quality issues wholly within the state of Missouri. Since the petition states have adopted chlordane criteria based on EPA recommendations or other scientifically defensible methods, states have mechanisms available to them ensure downstream water quality standards are attained and maintained, if necessary, and because the petitioner has not provided any specific instances (nor has EPA identified) where the differences in chlordane criteria are preventing a downstream or across stream state from attaining its designated uses (40 C.F.R. §131.10(b)), EPA concludes that it is unnecessary for EPA to federally promulgate numeric chlordane criteria for the petition states, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B).

d) *E. coli*/enterococci

The Sierra Club requests that EPA ensure water quality standards are adequate in the petition area by publishing water quality standards that include numeric criteria for *E. coli* and enterococci. Further, the Sierra Club illustrates its assertion that states protect their designated uses inconsistently by pointing out that Missouri's narrative criteria (i.e. lack of numeric criteria) for fecal coliform may be less protective than the numeric fecal coliform criteria that Nebraska and Kansas apply to the Missouri River. (See also discussion in "Recreation" section.) The Sierra Club concludes that this apparent inconsistency causes Nebraska and Kansas to violate water quality standards where they share a border with Missouri. Petition at 14. Addendum 14 of the petition describes which states have adopted fecal coliform criteria for the Missouri River and shows that Missouri is the only state along the Missouri River within the petition area that has not adopted a fecal coliform criterion of 200 organisms per 100 milliliters. The petition's addendum also shows that no state along the Missouri River in the petition area has adopted *E. coli* or enterococci criteria. Neither the petition nor its addenda include any information regarding the applicability of fecal coliform, *E. coli*, or enterococci criteria for the Mississippi River.

EPA evaluated the information submitted by the petitioner as well as the currently approved state water quality standards to determine if the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric bacteria criteria is necessary. EPA first reviewed the states' currently adopted and approved water quality standards to validate the petitioner's findings. Specifically, EPA evaluated state adopted numeric bacteria criteria to protect recreational uses and whether these are consistent with EPA's latest scientific recommendation.[29] EPA then sought to understand where various states were in their water quality standards review process to determine if any state is in the process of revising its bacteria criteria or is planning to in the near future.

EPA published its latest recommendation for bacteria criteria in 1986.[30] This 1986 criterion recommended that states adopt *E. coli* or enterococci as indicators for gastrointestinal illness in fresh recreation waters instead of fecal coliform, as previously recommended. Of the eight states in the petition area, Kansas, Nebraska, Iowa and Tennessee have adopted and EPA has approved *E. coli* criteria to protect a primary contact recreation use in the Mississippi and/or Missouri Rivers. Arkansas has adopted *E. coli* criteria and EPA expects Arkansas to submit revised water quality standards to EPA in June 2004. Kentucky has proposed adopting *E. coli* in its state rulemaking process and EPA expects Kentucky to submit revised water quality standards to EPA in the fall of 2004. On November 7, 2003, Missouri sent EPA a formal letter committing to adopt *E. coli* criteria for the petition area by July 2005. On March 23, 2004, Illinois sent EPA a formal letter committing to initiate adoption of *E. coli* criteria into water quality standards by September 30, 2004.

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[29] See Attachment B

[30] U.S. Environmental Protection Agency. *Ambient Water Quality Criteria for Bacteria – 1986*. Office of Water, Washington, D.C. EPA 440/5-84-002. < http://www.epa.gov/waterscience/beaches/1986crit.pdf> January 1986.

In its 1986 guidance, EPA recommended that states adopt *E. coli* or enterococci criteria in order to protect contact recreation uses in freshwaters, including those within the petition area, and enterococci in marine waters. Congress endorsed EPA's recommendation in 2000 with respect to coastal waters when it amended the CWA by enacting the Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act). The newly added CWA section 303(i) requires, by April 2004, that states "…adopt and submit to the Administrator water quality criteria and standards for the coastal recreation waters of the state for those pathogens and pathogen indicators for which the Administrator has published criteria under section 304(a)." (Coastal waters are defined in section 502(21) to include waters of the Great Lakes and marine coastal waters designated for use for swimming, boating, surfing, and similar water contact activities.) Further, section 303(i) directs EPA to propose and promulgate standards as protective as the 1986 criteria recommendations for states that fail to comply with section 303(i).

Based on the current scientific knowledge, EPA continues to recommend that states adopt *E. coli* or enterococci criteria to protect recreation waters. As described earlier, the CWA provides EPA the discretionary authority to set a new or revised standard for a state if the Administrator determines that new or revised water quality standards are necessary to meet the requirements of the CWA. However, with regard to the petition area, EPA concludes that it is unnecessary to initiate a rulemaking to promulgate federal *E. coli* or enterococci criteria for the petition area at this time to meet the requirements of the CWA under CWA section 303(c)(4)(B) since all eight states have either adopted *E. coli* or enterococci criteria, proposed adoption, or have committed to adopting such criteria to protect recreation uses in the petition area within a reasonable timeframe. EPA's decision is consistent with Congress' intent to "recognize, preserve, and protect the primary responsibilities and rights of states to prevent, reduce, and eliminate pollution…of … water resources." CWA Section 101(b).

Further, EPA believes the BEACH Act expresses Congress's intent for EPA to address the nation's coastal recreation waters as a first priority to ensure appropriate bacteria criteria are in place to protect beachgoers. As a result, EPA is focusing its efforts to assist states in adopting bacteria criteria consistent with the requirements under CWA section 303(i) and intends to promulgate bacteria criteria for coastal recreation waters, where necessary. If, however, Kentucky, Arkansas, Missouri or Illinois fail to follow through on their commitment to adopt appropriate bacteria criteria for the petition area, EPA will, if necessary, initiate a federal rulemaking to establish *E. coli* or enterococci criteria for the petition area within these states.

e) Dissolved Oxygen

While listed as one of the pollutants at issue, neither the petition nor the addenda to the petition discuss any specific issues/concerns related to numeric dissolved oxygen criteria in the petition area. Nonetheless, in the absence of any information from the petitioner, EPA analyzed currently approved state water quality standards, in conjunction

with implementation procedures that further describe how the state implements its water quality standards, and found that all of the petition states apply a dissolved oxygen criterion of 5 mg/l to protect aquatic life consistent with the CWA.[31] Therefore, it is unnecessary for EPA to federally promulgate numeric dissolved oxygen criteria for the petition area, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B

f) Ammonia

While listed as one of the pollutants at issue, neither the petition nor the addenda to the petition discuss any specific issues/concerns related to numeric ammonia criteria in the petition area. Nonetheless, in the absence of any information from the petitioner, EPA evaluated the petition states' currently approved water quality standards to determine if the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric ammonia criteria is necessary. EPA first reviewed the states' currently adopted and approved water quality standards to validate the petitioner's findings. Specifically, EPA looked to see whether any states have adopted numeric and/or narrative ammonia criteria to protect aquatic life consistent with EPA's recommendations.[32] If the criteria varied state to state, EPA looked to see why the criteria varied and whether the variation was within the states' scientific discretion and whether the resulting criteria were protective of the designated use. Finally, EPA looked at the petition states' 2002 section 303(d) impaired waters lists[33] to determine if any petition state identified ammonia as an impairing pollutant responsible for impairing aquatic life uses.

All eight of the petition states have adopted numeric ammonia criteria applicable to the portions of the Mississippi and Missouri Rivers within their jurisdiction. Kansas, Iowa, Nebraska and Tennessee adopted numeric ammonia criteria identical to EPA's most recent section 304(a) criteria recommendation published in 1999. Missouri, Illinois, and Kentucky have adopted criteria based on EPA's section 304(a) recommendations published before 1999. Arkansas adopted numeric ammonia criteria on April 23, 2004 and is expected to submit their revised water quality standards for EPA review and approval in June 2004. In the interim, Arkansas's narrative criterion may be used to control ammonia levels, if necessary, through water quality-based NPDES limits or TMDLs.[34] In EPA's review of the petition states' section 303(d) lists[35], no state within the petition area included (nor did EPA propose to include) ammonia as a pollutant impairing designated uses.

In developing its 304(a) criteria recommendations, EPA took into account the fact that ammonia is a complex pollutant with its effect on aquatic life dependent on several

[31] See Attachment B
[32] See Attachment B
[33] See Attachment G
[34] See Attachment A
[35] See Attachment G

factors, including temperature and pH. EPA's most recent recommended criteria reflect these complexities by providing numeric calculation approaches that consider these two variables. Further, states may modify EPA's section 304(a) criteria recommendations based on their own analysis of the available toxicity data taking into account local characteristics. In addition, EPA has not recommended a specific method to determine the appropriate temperature and pH to use when deriving numeric ammonia criteria. As a result, states may use temperature and pH differently leading to variations in the derived state numeric ammonia criteria. EPA evaluated these states' currently adopted and approved numeric ammonia criteria taking into account these variations and determined that all of the numeric ammonia criteria values applied by the petition states to the petition area are within the scientifically reasonable range and are expected to protect the designated uses consistent with the federal regulations at 40 C.F.R. §131.11. EPA continues to work with all states to ensure the latest scientific knowledge regarding ammonia is incorporated into state water quality standards.

Since ammonia criteria will generally vary with pH and temperature, any comparison of stringency among the state criteria depends on the pH and temperature used for the comparison. Scientifically, it is unclear what the most relevant pH and temperature conditions would be for making such comparisons. Therefore, it is not possible to rank, with confidence, state ammonia criteria by stringency. As mentioned earlier, the petition did not identify any specific instances of concern related to numeric ammonia criteria in the petition states nor do any of the petition states identify ammonia as an impairing pollutant on their section 303(d) list. Taking this into consideration as well as the fact that seven of the eight states' currently approved ammonia criteria are within the scientifically reasonable range and are expected to protect the designated uses consistent with the federal regulations at 40 C.F.R. §131.11 and the remaining state (Arkansas) has adopted a numeric ammonia criterion, EPA concludes it is unnecessary to federally promulgate numeric ammonia criteria for the petition area, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B).

g) Nutrients

The Sierra Club raises several concerns regarding nutrients in the petition. They assert that states inconsistently apply numeric criteria for nitrogen and phosphorus to the Mississippi and Missouri and that inadequate nutrient criteria in the petition area contributes to the hypoxic zone in the Gulf of Mexico. Petition at 17. Regarding the petitioner's concern of inconsistent nutrient criteria, the Sierra Club specifically indicates that Kentucky has a narrative criterion while neighboring Missouri has a numeric nitrogen criterion and that Arkansas is the only state in the petition area to apply a numeric phosphorus criterion to the Mississippi River. Petition at 13 – 14. Addenda 9 and 15 appear to support these examples of inconsistent criterion on the Mississippi River and offer additional information, but only describe the criteria applicable to the Mississippi River and not the Missouri River within the petition area.

To support their request that EPA publish numeric criteria for nutrients in the petition area, the Sierra Club referred to a recent General Accounting Office (GAO) report that stated "sediments, nutrients and pathogens (including *E. coli* and enterococci) - account for fifty percent [sic] of the impaired waters nationwide." The petitioner goes on to state that despite this statistic, EPA has not developed recommendations for numeric water quality criteria for nutrients. Petition at 15 – 16. The GAO report indicates that EPA is in the process of developing numeric criteria for nutrients.[36]

EPA evaluated the petition information as well as the currently approved state water quality standards to determine if the petition states' water quality standards are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric nutrient criteria is necessary. EPA first looked to see which states have adopted numeric nitrogen or phosphorus criteria to protect designated uses. Second, EPA looked to see if the petition states have adopted narrative criteria for nutrients and whether there are accompanying procedures to derive numeric criteria. Third, EPA identified the current state efforts and where the petition states are in their process to adopt numeric criteria based on the latest scientific information. Finally, EPA collected information regarding the scientific understanding of nutrients and designated uses (in local waters and the effect on the Gulf of Mexico) to determine if the science is sufficient, at this time, to support EPA or state development of numeric ambient water quality criteria for the Mississippi and Missouri Rivers.

Based on its evaluation, EPA found that Tennessee recently adopted, and EPA approved, narrative criteria for nutrients along with a procedure to derive numeric nutrient criteria applicable to free flowing streams to protect designated uses from the effects of excessive algal growth. Kansas applies numeric criterion for elemental phosphorus for the petition area. Iowa, Illinois, Missouri, Nebraska, and Kansas apply a numeric criterion for nitrates and/or nitrites to the petition area to protect human health. Arkansas has recently adopted narrative criteria for nutrients in place of previous numeric phosphorus guidelines (which is not considered to be a criterion). However, through its implementation procedures approved by EPA, Arkansas does establish point source discharge limits for nitrate-nitrogen to protect drinking water uses in surface waters.[37] EPA is currently working with these states to determine if additional criteria or procedures are necessary for nitrogen and phosphorus to protect surface waters from adverse effects due to nutrient overenrichment. All eight petition states have narrative criteria applicable to nutrients that may be used for establishing NPDES permits, listing waters as impaired by nutrients on section 303(d) lists and developing TMDLs, if necessary.

As indicated earlier, the petitioner further expresses its concern regarding nutrients in the Mississippi and Missouri Rivers by referencing the hypoxic zone in the

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[36] General Accounting Office. *Water Quality: Improved EPA Guidance and Support Can Help States Develop Standards that Better Target Cleanup Efforts*. GAO-03-308 < http://www.gao.gov/new.items/d03308.pdf> (January 2003). p 37.

[37] Arkansas Department of Environmental Quality. *Arkansas Water Quality Planning and Management: State Continuing Planning Process*. Little Rock, Arkansas. 1999.

northern Gulf of Mexico as "a graphic demonstration of the inadequacy of current water quality standards in the vicinity of the petition area." Petition at 16. While the Sierra Club specifically quotes the discussion contained in The Mississippi River/Gulf of Mexico Watershed Nutrient Task Force's *Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico* regarding the significant impact of nutrients carried to the Gulf (from the Mississippi River basin) on the Hypoxic zone, the *Action Plan* also states that "There are no simple solutions that will reduce hypoxia in the Gulf. An optimal approach would take advantage of the full range of possible actions to reduce nutrient loads and increase nitrogen retention and denitrification."[38]

According to the *Action Plan*, 56% of the nitrate load enters the Mississippi River above the Ohio River and the Ohio River basin itself adds 34% of the nitrate load. About 90% of the total nitrate load to the Gulf comes from nonpoint sources. Modeling by Alexander et al (2000)[39] indicates that more than 90% of the nitrate reaching the Mississippi River will be transported downstream to the Gulf of Mexico. This implies that the Mississippi River primarily transports nutrients downstream with little or no processing or removal of nitrogen occurring.[40,41] Battaglin et al (2001) believe that the ability of the Mississippi River to process nitrate normally is being overwhelmed by the nitrate loads from upstream sources. As a result, the Mississippi River is unable to achieve the net decrease in nitrate amounts that normally would occur. USGS studies show that denitrification could be optimized in the Upper Mississippi River (source of Mississippi River to confluence with Illinois River) by diverting water from the river to off-channel "backwater" areas that have conditions to promote nitrogen removal during non-flooding periods. However, even optimal denitrification in the Upper Mississippi River would only result in 5-10% reduction in load to the Gulf of Mexico.[42] The ability to use this method to achieve optimal denitrification in the middle and lower Mississippi Rivers is very small since the River is essentially disconnected from the carbon-rich floodplain ecosystem that could help process nitrogen, by flood control levees.[43] In other words, even if the Mississippi River could optimally process nitrogen like many other waters, the amount of nitrogen being loaded into the river prevents the river from reducing total nitrogen loadings into the Gulf more than 10%. These studies emphasize how complex the nutrients problem is in the Mississippi River basin and the need for states to control nutrients at the source.

In 2001, EPA began providing states with waterbody specific technical guidance manuals and numeric nutrient criteria recommendations for states to use as starting points

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[38] Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. *Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico.* http://www.epa.gov/msbasin/actionplan.htm. January 2001.
[39] Alexander, R.B., Smith, R.A., and Schwarz, G.E. 2000. *Effect of stream channel size on the delivery of nitrogen to the Gulf of Mexico*. Nature 403: 758-761.
[40] Richardson, W.B., Strauss, E.A., Bartsch, L.A., Monroe, E.M., Cavanaugh, J.C., Vingum, L., and Soballe, D.M. *Denitrification in the Upper Mississippi River: rates, controls, and contribution to the nitrate flux.* (in press).
[41] Battaglin, W.A., Kendall, C., Chang, C.C.Y., Silva, S.R., and Campbell, D.H. 2001. Chemical and isotopic evidence of nitrogen transformation in the Mississippi River, 1997-1998. Hydrol. Process. 15: 1285-1300.
[42] Richardson, W.B., Strauss, E.A., Bartsch, L.A., Monroe, E.M., Cavanaugh, J.C., Vingum, L., and Soballe, D.M. *Denitrification in the Upper Mississippi River: rates, controls, and contribution to the nitrate flux.* (in press).
[43] U.S. Geological Survey. *Nutrients in the Upper Mississippi River: Scientific Information to Support Management Decision, The Upper Mississippi River – Values and Vulnerability*. USGS Fact Sheet 105-03. July 2003.

to protect aquatic life from eutrophication resulting from excessive nutrients, not just toxic effects. EPA has provided nutrient criteria recommendations for most of the freshwater in the nation, excluding wetlands (see http://www.epa.gov/ost/standards/nutrient.html).

States throughout the United States have been working with EPA to develop appropriate nutrient criteria plans to quantitatively address nutrients in their waters. EPA expects these plans to be developed collaboratively with EPA and to include descriptions of the approach the state will use to develop criteria, the relative priorities of waterbodies or waterbody type, data collection plans, and a schedule describing the major milestones for developing and adopting nutrient criteria. EPA's policy was described to the states in a November 14, 2001, memo available at http://www.epa.gov/waterscience/criteria/nutrientswqsmemo.pdf. Since data are more readily available and the science is better understood for lakes, reservoirs and tributaries to the Mississippi and Missouri Rivers, states have generally indicated in their plans that they are focusing on developing nutrient criteria for these waters prior to adopting quantitative nutrient criteria specifically for the Mississippi and Missouri Rivers.

EPA believes that it is important that states establish quantitative nutrient criteria, where necessary to protect designated uses, for all waters where criteria can be developed based on sound science. The studies discussed above support EPA's position that state adoption and implementation of nutrient criteria for tributaries of the Mississippi and Missouri Rivers will lead to an overall reduction of nutrient loadings in the Mississippi and Missouri River basin. These reductions will improve water quality and help protect the designated uses of these rivers as well as the Gulf of Mexico, in the near term. Therefore, while states are not currently focused on adopting quantitative nutrient criteria specifically for the Mississippi and Missouri Rivers, EPA believes that the states in the petition area are appropriately focusing attention and resources on the smaller waterbodies that flow into these rivers before addressing these two large rivers themselves. EPA intends to work with the states to establish quantitative nutrient criteria for these waters. As a result, EPA also expects, as the *Action Plan* states, that "…. actions taken to address local water quality problems in the basin will frequently also contribute to reductions in nitrogen loadings to the Gulf."[44]

EPA will work closely in the petition area with the five states that have not yet provided EPA with draft nutrient criteria plans to ensure that an appropriate approach and timeframe to develop nutrient criteria is established consistent with its November 2001 policy memo. EPA will work with the other states in the petition area that have developed nutrient criteria plans to ensure successful implementation. Whether a state has developed a nutrient criteria plan or not, EPA expects states to adopt nutrient criteria for the tributaries to the petition area in a timeframe consistent with EPA's guidance in the November 2001 policy memo and will evaluate the need to promulgate federal nutrient criteria, as necessary, if a state fails to do so. In the interim, petition states'

[44] Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. *Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico.* http://www.epa.gov/msbasin/actionplan.htm. January 2001.

narrative criteria may serve as the basis for NPDES permits, section 303(d) listings and TMDLs, if necessary.

Although EPA has provided nutrient criteria recommendations for the ecoregions that encompass the Mississippi and Missouri Rivers, EPA's water quality criteria recommendations for nutrients are based on a reference condition approach (a reference condition reflects minimally impacted water quality conditions). In deriving the criteria recommendations, EPA incorporated data from the Mississippi and Missouri Rivers, however, since EPA's recommendations are based on reference conditions and are statistically derived to generally protect the designated uses of specific waterbody types in a specific ecoregion, it is not likely that EPA's approach which takes the 25th percentile of data from all flowing waterbodies in the ecoregions containing the Mississippi and Missouri Rivers will generate a reference condition value appropriate to base development of a nutrient criterion for these rivers. The Mississippi and Missouri Rivers have unique qualities (i.e., flow, depth, temperature and nutrient-algal response relationships) in their respective ecoregions, and EPA believes further consideration of historical data and water quality conditions are necessary before establishing nutrient criteria specifically for these rivers. Until more monitoring and research have been conducted to better understand how these large and complex rivers respond to nutrient enrichment, establishing numeric nutrient criteria for the petition area, today, would be less meaningful and effective than ensuring that quantitative nutrient criteria are adopted for waters where the linkage between nutrient concentrations and biological response are better understood and where the sources of nutrient loadings can be adequately controlled.

The *Action Plan* acknowledges the complex nature of nutrient cycling in the Mississippi and Atchafalya River basins as well as the Gulf of Mexico. As a result, it is "…difficult to predict specific improvements in water quality that will occur both in the Gulf as well as the entire Mississippi River basin for a given course of action….Further, …while the current understanding of the causes and consequences of Gulf of Mexico hypoxia is drawn from a massive amount of direct and indirect evidence collected and reported over many years of scientific inquiry, significant uncertainties remain. Further monitoring, modeling, and research are needed to reduce those uncertainties in future assessments and to aid decision making in an adaptive management framework." The Mississippi River/Gulf of Mexico Watershed Nutrient Federal, State, and Tribal Task Force (Nutrient Task Force) was chartered in 1998 to understand the causes and effects of eutrophication in the Gulf of Mexico and to coordinate activities to reduce the size, severity and duration of the Hypoxic zone and its effects. To combat the issues identified in the *Action Plan*, the Nutrient Task Force is developing the document *A Strategy for Monitoring, Modeling, and Research in Support of Managing Excess Nutrients in the Mississippi River Basin and Hypoxia in the Northern Gulf of Mexico*, that is intended to describe a framework for implementing monitoring, modeling, and research activities. This framework will provide a sound basis of scientific information to support implementation of a management plan to address nutrient over-enrichment in the Mississippi River basin and Hypoxia in the northern Gulf of Mexico. Scientific information will be provided in an adaptive-management framework through monitoring

and periodic interpretation, model analysis, and continual improvement in knowledge and methods by supporting research. The Task Force is also investigating ways to track how existing federal, state, and local efforts are likely to decrease the size of the hypoxic zone.

Once the complex effects of nutrients unique to the Mississippi River basin and their affect on the hypoxic zone in the Gulf of Mexico are better understood, EPA will be able to confidently evaluate whether states have adopted nutrient criteria into water quality standards that adequately protect designated uses in the Mississippi and Missouri Rivers and the Gulf of Mexico, and ascertain whether federally promulgated nutrient criteria are needed. EPA has taken a strong leadership role in the Nutrient Task Force's efforts to establish a strategy to reduce the size of the hypoxic zone and is working with federal and state partners to investigate remaining scientific uncertainties. EPA agrees with the petitioner that it is important that states establish quantitative nutrient criteria for the Mississippi and Missouri Rivers to protect designated uses and serve as appropriate benchmarks for nutrient controls. Yet, EPA also believes that nutrient criteria must be based on sound science. Therefore, EPA intends to continue its leadership role on nutrients and facilitate federal and state collaborative efforts that will support the development and adoption of quantitative nutrient criteria into water quality standards that will not only protect against local effects of nutrients within the Mississippi River basin, but also help to reduce the size of the hypoxic zone in the Gulf of Mexico. EPA will work with key partners to determine the appropriate ambient water quality criteria for nutrients necessary to protect the unique ecosystems of the Mississippi and Missouri Rivers based on a sound scientific understanding of the relationship between nutrient concentrations and the biological response in these rivers.

EPA believes the most effective way to begin to address ambient water quality criteria for nutrients in the Mississippi and Missouri Rivers is to reach a consensus with the affected entities on a coordinated approach on addressing nutrients in the basin. Therefore, EPA will convene key partners at a multi-day national workshop to discuss the development and adoption of appropriate ambient water quality criteria for nutrients into water quality standards for the Mississippi and Missouri Rivers that will protect the rivers and the Gulf of Mexico. The workshop will include invitees from various federal agencies (e.g., U.S. EPA's Office of Water and Office of Research and Development, U.S. Geological Survey, and U.S. Department of Agriculture), states and other stakeholders with the objective of identifying the existing federal and state nutrients efforts along the Mississippi River, the Missouri River and the Gulf of Mexico; understanding the current state of the science and the barriers states are facing; determining additional research needs and priorities; and how federal and state agencies and stakeholders can work together to develop quantitative nutrient criteria for the Mississippi and Missouri Rivers. Following the workshop, EPA will publish a report to summarize the results of the workshop and identify next steps. This report will establish a roadmap for how EPA intends to work with its partners to address nutrients in the Mississippi and Missouri Rivers. This effort will also be closely linked with the Task Force to ensure that all related nutrient work is effectively coordinated. EPA has identified the needed funds and will begin planning the workshop immediately with the intent to hold the workshop in 2005. EPA agrees with the petitioner that the Mississippi

and Missouri Rivers and the Gulf of Mexico are valuable resources and hopes that the Sierra Club and other stakeholders will actively participate in this effort to help ensure success.

Since EPA's current criteria recommendations may not be appropriate to promulgate for the Mississippi and Missouri Rivers, EPA intends to convene a national workshop that will initiate discussions on a collaborative approach to determining the appropriate ambient water quality nutrient criteria for the Mississippi and Missouri Rivers (taking into account the effects on the Gulf of Mexico). In order for EPA to promulgate nutrient criteria for the petition area based on sound science, EPA must first address the scientific uncertainties that remain regarding ambient water quality criteria for nutrients for the Mississippi and Missouri Rivers. In the interim, however, the states are actively working with EPA to develop and adopt quantitative nutrient criteria for tributaries to these rivers that will lead to an overall reduction of nutrients within the basin. Therefore, in the absence of scientifically sound criteria appropriate for these rivers, EPA concludes that it is unnecessary for EPA to federally promulgate numeric nutrient criteria for the petition area, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B).

h) Sediments

In section IV of the petition titled "Existing water quality standards for the Mississippi and Missouri Rivers in the Petition area are inadequate", the Sierra Club discusses the January 2003 GAO report stating that EPA has not yet developed national numeric criteria for sedimentation despite the fact that "sediments, nutrients and pathogens (including *E. coli* and enterococci) - account for fifty percent [sic] of the impaired waters nationwide,". Neither the petition nor the addenda to the petition discuss any specific issues of concern related to numeric sedimentation criteria in the petition area. In the absence of any information from the petitioner, EPA evaluated the petition states' currently approved water quality standards to determine if they are inconsistent with the CWA and federal regulations at 40 C.F.R. Part 131 such that a federal promulgation of numeric sedimentation criteria is necessary. EPA first looked to see whether any states have adopted numeric and/or narrative criteria related to sedimentation to protect designated uses. Then EPA evaluated the scientific understanding about sedimentation and designated uses to determine if the science is sufficient at this time to support EPA or state development of ambient water quality criteria.

All eight of the petition states currently have narrative criteria related to sedimentation that may be used for establishing NPDES permit limits, listing waters as impaired by sediments on section 303(d) impaired waters lists, and developing TMDLs, if necessary. Arkansas applies a numeric criterion for turbidity to the petition area.

EPA has not yet published numeric criteria recommendations under section 304(a) of the CWA for sediments (suspended and bedded sediments (i.e. sediments accumulated on the bottom of a stream bed)) because the science is not yet fully

understood regarding how to appropriately establish criteria for sedimentation in surface waters. As part of the Water Quality Standards and Criteria Strategy, finalized in August 2003 (see EPA's website at http://www.epa.gov/waterscience/standards/strategy/), EPA committed to developing a Suspended and Bedded Sediment Criteria Strategy after consulting with EPA's Science Advisory Board. This strategy will inform EPA's development of guidance on controlling excess sediments. The suspended and bedded sediment strategy is expected to identify methods for developing numeric suspended and bedded sediment criteria and lead to recommendations that states can use to adopt their own numeric criteria for suspended and bedded sediments. These recommendations will also provide a benchmark for EPA to evaluate the effectiveness of state water quality standards programs. Since the Agency is currently developing a Suspended and Bedded Sediment Criteria Strategy to inform EPA's criteria recommendations for suspended and bedded sediment criteria and all the petition states have narrative criteria to provide a basis for controlling suspended and bedded sediments in the interim, if necessary, EPA concludes that it is unnecessary for the Administrator to federally promulgate numeric sedimentation criteria for the petition states, at this time, to meet the requirements of the CWA under CWA section 303(c)(4)(B), at this time. However, once EPA has published section 304(a) criteria recommendations for suspended and bedded sediments and has provided states appropriate time to incorporate the latest science into water quality standards, EPA will reevaluate the need for the Administrator to determine that a federal promulgation of numeric suspended and bedded sediment criteria is necessary to meet the requirements of the CWA.

i) IBI

Neither the petition nor the addenda to the petition discuss any specific concerns related to an index of biological integrity (IBI) in the petition area beyond their request that EPA publish numeric criteria. An index of biological integrity adopted as a water quality criterion in water quality standards is known as "biocriteria". EPA does not require that states adopt biocriteria into water quality standards to protect designated uses, however EPA believes that biocriteria and bioassessments are desired elements of a robust water quality program, which help to achieve the objectives of the CWA under section 101(a).

The CWA section 304(a)(8) provides that EPA shall publish "…methods for establishing and measuring water quality criteria for toxic pollutants on other bases than pollutant-by-pollutant criteria, including biological monitoring and assessment methods." Since numeric biocriteria (response criteria based on water body condition) must be developed on a regional or water body-specific basis using bioassessment monitoring data gathered from those water bodies, EPA does not publish national recommended biocriteria. Instead, states use EPA's recommended methods to develop and adopt biocriteria to protect their designated uses, as needed.

EPA has published biocriteria methods for streams, small rivers, lakes, reservoirs, wetlands, and estuaries and continues to develop methods for all other water body types. (see http://www.epa.gov/waterscience/biocriteria/). EPA's 10 Regional Offices have developed biocriteria implementation strategies for their individual states and the Agency provides technical support through grants, contracts and training. As of 2001, all states and some Tribes and territories had bioassessment programs for streams and small rivers and most are in the process of developing quantitative biocriteria. In the petition area, Nebraska and Missouri have adopted narrative biocriteria into water quality standards. Arkansas, Kentucky, and Tennessee have adopted narrative biocriteria into water quality standards and have also developed a quantitative implementation procedure or translator to interpret this narrative for wadeable streams. Missouri is currently working to develop a procedure for wadeable streams to interpret their narrative, while Iowa is actively working to develop narrative and numeric biocriteria for wadeable streams.[45] Since EPA has not yet provided biocriteria methods for large rivers, it is unlikely that the procedures adopted by the petition states are applicable to the Mississippi and Missouri Rivers. However, it is clear the states are making substantial progress toward developing and adopting biocriteria for other water bodies, statewide. Further, CWA section 106(e)(1) includes biological monitoring in the description of a monitoring program necessary to receive a grant from the Administrator. Since 40 C.F.R. §130.7(b)(5) requires states to "assemble and evaluate all existing and readily available water quality-related data and information," any available biological information will continue to be a part of the state assessment process.

While EPA has not yet developed biocriteria methods for large rivers, EPA is developing large river indicators of biological and physical habitat condition to help states and tribes assess the water quality conditions and identify impairments in large rivers. Two guidance manuals have been produced to date. One of these manuals details the differences between the methods used by various agencies to assess small and large rivers in the U.S. (see http://www.epa.gov/nerleerd/MCD_nocover.pdf); the second manual is a logistical guide for conducting ecological assessments in large rivers (http://www.epa.gov/nerleerd/logistics_nocover.pdf). New methods specifically designed to adequately sample large rivers are being tested currently. The results from this research will provide additional information to enable states and tribes to make informed decisions about the selection of scientifically robust and efficient methods to assess the biological conditions of large rivers using various relevant endpoints.

EPA is promoting state collection of biological data in large rivers in several other ways. For example, two classes addressing large river bioassessment and monitoring were taught at the first National Biocriteria Workshop at Coeur d'Alene, Idaho in 2003. The workshop was very well attended by states, including those along the Mississippi and Missouri Rivers. In addition, EPA scientists are working with the Kentucky Department of Natural Resources (DNR) in their implementation of the large river monitoring component of a Conservation Reserve Enhancement Program (CREP). This work is serving as the first step in Kentucky DNR's effort to initiate a state-wide large river bioassessment and monitoring program, and it may serve as an

[45] U.S. Environmental Protection Agency. *States and Tribes Embrace Bioassessment and Biocriteria for Protecting Streams and Small Rivers*. EPA - 822-F-03-005. June 2003.

example for other states to follow. Also, a team of scientists composed of national and regional large river experts is using the findings of completed research to develop a scientifically sound and logistically feasible large river bioassessment program for the Mississippi DNR.

For the reasons discussed above, EPA concludes that it is unnecessary for EPA to federally promulgate water quality standards that include an index of biological integrity for the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B). However, EPA believes that biocriteria and biomonitoring are important tools to support the state water quality programs and will continue to work with and encourage states to incorporate biological conditions/criteria into state water quality programs.

3) Monitoring

Petitioner's Position – The Sierra Club believes that limited and inconsistent water quality monitoring by states in the petition area is "a weak link in this system." Petition at 17. They assert that most of the states in the petition area do not routinely monitor water quality and that very little funding is devoted to ambient water quality monitoring. The Sierra Club also asserts that state monitoring approaches and methodologies lack consistency across the area leading to inconsistent and unreliable conclusions about waters meeting the applicable water quality standards, waters being listed as impaired under CWA section 303(d), and in identifying causes of impairment. The petitioner requests that EPA promulgate water quality standards that include monitoring provisions to support uniform, statistically based method for determining whether the rivers are actually meeting applicable water quality standards.

EPA's Response – EPA denies the petitioner's request that EPA promulgate monitoring requirements as part of state water quality standards for the petition area. The "Statutory and Regulatory Background" section of this response describes the requirements for state water quality standards programs. Neither the CWA nor the implementing regulations require that water quality standards include monitoring provisions. EPA agrees with the petitioner that addressing shortcomings in state monitoring programs is a priority but believes that EPA's non-regulatory approaches planned and underway will achieve the outcome of strengthened and more consistent monitoring and assessment activity in the petition states.

<u>Background</u>

CWA section 305(b) requires a comprehensive biennial report on water quality and CWA section 303(d) requires states to assess waters and develop lists of impaired waters that do not meet water quality standards, even after point sources of pollution have installed the required levels of pollution control technology. States have flexibility to devise various approaches to assess waters and determine which waters are impaired and should be listed under section 303(d). EPA does not approve or disapprove a state's assessment and listing methodology but does approve or disapprove a state's section 303(d) list and may raise any issues about the state

assessment methodology during this process. When developing the list of impaired waters, the CWA and EPA's implementing regulations require that states "…assemble and evaluate all existing and readily available water quality-related data and information." 40 C.F.R. §130.7(b)(5).

The CWA and implementing regulations confer broad latitude on states and provide for state flexibility in assigning priorities and employing different assessment and water quality management methods. Assessment and listing of interstate waters can pose challenges because of differences among methodologies and priorities in state water quality management programs. As the petition demonstrates, different state approaches on shared waterbodies can also create public concern and confusion. Major contributors to uncertainty about the water quality status of many waters, including shared waters, are gaps in monitoring and assessment.

EPA Efforts to Improve State Monitoring and Assessment Overall

Improving the rigor and consistency of state monitoring and assessment programs is a top priority for EPA because the Agency recognizes these programs are an essential foundation for effective water quality management. EPA is devoting substantial resources and attention to this issue. In fiscal year (FY) 2004, EPA received $4 million to improve our ability to answer questions about water quality on a national basis. The President's FY 2005 Budget Request seeks $20 million to help states and tribes develop and implement statistically representative water quality monitoring programs. A key objective of this effort is greater consistency in monitoring across state programs.

In addition, EPA issued *The Consolidated Assessment and Listing Methodology (CALM) (July 2002)*[46]. CALM provides a framework for states to document how they collect and use water quality data and information for environmental decision-making, in particular for determining whether waters are attaining water quality standards, identifying waters that are impaired and need to be included in the section 303(d) lists, and identifying waters that are meeting standards so that they can be removed from the list.

In March 2003, EPA provided guidance to states on the elements needed to strengthen state monitoring and assessment programs, *Elements of a State Water Monitoring and Assessment Program.*[47] The guidance calls for states to develop or commit to develop a Comprehensive State Monitoring Strategy in FY04. This strategy should be a long-term implementation plan for improving monitoring and assessment and emphasize a comprehensive approach to assessing all waterbody types over time through the use of multiple tools.

In a related effort, EPA is encouraging states to adopt a consistent format for categorizing and reporting the status of waters according to whether they have met water quality standards, require more data, or require a Total Maximum Daily Load (TMDL). This "integrated reporting" guidance emphasizes the importance for states to clearly articulate their methodology

[46] U.S. Environmental Protection Agency. Consolidated and Assessment Listing Methodology.: Toward a Compendium of Best Practices. 2002. <http://www.epa.gov/owow/monitoring/calm.html>
[47] U.S. Environmental Protection Agency. Elements of a State Water Monitoring and Assessment Program. 2003. < http://www.epa.gov/owow/monitoring/elements/elements03_14_03.pdf> EPA 841-B-03-003.

for assessing waters and provide the public an opportunity to comment on both the methodology and proposed list of impaired waters. See *EPA's Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, July 2003 (*www.epa.gov/owow/tmdl/tmdl0103/index.html). The guidance also emphasizes that, where waters are shared among states, states should work together to collect, assemble, solicit, and assess all readily available data and information relevant to shared waters so that assessments are as consistent as possible. This coordination on shared waters is especially important for waters that are to be listed as impaired under CWA section 303(d) which then requires developing a TMDL.[48]

EPA expects that, through targeted funding and greater implementation of recent agency guidance, the quality and consistency of state monitoring and assessment programs will improve.

EPA and State Efforts to Improve Monitoring and Assessment in the Mississippi and Missouri Rivers

The challenge of improving water quality monitoring programs is even more daunting for large rivers such as the Mississippi and Missouri Rivers. The size and complexity of these rivers make representative data collection more difficult. Due to dilution in rivers of this size, localized water quality impairments may go undetected without intensive monitoring. Further, variability in river conditions means there is limited ability to extrapolate site-specific data where it does exist. To address the assessment challenges specific to large rivers, EPA's Office of Research and Development is preparing The Great Waters Initiative, a framework for state-based monitoring programs to assess the ecological condition of the Mississippi, Missouri and Ohio Rivers (see http://www.epa.gov/emap/greatriver/FactSheet.pdf). The framework is expected to include a probability-based design and indicators that could be used to assess the ecological condition of the three great rivers.

In the Upper Mississippi River basin, EPA Regions 5 and 7 are working directly with states to improve coordination on water quality management issues. The Upper Mississippi River Basin Association (UMRBA) is a regional interstate organization formed by the governors of Illinois, Iowa, Minnesota, Missouri, and Wisconsin to help coordinate the states' water quality issues related to the Mississippi River. UMRBA implemented a Water Quality Coordination Project that aimed to discern underlying reasons for state inconsistencies in assessment and listing and to initiate actions to address inconsistencies (www.umrba.org/wq/wq2002rpt.pdf). For example, one outcome of the project is a Memorandum of Understanding among the five UMRBA states to use a minimum number of common water reaches for purposes of characterizing water quality under CWA section 305(b) and identifying water quality impairments under section 303(d).

Over time, these efforts in the Upper Mississippi River basin should lead to improved consistency in state section 305(b) assessments and section 303(d) listings throughout Mississippi and Missouri basins. In addition to these ongoing efforts, EPA will work with the

[48] U.S. Environmental Protection Agency. 2003. *EPA's Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, July 2003.* http://www.epa.gov/owow/monitoring/repguid.html).

petition states during the 2006 reporting and listing cycle (now underway) to resolve or explain, where possible, inconsistencies in the listing of impaired waters on the Mississippi and Missouri Rivers. Examples cited by the petitioner, including the fact that Arkansas and Kentucky did not include the Mississippi River on their 1998 section 303(d) list and that Kansas did not list the Missouri River in 1998, will be given particular consideration. EPA will continue through successive listing cycles to use any new sources of water quality data for the affected river segments, such as data generated through the Great Waters Initiative, to work with states in refining their impaired water lists. Therefore, EPA concludes it is unnecessary for EPA to federally promulgate monitoring requirements in water quality standards for the petition area to meet the requirements of the CWA under CWA section 303(c)(4)(B).

Conclusion

For the foregoing reasons, EPA denies the petition's request for EPA to publish water quality standards for the petition area, at this time.

ATTACHMENT A – WATER QUALITY STANDARDS FOR PETITION STATES: LIST AND CITATIONS

State	State Regulation Information
Arkansas	Arkansas Pollution Control and Ecology Commission; Regulation 2 - Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas; (October 28, 2002); Effective under Clean Water Act - January 23, 2003. http://www.epa.gov/ost/standards/wqslibrary/ar/ar.html
Illinois	Title 35: Environmental Protection; Subtitle C: Water Pollution; Chapter 1: Pollution Control Board Parts 301 Introductions & Park 302 Water Quality Standards (August 26, 1999) http://www.epa.gov/ost/standards/wqslibrary/il/il.html
Iowa	567 Iowa Administrative Code Chapter 61 – Water Quality Standards Effective under Clean Water Act – June 16, 2004 http://www.epa.gov/ost/standards/wqslibrary/ia/ia.html
Kansas	Kansas Department of Health and Environment; Division of Environment; Bureau of Environmental Field Services Kansas Surface Water Register (December 15, 2003) Effective Under Clean Water Act–To be acted upon June 2004 Kansas Administrative Regulations Title 28, Article 16 – Surface Water Quality Standards (September 25, 2003) Effective Under the Clean Water Act – November 3, 2003 http://www.epa.gov/ost/standards/wqslibrary/ks/ks.html
Kentucky	Natural Resources and Environmental Protection Cabinet; Department for Environmental Protection; Division of Water Kentucky Administrative Regulations, Title 401, Chapter 5 Effective Under the Clean Water Act – December 8, 1999 http://www.epa.gov/ost/standards/wqslibrary/ky/ky.html
Missouri	Code of State Regulations Title 10 - Rules of Department of Natural Resources; Division 20 – Clean Water Commission; Chapter 7 – Water Quality 10 CSR 20-7 (10/31/99) http://www.epa.gov/ost/standards/wqslibrary/mo/mo.html
Nebraska	Nebraska Department of Environmental Quality Title 117 – Nebraska Surface Water Quality Standards (12/31/02) Effective Under the Clean Water Act – August 8, 2003 http://www.epa.gov/ost/standards/wqslibrary/ne/ne.html
Tennessee	Rules of the Tennessee Department of Environment and Conservation; Division of Water Pollution Control Chapter 1200-4-3 General Water Quality Criteria (October 1999) Effective Under the Clean Water Act – October 11, 1999 http://www.epa.gov/ost/standards/wqslibrary/tn/tn.html

Attachment B -- EPA analysis of State Water Quality Standards in the Petition Area
(Mississippi River)

NOTE: ***Spreadsheet reflects applicable numeric criteria only.***
Numeric criteria reflected are most stringent criteria applicable to segment.

STATE	DESIGNATED USE											NUMERIC WATER QUALITY CRITERIA										
EPA's most recent 304(a) recommendations next to pollutant label	Outstanding State Resource Water	Primary Rec	Secondary Rec	Aquatic Life	Aesthetics	Fish Consumption	Drinking Water/Domestic Water Supply	Agriculture	Irrigation	Livestock & Wildlife watering	Navigation	Industrial	chlordane (CCC = .0043 µg/l, water + organism = .00080 µg/l, organism only = .00081 µg/l) MCL = .002mg/L or 2 µg/l	atrazine 1500 µg/l freshwater, 760 µg/l saltwater, MCL = 3 ppb or 3 µg/l	Total PCBs (CCC = .014 µg/l, HH = .000064 µg/l updated) MCL = .5 ppb or .5 µg/l	e.coli (126 / 100 ml)	enterococci (33 per 100 ml)	DO (5 mg/l 1 day minimum)	Ammonia (1999 update, pH/temp. dependent)	Phosphorus (ecoregional based)	Nitrogen (ecoregional based)	Sediments (narrative. Sedimentation criteria in development)
IA (effective 6/16/04)																						
Skunk River to Iowa River		X		Significant Resource Warm Water (Class B(WW))				X	X	X		X	C = .004 µg/l* A = 2.5 µg/l* HH (fish consumption) = .006 µg/l *		C = .014 µg/l * A = 2 µg/l * HH (fish consumption) = .0004 µg/l *	E. coli = 126/100 ml* (geometric) Mar 15 - Nov 15, 235/100 ml* (single sample max)		no less than 5 mg/l (at any time)				Turbidity shall not be increased by more than 25 NTU by any point source discharge
IA-MO state line to confluence w/ Skunk R.		X		Significant Resource Warm Water (Class B(WW))				X	X	X		X	C = .004 µg/l* A = 2.5 µg/l* HH (fish consumption) = .006 µg/l *		C = .014 µg/l * A = 2 µg/l * HH (fish consumption) = .0004 µg/l *	E. coli = 126/100 ml* (geometric) Mar 15 - Nov 15, 235/100 ml* (single sample max)		no less than 5 mg/l (at any time)				Turbidity shall not be increased by more than 25 NTU by any point source discharge
Burlington Water works							X	X	X	X		X	PWS = .021 µg/l *	PWS = 3 µg/l *	PWS = .0017 µg/l*						Nitrate as N = 10 mg/l Nitrate + Nitrite as N = 10 mg/l Nitrite as N = 1 mg/l	Turbidity shall not be increased by more than 25 NTU by any point source discharge
Koekuk Municipal Water Works Intake							X	X	X	X		X	PWS = .021 µg/l *	PWS = 3 µg/l *	PWS = .0017 µg/l*						Nitrate as N = 10 mg/l Nitrate + Nitrite as N = 10 mg/l Nitrite as N = 1 mg/l	Turbidity shall not be increased by more than 25 NTU by any point source discharge
Fort Madison Municipal Water Works Intake							X	X	X	X		X	PWS = .021 µg/l *	PWS = 3 µg/l *	PWS = .0017 µg/l*						Nitrate as N = 10 mg/l Nitrate + Nitrite as N = 10 mg/l Nitrite as N = 1 mg/l	Turbidity shall not be increased by more than 25 NTU by any point source discharge
IL(effective 8/26/99)	Designated General Use Water (protects for multiple uses)																					
Mississippi River		X^	X	X	X			X		X		X	Narrative w/Translator A = 2.4 µg/l C = .0043 µg/l noncancer = .72 ng/l	A = 280 µg/l ## C = 12 µg/l ## HH = .015 ng/L		Fecal = 200 (geometric)* nor 400* in 10% of 30 day samples		no less than 5 mg/l (at any time) or less than 6 mg/l 16 of 24 hours		.05 mg/l* in reservoir/lake 8.1 hectares (or entering stream)		
Mississippi R. at Drinking Water/Food Processing Intakes		X^	X	X	X		Public and Food Processing Water Supply	X		X		X	.003 mg/l*	A = 280 µg/l ## C = 12 µg/l ## HH = .015 ng/L (fish consumption only)		Fecal = 2000 (geometric)*		no less than 5 mg/l (at any time) or less than 6 mg/l 16 of 24 hours		.05 mg/l* in reservoir/lake 8.1 hectares (or entering stream)	Nitrate-Nitrogen = 10 mg/l*	
MO (effective 10/31/99)																						
State Line to Ohio R.			X	WW & HH fish consumption		X	X		X	X		X	HH (fish consumption) = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	HH = .000045 µg/l*			5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	
Ohio R. to Missouri R.			X	WW & HH fish consumption		X	X		X	X		X	HH (fish consumption) = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	HH = .000045 µg/l*			5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	
Missouri R. to Des Moines R.		X	X	WW & HH fish consumption		X	X			X		X	HH (fish consumption) = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	HH = .000045 µg/l*	Fecal = 200*		5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	
KY (12/8/99)																						
Mississippi R. - Confluence w/ Ohio R. to River Mile 947.0		X	X	Warm Water Aquatic Habitat									(Proposing to adopt 2002 EPA HH recommendations) C = .0043 µg/l*		C = .0014µg/l*	Fecal = 200 (geometric, not less than 5 samples/month)* nor <400* in more 20% or more of all samples in month		Daily average = 5.0 mg/l (no less than)** Minimum = 4.0 mg/l(no less than)*	un-ionized = 0.05 mg/l*			
													A = 2.4 µg/l*		A = LC1* or 1/3 LC50* or .3 acute toxicity units*							
													HH (fish consumption) = 0.0022 µg/l*		HH (fish consumption) = .000079 µg/l*							
Mississippi R. - River mile 947.0 to 945.0	X	X	X	Warm Water Aquatic Habitat									"		"	"	"	"	"			
Mississippi R. - River mile 945.0 to KY/TN state line		X	X	Warm Water Aquatic Habitat									"		"	"	"	"	"			

Attachment B -- EPA analysis of State Water Quality Standards in the Petition Area
(Mississippi River)

STATE		DESIGNATED USE											NUMERIC WATER QUALITY CRITERIA										
EPA's most recent 304(a) recommendations next to pollutant label	Outstanding State Resource Water	Primary Rec	Secondary Rec	Aquatic Life	Aesthetics	Fish Consumption	Drinking Water/Domestic Water Supply	Agriculture	Irrigation	Livestock & Wildlife watering	Navigation	Industrial	chlordane (CCC = .0043 µg/l, water + organism = .00080 µg/l, organism only = .00081 µg/l) MCL=.002mg/L or 2 µg/l	atrazine 1500 µg/l freshwater, 760 µg/l saltwater, MCL = 3 ppb or 3 µg/l	Total PCBs (CCC = .014 µg/l, HH = .000064 µg/l updated) MCL = .5 ppb or .5 µg/l	e.coli (126 / 100 ml)	enterococci (33 per 100 ml)	DO (5 mg/l 1 day minimum)	Ammonia (1999 update, pH/temp. dependent)	Phosphorus (ecoregional based)	Nitrogen (ecoregional based)	Sediments (narrative. Sedimentation criteria in development)
AR (effective 1/23/03)																							
Mississippi River		X	X	Perrenial Delta Fishery			X		X			X	C = .0043 µg/l** A = 2.4 µg/l* HH = 5 ng/l		C = .0140 µg/l** HH = .4 ng/l	fecal = 200* (geometric) nor 400* in more than 10% of 30 day samples		5 mg/l (no less than)		TP = 100 µg/l***	10 mg/l effluent limit for dischargers near domestic water supply uses #	Turbidity = 50 NTU
TN (effective 10//11/99)																							
Mississippi R. Mile 741.0 to 820.0		X		X			X		X	X	X	X	(Adopted 2002 EPA HH recommendations, pending approval) C = .0043 µg/l A = 2.4 µg/l 2 µg/l* (PWS) water+organism = .0057 µg/l, organism only = .0059 µg/l	3 µg/l* (PWS)	C = .014 µg/l (each aroclor) 0.5 µg/l* (PWS) water+organism = .00044 µg/l total, organism only = .00045 µg/l total	Fecal = 200* , E.coli = 126 *(geometric based on 10 samples)		5 mg/l (no less than)				
Mississippi R. Mile 820.0 to TN/KY state line (Mile 905.0)		X		X			X		X	X	X	X	(Adopted 2002 EPA HH recommendations, pending approval) C = .0043 µg/l A = 2.4 µg/l 2 µg/l* (PWS) water+organism = .0057 µg/l, organism only = .0059 µg/l	3 µg/l* (PWS)	C = .014 µg/l (each aroclor) 0.5 µg/l* (PWS) water+organism = .00044 µg/l , organism only = .00045 µg/l	Fecal = 200* , E.coli = 126 *(geometric based on 10 samples)		5 mg/l (no less than)				

* Shall not exceed
** 24 hour average
*** As a guideline, shall not exceed
^Protects for Primary "for all General Use waters whose physical configuration permits
Based on Arkansas Water Quality Planning and Management: State Continuing Planning Process (1999)
Based on Narrative Procedure to derive Numeric Criteria

Attachment B -- EPA Analysis of State Water Quality Standards in the Petition Area
(Missouri River)

NOTE: ***Spreadsheet reflects applicable numeric criteria only.***
Numeric criteria reflected are most stringent criteria applicable to segment.

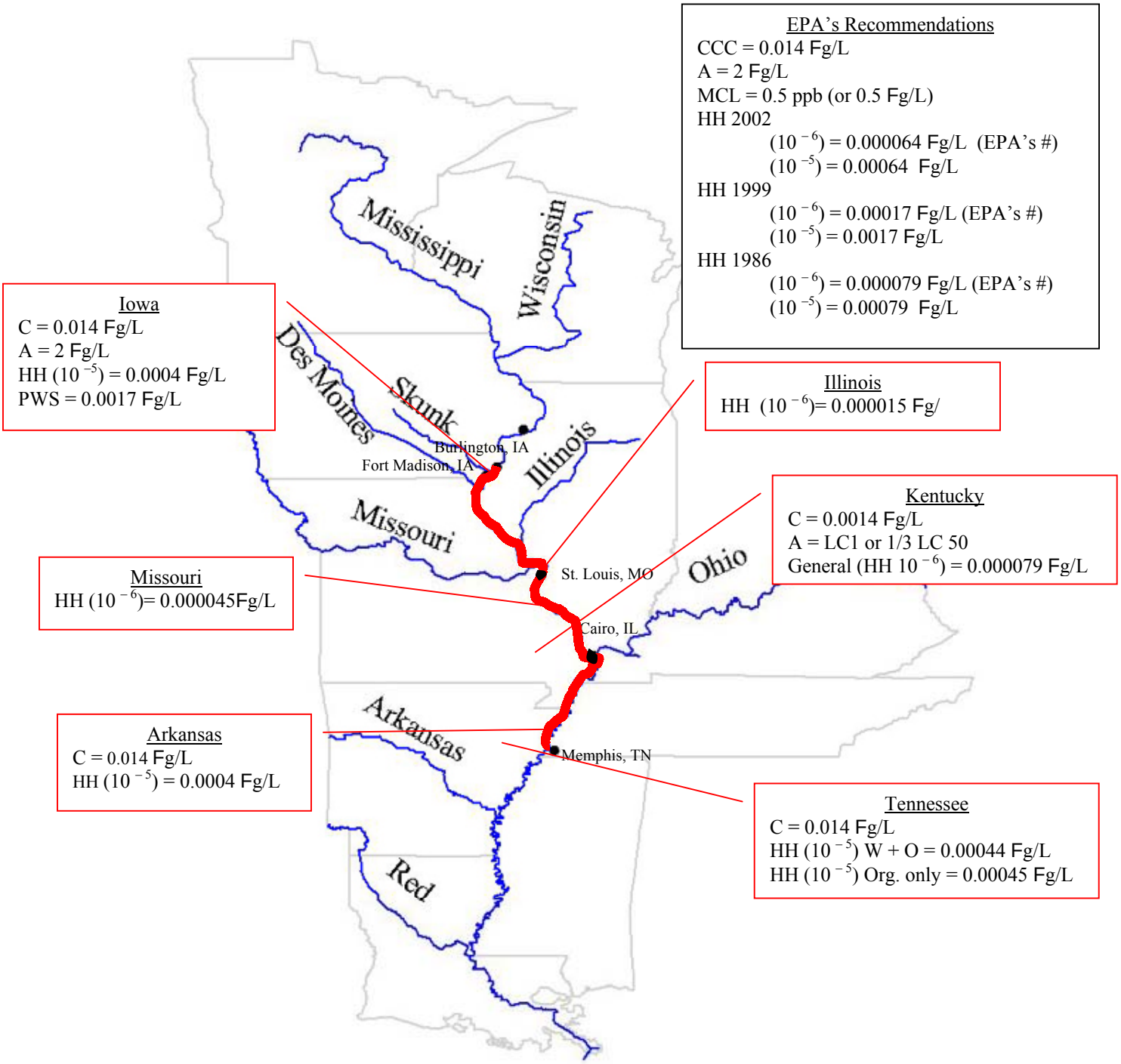
STATE	DESIGNATED USE										NUMERIC WATER QUALITY CRITERIA									
	Primary Rec	Secondary Rec	Aquatic Life	Aesthetics	Food Procurement/ Fish consumption	Public/Domestic Water Supply	Agricultural	Irrigation	Livestock & Wildlife watering	Industrial	chlordane (CCC = .0043 µg/l, water + organism = .00080 µg/l, organism only = .00081 µg/l) MCL=.002mg/L or 2 µg/l	atrazine 1500 µg/l freshwater, 760 µg/l saltwater, MCL = 3 ppb or 3 µg/l	Total PCBs (CCC = .014 µg/l, CMC = 2 µg/l, HH = .000064 µg/l updated) MCL = .5 ppb or .5 µg/l	e.coli (126 per 100 ml)	enterococci (33 per 100 ml)	DO (5 mg/l 1 day minimum)	Ammonia (1999 update, pH/temp. dependent)	Phosphorus (ecoregional based)	Nitrogen (ecoregional based)	Sediments (narrative. Sedimentation criteria in development)
IA (effective 6/16/04)																				
IA-MO state line to confluence w/ Big Sioux R.	X		Significant Resource Warm Water (Class B(WW))				X	X	X	X	C = .004 µg/l * A = 2.5 µg/l* HH = .006 µg/l*		C = .014 µg/l* A = 2 µg/l* HH = .0004 µg/l*	E. coli = 126/100 ml* (geometric) Mar 15 - Nov 15, 235/100 ml* (single sample max)		no less than 5 mg/l (at any time)				Turbidity shall not be increased by more than 25 NTU by any point source discharge
City of Council Bluffs Water Works Intake						X	X	X	X	X	PWS = .021 µg/l*	PWS = 3µg/l*	PWS = .0017µg/l*						Nitrate as N = 10 mg/l Nitrate + Nitrite as N = 10 mg/l Nitrite as N = 1 mg/l	Turbidity shall not be increased by more than 25 NTU by any point source discharge
NE (effective 8/8/03)	Water quality criteria to protect downstream beneficial uses shall be applicable to all surface waters, whether or not those beneficial uses are assigned to a given water body.																			
Platte R. to NE-KS border	X		Class A Warm Water	X		X	X			X	C = .0043 µg/l** A = 2.4 µg/l* PWS = 2 µg/l*	C = 12 µg/l (4 day average) A = 330 µg/l (1 hr average) PWS = 3 µg/l*	C = .0017 µg/l** A = 2 µg/l* PWS = .5 µg/l*	fecal = 200 (geometric mean)* or 400 (no more than 10% of samples shall equal or exceed) E.coli = 126/100ml* (5 samples, 30-day period)		1 day min no less than 5 mg/l (April 1 - Sep. 30 - early life stages) 1 day min no less than 3 mg/l (Oct. 1 - Mar. 31)			(AG) Nitrate + Nitrite = 100 mg/l* (PWS) Nitrate-nitrogen = 10 mg/L* (PWS) Nitrite-Nitrogen = 1 mg/L*	
Big Sioux R. to Platte R.	X		Class A Warm Water	X		X	X			X	C = .0043 µg/l** A = 2.4 µg/l* PWS = 2 µg/l*	C = 12 µg/l (4 day average) A = 330 µg/l (1 hr average) PWS = 3 µg/l*	C = .0017 µg/l** A = 2 µg/l* PWS = .5 µg/l*	fecal = 200 (geometric mean)* or 400 (no more than 10% of samples shall equal or exceed) E.coli = 126/100ml* (5 samples, 30-day period)		1 day min no less than 5 mg/l (April 1 - Sep. 30 - early life stages) 1 day min no less than 3 mg/l (Oct. 1 - Mar. 31)			(AG) Nitrate + Nitrite = 100 mg/l* (PWS) Nitrate-nitrogen = 10 mg/L* (PWS) Nitrite-Nitrogen = 1 mg/L*	
MO (10/31/99)																				
Mouth to Gasconade R.		X	WW & HH fish consumption			X		X	X	X	HH = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	C = .000045 µg/l*			5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	
Gasconade R. to Chariton R.		X	WW & HH fish consumption			X		X	X	X	HH = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	C = .000045 µg/l*			5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	
Chariton R. to Kansas R.		X	WW & HH fish consumption			X		X	X	X	HH = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	C = .000045 µg/l*			5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	
Kansas R. to State Line		X	WW & HH fish consumption			X		X	X	X	HH = .00048 µg/l* PWS = 2 µg/l*	PWS = 3 µg/l*	C = .000045 µg/l*			5 mg/l (no less than)			PWS Nitrate-Nitrogen = 10 mg/L	

Attachment B -- EPA Analysis of State Water Quality Standards in the Petition Area
(Missouri River)

STATE	DESIGNATED USE										NUMERIC WATER QUALITY CRITERIA									
	Primary Rec	Secondary Rec	Aquatic Life	Aesthetics	Food Procurement/ Fish consumption	Public/Domestic Water Supply	Agricultural	Irrigation	Livestock & Wildlife watering	Industrial	chlordane (CCC = .0043 µg/l, water + organism = .00080 µg/l, organism only = .00081 µg/l) MCL=.002mg/L or 2 µg/l	atrazine (1500 µg/l freshwater, 760 µg/l saltwater, MCL = 3 ppb or 3 µg/l	Total PCBs (CCC = .014 µg/l, CMC = 2 µg/l, HH = .000064 µg/l updated) MCL = .5 ppb or .5 µg/l	e.coli (126 per 100 ml)	enterococci (33 per 100 ml)	DO (5 mg/l 1 day minimum)	Ammonia (1999 update, pH/temp. dependent)	Phosphorus (ecoregional based)	Nitrogen (ecoregional based)	Sediments (narrative. Sedimentation criteria in development)
KS (effective 11/3/03)																				
Missouri R. (HUC 10240005, Seg. 1)	Class B	X	Special Aquatic Life Use (applicable criteria same for all aquatic life use designations. Only use name differs)		X	X		X	X	X	C = .0043 µg/l* A = 2.4 µg/l* HH (fish consumption) = .00048 µg/l* (3 µg/l for LWW) PWS = .00057 µg/l (EPA)	C = 3 µg/l* A = 170 µg/l* PWS = 3 µg/l*	C = .014 µg/l* A = 2 µg/l* HH (fish consumption) = .0000079 µg/l* PWS = .00017 µg/l (EPA)	E.coli (geometric mean)* = 262/100 mL		not less than 5 mg/l		Elemental P = .1 µg/l	Nitrate as N = 10 mg/l (PWS) Nitrite + Nitrate as N = 10 mg/l (PWS) or 100 mg/l (LWW)	
Missouri R. (HUC 10240005, Seg. 19)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240005, Seg. 2)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240005, Seg. 21)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 1)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 11)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 13)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 15)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 19)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 2)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 4)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 5)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 7)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 9)	"	X	Special Aquatic Life Use		X	X		X	X	X	"	"	"	"	"	"		"	"	
Missouri R. (HUC 10240011, Seg. 9099)	"	X	Expected Aquatic Life Use		X	X	X	X	X	X	"	"	"	"	"	"		"	"	

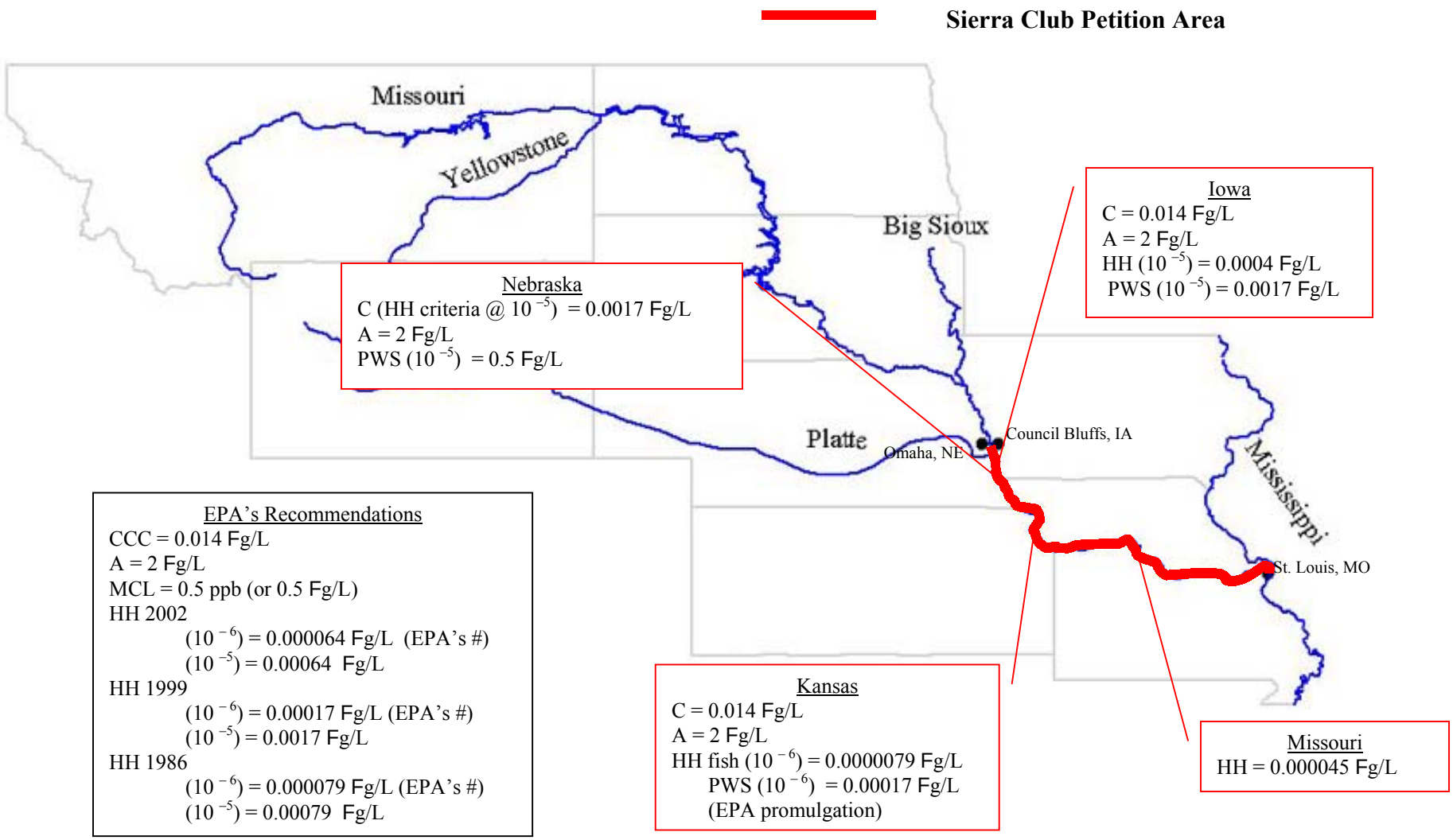
* Shall not exceed
** 24 hour average

ATTACHMENT C
PCB CRITERIA ON MISSISSIPPI RIVER

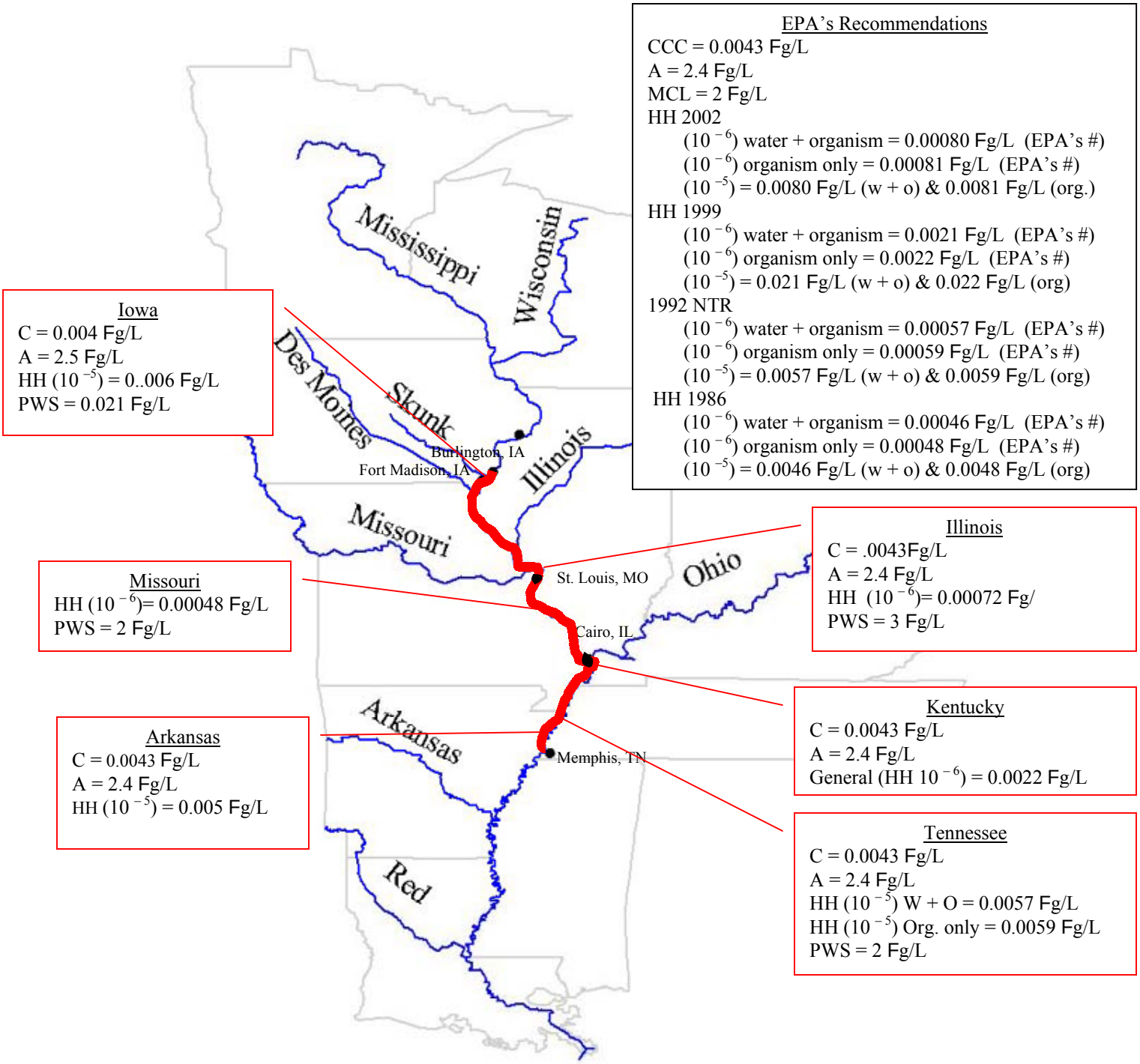


Sierra Club Petition Area

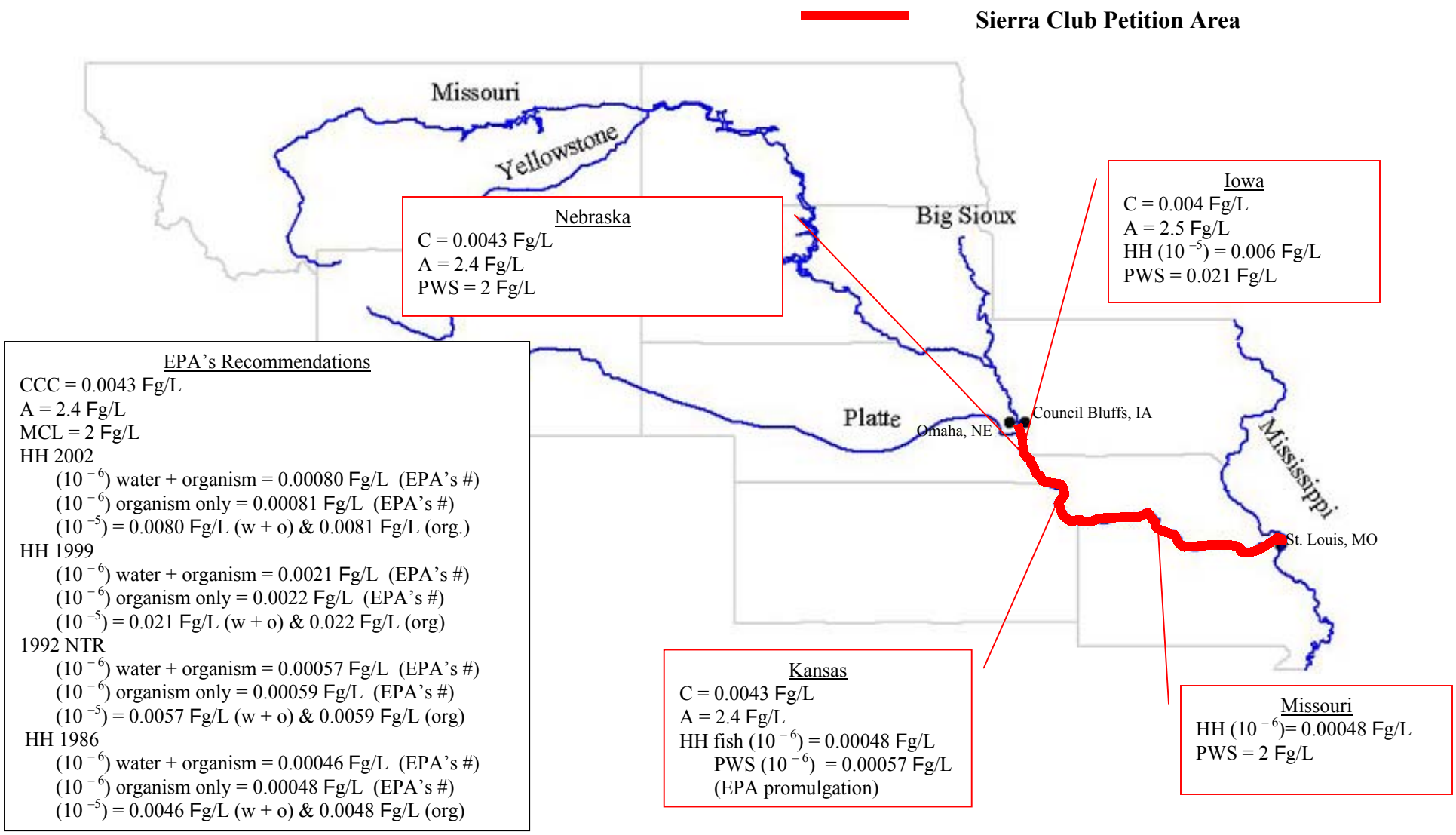
ATTACHMENT D
PCB CRITERIA ON MISSOURI RIVER



ATTACHMENT E
CHLORDANE CRITERIA ON MISSISSIPPI RIVER



ATTACHMENT F
CHLORDANE CRITERIA ON MISSOURI RIVER



ATTACHMENT G
PETITION STATES' CWA SECTION 303(D) IMPAIRED WATERS LISTINGS FOR MISSISSIPPI AND MISSOURI RIVER
(As Of March 2004)

Mississippi River

	Segment	Location	Impairment	Use impaired
Iowa				
	IA-1-NEM-0010_2	L&D 15 to L&D 14	arsenic	Drinking water
	IA01-NEM-0010_4	Wapsipinicon R. to L&D 13	organic enrichment	Aquatic life
	IA-03-SKM-0010_1	MO state line to outfall of Ft. Madison WWTP	arsenic	Drinking water
Illinois				
	ILI01_I 05	Mississippi River South	PCBs	Overall use, drinking water supply, fish consumption, aquatic life, primary contact (swimming)
	ILJ81_J 01		PCBs	Overall use, drinking water supply, fish consumption, aquatic life
	ILJ83_J 05		PCBs, Siltation, Suspended Solids, Metals, Nutrients, Phosphorus, Total Ammonia-N, Nitrates	Overall use, fish consumption, aquatic life, primary contact (swimming)
	ILJ83_J 06		PCB siltation, flow alterations, habitat, nutrients	Overall use, fish consumption, aquatic life

	Segment	Location	Impairment	Use impaired
	ILJ03_J 11		Nonpriority Organics, Siltation, Habitat Alteration, Suspended Solids, Priority Organics	Overall use, drinking water supply, fish consumption, aquatic life
	ILK04_K 22		PCBs, Pathogens, Organic Enrichment, Priority Organics	Overall u7se, drinking water supply, fish consumption, aquatic life, primary contact (swimming)
	ILK03_K 17		PCBs, Organic Enrichment, Priority Organics	Overall use, drinking water supply, fish consumption, aquatic life
	ILK06_K 21		PCBs, Organic Enrichment, Priority Organics	Overall use, fish consumption, aquatic life
	ILM02_M 06		PCBs	Overall use, fish consumption, aquatic life
	ILM03_M 03		PCBs	Overall use, fish consumption, aquatic life
	ILM04_M 04		PCBs	Overall use, fish consumption, aquatic life, primary contact (swimming)
	ILM05_M 05		PCBs	Overall use, drinking water supply, fish consumption, aquatic life

	Segment	Location	Impairment	Use impaired
	ILM10_M 10		PCBs	Overall use, fish consumption, aquatic life, primary contact (swimming)
	ILI84_I 84		PCBs	Overall use, fish consumption, aquatic life, primary contact (swimming)
Missouri				
	WBID 1707	Ohio R to Missouri R. @ Herculaneum (5 mi)	lead, zinc	Aquatic life
	WBID 3152	Ohio R. to state line	chlordane, PCBs	Aquatic life (fish consumption)
	WBID 1707	Missouri R. to Ohio R.	chlordane, PCBs	Aquatic life (fish consumption)
	WBID 1	Des Moines R. to Missouri R.	chlordane, PCBs	Aquatic life (fish consumption)
Kentucky	No 303(d) listings			
Tennessee				
	TN08010100001 - 0200	BLUE BANK BAYOU	Nutrients. siltation	Fish and aquatic life use
	TN08010100001 –1000	MISSISSIPPI RIVER	PCBs, dioxin, chlordane, nitrate, siltation, other habitat alterations	Fishing advisory originally due to chlordane

	Segment	Location	Impairment	Use impaired
	TN08010100001 - 1100	MCKELLAR LAKE	PCBs, chlordane, dioxin, siltation, organic enrichment/low DO, pathogens	Fishing advisory originally due to chlordane.
	TN08010100001 - 2000	MISSISSIPPI RIVER	PCBs, dioxin, chlordane, nitrate, siltation, other habitat alterations	Fish and aquatic life use.
	TN08010100001 - 3000	MISSISSIPPI RIVER	PCBs, dioxin, chlordane, nitrate, siltation, other habitat alterations	Fish and aquatic life use
	TN08010100001 - 4000	MISSISSIPPI RIVER	PCBs, dioxin, chlordane, nitrate, siltation, other habitat alterations	Documented habitat for a federally listed fish: the pallid sturgeon (Scaphirhynchus albus).
	TN08010100001 - 5000	MISSISSIPPI RIVER	PCBs, dioxin, chlordane, nitrate, siltation, other habitat alterations	Fish and aquatic life use.
	TN08010100POPLARTLK	POPLAR TREE LAKE	Nutrients	No recent data on this 125 acre lake.
Arkansas	No 303(d) listings			

Missouri River

	Segment	Location	Impairment	Use impaired
Iowa				
	IA06-WEM-0020_2	Council Bluffs water supply intake to Boyer R.	arsenic	Drinking water
	IA06-WEM-0020_2	Council Bluffs water supply intake to Boyer R.	bacteria	Primary contact recreation
Nebraska				
	MT1-10000	Big Sioux R. to Platte R.	fecal coliform	Primary contact recreation
	NE1-10000	Platte R. to Kansas border	fecal coliform	Primary contact recreation
Kansas	No 303(d) listings			
Missouri				
	WBID 1604	Gasconade R. to mouth	chlordane, PCBs	Aquatic life (fish consumption)
	WBID 701	Chariton R. to Gasconade R.	chlordane, PCBs	Aquatic life (fish consumption)
	WBID 356	Kansas R. to Chariton R.	chlordane, PCBs	Aquatic life (fish consumption)
	WBID 226	Iowa sate line to Kansas R.	chlordane, PCBs	Aquatic life (fish consumption)
	WBID 356	Kansas R. to Chariton R.	mercury	Aquatic life (fish consumption)
	WBID 226	Kansas R. to Iowa State line	mercury	Aquatic life (fish consumption)

FACT SHEET FOR NPDES PERMIT WA-0093317

Spokane County Regional Water Reclamation Facility (SCRWRF)

PURPOSE of this Fact Sheet

This fact sheet explains and documents the decisions Ecology made in drafting the proposed National Pollutant Discharge Elimination System (NPDES) Permit for the Spokane County Regional Water Reclamation Facility (SCRWRF).

This fact sheet complies with Section 173-220-060 of the Washington Administrative Code (WAC), which requires Ecology to prepare a draft permit *and accompanying fact sheet* for public evaluation before issuing an NPDES permit.

Ecology makes the draft permit and fact sheet available for public review and comment at least thirty (30) days before issuing the final permit. Copies of the fact sheet and draft permit for the Spokane County Regional Water Reclamation Facility NPDES Permit WA-0093317**,** are available for public review and comment from June 28, 2011 until August 29, 2011. For more details on preparing and filing comments about these documents, please see **Appendix A - Public Involvement**.

Spokane County Utilities and CH2M Hill reviewed the draft fact sheet for factual accuracy. Ecology corrected any errors or omissions regarding the facility's location, history, discharges, or receiving water.

After the public comment period closes, Ecology will summarize substantive comments and provide responses to them. Ecology will include the summary and responses to comments in this Fact Sheet as **Appendix E - Response to Comments**, and publish it when issuing the final NPDES Permit. Ecology will not revise the rest of the fact sheet, but the full document will become part of the legal history contained in the facility's permit file.

SUMMARY

The Spokane County Regional Water Reclamation Facility (SCRWRF) is an advanced wastewater treatment plant. It will provide an initial 8 million gallons per day (MGD) of capacity with an ability to expand capacity in phases up to 24 MGD. Spokane County owns and is financing the Facility. CH2M Hill Constructors, Inc. designed and built the facility, and will operate, maintain, and repair the Facility for an initial 20-year period. CH2M Hill Constructors, Inc. will be responsible for on-site biosolids treatment. The County constructed improvements to the conveyance system, including the force mains, pump stations and the outfall for the Facility, as separate public works projects. The Facility includes a treatment process incorporating a step-feed nitrification/denitrification membrane bioreactor with the following key components: fine screening, grit removal, primary clarification, sodium hypochlorite disinfection, gravity belt thickening for primary and waste activated sludge, anaerobic digestion, aerobic digestion/solid storage, centrifuge dewatering, and chemical feed systems. Other facilities include odor control, an administration building with a laboratory, a water resource center, and a maintenance building.

TABLE OF CONTENTS

I. INTRODUCTION 1

II. BACKGROUND INFORMATION 2
- A. Facility Description 3
  - History 3
  - Collection System Status 4
  - Treatment Processes 6
  - Solid Wastes 10
- B. Permit Status 10
- C. Wastewater Characterization 10
- D. SEPA Compliance 11

III. PROPOSED PERMIT LIMITS 11
- A. Design Criteria 12
- B. Technology-Based Effluent Limits 12
- C. Surface Water Quality-Based Effluent Limits 13
- Description of the Receiving Water 13
  - Numerical Criteria for the Protection of Aquatic Life and Recreation 15
  - Numerical Criteria for the Protection of Human Health 15
  - Narrative Criteria 15
  - Antidegradation 16
  - Mixing Zones 18
- D. Designated Uses and Surface Water Quality Criteria 23
- E. Evaluation of Surface Water Quality-Based Effluent Limits for Numeric Criteria 23
- F. Whole Effluent Toxicity 32
- G. Human Health 33
- H. Sediment Quality 34
- I. Ground Water Quality Limits 34

IV. MONITORING REQUIREMENTS 34
- A. Lab Accreditation 35
- B. Receiving Water Monitoring 35
- C. Effluent Limits Which are Near Detection or Quantitation Levels 35

V. OTHER PERMIT CONDITIONS 36
- A. Reporting and Record Keeping 36
- B. Prevention of Facility Overloading 36
- C. Operation and Maintenance (O&M) 36
- D. Pretreatment 36
  - Duty to Enforce Discharge Prohibitions 36
- Requirements for Performing an Industrial User Survey 38
- E. Solid Waste Control 39
- F. Spill Plan 40

G. Toxic Source Control Action Plan 40
H. Regional Toxics Task Force 40
I. General Conditions 42

VI. PERMIT ISSUANCE PROCEDURES 42
A. Permit Modifications 42
B. Proposed Permit Issuance 42

VII. REFERENCES FOR TEXT AND APPENDICES 43

APPENDIX A - PUBLIC INVOLVEMENT INFORMATION 45

APPENDIX B - YOUR RIGHT TO APPEAL 46

APPENDIX C – GLOSSARY 47

APPENDIX D – TECHNICAL CALCULATIONS 55

APPENDIX E – RESPONSE TO COMMENTS 57

APPENDIX F – REVISED TECHNICAL CALCULATIONS 58

APPENDIX G 59

LIST OF TABLES

Table 1: General Facility Information 2
Table 2: Wastewater Characterization 11
Table 3: Design Loading Criteria for the SCRWRF 12
Table 4: Technology-Based Limits 13
Table 5: Conventional Ambient Background Data 14
Table 6: Ambient Background Data for Metals 14
Table 7: Ambient Background Data for PCBs (Recheck) 14
Table 8: Design Flows for SCRWRF Outfall 20
Table 9: Aquatic Life Uses & Associated Criteria 23
Table 10: Recreational Uses and Associated Criteria 23
Table 11: Predicted Mixing Zone Dimensions and Dilution Factors for SCRWRF Outfall from Technical Memorandum from Cosmopolitan Engineers to HDR Engineers representing Spokane County Utilities 25
Table 12: Ecology determined Dilution Factors (DF) at a summer 7Q20 of 573 cfs and a winter 7Q20 of 1047 cfs (Pelletier 1997) 25

LIST OF FIGURES

Figure 1: Facility Location Map 3
Figure 2: A Map of the County's North Spokane Service Area 5
Figure 3: A Map of the Spokane Valley Service Area 6
Figure 4: Schematics Diagrams of the Liquid and Solids Process Trains 8

I. INTRODUCTION

The Federal Clean Water Act (FCWA, 1972, and later amendments in 1977, 1981, and 1987) established water quality goals for the navigable (surface) waters of the United States. One mechanism for achieving the goals of the Clean Water Act is the National Pollutant Discharge Elimination System (NPDES), administered by the federal Environmental Protection Agency (EPA). The EPA authorized the State of Washington to manage the NPDES permit program in our state. Our state legislature accepted the delegation and assigned the power and duty for conducting NPDES permitting and enforcement to Ecology. The legislature defined Ecology's authority and obligations for the wastewater discharge permit program in 90.48 RCW (Revised Code of Washington).

The following regulations apply to municipal NPDES permits:

- Procedures Ecology follows for issuing NPDES permits (chapter 173-220 WAC)
- Technical criteria for discharges from municipal wastewater treatment facilities (chapter 173-221 WAC)
- Water quality criteria for surface waters (chapter 173-201A WAC) and for ground waters (chapter 173-200 WAC)
- Sediment management standards (chapter 173-204 WAC)
- Submission of Plans and Reports for Construction of Wastewater Facilities (Chapter 173-240 WAC)

These rules require any treatment facility operator to obtain an NPDES permit before discharging wastewater to state waters. They also help define the basis for limits on each discharge and for requirements imposed by the permit.

Under the NPDES permit program and in response to a complete and accepted permit application, Ecology must prepare a draft permit and accompanying fact sheet, and make them available for public review before final issuance. Ecology must also publish an announcement (public notice) telling people where they can read the draft permit, and where to send their comments, during a period of thirty days (WAC 173-220-050). (See **Appendix A - *Public Involvement*** for more detail about the public notice and comment procedures). After the public comment period ends, Ecology may make changes to the draft NPDES Permit. Ecology will summarize the responses to comments and any changes to the permit in **Appendix E.**

II. BACKGROUND INFORMATION

Table 1: General Facility Information

Applicant:	Spokane County Utilities
Facility Name and Address:	Spokane County Regional Water Reclamation Facility 1004 North Freya Street Spokane, WA 99202
Type of Treatment:	Step-feed nitrification/denitrification membrane bioreactor with chemical phosphorus removal and the following key components: fine screening, grit and scum removal, primary clarification, sodium hypochlorite disinfection, dechlorination, gravity belt thickening for primary and waste activated sludge, anaerobic digestion, aerobic digestion/solid storage, centrifuge dewatering, chemical feed systems and odor control systems.
Discharge Location:	Spokane River Latitude: 47.675833 N Longitude: -117.346944 W
Facility Contact:	John Keady, Operator 1004 N. Freya Street Spokane, WA 99202 (509) 536-3701
Responsible Official:	N. Bruce Rawls, P.E.; Utilities Director 1026 W. Broadway Spokane, WA 99260 (509) 477-3604

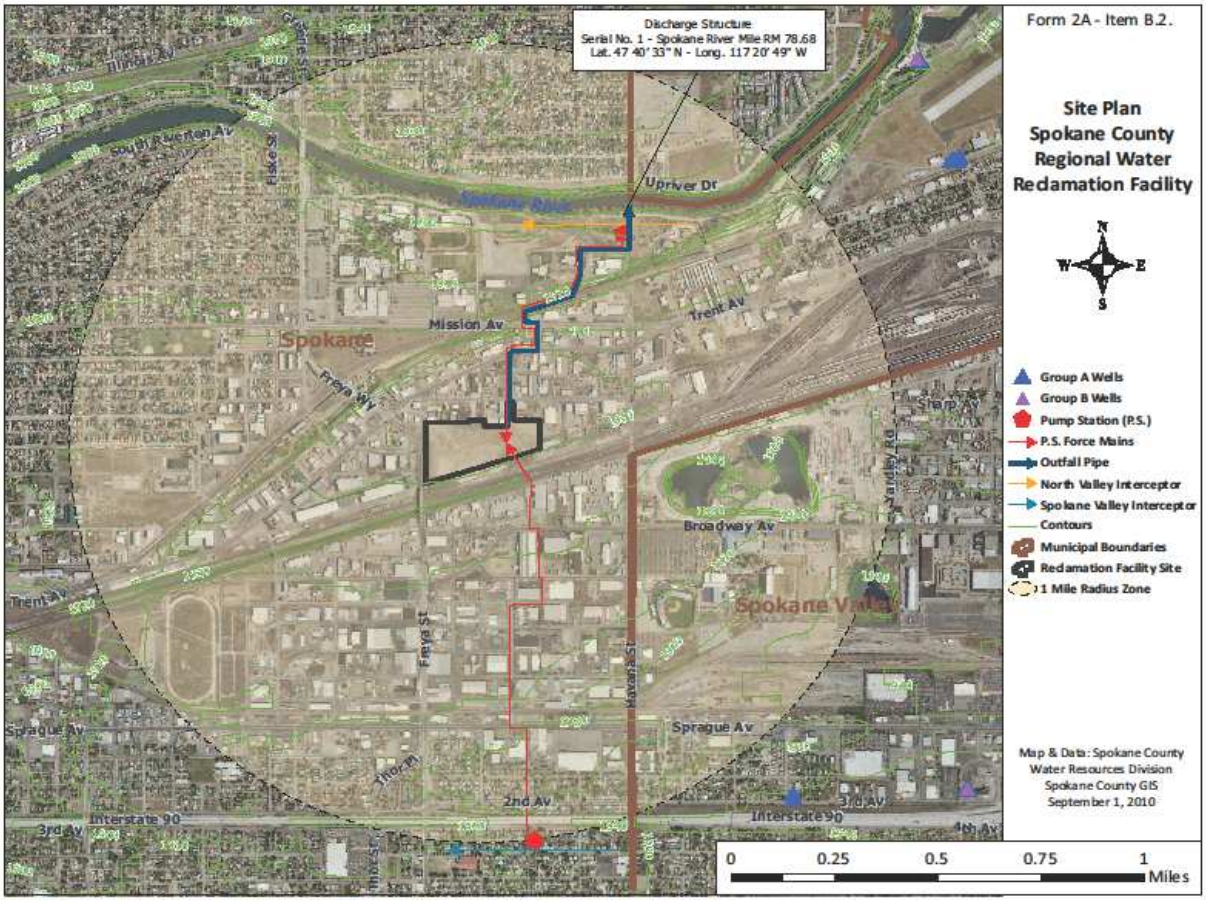


Figure 1: **Facility Location Map**

A. Facility Description

History

Sewer service by Spokane County Utilities began in the 1970's with studies to determine impacts of wastewater in the urbanizing portions of the county. The first comprehensive wastewater management plan was in 1981.

The County began a program in 1980 to eliminate septic tanks and connect customers to the County's sewer system to protect the Spokane Aquifer. Since the program began, over 38,000 customers have connected including approximately 25,000 septic tank conversions. This sewer expansion program is projected to continue through the year 2015 to provide wastewater service to all existing development within the County's sewer service area. By 2015, it is expected that approximately 9,000 additional existing septic tank customers will connect to the sewer system.

The planning area for Spokane County Utilities is divided into the 8,359-acre North Spokane section and the 31,103-acre Spokane Valley section (see Figures 2 & 3 Spokane County Utilities Service Area).
Two major interceptors further divide the Spokane Valley section into the "North Valley Service Area" and the "Spokane Valley Service Area."

Planning for the Spokane County Regional Water Reclamation Facility began with the 2001 Comprehensive Wastewater Management Plan. The construction is proceeding as a design build operate contract as authorized by Chapter 70.150 RCW Water Quality Joint Development Act.

The initial construction project is an 8 MGD water reclamation facility designed to meet the requirements of the Spokane River and Lake Spokane DO TMDL and more. The second phase will expand the facility to 12 MGD in approximately the year 2030. The County also owns 10 MGD of capacity at the City's Riverside Park Water Reclamation Facility (RPWRF), 6.5 MGD of which currently comes from the valley area. When the valley area growths and flows exceed 8 MGD, the excess will go the RPWRF until the phase 2 expansion is completed. The site has been laid out for incremental expansions to accommodate up to 24 MGD annual average flow.

Construction of the facility is proceeding with startup and testing commencing in August 2011 and a projected discharge to the Spokane River likely by December 2011.

Collection System Status

The collection system is relatively new and has been built principally of PVC pipe. The system's infiltration and inflow is minimal. It is also a separated system versus the combined storm water and sewerage system found in parts of the City of Spokane. Comparing current estimated population to measured flow, the gallons per capita per day (gpcd) is 80.5

The County collection system is connected to the City of Spokane interceptor system and Riverside Park Water Reclamation Facility. Wastewater that is not diverted to the Spokane County Regional Water Reclamation Facility will flow to the Riverside Park Water Reclamation Facility. Additionally, provisions have been made to allow effluent discharge from the Spokane County Regional Water Reclamation Facility to be routed back to the interceptor system and the Riverside Park Water Reclamation Facility. It is anticipated that this arrangement may be used during commissioning and startup of the Spokane County Regional Water Reclamation Facility. The County's North Spokane Interceptor also flows to the Riverside Park Water Reclamation Facility.

Figure 2: A Map of the County's North Spokane Service Area

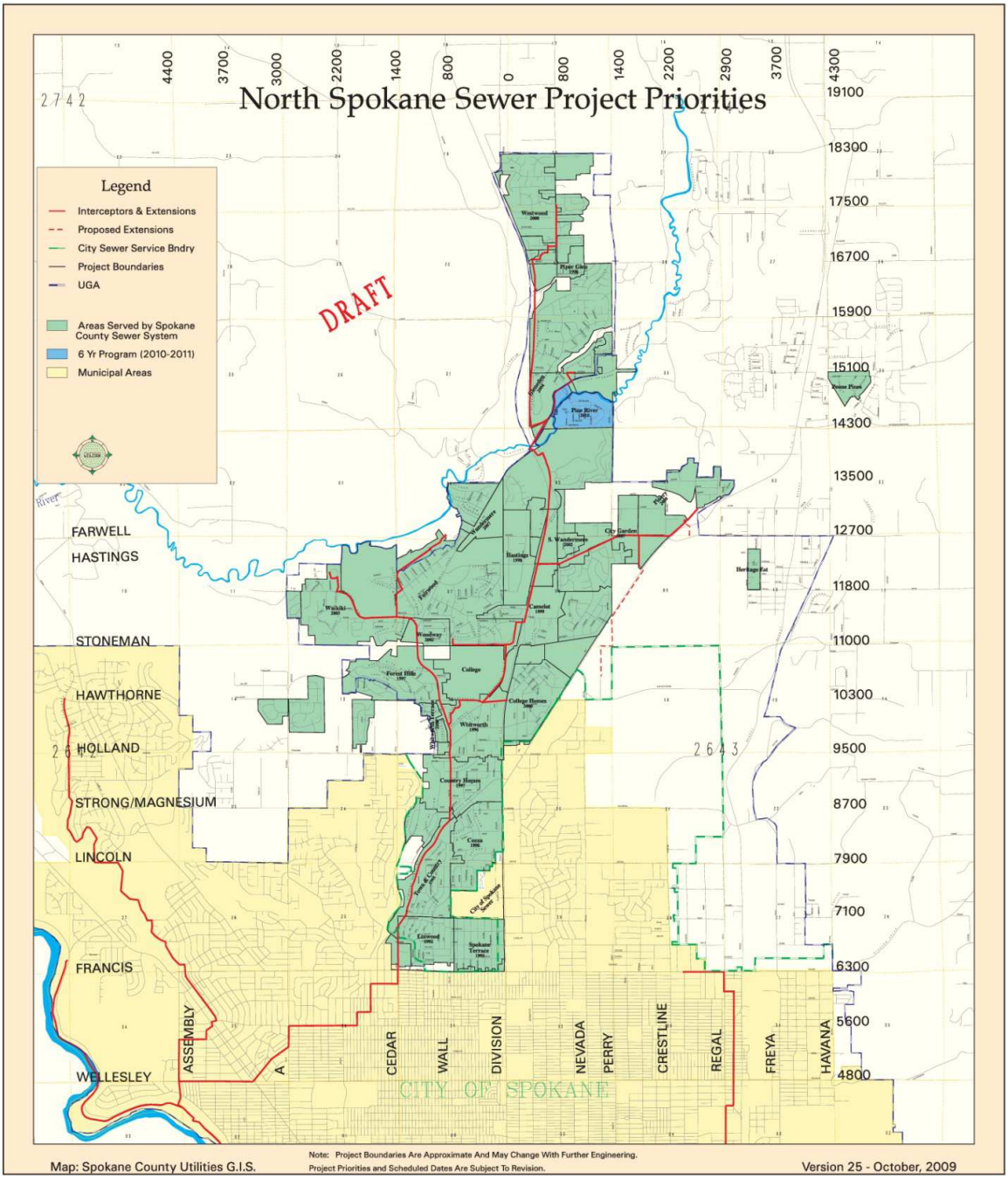
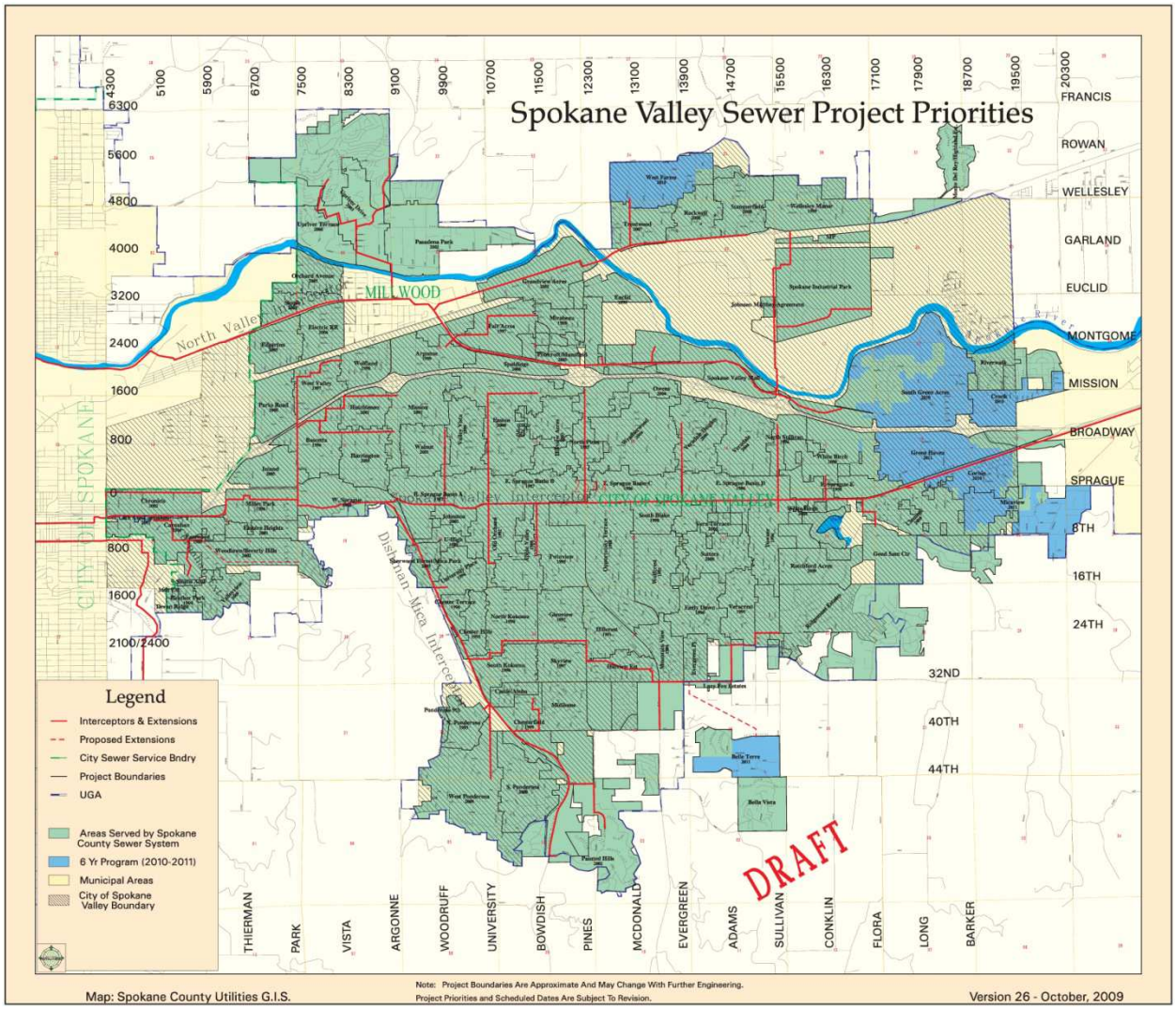


Figure 3: A Map of the Spokane Valley Service Area



Treatment Processes

The Spokane County Regional Water Reclamation Facility (SCRWRF) will provide advanced wastewater treatment to an initial 8 MGD of wastewater with an ability to expand capacity in phases up to 24 MGD. Spokane County will own and finance the Facility. CH2M Hill Constructors, Inc. will design and build the Facility, and will operate, maintain, and repair the Facility for an initial 20-year period. CH2M Hill Constructors, Inc. will also be responsible for on-site biosolids treatment. The County has selected a firm to haul the biosolids from the facility but contract details are not yet finalized. Several biosolids management alternatives have been considered including land application and composting.

The County has constructed improvements to the conveyance system, including the force mains, pump stations and the outfall for the Facility, as separate public works projects. The Facility includes a treatment process incorporating a step-feed nitrification/denitrification membrane bioreactor with chemical phosphorus removal and the following key components: fine screening, grit removal, primary clarification, sodium hypochlorite disinfection, liquid sodium bisulfite dechlorination, gravity belt thickening for primary and waste activated sludge, anaerobic digestion, aerobic digestion/solid storage, centrifuge dewatering, chemical feed systems and odor control systems. Sludge digestion employs both anaerobic and aerobic processes to further reduce effluent nitrogen content, reduce solids production and improve sludge quality. Other on-site facilities include an administration building with a laboratory, a water resource center, and a maintenance building.

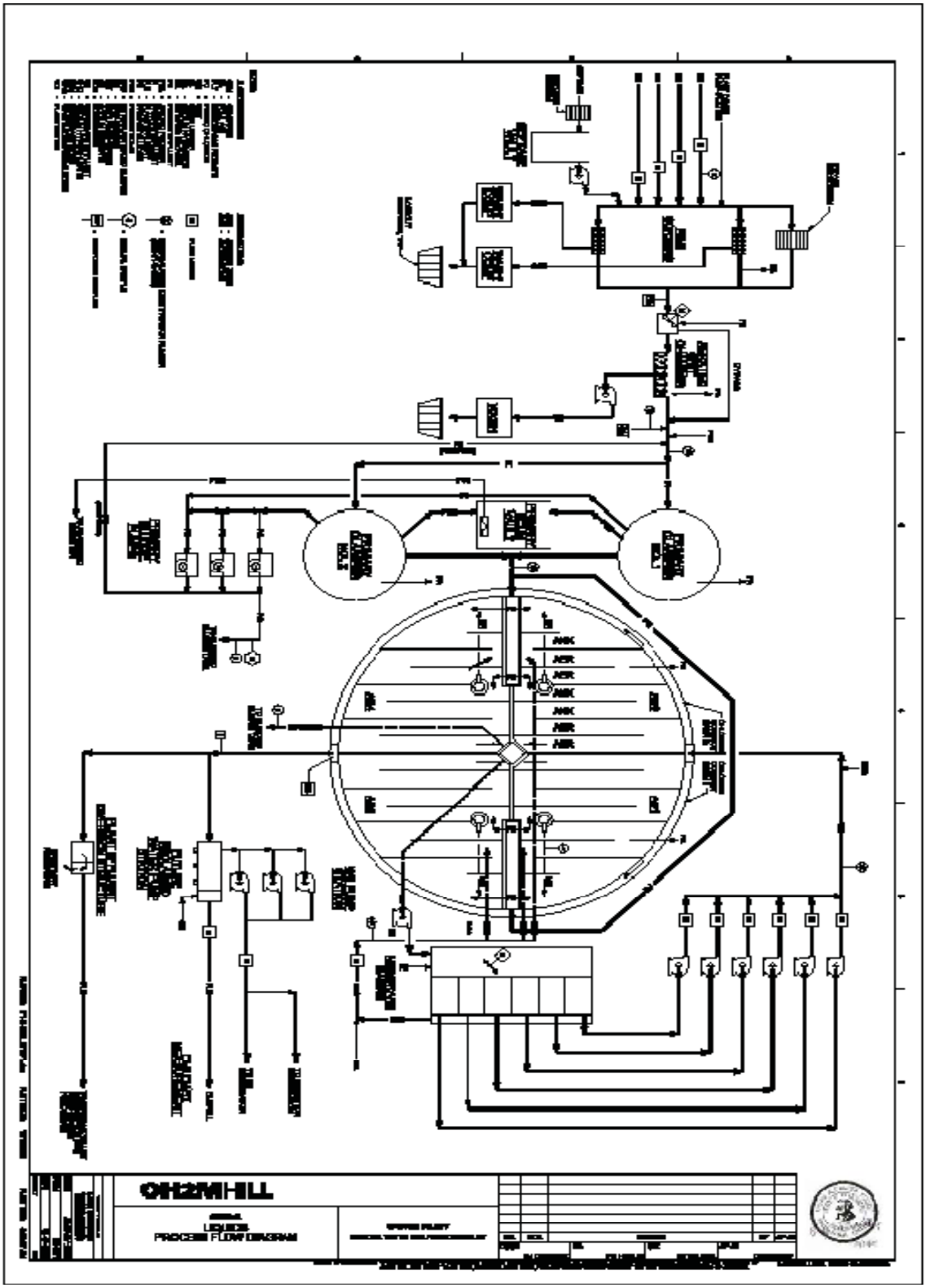
As an activated sludge treatment facility providing tertiary treatment (nitrification/denitrification with phosphorus removal) over 5 MGD the facility will be a Class IV facility.

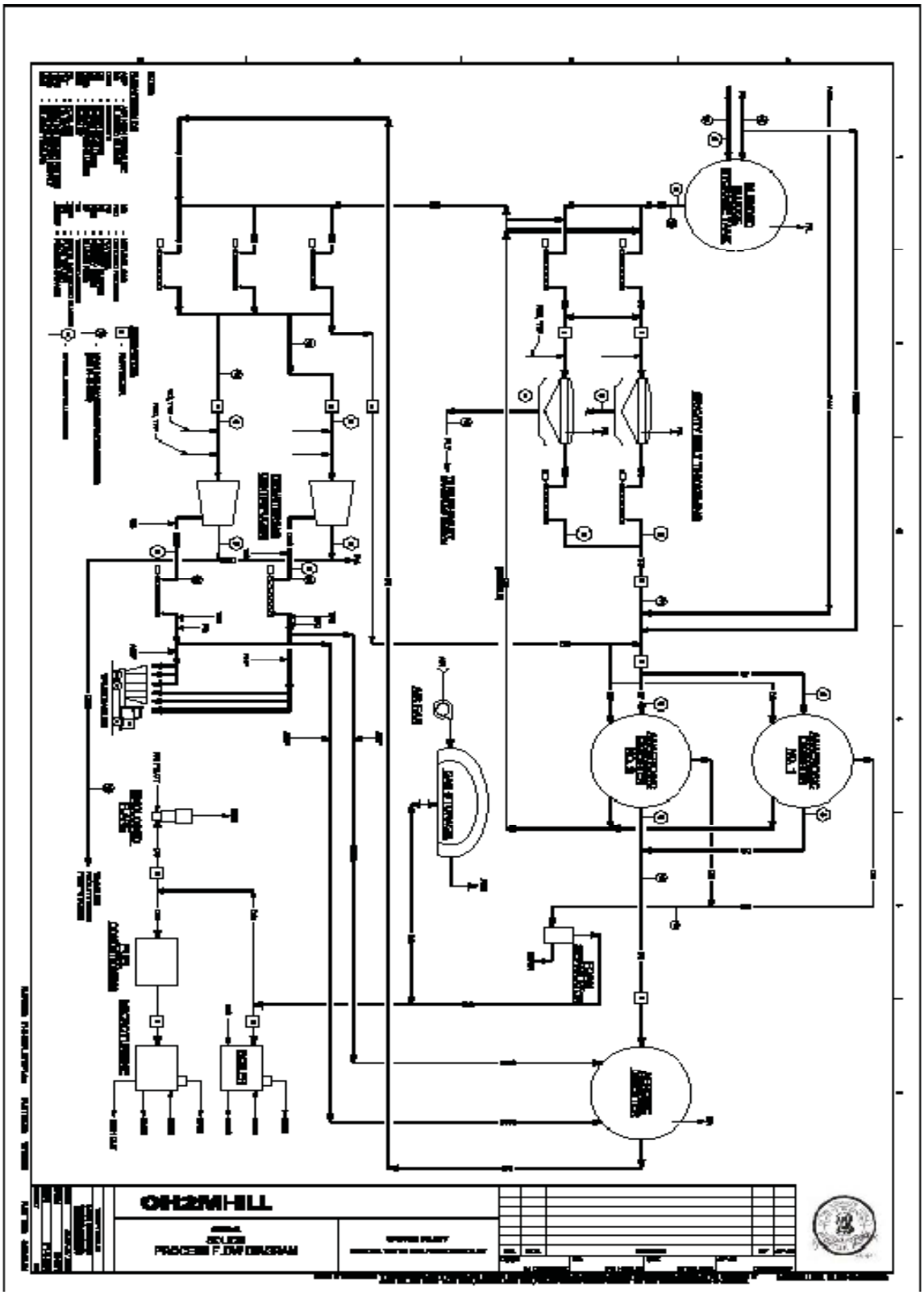
The portion of the County system in Spokane Valley has 2 Significant Industrial Users (SIUs) and 6 Categorical Industrial Users (CIUs).

Discharge Outfall

The treated, disinfected and dechlorinated effluent will flow into the Spokane River through a 36-inch diameter duckbill style Tideflex valve. The outfall extends north into the river about 75 feet beyond the ordinary high water level on the south bank of the river. The top of the pipe is roughly 15 feet below the ordinary high water. At the outfall location the river width varies from about 200 feet to 150 feet depending on river flow.

Figure 4: Schematics Diagrams of the Liquid and Solids Process Trains




CH2MHILL
PROCESS FLOW DIAGRAM

Solid Wastes

The treatment facilities remove solids during the treatment of the raw wastewater at the headworks (grit and screenings), in addition to incidental solids (rags, scum, and other debris) removed as part of the routine maintenance of the equipment. Grit, rags, scum, and screenings are drained and disposed of as solid waste at the local landfill. Sludges removed from the primary clarifier and secondary treatments system are thickened and treated.

The solids process train is: gravity belt thickening for primary and waste activated sludge, anaerobic digestion, aerobic digestion/solid storage, and centrifuge dewatering. Spokane County evaluated several options for Biosolids management, including negotiation of an agreement with the City of Spokane to have the County biosolids land applied on the same land as the City. The selected option is composting at the Barr-Tech facility in Lincoln County. However, the details of a contract between the County and a joint contract CH2M-Hill and Barr-Tech are still being negotiated. A backup plan with Parker Ag is also being pursued.

B. Permit Status

This is a new, previously unpermitted facility. The existing wastewater is currently treated at the City of Spokane's Riverside Park Reclaimed Water Facility and discharged to the Spokane River.

The treatment facility is owned by the county and designed, built, operated and maintained by a contractor, CH2M-Hill Constructors, Inc. As such, Ecology must decide whether to issue the permit to each entity as co-permittees or to the County alone. The contract between Spokane County and CH2M-Hill Constructors, Inc. has been reviewed by Ecology and judged to provide adequate definition of responsibilities between the contracting parties. The responsibilities are found to be protective of water quality and in accord with Chapter 70.150 RCW. The permit will be issued to Spokane County, Utilities Division.

Spokane County Utilities Division submitted an application for a permit on September 30, 2010. Ecology accepted it as complete on October 15, 2010.

C. Wastewater Characterization

The expected concentration of pollutants in the discharge was reported in the NPDES permit application, the DBO performance guarantee, Appendix 10; and the June 2010 engineering report. The tabulated data represents the anticipated quality of the effluent to be discharged. The effluent is characterized as follows:

Table 2: Wastewater Characterization

Parameter	Average Concentration	Maximum Concentration
$CBOD_5$	--	2 mg/L
TSS*	<30 mg/L	--
Ammonia – N, March through May and October	1 mg/L	--
Ammonia – N, June through September	0.25 mg/L	--
Total Phosphorus, seasonal average	0.05 mg/L	--
* The treatment technology selected utilizes membranes producing a $CBOD_5$ of less than 2 mg/L and typically a TSS with a comparable single digit concentration.		

D. SEPA Compliance

To meet the intent of SEPA, an existing, unpermitted discharge must undergo SEPA review during the permitting process. The County filed a SEPA checklist and SERP environmental review documents (EIS) for federal funding with Ecology initially in February 2003 with updates in April 2004, and December 2006. Ecology issued a determination of non-significance for the project in February 2003. With the DO TMDL approved, the County submitted the final wastewater facilities amendment June 2010 and a final SERP concurrence was initiated. The Department of Archaeology and Historic Preservation (DAHP) issued their Determination of No Historic Properties affected on June 1, 2010.

The USEPA issued a determination of no effect on ESA listed species on November 11, 2010. Ecology reviewed the documentation and issued a SERP compliance determination on December 23, 2010.

III. PROPOSED PERMIT LIMITS

Federal and state regulations require that effluent limits in an NPDES permit must be either technology- or water quality-based.

- Technology-based limits are based upon the treatment methods available to treat specific pollutants. Technology-based limits are set by the EPA and published as a regulation, or Ecology develops the limit on a case-by-case basis (40 CFR 125.3, and chapter 173-220 WAC).

- Water quality-based limits are calculated so that the effluent will comply with the Surface Water Quality Standards (chapter 173-201A WAC), Ground Water Standards (chapter 173-200 WAC), Sediment Quality Standards (chapter 173-204 WAC) or the National Toxics Rule (40 CFR 131.36).

- Ecology must apply the most stringent of these limits to each parameter of concern. These limits are described below.

The limits in this permit reflect information received in the application and from supporting reports (engineering, hydrogeology, etc.). Ecology evaluated the permit application and determined the limits needed to comply with the rules adopted by the state of Washington. Ecology does not develop effluent limits for all reported pollutants**.** Some pollutants are not treatable at the concentrations reported, are not controllable at the source, are not listed in regulation, and do not have a reasonable potential to cause a water quality violation.

Nor does Ecology usually develop limits for pollutants that were not reported in the permit application but that may be present in the discharge. The permit does not authorize discharge of the non-reported pollutants. If significant changes occur in any constituent of the effluent discharge, or if other constituents are identified in effluent monitoring, Spokane County is required to notify Ecology (40 CFR 122.42(a)). Spokane County could potentially be in violation of the permit until Ecology modifies the permit to reflect the additional discharge of pollutants.

A. Design Criteria

Under WAC 173-220-150 (1)(g), flows and waste loadings must not exceed approved design criteria. Ecology-approved design criteria for this facility's treatment plant were obtained from the engineering report/facility plan/plans & specifications prepared by HDR, Inc. and CH2M Hill Constructors, Inc.

Table 3: Design Loading Criteria for the SCRWRF

Parameter	Design Quantity
Monthly Average Flow	8.0 MGD
Maximum Month Design Flow (MMDF)	8.5 MGD
Peak Design Flow (Peak Hour)	13.8 MGD
BOD_5 loading for maximum month	18,270 lbs/day
TSS loading for maximum month	20,080 lbs/day
Orthophosphate PO_4-P	281 lbs/day
Total Phosphorus TP	603.1 lbs/day
Ammonia NH_4-N	1,967 lbs/day
Total Nitrogen TN	2,978 lbs/day

B. Technology-Based Effluent Limits

Federal and state regulations define technology-based effluent limits for municipal wastewater treatment plants. These effluent limits are given in 40 CFR Part 133 (federal) and in chapter 173-221 WAC (state). These regulations are performance standards that constitute all known, available, and reasonable methods of prevention, control, and treatment (AKART) for municipal wastewater.

Chapter 173-221 WAC lists the following technology-based limits for pH, fecal coliform, BOD_5, and TSS:

Table 4: Technology-Based Limits

Parameter	Limit
pH	The pH must measure within the range of 6 to 9 standard units.
Fecal Coliform Bacteria	Monthly Geometric Mean = 200 organisms/100 mL Weekly Geometric Mean = 400 organisms/100 mL
BOD_5 (concentration)	Average Monthly Limit is the most stringent of the following: - 30 mg/L - may not exceed fifteen percent (15%) of the average influent concentration Average Weekly Limit = 45 mg/L
TSS (concentration)	Average Monthly Limit is the most stringent of the following: - 30 mg/L - may not exceed fifteen percent (15%) of the average influent concentration Average Weekly Limit = 45 mg/L

The above technology based limits are generally superseded by the requirement of the Spokane River and Lake Spokane DO TMDL directly (such as CBOD) or indirectly (such as TSS).

C. Surface Water Quality-Based Effluent Limits

Description of the Receiving Water

The Spokane County Regional Water Reclamation Facility will discharge to the Spokane River at river mile 78.7 (lat 47° 40’ 33” long. 117° 20’ 49”). Other nearby point sources are:

- Downstream outfalls for the City of Spokane are CSO outfalls 40, 39 and 38,
- CSO 41 which is directly across the river from the County’s outfall (a storage tank is to be installed in 2011),
- Inland Empire Paper outfall which is roughly 4 miles east or upstream.

In 1998, Ecology developed a Dissolved Metals TMDL for Zinc, Lead and Cadmium. The TMDL for Dissolved Oxygen was approved in May 2010. The Spokane River is also listed for PCBs and Ecology has published a reduction strategy *Reducing Toxics in the Spokane River Watershed*, August 2009 that includes PCBs.

The conventional ambient background data used for this permit includes the following from the Environmental Assessment Program’s monitoring station 57A140 at the Plante’s Ferry foot bridge at river mile 84.7. Finalized data exists for 2008 and 2009.

Table 5: Conventional Ambient Background Data

Parameter	Value Used
Temperature (highest annual 1-DADMax)	18.1^{o} C
Temperature (highest annual 7-DADMax)	NA
Temperature (**some waterbodies have specific temperature criteria as assigned in Table 602)	20° C
pH (Maximum / Minimum)	8.06/7.58
Dissolved Oxygen	12.86 to 8.3 mg/L
Total Ammonia-N	No more than 0.019 mg/L
Fecal Coliform	21/100 mL dry weather (180/100 mL storm related)
Turbidity	1 NTU

The City of Spokane has done monitoring of fecal coliforms at Plantes Ferry during storm events. The highest storm related fecal coliform count was 240/100 ml on 9/17/2004.

The metal data is from monitoring station 57A150 at state line.

Table 6: Ambient Background Data for Metals

Parameter	Value used
Hardness	23.9 mg/L as CaCO3
Alkalinity*	21 mg/L as CaCO3
Lead	2 µg/L
Copper	1.0 µg/L
Zinc	53 µg/L
Cadmium	0.22 µg/L
*The alkalinity data was extracted from the EIM data base and is from Greg Pelletiers metal study, *Cadmium, Copper, Mercury, Lead and Zinc in the Spokane River*, (Publication 94-09) published in 1994.	

The following data is from the draft report "*Spokane River PCB Source Assessment 2003-2007.*"

Table 7: Ambient Background Data for PCBs (Recheck)

Location description	**River Mile**	Mean Total **PCB** concentration in the water column, pg/L
Stateline	96.1	106
Upriver Dam	80.3	77
Monroe St.	74.8	199
Nine Mile	63.6	311

Nine Mile (2008)*	58.1	90
Lower Lake Spokane	38.4	399
**Trend Monitoring for Chlorinated Pesticides, PCBs, PAHs, and PBDEs in Washington Rivers and Lakes, 2008* sampling location at Nine Mile Dam RM 58.1 on 5/9/08 & 9/10/08.		

The Washington State Surface Water Quality Standards (chapter 173-201A WAC) are designed to protect existing water quality and preserve the beneficial uses of Washington's surface waters. Waste discharge permits must include conditions that ensure the discharge will meet the surface water quality standards (WAC 173-201A-510). Water quality-based effluent limits may be based on an individual waste load allocation or on a waste load allocation developed during a basin wide total maximum daily load study (TMDL).

Numerical Criteria for the Protection of Aquatic Life and Recreation

Numerical water quality criteria are listed in the water quality standards for surface waters (chapter 173-201A WAC). They specify the maximum levels of pollutants allowed in receiving water to protect aquatic life and recreation in and on the water. Ecology uses numerical criteria along with chemical and physical data for the wastewater and receiving water to derive the effluent limits in the discharge permit. When surface water quality-based limits are more stringent or potentially more stringent than technology-based limits, the discharge must meet the water quality-based limits.

Numerical Criteria for the Protection of Human Health

The U.S. EPA has published 91 numeric water quality criteria for the protection of human health that are applicable to dischargers in Washington State (EPA 1992). These criteria are designed to protect humans from exposure to pollutants linked to cancer and other disease, based on consuming fish and shellfish and drinking contaminated surface waters. The water quality standards also include radionuclide criteria to protect humans from the effects of radioactive substances.

Narrative Criteria

Narrative water quality criteria (e.g., WAC 173-201A-240(1); 2006) limit the toxic, radioactive, or other deleterious material concentrations that the facility may discharge to levels below those which have the potential to:

- Adversely affect designated water uses.
- Cause acute or chronic toxicity to biota.
- Impair aesthetic values.
- Adversely affect human health.

Narrative criteria protect the specific designated uses of all fresh waters (WAC 173-201A-200, 2006) and of all marine waters (WAC 173-201A-210, 2006) in the State of Washington.

Antidegradation

The purpose of Washington's Antidegradation Policy (WAC 173-201A-300-330; 2006) is to:

- Restore and maintain the highest possible quality of the surface waters of Washington.
- Describe situations under which water quality may be lowered from its current condition.
- Apply to human activities that are likely to have an impact on the water quality of surface water.
- Ensure that all human activities likely to contribute to a lowering of water quality, at a minimum, apply all known, available, and reasonable methods of prevention, control, and treatment (AKART).
- Apply three tiers of protection (described below) for surface waters of the state.

Tier I ensures existing and designated uses are maintained and protected and applies to all waters and all sources of pollutions. Tier II ensures that waters of a higher quality than the criteria assigned are not degraded unless such lowering of water quality is necessary and in the overriding public interest.

Tier II applies only to a specific list of polluting activities. Tier III prevents the degradation of waters formally listed as "outstanding resource waters," and applies to all sources of pollution.

A facility must prepare a Tier II analysis when all three of the following conditions are met:

- The facility is planning a new or expanded action. This condition applies to the new county treatment facility.
- Ecology regulates or authorizes the action. This condition applies to the new county treatment facility.
- The action has the potential to cause measurable degradation to existing water quality at the edge of a chronic mixing zone.

  However, the ambient water quality of the Spokane River is not better than the water quality standards human health criterion for PCBs. Long term trend monitoring does show decreasing PCB concentrations. The tertiary treatment processes under construction will further decrease concentrations of PCBS and other toxicants in the Spokane River. The tertiary treatment processes under construction is designed to comply with the requirements of the DO TMDL and will generally improve DO concentrations in the Spokane River.

  The issuance of an NPDES permit will not cause measurable degradation but will further ongoing improvements in water quality.

A tier II analysis is not required.

This facility must meet Tier I requirements.

- Dischargers must maintain and protect existing and designated uses. Ecology must not allow any degradation that will interfere with, or become injurious to, existing or designated uses, except as provided for in chapter 173-201A WAC.

Ecology's analysis described in this section of the fact sheet demonstrates that the existing and designated uses of the receiving water will be protected under the conditions of the proposed permit implementing the Spokane River and Lake Spokane DO TMDL, the Spokane River Dissolved Metals Total Maximum Daily Load. However, the Spokane Tribe's human health criterion for PCBs is problematic, given that the standard of 3.37 pg/L is below current method detection limits used in the report "*Spokane River PCB Source Assessment 2003-2007*." The reporting limit given was 100 pg/L (table 16 of the report).

The treatment technology selected to ensure compliance with the Spokane River and Lake Spokane DO TMDL will also ensure compliance with dissolved metals TMDL. For total PCB, the chronic fresh water criterion for aquatic organisms is 14,000 pg/L, the human health criterion from the National Toxics Rule (NTR) is 170 pg/L and the downstream tribal human health standard is 3.37 pg/L.

Currently the Spokane conventional secondary wastewater treatment facilities (Liberty Lake S&W District and Riverside Park Water Reclamation Facility) have estimated effluent concentrations that range from about 110 pg/L to about 2,400 pg/L, though the treatment processes themselves are not sources. While tertiary treatment will further reduce the effluent concentrations, how much is uncertain until further effluent data is available from the upgraded and operational advanced wastewater treatment which will be designed to comply with the requirements of the Spokane River and Lake Spokane DO TMDL. Also, while PCBs are considered a legacy pollutant and are prohibited in many products, the ban is not universal and many products currently in use continue to be sources of PCBs. For example, TOSCA allows PCBs in many currently used products such as paints, caulking and ink. By itself, no currently available treatment technology is likely to provide adequate removal sufficient to comply with either state water quality standard for PCBs or the more stringent tribal water quality standard. A broader, more comprehensive approach is needed. Aggressive toxic source identification, control and reduction or elimination is an essential part of the strategy. The County has floated the concept of a regional task force to attack the toxic issue and the concept has support from most stakeholders in the watershed. The rudiments of a Regional Toxics Task Force are described in the permit, but many details are left for the NPDES permittees and other stakeholders to cooperatively develop.

For a carcinogen the harmonic mean flow is used for calculating a dilution factor. The harmonic mean dilution factor is 35.7 for the new County facility (see table 12). The resulting PCB concentration in the water column could be less that the PCB concentration coming across the state line but still above the tribal standard. Where it specifically lies will depend on actual treatment efficiency and source control effectiveness and scope.

Mixing Zones

A mixing zone is the defined area in the receiving water surrounding the discharge port(s), where wastewater mixes with receiving water. Within mixing zones the pollutant concentrations may exceed water quality numeric standards, so long as the discharge does not interfere with designated uses of the receiving water body (for example, recreation, water supply, and aquatic life and wildlife habitat, etc.) The pollutant concentrations outside of the mixing zones must meet water quality numeric standards.

State and federal rules allow mixing zones because the concentrations and effects of most pollutants diminish rapidly after discharge, due to dilution. Ecology defines mixing zone sizes to limit the amount of time any exposure to the end-of-pipe discharge could harm water quality, plants, or fish.

The state's water quality standards allow Ecology to authorize mixing zones for the facility's permitted wastewater discharges only if those discharges already receive all known, available, and reasonable methods of prevention, control, and treatment (AKART) which will be case once the County's treatment facility is operational. Mixing zones typically require compliance with water quality criteria within a specified distance from the point of discharge and use no more than 25% of the available width of the water body for dilution. Ecology uses modeling to estimate the amount of mixing within the mixing zone. Through modeling Ecology determines the potential for violating the water quality standards at the edge of the mixing zone and through that process derives any necessary effluent limits. Steady-state models are the most frequently used tools for conducting mixing zone analyses. Ecology chooses values for each effluent and for receiving water variables that correspond to the time period when the most critical condition is likely to occur (see Ecology's *Permit Writer's Manual*). Each critical condition parameter, by itself, has a low probability of occurrence and the resulting dilution factor is conservative. The term "reasonable worst-case" applies to these values.

The mixing zone analysis produces a numerical value called a dilution factor (DF). A dilution factor represents the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. For example, a dilution factor of 10 means the effluent is 10% and the receiving water is 90% of the total volume of water at the boundary of the mixing zone. Ecology uses dilution factors with the water quality criteria to calculate reasonable potentials and effluent limits. Water quality standards include both aquatic life-based criteria and human health-based criteria, such as for PCBs. The former are applied at both the acute and chronic mixing zone boundaries; the latter are applied only at the chronic boundary. The concentration of pollutants at the boundaries of any of these mixing zones may not exceed the numerical criteria for that zone.

Each aquatic life **acute** criterion is based on the assumption that organisms are not exposed to that concentration for more than one hour and more often than one exposure in three years. Each aquatic life **chronic** criterion is based on the assumption that organisms are not exposed to that concentration for more than four consecutive days and more often than once in three years.

The two types of human health-based water quality criteria distinguish between those pollutants linked to non-cancer effects (non-carcinogenic) and those linked to cancer effects (carcinogenic) such as PCBs. The human health-based water quality criteria incorporate several exposure and risk assumptions. These assumptions include:

- A 70-year lifetime of daily exposures.
- An ingestion rate for fish or shellfish measured in kg/day.
- An ingestion rate of two liters/day for drinking water
- A one-in-one-million cancer risk for carcinogenic chemicals.

This permit authorizes a small acute mixing zone, surrounded by a chronic mixing zone around the point of discharge (WAC 173-201A-400). The water quality standards impose certain conditions before allowing the discharger a mixing zone:

1. **Ecology must specify both the allowed size and location in a permit.**

   The proposed permit specifies the size and location of the allowed mixing zone.

   For this discharge, the percent volume restrictions of the water quality standards resulted in a lower dilution factor than the distance and width restrictions. Therefore, the dilution factor calculated at a 10-year low flow was used to determine reasonable potential to exceed water quality standards. To design the outfall, the County's consultant followed Ecology's guidance and rules.

2. **The facility must fully apply "all known, available, and reasonable methods of prevention, control and treatment" (AKART) to its discharge.**

   Ecology has determined that the treatment provided at the Spokane County Regional Water Reclamation Facility employs treatment process going well beyond the requirements of AKART (see "Technology based Limits").

3. **Ecology must consider critical discharge conditions.**

   Surface water quality-based limits are derived for the waterbody's critical condition (the receiving water and waste discharge condition with the highest potential for adverse impact on the aquatic biota, human health, and existing or designated waterbody uses). The critical discharge condition is often pollutant-specific or waterbody-specific.

Critical discharge conditions are those conditions that result in reduced dilution or increased effect of the pollutant. Factors affecting dilution include the depth of water, the density stratification in the water column, the currents, and the rate of discharge. Density stratification is determined by the salinity and temperature of the receiving water. Temperatures are warmer in the surface waters in summer. Therefore, density stratification is generally greatest during the summer months. Density stratification affects how far up in the water column a freshwater plume may rise. The rate of mixing is greatest when an effluent is rising. The effluent stops rising when the mixed effluent is the same density as the surrounding water. After the effluent stops rising, the rate of mixing is much more gradual. Water depth can affect dilution when a plume might rise to the surface when there is little or no stratification. Ecology's *Permit Writer's Manual* describes additional guidance on criteria/design conditions for determining dilution factors. The manual can be obtained from Ecology's website at http://www.ecy.wa.gov/biblio/92109.html.

Ambient data at critical conditions in the vicinity of the outfall is found in the '*Spokane River and Lake Spokane Dissolved Oxygen TMDL*' report approved in May 2010.

The outfall was designed using the following critical conditions:

- Water depth at summer 7Q20 flow of about 16.2 feet. (figure 1 in TM)
- At summer 7Q20 flow the average ambient current speed is 0.38 fps or 0.116 m/sec. At a winter 7Q20 flow the average ambient current speed is 0.65 fps or 0.198 m/sec. (sec 4.2.4 in TM)
- 1 Day MAX Effluent temperature of 18.4 degrees C.

Table 8: **Design Flows for SCRWRF Outfall (MGD)**

Criterion	2012	2030	2060	Ultimate
Average Day	8.0	12.0	16.0	24.0
Maximum Month	8.5	12.6	16.8	25.2
Maximum Day	12.1	17.8	24	36.0
Peak Hour	18.4	26.4	36.4	52.8

4. Supporting information must clearly indicate the mixing zone would not:

- **Have a reasonable potential to cause the loss of sensitive or important habitat.**
- **Substantially interfere with the existing or characteristic uses.**
- **Result in damage to the ecosystem.**
- **Adversely affect public health.**

Ecology established Washington State water quality criteria for toxic chemicals using EPA criteria. EPA developed the criteria using toxicity tests with numerous organisms and set the criteria to generally protect the species tested and to fully protect all commercially and recreationally important species.

EPA sets acute criteria for toxic chemicals assuming organisms are exposed to the pollutant at the criteria concentration for one hour. They set chronic standards assuming organisms are exposed to the pollutant at the criteria concentration for four days. Dilution modeling under critical conditions generally shows that both acute and chronic criteria concentrations are reached within minutes of being discharged.

The discharge plume does not impact drifting and non-strong swimming organisms because they cannot stay in the plume close to the outfall long enough to be affected. Strong swimming fish could maintain a position within the plume, but they can also avoid the discharge by swimming away. The SCRWRF discharge plume is small and the presence of a strong swimming fish for long is minimal. Mixing zones generally do not affect benthic organisms (bottom dwellers) because the buoyant plume rises in the water column. Ecology has additionally determined that the temperature of the water will not create lethal conditions or blockages to fish migration.

Ecology evaluates the cumulative toxicity of an effluent by testing the discharge with whole effluent toxicity (WET) testing.

Ecology reviewed the above information, the specific information on the characteristics of the discharge, the receiving water characteristics and the discharge location. Based on this review, Ecology concluded that the discharge does not have a reasonable potential to cause the loss of sensitive or important habitat, substantially interfere with existing or characteristics uses, result in damage to the ecosystem, or adversely affect public health if the permit limits are met.

5. The discharge/receiving water mixture must not exceed water quality criteria outside the boundary of a mixing zone.

Ecology conducted a reasonable potential analysis using procedures established by the EPA and by Ecology for each pollutant and concluded the discharge/receiving water mixture will not violate water quality criteria outside the boundary of the mixing zone if permit limits are met.

6. The size of the mixing zone and the concentrations of the pollutants must be minimized.

At any given time, the effluent plume uses only a portion of the acute and chronic mixing zone, which minimizes the volume of water involved in mixing. The plume rises through the water column as it mixes, therefore much of the receiving water volume at lower depths in the mixing zone may not mix with discharge. The County installed a duckbill style diffuser for mixing.

When a diffuser is installed, the discharge is more completely mixed with the receiving water in a shorter time. Ecology also minimizes the size of the mixing zone (in the form of the dilution factor) using design criteria with a low probability of occurrence. For example, Ecology uses the expected 95th percentile pollutant concentration, the 90th percentile background concentration, the centerline dilution factor, and the lowest flow occurring once in every ten years to perform the reasonable potential analysis.

Because of the above reasons, Ecology has effectively minimized the size of the mixing zone authorized in the proposed permit.

7. Maximum size of mixing zone.

The authorized mixing zone does not exceed the maximum size restriction.

8. Acute Mixing Zone.

- **The discharge/receiving water mixture must comply with acute criteria as near to the point of discharge as practicably attainable.**

  Ecology requires that the acute criteria will be met at 10% of the volume of the chronic mixing zone at the ten year low flow. The design accommodates this requirement.

- **The pollutant concentration, duration, and frequency of exposure to the discharge will not create a barrier to migration or translocation of indigenous organisms to a degree that has the potential to cause damage to the ecosystem.**

  As described above, the toxicity of any pollutant depends upon the exposure, the pollutant concentration, and the time the organism is exposed to that concentration. Authorizing a limited acute mixing zone for this discharge assures that it will not create a barrier to migration. The effluent from this discharge will rise as it enters the receiving water, assuring that the rising effluent will not cause translocation of indigenous organisms near the point of discharge (below the rising effluent). The plume is also small and will not cause translocation of indigenous organisms near the point of discharge.

- **Comply with size restrictions.**

  The mixing zone authorized for this discharge complies with the size restrictions published in chapter 173-201A WAC.

9. Overlap of Mixing Zones.

This mixing zone does not overlap another mixing zone. No other outfall is in close enough proximity. The only nearby outfall is the other side of the river and flow is very intermittent.

D. Designated Uses and Surface Water Quality Criteria

Applicable designated uses and surface water quality criteria are defined in chapter 173-201A WAC. In addition, the U.S. EPA set human health criteria for toxic pollutants (EPA 1992). Criteria applicable to this facility's discharge are summarized below in Table 9.

- Aquatic Life Uses are designated based on the presence of, or the intent to provide protection for, the key uses. All indigenous fish and non-fish aquatic species must be protected in waters of the state in addition to the key species. The Aquatic Life Uses for this receiving water are identified below.

Table 9: Aquatic Life Uses & Associated Criteria

Salmonid Spawning, Rearing, and Migration	
Temperature Criteria – Highest 7DAD MAX	17.5°C (63.5°F)
Temperature Criteria – 1-DayMax	20.0°C due to human activities.
Dissolved Oxygen Criteria – Lowest 1-Day Minimum	8.0 mg/L
Turbidity Criteria	• 5 NTU over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU
Total Dissolved Gas Criteria	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection
pH Criteria	pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.5 units

- The recreational uses are primary contact recreation. The recreational uses for this receiving water are identified below.

Table 10: Recreational Uses and Associated Criteria

Recreational Use	**Criteria**
Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies /100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies /100 mL.

- The **water supply uses** are domestic, agricultural, industrial, and stock watering.
- The **miscellaneous freshwater use**s are wildlife habitat, harvesting, commerce and navigation, boating, and aesthetics.

E. Evaluation of Surface Water Quality-Based Effluent Limits for Numeric Criteria

Pollutants in an effluent may affect the aquatic environment near the point of discharge (near-field) or at a considerable distance from the point of discharge (far-field).

Toxic pollutants, for example, are near-field pollutants—their adverse effects diminish rapidly with mixing in the receiving water. Conversely, a pollutant such as biological oxygen demand (BOD) is a far-field pollutant whose adverse effect occurs away from the discharge even after dilution has occurred.

Thus, the method of calculating surface water quality-based effluent limits varies with the point at which the pollutant has its maximum effect.

With technology-based controls (AKART), predicted pollutant concentrations in the discharge exceed water quality criteria. Ecology therefore authorizes a mixing zone in accordance with the geometric configuration, flow restriction, and other restrictions imposed on mixing zones by chapter 173-201A WAC.

The treated and disinfected effluent flows into the Spokane River through a 36-inch diameter duckbill style Tideflex valve. The outfall extends north into the river about 75 feet beyond the ordinary high water level on the south bank of the river. Top of pipe is roughly 15 feet below the ordinary high water.

Chronic Mixing Zone

WAC 173-201A-400(7)(a) specifies that mixing zones must not extend in a downstream direction from the discharge ports for a distance greater than 300 feet plus the depth of water over the discharge ports or extend upstream for a distance of over 100 feet, not utilize greater than **25%** of the flow, and not occupy greater than **25%** of the width of the water body.

Acute Mixing Zone

WAC 173-201A-400(8)(a) specifies that in rivers and streams a zone where acute toxics criteria may be exceeded must not extend beyond 10% of the distance towards the upstream and downstream boundaries of the chronic zone, not use greater than **2.5%** of the flow and not occupy greater than **25%** of the width of the water body.

The dilution factors, shown in the table below, are predicted for the SCRWRF outfall in the Technical Memorandum *Task G102 – Mixing Zone and Water Quality Update* from Cosmopolitan Engineers to HDR Engineers representing Spokane County Utilities, dated October 29, 2007

Table 11: **Predicted Mixing Zone Dimensions and Dilution Factors by Cosmopolitan Engineers**

Season	Distance to mixing zone boundary		Dilution at mixing zone boundary		Plume Width at chronic mixing zone boundary (ft.)
	Acute (ft.)	Chronic (ft.)	Acute (ft.)	Chronic (ft.)	
Summer	**4.7**	**47**	**1.4**	**8.6**	**21**
Winter	**12**	**118**	**2.6**	**15**	**18**

Table 12: Ecology determined Dilution Factors (DF)

	Summer		Winter	
Criteria	**Acute**	**Chronic**	**Acute**	**Chronic**
Aquatic Life	1.77	11.89	2.41	20.90
Human Health, Carcinogen		35.72		64.44
Human Health, Non-carcinogen		16.78		28.86

Ecology determined the dilution factors in Table 12 using a summer 7Q20 of 573 cfs and a winter 7Q20 of 1047 cfs (Pelletier 1997).

Ecology will use the dilution zone determined by the County consultants for defining a maximum size for the dilution zone in the proposed permit. It reflects a future design flow of 12 MGD. Table 12 reflects dilution factors for a design flow of 8 MGD. Ecology determined the impacts of dissolved oxygen deficiency as part of the modeling for the Spokane River and Lake Spokane DO TMDL which was approved by the USEPA in May 2010.

Ecology determined the impacts of Temperature, pH, Fecal Coliform, Chlorine, Ammonia Toxicity, and Metals, as described below, using the dilution factors in the above Table 12. The derivation of surface water quality-based limits also takes into account the variability of pollutant concentrations in both the effluent and the receiving water.

Oxygen Demanding Pollutants

The Spokane River and Lake Spokane (Long Lake) Dissolved Oxygen TMDL report sets WLAs for Total Phosphorus, $CBOD_5$, and Ammonia for each NPDES discharger to the Spokane River. The TMDL's managed implementation plan outlines the approach Ecology will take to meet these waste load allocations (WLAs) and ultimately achieve the water quality standard for dissolved oxygen in Lake Spokane.

This approach is spread over a twenty year managed implementation plan (MIP). During the first ten years of the MIP, efforts focus on phosphorus reduction to the Spokane River.

Before the end of the first ten years of the MIP, a thorough assessment will provide any necessary information to guide actions for the second ten year period.

These second period actions will include continuation of successful measures conducted in the first 10 years, such as operation of the phosphorus treatment technology and other permanent phosphorous reduction efforts. They may also include new actions such as additional treatment technologies, consideration of river oxygenation, and/or reconsideration of Water Quality Standards applied to the River and Lake Spokane. If new information from the "Ten Year Assessment" justifies relaxing WLAs and the water quality-based effluent limits (WQBELs), Ecology will relax the WQBELs. If so, the following section in federal regulation regarding "anti-backsliding" applies:

122.44(l) Reissued permits.
1) ***Except as provided in paragraph (l)(2)*** *of this section when a permit is renewed or reissued, interim effluent limitations, standards or conditions must be at least as stringent as the final effluent limitations, standards, or conditions in the previous permit (unless the circumstances on which the previous permit was based have materially and substantially changed since the time the permit was issued and would constitute cause for permit modification or revocation and reissuance under Sec. 122.62.)*

(2) In the case of effluent limitations established on the basis of Section 402(a)(1)(B) of the CWA, a permit may not be renewed, reissued, or modified on the basis of effluent guidelines promulgated under section 304(b) subsequent to the original issuance of such permit, to contain effluent limitations which are less stringent than the comparable effluent limitations in the previous permit.
(i) ***Exceptions****--A permit with respect to which paragraph (l)(2) of this section applies may be renewed, reissued, or modified to contain a less stringent effluent limitation applicable to a pollutant, if--*
Information is available which was not available at the time of permit issuance (other than revised regulations, guidance, or test methods) and which would have justified the application of a less stringent effluent limitation at the time of permit issuance; or

Ecology will establish WLAs and WQBELs on the best scientific information and interpretation available based on the facts that the "Ten Year Assessment" produces. Ecology will also examine and revise as needed the implementation of water quality based effluent limitations in terms of long term average versus monthly averages or maximums.

$CBOD_5$ - For the Spokane County Regional Water Reclamation Facility, SCRWRF, the Spokane River and Lake Spokane DO TMDL projects that compliance requires the effluent $CBOD_5$ concentration be less than 4.2 mg/L.

The effluent limitation will express this as a mass limit for the season March 1 to October 31 (245 days) of 280.2 lbs/day or 68,654 lbs total for the season.

Phosphorus - For the Spokane County Regional Water Reclamation Facility, SCRWRF, the Spokane River and Lake Spokane DO TMDL projects that compliance requires the effluent Total Phosphorus concentration be less 42 ug/L on a monthly average basis.

The effluent limitation will express the monthly average of 42 ug/L as a mass limit for the season March 1 to October 31 (245 days) of 2.80 lbs/day or 686.5 lbs total for the season.

Ammonia - For the Spokane County Regional Water Reclamation Facility, SCRWRF, the Spokane River and Lake Spokane DO TMDL projects that compliance requires the effluent ammonia to have less than the following loadings:

The following 3 seasons will have average mass per day limit as noted below:

1. For the season of March 1 to May 30, the allowable mass of NH_3 is 55.4 lbs/day.
2. For the season of June 1 to September 30, the allowable mass of NH_3 is 14.0 lbs/day.
3. For the season of October 1 to October 31, the allowable mass of NH_3 is 55.4 lbs/day.

For the 3 parameters above, federal rules normally require publically owned treatment works to have effluent limitations to be expressed in terms of monthly and weekly averages and daily maximums for applicable toxicants. However, that is not a mandatory permit requirement and 40 CFR122.45(d) does allow that if the normal monthly averages, weekly averages and daily maximum are impractical, alternatives such as an annual or seasonal limit may be appropriate. For the Spokane River and Spokane Lake system impractical means the water body does not respond in a measurable way to short term variations. Therefore, long term trend analysis and measurements descriptive of long term trends such as seasonal averages and seasonal totals are appropriate.

For the municipal dischargers to the Spokane River and Spokane Lake system impractical also means that reliable data sets with log normal distributions for conversion of maximums to averages do not exist. In Chesapeake Bay, EPA recognized that temperature affected plant performance resulting in a skewed data set, making it impracticable to establish monthly and weekly averages. For Chesapeake Bay the U.S. EPA cited reasons of temperature affecting plant performance resulting in a skewed data set. A skewed data set can also result when the low end of the data set is determined by the detection limit. Both reasons apply in this situation, leading to the conclusion that it is currently impracticable to establish monthly and weekly effluent limitations for all 3 parameters.

Pollutant Equivalencies and Alternate Effluent Limitations

The County's approved Wastewater Facilities Plan (WWFP) amendment Chapter 2 (Final – June 2010) addressed pollutant equivalency through modeling using the CE-Qual-W2 model that established the Spokane River and Lake Spokane DO TMDL and WLAs.
With the technology selected, the $CBOD_5$ should be less than 2.0 mg/L. In fact the County's contract with the DBO contractor, CH2M Hill constructors requires the $CBOD_5$ be 2.0 mg/L or less.

The WWFP amendment considered 2 scenarios this capability provides. Both scenarios considered a TP of 50 ug/L or less. The scenarios were:

1) An ammonia excursion due to cold water temperatures and poor nitrification of up to 16 mg/L in March, the remainder of spring (April through May) at 1.0 mg/L, Summer (June through September) at 0.25 mg/L, and October at 1.0 mg/L

2) 1.0 mg/L for March through May, Summer (June through September) at 0.25 mg/L, and October at 1.0 mg/L

In both scenarios DO concentrations improve very slightly according to the CE-Qual-W2 model predictions, see table 2 of the Limno Tech memo of March 11, 2010 that is in the Wastewater Facilities Plan Amendment of June 2010. The model does justify the use of alternate effluent limitation due to the ability of the treatment processes to remove $CBOD_5$ to below 2.0 mg/L

In May of 2011, Limno Tech and Ecology both ran the CE-Qual-W2 model with alternate limits for Spokane County and the Idaho dischargers. In this run a 16 mg/L daily maximum for ammonia was considered for the County discharge with TP of 50 ug/L and CBOD5 of 2.0 mg/L. This model run also confirmed the viability of alternate permit limits for a group of dischargers.

Temperature - The state temperature standards (WAC 173-201A-200-210 and 600-612) include multiple elements:

- Annual summer maximum threshold criteria (June 15 to September 15).
- Supplemental spawning and rearing season criteria (September 15 to June 15) but such are not defined for the Spokane River/
- Incremental warming restrictions.
- Protections against acute effects.

Ecology evaluates each criterion independently to determine reasonable potential and derive permit limits.

- Annual summer maximum and supplementary spawning/rearing criteria.

  Each water body has an annual maximum temperature criterion [WAC 173-201A-200(1)(c), 210(1)(c), and Table 602]. These threshold criteria (e.g., 12, 16, 17.5, 20°C) protect specific categories of aquatic life by controlling the effect of human actions on summer temperatures.

Some waters, not the Spokane River, have an additional threshold criterion to protect the spawning and incubation of salmonids (9°C for char and 13°C for salmon and trout) [WAC 173-201A-602, Table 602]. These criteria apply during specific date-windows.

The threshold criteria apply at the edge of the chronic mixing zone. Criteria for most fresh waters are expressed as the highest 7-Day average of daily maximum temperature (7-DADMax).

The 7-DADMax temperature is the arithmetic average of seven consecutive measures of daily maximum temperatures. Criteria for marine waters and some fresh waters are expressed as the highest 1-Day annual maximum temperature (1-DMax).

- Incremental warming criteria

The water quality standards limit the amount of warming human sources can cause under specific situations [WAC 173-201A-200(1)(c)(i)-(ii), 210(1)(c)(i)-(ii)]. The incremental warming criteria apply at the edge of the chronic mixing zone.

At locations and times when background temperatures are cooler than the assigned threshold criterion, point sources are permitted to warm the water by only a defined increment.

These increments are permitted only to the extent doing so does not cause temperatures to exceed either the annual maximum or supplemental spawning criteria.

At locations and times when a threshold criterion is being exceeded due to natural conditions, all human sources, considered cumulatively, must not warm the water more than 0.3°C above the naturally warm condition.

When Ecology has not yet completed a temperature TMDL, our policy allows each point source to warm water at the edge of the chronic mixing zone by 0.3°C. This is true regardless of the background temperature and even if doing so would cause the temperature at the edge of a standard mixing zone to exceed the numeric threshold criteria. Allowing a 0.3°C warming for each point source is reasonable and protective where the dilution factor is based on 25% or less of the critical flow. This is because the fully mixed effect on temperature will only be a fraction of the 0.3°C cumulative allowance (0.075°C or less) for all human sources combined.

- Temperature Acute Effects

Instantaneous lethality to passing fish: The upper 99th percentile daily maximum effluent temperature must not exceed 33°C; unless a dilution analysis indicates ambient temperatures will not exceed 33°C 2-seconds after discharge.

General lethality and migration blockage: Measurable (0.3°C) increases in temperature at the edge of a chronic mixing zone are not allowed when the receiving water temperature exceeds either a 1DMax of 23°C or a 7DADMax of 22°C.

Lethality to incubating fish: Human actions must not cause a measurable (0.3°C) warming above 17.5°C at locations where eggs are incubating.

Annual summer maximum, and incremental warming criteria: Ecology calculated the reasonable potential for an assumed discharge temperature based on the City of Spokane operational data to exceed the annual summer maximum, and the incremental warming criteria at the edge of the chronic mixing zone during critical condition(s). No reasonable potential exists to exceed the temperature criterion where:

$(\text{Criterion} + 0.3) > (\text{Criterion} + (T_{effluent95} - \text{Criterion}))/DF$

$(20 + 0.3) > (20 + (20.5 - 20))/11.89)$. $20.3 > 1.72$

Therefore, the proposed permit does not include a temperature limit. The permit requires additional monitoring of effluent and ambient temperatures. Ecology will reevaluate the reasonable potential during the next permit renewal.

pH - Ecology modeled the impact of the effluent pH on the receiving water using the calculations from EPA, 1988, and the chronic dilution factor of 11.89. The receiving water input variables used are listed above in Table 5. The effluent input variables used are assumed.

Under critical conditions, modeling predicts a violation of the pH criteria for the receiving water if the effluent pH drops below 7.0 with an ambient alkalinity of 40 mg/L $CaCO_3$ or less. Therefore, the proposed permit includes water quality-based effluent limits for pH of 7.0 to 9.0. The permit will require monitoring of alkalinity of the effluent and the receiving water.

Fecal Coliform – The approved design criteria is 200 colonies per 100ml (200 cfu/100mL) monthly average. Ecology modeled the numbers of fecal coliform by simple mixing analysis using the technology-based limit of 200 organisms per 100 mL and an acute dilution zone factor of 1.77. At the design value and with a 7Q10 flow the water quality standard would be exceeded slightly immediately beyond the acute mixing zone, 4.7 feet from the end of the tideflex valve. With the depth of the diffuser, small size of dilution zone, velocity of water, cobbly nature of the river bank and vegetation, there is no significant public health risk that the EPA guidance seeks to avoid. Additionally, the SCRWRF will perform much better than the approved design criteria. It is anticipated that the fecal coliform count will be below 100 cfu/100ml exiting the membranes and disinfection will reduce it further. Meeting the water quality criterion of 100 cfu/100 mL at end of pipe is attainable and very likely realized.

Toxic Pollutants - Federal regulations (40 CFR 122.44) require Ecology to place limits in NPDES permits on toxic chemicals in an effluent whenever there is a reasonable potential for those chemicals to exceed the surface water quality criteria.
Ecology does not exempt facilities with technology-based effluent limits from meeting the surface water quality standards.

The following toxic pollutants are present in the discharge: Ammonia, Chlorine, Heavy Metals, PCBs, Dioxins and PBDEs. Ecology conducted a reasonable potential analysis (See **Appendix D**) on these parameters to determine whether it would require effluent limits in this permit.

Ammonia's toxicity depends on that portion which is available in the unionized form. The amount of unionized ammonia depends on the temperature and pH in the receiving freshwater. To evaluate ammonia toxicity, Ecology used the available receiving water information for ambient stations and Ecology spreadsheet tools.

Valid ambient background data was available for ammonia, heavy metals and PCBs. Though for PCBs the quantity of data was limited. Ecology used all applicable data to evaluate reasonable potential for this discharge to cause a violation of water quality standards. The ambient stations were 54A120 and 57A150 for metals and hardness; 54A130, 57A125, 57A140 and 57A150 for conventional parameters.

Ecology determined that ammonia has no reasonable potential to exceed the toxicity water quality criteria. However, the County contract with CH2M Hill Constructors has maximum day limits based on higher flows than the first phase facility accommodates which are reflected in the permit. The no reasonable potential scenario was modeled using procedures given in EPA, 1991 (**Appendix D)**.

The Heavy Metals TMDL requires either a performance based limit or a water quality based limit using the end of pipe hardness which is unknown. Ambient concentrations for Cadmium, Lead and Zinc exceed the water quality standards. The calculations for reasonable potential require a maximum effluent concentration which isn't available. Instead, the County's permit application proposed to use the effluents limits for the Riverside Park Water Reclamation Facility under the assumption that the influent pollutant concentrations would be similar. The SCRWRF will also be employing the next level of treatment, chemical addition and filtration, and would be expected to provide better metals removal than the current Riverside Park Water Reclamation Facility. Additionally, the SCRWRF has a larger dilution factor so that using RPWRF effluent limits for metals is deemed to be conservative and acceptable until operational data is available.

The resultant effluent limits are as follows:

Parameter	Average Monthly	Maximum Daily
Cadmium (total)	0.076 µg/L	0.233 µg/L
Lead (total)	0.772 µg/L	1.34 µg/L
Zinc (total)	53.8 µg/L	72.6 µg/L
Total Ammonia (as NH_3-N)		
For "season" of March 1 to May 31	55.4 lbs/day	16 mg/L
For "season" of June 1 to Sept. 30	14.0 lbs/day	7.5 mg/L
For "season" of Oct. 1 to Oct. 31	55.4 lbs/day	16 mg/L

Water quality criteria for most metals published in chapter 173-201A WAC are based on the dissolved fraction of the metal (see footnotes to table WAC 173-201A-240(3); 2006).

Spokane County Utilities may provide data clearly demonstrating the seasonal partitioning of the dissolved metal in the ambient water in relation to an effluent discharge. Ecology may adjust metals criteria on a site-specific basis when data is available clearly demonstrating the seasonal partitioning in the ambient water in relation to an effluent discharge.

F. Whole Effluent Toxicity

The water quality standards for surface waters forbid discharge of effluent that causes toxic effects in the receiving waters. Many toxic pollutants cannot be measured by commonly available detection methods. However, laboratory tests can measure toxicity directly by exposing living organisms to the wastewater and measuring their responses. These tests measure the aggregate toxicity of the whole effluent, so this approach is called whole effluent toxicity (WET) testing. Some WET tests measure acute toxicity and other WET tests measure chronic toxicity.

- *Acute toxicity tests measure mortality as the significant response* to the toxicity of the effluent. Dischargers who monitor their wastewater using acute toxicity tests find early indications of any potential lethal effect of the effluent on organisms in the receiving water.

- *Chronic toxicity tests measure various sublethal toxic responses,* such as retarded growth or reduced reproduction. Chronic toxicity tests often involve either a complete life cycle test on an organism with an extremely short life cycle, or a partial life cycle test during a critical stage of a test organism's life. Some chronic toxicity tests also measure organism survival.

Using the screening criteria in WAC 173-205-040, Ecology determined that the Spokane County Regional Water Reclamation Facility's effluent has the potential to cause aquatic toxicity based solely on probable influent characteristics. Spokane County has a delegated pretreatment program indicative of influent organic and inorganic compounds not necessarily removed by wastewater treatment adequately. To verify protection of beneficial uses, the proposed permit contains WET testing requirements as authorized by RCW 90.48.520 and 40 CFR 122.44, using procedures from WAC 173-205.

The proposed permit requires the facility to conduct WET testing at prescribed intervals for one year, to characterize both the acute and chronic toxicity of the effluent.

If the year of WET testing shows acute or chronic toxicity levels that have a reasonable potential to cause receiving water toxicity, then the proposed permit will:

- Set a limit on acute or chronic toxicity.

- Require this facility operator to conduct WET testing to monitor compliance with an acute toxicity limit, a chronic toxicity limit, or both.

- Specify the procedures the facility operator must use to come back into compliance if toxicity exceeds the limits.

Ecology-accredited WET testing laboratories use the proper WET testing protocols, fulfill the data requirements, and submit results in the correct reporting format.

Accredited laboratory staff knows how to calculate an NOEC, LC_{50}, EC_{50}, IC_{25}, etc. Ecology gives all accredited labs the most recent version of Ecology Publication No. WQ-R-95-80, *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* (http://www.ecy.wa.gov/biblio/9580.html), which is referenced in the permit. Ecology recommends that each regulated facility send a copy of the acute or chronic toxicity sections(s) of its NPDES permit to the laboratory.

If the WET tests performed for effluent characterization purposes indicate no reasonable potential to cause receiving water toxicity, the proposed permit will not impose WET limits, but will require rapid screening tests to detect any toxicity that may appear.

- If a rapid screening test indicates apparent effluent toxicity, the facility operator must investigate immediately, take appropriate action, and report to Ecology.
- If this facility makes process or material changes which, in Ecology's opinion, increase the potential for effluent toxicity, then Ecology may (in a regulatory order, by permit modification, or in the permit renewal) require the facility to conduct additional effluent characterization.
- If WET testing conducted as a follow-up to rapid screening tests fails to meet the performance standards in WAC 173-205-020, Ecology will assume that effluent toxicity has increased.

G. Human Health

Washington's water quality standards include 91 numeric human health-based criteria that Ecology must consider when writing NPDES permits. These criteria were established in 1992 by the U.S. EPA in its National Toxics Rule (40 CFR 131.36). The National Toxics Rule allows states to use mixing zones to evaluate whether discharges comply with human health criteria.

The draft *Spokane River PCB Source Assessment 2003-2007* (Publication No. 11-03-013) identifies the various municipal discharges as sources of toxics such as PCBs to the Spokane River.

The draft source assessment estimates that a PCB load reduction in excess of 99% by all sources will be needed for compliances with the human health criterion for PCBs. The above effluent concentrations are from conventional secondary treatment. All three Washington municipal discharges will soon be employing tertiary treatment for phosphorus reduction including filtration. Further reduction of toxics, such as PCBs, is likely.

The permits for each NPDES discharger to the Washington section of the Spokane River has a narrative limit for PCBs requiring source identification, and control activities, establishment of performance based effluent limits leading to a long term goal of meeting applicable water quality standards. The permits also require the creation and participation in a Regional Toxics Task Force.

Not all toxicants of potential human health concern are not anticipated to be present, but periodic monitoring will be required to verify the absence of other human health toxicants.

Ecology evaluated the discharge's potential to violate the water quality standards as required by 40 CFR 122.44(d) by following the procedures published in the *Technical Support Document for Water Quality-Based Toxics Control* (EPA/505/2-90-001) and Ecology's *Permit Writer's Manual* to make a reasonable potential determination.

The evaluation showed that the discharge has no reasonable potential other than PCBs to cause a violation of water quality standards. A numeric effluent limit will be established based on plant performance in the next permit cycle. A plan for source control is needed (see V. Other Permit Conditions sections G & H).

H. Sediment Quality

The aquatic sediment standards (chapter 173-204 WAC) protect aquatic biota and human health. Under these standards Ecology may require a facility to evaluate the potential for its discharge to cause a violation of sediment standards (WAC 173-204-400). You can obtain additional information about sediments at the Aquatic Lands Cleanup Unit website at http://www.ecy.wa.gov/programs/tcp/smu/sediment.html.

Through a review of the discharger characteristics and of the effluent characteristics, Ecology determined that this discharge has no reasonable potential to violate the sediment management standards due to pollutant removal efficiency, stream velocity and a lack of particulates in the river and effluent for pollutants to absorb to.

I. Ground Water Quality Limits

The ground water quality standards (chapter 173-200 WAC) protect beneficial uses of ground water. Permits issued by Ecology must not allow violations of those standards (WAC 173-200-100).

The Spokane County Regional Water Reclamation Facility does not discharge wastewater to the ground. No permit limits are required to protect ground water.

IV. MONITORING REQUIREMENTS

Ecology requires monitoring, recording, and reporting (WAC 173-220-210 and 40 CFR 122.41) to verify that the treatment process is functioning correctly and that the discharge complies with the permit's effluent limits.

The monitoring schedule is detailed in the proposed permit under Condition S2. Specified monitoring frequencies take into account the quantity and variability of the discharge, the treatment method, past compliance, significance of pollutants, and cost of monitoring.

The required monitoring frequency is consistent with agency guidance given in the current version of Ecology's *Permit Writer's Manual* (Publication Number 92-09) for a tertiary activated sludge treatment plant discharging over 5 MGD.

Monitoring of sludge quantity and quality is necessary to determine the appropriate uses of the sludge. Biosolids monitoring is required by the current state and local solid waste management program and also by EPA under 40 CFR 503.

As a Pretreatment Publicly Owned Treatment Works (POTW), Spokane County Utilities is required to sample influent, primary clarifier effluent, final effluent, and sludge for toxic pollutants in order to characterize the industrial input. Sampling is also done to determine if pollutants interfere with the treatment process or pass-through the plant to the sludge or the receiving water. Spokane County Utilities will use the monitoring data to develop local limits which commercial and industrial users must meet.

A. Lab Accreditation

Ecology requires that facilities must use a laboratory registered or accredited under the provisions of chapter 173-50 WAC, *Accreditation of Environmental Laboratories* to prepare all monitoring data (with the exception of certain parameters). The plan for start up of the facility is to use a contract laboratory initially, tentatively Anatek Labs, Inc. Approximately 6 months after start up, the SCRWRF's on site laboratory would commence the Ecology accreditation protocols.

B. Receiving Water Monitoring

Ecology monitors the ambient water quality upstream and downstream of the SCRWRF outfall, but not in a location to distinguish any water quality impact of the county discharge from other outfalls. This permit will require the County to monitor the upstream and downstream water quality for a number of conventional parameters and metals in the second and fourth years of the permit.

C. Effluent Limits Which are Near Detection or Quantitation Levels

The water quality-based effluent concentration limits for total phosphorus are near the limits of current analytical methods to detect or accurately quantify.

The method detection level (MDL) is the minimum concentration of a pollutant that can be measured and reported with a 99 percent confidence that its concentration is greater than zero (as determined by a specific laboratory method). The quantitation level is the level at which concentrations can be reliably reported with a specified level of error.

Estimated concentrations are the values between the MDL and the QL. Ecology requires estimated concentrations to be reported.

When reporting maximum daily effluent concentrations, Ecology requires the facility to report "less than X" where X is the required detection level if the measured effluent concentration falls below the detection level. When calculating average monthly concentrations, the facility must use all the effluent concentrations measured below the quantitation level but above the method detection level. USEPA guidance states that when any sample analyzed in accordance with a method having the appropriate MDL and QL and found to be below the QL will be considered in compliance with the permit limits unless other monitoring information indicates a violation.

V. OTHER PERMIT CONDITIONS

A. Reporting and Record Keeping

Ecology based permit condition S3. on our authority to specify any appropriate reporting and record keeping requirements to prevent and control waste discharges (WAC 173-220-210).

B. Prevention of Facility Overloading

Overloading of the treatment plant is a violation of the terms and conditions of the permit. To prevent this from occurring, RCW 90.48.110 and WAC 173-220-150 requires Spokane County to take the actions detailed in proposed permit requirement S4. to plan expansions or modifications before existing capacity is reached and to report and correct conditions that could result in new or increased discharges of pollutants. Condition S4. restricts the amount of flow.

C. Operation and Maintenance (O&M)

The proposed permit contains Condition S5. as authorized under RCW 90.48.110, WAC 173-220-150, chapter 173-230 WAC, and WAC 173-240-080. Ecology included it to ensure proper operation and regular maintenance of equipment, and to ensure that Spokane County and CH2M Hill Constructors, Inc will take adequate safeguards so that it uses the constructed facilities to their optimum potential in terms of pollutant capture and treatment.

The proposed permit requires submission of an O&M manual.

D. Pretreatment

Duty to Enforce Discharge Prohibitions

The City of Spokane and Spokane County are Co-Permittees for the pretreatment sections of the City of Spokane's NPDES Permit for the Riverside Park Water Reclamation Facility.

The County's permit pretreatment section for its new water reclamation facility will therefore match the County's pretreatment section of the City's permit for which they are a Co-Permittee.

This pretreatment provision prohibits the POTW from authorizing or permitting an industrial discharger to discharge certain types of waste into the sanitary sewer.

A meeting was held on October 20, 2004 at the Department of Ecology Eastern Regional Office on the subject of Spokane-area pretreatment. The following are items that staff of the Department of Ecology, City of Spokane, Spokane County, and the City of Spokane Valley agreed upon pertaining to Delegated Pretreatment Programs in the Spokane area:

1) Spokane County has the authority to administer its Delegated Pretreatment Program to their present and future sewer customers located within their designated sewer service areas in Spokane County and in the City of Spokane Valley.

For the purpose of this meeting, this applies to customers who contribute wastewater into the Spokane County sewer collection system and are located outside of the corporate limits of the City of Spokane and within the City of Spokane Valley and Spokane County. Existing permitted facilities that this applies to are Ecolite Mfg Co., Galaxy Compound Semiconductors, Inc.; Honeywell Electronic Materials, Inc.; Lloyd Industries LLC, Kemira Water System, American On-Site Services and Novation, Inc. in the City of Spokane Valley, and the Mica Landfill in Spokane County.
The County acknowledges that as owner and operator of a wastewater collection system it has the responsibility to protect its infrastructure, and by agreement the infrastructure of the downstream POTW, and accepts the obligations of a Delegated Pretreatment Program. The City may through its Multi-Jurisdictional agreement request the County to serve select city customer's and exercise appropriate pretreatment authority over the discharger.

2) The City of Spokane has the authority to administer its delegated Pretreatment Program to their present and future sewer customers located within its designated sewer service areas in City of Spokane Valley, in Spokane County, and in the City of Spokane. For the purpose of this meeting, this applies to customers who contribute wastewater into the City of Spokane sewer collection system and are located either within or outside of the corporate limits of the City of Spokane. Existing permitted facilities that this applies to are Brenntag Pacific in the City of Spokane Valley, and Goodrich, Johnna Beverages, and Reliance Trailer in the West Plains Area of Spokane County. The City acknowledges that as owner and operator of a wastewater collection system and POTW it is their responsibility to protect their infrastructure, and accepts the obligations of a Delegated Pretreatment Program.

3) Both the City of Spokane and Spokane County, as the control authority for their Delegated Pretreatment Programs, will continue to enforce and update, if necessary and appropriate, their interlocal agreements and/or multijurisdictional pretreatment agreements with "contributing" jurisdictions such as Millwood, and Airway Heights. Some of these actions may include conducting Industrial User Surveys, monitoring, and permitting commercial and/or industrial users.

4) The agreements reached in the October 20, 2004 meeting are based upon individual and collective understanding of applicable laws, rules, regulations, and agreements pertaining to NPDES pretreatment requirements and programs in Washington State, and upon legal opinions provided by Spokane County and the City of Spokane Valley dated October 11, 2004 and October 12, 2004 respectively.

An industrial user survey is required to determine the extent of compliance of all industrial users of the sanitary sewer and wastewater treatment facility with federal pretreatment regulations (40 CFR Part 403 and Sections 307(b) and 308 of the Clean Water Act), with state regulations (Chapter 90.48 RCW and Chapter 173-216 WAC), and with local ordinances.

As sufficient data becomes available, the Permittees shall, in consultation with the Ecology, reevaluate their local limits in order to prevent pass through or interference. Upon determination by the Ecology that any pollutant present causes pass through or interference, or exceeds established sludge standards, the Permittees shall establish new local limits or revise existing local limits as required by 40 CFR 403.5.

In addition, Ecology may require revision or establishment of local limits for any pollutant that causes an exceedance of the Water Quality Standards or established effluent limits, or that causes whole effluent toxicity. The maximum effluent concentration reported in the City of Spokane's NPDES application does not exceed the reasonable potential criterion for mercury. However, Mercury in the Riverside Park Reclaimed Water Facilities effluent equaled or exceeded the chronic water quality criteria seven times from January 2002 through October 2004. It is Ecology's determination that the Permittees need to develop and implement a mercury abatement and control program. Additional Mercury Plan development guidance can be found at the following locations:

Ecology Mercury Website: http://www.ecy.wa.gov/mercury/
For Dental Plan Guidance: http://www.ecy.wa.gov/dentalbmps/index.html
Reduction Plan Guidance: http://www.ecy.wa.gov/biblio/0303001.html

Ecology may modify this permit to incorporate additional requirements relating to the establishment and enforcement of local limits for pollutants of concern

Requirements for Performing an Industrial User Survey

This POTW has the potential to serve significant industrial or commercial users and is required to perform an Industrial User Survey. The goal of this survey is to develop a list of SIUs and PSIUs, and of equal importance, to provide sufficient information about industries which discharge to the POTW, to determine which of them require issuance of State waste discharge permits or other regulatory controls. An Industrial User Survey is an important part of the regulatory process used to prevent interference with treatment processes at the POTW and to prevent the exceedance of water quality standards. The Industrial User Survey also can be used to contribute to the maintenance of sludge quality, so that sludge can be a useful biosolids product rather than an expensive waste problem.

An Industrial User Survey is a rigorous method for identifying existing, new, and proposed significant industrial users and potential significant industrial users. A complete listing of methodologies is available in Ecology's guidance document entitled "Conducting an Industrial User Survey".

- The first section of the pretreatment requirements prohibits the POTW from accepting pollutants which causes "Pass-through" or "Interference". This general prohibition is from 40 CFR §403.5(a). **Appendix C** of this fact sheet defines these terms.

- The second section reinforces a number of specific State and Federal pretreatment prohibitions found in WAC 173-216-060 and 40 CFR §403.5(b). These reinforce that the POTW may not accept certain wastes, which:

    - Are prohibited due to dangerous waste rules.
    - Are explosive or flammable.
    - Have too high or low of a pH (too corrosive, acidic or basic).
    - May cause a blockage such as grease, sand, rocks, or viscous materials.
    - Are hot enough to cause a problem.
    - Are of sufficient strength or volume to interfere with treatment.

- Contain too much petroleum-based oils, mineral oil, or cutting fluid.
- Create noxious or toxic gases at any point.

40 CFR Part 403 contains the regulatory basis for these prohibitions, with the exception of the pH provisions which are based on WAC 173-216-060.

- The third section of pretreatment conditions reflects state prohibitions on the POTW accepting certain types of discharges unless the discharge has received prior written authorization from Ecology.

  These discharges include:

  - Cooling water in significant volumes.
  - Stormwater and other direct inflow sources.
  - Wastewaters significantly affecting system hydraulic loading, which do not require treatment.

Ecology delegated authority to Spokane County Utilities for permitting, monitoring, and enforcement over industrial users discharging to their treatment system to provide more direct and effective control of pollutants.

Ecology oversees the delegated Industrial Pretreatment Program to assure compliance with federal pretreatment regulations (40 CFR Part 403) and categorical standards and state regulations (chapter 90.48 RCW and chapter 173-216 WAC).

As sufficient data becomes available, Spokane County Utilities must, in consultation with Ecology, reevaluate its local limits in order to prevent pass-through or interference. If any pollutant causes pass-through or interference, or exceeds established sludge standards, Spokane County Utilities must establish new local limits or revise existing local limits as required by 40 CFR 403.5.

In addition, Ecology may require revision or establishment of local limits for any pollutant that causes a violation of water quality standards or established effluent limits, or that causes whole effluent toxicity.

Ecology may modify this permit to incorporate additional requirements relating to the establishment and enforcement of local limits for pollutants of concern.

E. Solid Waste Control

To prevent water quality problems the facility is required in permit Condition S7. to store and handle all residual solids (grit, screenings, scum, sludge, and other solid waste) in accordance with the requirements of RCW 90.48.080 and state water quality standards.

The final use and disposal of sewage sludge from this facility is regulated by U.S. EPA under 40 CFR 503, and by Ecology under chapter 70.95J RCW, chapter 173-308 WAC "Biosolids Management," and chapter 173-350 WAC "Solid Waste Handling Standards." The disposal of other solid waste is under the jurisdiction of the Spokane County Health District.

Requirements for monitoring sewage sludge and record keeping are included in this permit. This information will be used by Ecology to develop or update local limits and is also required under 40 CFR 503.

F. Spill Plan

This facility stores a quantity of chemicals on-site that normally would have the potential to cause water pollution if accidentally released. Ecology can require a facility to develop best management plans to prevent this accidental release [Section 402(a)(1) of the Federal Water Pollution Control Act (FWPCA) and RCW 90.48.080]. However, the City of Spokane requires secondary containment of storage vessels and connections. Further best management plans are not necessary.

G. Toxic Source Control Action Plan

As described in III.C Anti-degradation and III.G Human Health, an action plan for identifying and controlling sources of toxics is needed. Known wastewater treatment technologies can not reduce influent PCBs adequately to meet current water quality standards for PCBs. What PCBs are removed are transferred to the biosolids which is less than an optimum option. Source control is essential.

- An Annual Toxics Management Report shall be prepared by the County and submitted to Ecology on an annual basis for review and evaluation on the PCB management effort. Activities planned for PCB reduction in the subsequent year of operation shall be jointly reviewed and agreed upon.
- The Toxics Management Plan is implementing a narrative effluent limit for PCBs. As such the Plan has 2 goals.
    - To reduce toxicant loadings, including PCBs, to the Spokane River to the maximum extent practicable realizing statistically significant reductions in the influent concentration of toxicants to the SCRWRF over the next 10 years.
    - Reduce PCBs in the effluent to the maximum extent practicable so that in time the effluent does not contribute to PCBs in the Spokane River exceeding applicable water quality standards.

H. Regional Toxics Task Force

During development of the proposed permit, the Spokane Riverkeeper expressed concerns about PCBs and water quality standards compliance to Spokane County.
As a result, Spokane County and the Spokane Riverkeeper put forth the idea of a Regional Toxics Task Force and offered up a number of ideas as to its functions and structure. While the initial concept was directed at PCBs as the primary toxicant, the River does have a 303(d) listing for dioxin in fish tissue. The Washington State Water Quality Standards do not have a criterion for PBDEs, but sampling by Ecology has shown elevated concentrations of PBDEs. PBDEs are now banned in some states, including Washington and presumably will be decreasing, but that was thought to be true of PCBs at one time.

The focus of the Task Force is appropriately on 303(d) listed toxics such as PCBs, however source identification and reduction efforts should not overlook opportunities to reduce the levels of PBDEs when possible.

The Spokane Tribe of Indians expressed very similar concerns. The tribal representatives are supportive of narrative limits with clearly stated goals (stated above).

Ecology does not want to be prescriptive regarding the organization and structure of a Task Force, but believes cooperative action is in the best interest of all stakeholders. Ecology also believes the time for action is now. Therefore, the rudiments of a Regional Toxics Task Force are described in the permit, but many details are left for the NPDES Permittees and other stakeholders to cooperatively develop.

The proposed permit does require the creation of a Regional Toxics Task Force and participation in it. The Task Force and Ecology's "Spokane River Toxics Reduction Strategy" are intended to avoid the need for a PCB TMDL and initiate source reduction and clean up actions sooner than if a TMDL came first. However, Ecology does have the obligation to use its regulatory authority to bring the river's water quality into compliance with applicable water quality standards. If the proposed Task Force approach is not successful, other means and methods will be employed including the option of a PCB TMDL.

It is anticipated that activities of the Task Force will begin with the following:

(1) Identify data gaps and collect necessary data on PCBs and other toxics on the 2008 year 303(d) list for the Spokane River;

(2) Further analyze the existing and future data to better characterize the amounts, sources, and locations of PCBs and other toxics on the 2008 year 303(d) list for the Spokane River;

(3) Prepare recommendations for controlling and reducing the sources of listed toxics in the Spokane River;

(4) Review proposed Toxic Management Plans, Source Management Plans, and BMPs;

(5) Monitor and assess the effectiveness of toxic reduction measures;

(6) Identify a mutually agreeable entity to serve as the clearinghouse for data, reports, minutes, and other information gathered or developed by the Task Force and its members. This information shall be made publicly available by means of a website and other appropriate means;

To accomplish the above tasks it is anticipated that the Task Force will need technical assistance in the person of an independent consultant.

Ecology, the US EPA Region X and Spokane Tribal representatives have conferred on this and are supportive of the Task Force creation and objectives.

For each Washington discharger to the Spokane River, Ecology is requiring prompt action on the concept and the proposed permit is requiring that:

(1) By **November 30, 2011**, the Permittee shall provide Ecology with the organizational structure, specific goals, funding and the governing documents of the Regional Toxics Task Force.

I. General Conditions

Ecology bases the standardized General Conditions on state and federal law and regulations. They are included in all individual municipal NPDES permits issued by Ecology.

VI. PERMIT ISSUANCE PROCEDURES

A. Permit Modifications

Ecology may modify this permit to impose numerical limits, if necessary to comply with water quality standards for surface waters, with sediment quality standards, or with water quality standards for ground waters, based on new information from sources such as inspections, effluent monitoring, outfall studies, and effluent mixing studies.

Ecology may also modify this permit to comply with new or amended state or federal regulations.

B. Proposed Permit Issuance

This proposed permit meets all statutory requirements for Ecology to authorize a wastewater discharge. The permit includes limits and conditions to protect human health and aquatic life, and the beneficial uses of waters of the state of Washington. Ecology proposes to issue this permit for a term of five (5) years.

VII. REFERENCES FOR TEXT AND APPENDICES

Environmental Protection Agency (EPA)

1992. *National Toxics Rule.* Federal Register, V. 57, No. 246, Tuesday, December 22, 1992.

1991. *Technical Support Document for Water Quality-based Toxics Control*. EPA/505/2-90-001.

1988. *Technical Guidance on Supplementary Stream Design Conditions for Steady State Modeling.* USEPA Office of Water, Washington, D.C.

1985. *Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water*. EPA/600/6-85/002a.

1983. *Water Quality Standards Handbook.* USEPA Office of Water, Washington, D.C.

Guidance on Water Quality Based Effluent Limits Set Below Analytical Detection/Quantitation Limits From: Cindi Godsey, NPDES Permits Unit To: NPDES Permits Unit Consistency Book dated April 25, 2005

Tsivoglou, E.C., and J.R. Wallace.

1972. *Characterization of Stream Reaeration Capacity*. EPA-R3-72-012. (Cited in EPA 1985 op.cit.)

Washington State Department of Ecology.

2006. *Permit Writer's Manual.* Publication Number 92-109 (http://www.ecy.wa.gov/biblio/92109.html)

Laws and Regulations (http://www.ecy.wa.gov/laws-rules/index.html)

Permit and Wastewater Related Information (http://www.ecy.wa.gov/programs/wq/wastewater/index.html)

Spokane River PCB Source Assessment 2003-2007, Publication No. 11-03-013

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1976. *Chlorination of Wastewater.*

Wright, R.M., and A.J. McDonnell.

1979. *In-stream Deoxygenation Rate Prediction.* Journal Environmental Engineering Division, ASCE. 105(EE2). (Cited in EPA 1985 op.cit.)

Spokane County Wastewater Facilities Plan Amendment – Revised Final Draft of December 2007 prepared by HDR

2010 Wastewater Facilities Plan Amendment prepared by HDR

Spokane County Regional Water Reclamation Facility PDD Update by CH2M Hill 9/24/2007, September 2008

Mixing Zone Study Report for the Proposed Spokane County Discharge to the Spokane River, Washington, Limno Tech, June 2004

Technical Memorandum *Task G102 – Mixing Zone and Water Quality Update* from Cosmopolitan Engineers to HDR Engineers representing Spokane County Utilities, dated October 29, 2007

Technical Memorandum: Water Quality Assessment of Alternate Spokane County Permit Limits, Limno Tech, March 11, 2010

Cadmium, Copper, Mercury, Lead and Zinc in the Spokane River, (Publication 94-09)

Final Draft *Spokane River PCB Source Assessment 2003-2007* (Publication No. 11-03-013)

APPENDIX A - PUBLIC INVOLVEMENT INFORMATION

Ecology proposes to issue a permit to the Spokane County Regional Water Reclamation Facility. The permit includes wastewater discharge limits and other conditions. This fact sheet describes the facility and Ecology's reasons for requiring permit conditions.

Ecology placed a Public Notice of Application on November 22, 2010 and November 29, 2010 in the Spokesman Review to inform the public about the submitted application and to invite comment on the issuance of this permit.

Ecology will place a Public Notice of Draft on June 28, 2011 in the Spokesman Review to inform the public and to invite comment on the proposed draft National Pollutant Discharge Elimination System permit and fact sheet.

The notice:

- Tells where copies of the draft permit and fact sheet are available for public.
- Offers to provide the documents in an alternate format to accommodate special needs.
- Asks people to tell us how well the proposed permit would protect the receiving water.
- Invites people to suggest fairer conditions, limits, and requirements for the permit.
- Invites comments on Ecology's determination of compliance with antidegradation rules.
- Urges people to submit their comments, in writing, before the end of the comment period.
- Tells how to request a public hearing about the proposed NPDES permit.
- Explains the next step(s) in the permitting process.

Ecology has published a document entitled *Frequently Asked Questions about Effective Public Commenting* which is available on our website at http://www.ecy.wa.gov/biblio/0307023.html.

You may obtain further information from Ecology by telephone at (509) 329-3519 or by writing to the address listed below.

Mr. Richard Koch
Department of Ecology
Eastern Regional Office
4601 North Monroe Street
Spokane, WA 99205-1295
rkoc461@ecy.wa.gov

The primary author of this permit and fact sheet is Richard A. Koch, P.E

APPENDIX B - YOUR RIGHT TO APPEAL

You have a right to appeal this permit to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of the final permit. The appeal process is governed by chapter 43.21B RCW and chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2) (see glossary).

To appeal you must do the following within 30 days of the date of receipt of this permit:

- File your appeal and a copy of this permit with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this permit on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in chapter 43.21B RCW and chapter 371-08 WAC.

ADDRESS AND LOCATION INFORMATION

Street Addresses	Mailing Addresses
Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey, WA 98503 **Pollution Control Hearings Board** 1111 Israel RD SW STE 301 Tumwater, WA 98501	**Department of Ecology** Attn: Appeals Processing Desk PO Box 47608 Olympia, WA 98504-7608 **Pollution Control Hearings Board** PO Box 40903 Olympia, WA 98504-0903

APPENDIX C – GLOSSARY

1-DMax or 1-Day Maximum Temperature - The highest water temperature reached on any given day. This measure can be obtained using calibrated maximum/minimum thermometers or continuous monitoring probes having sampling intervals of thirty minutes or less.

7-DADMax or 7-Day Average of the Daily Maximum Temperatures - The arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days prior and the three days after that date.

Acute Toxicity - The lethal effect of a compound on an organism that occurs in a short time period, usually 48 to 96 hours.

AKART - The acronym for "all known, available, and reasonable methods of prevention, control and treatment." AKART is a technology-based approach to limiting pollutants from wastewater discharges, which requires an engineering judgment and an economic judgment. AKART must be applied to all wastes and contaminants prior to entry into waters of the state in accordance with RCW 90.48.010 and 520, WAC 173-200-030(2)(c)(ii), and WAC 173-216-110(1)(a).

Alternate Point of Compliance - An alternative location in the ground water from the point of compliance where compliance with the ground water standards is measured. It may be established in the ground water at locations some distance from the discharge source, up to, but not exceeding the property boundary and is determined on a site specific basis following an AKART analysis. An "early warning value" must be used when an alternate point is established. An alternate point of compliance must be determined and approved in accordance with WAC 173-200-060(2).

Ambient Water Quality - The existing environmental condition of the water in a receiving water body.

Ammonia - Ammonia is produced by the breakdown of nitrogenous materials in wastewater. Ammonia is toxic to aquatic organisms, exerts an oxygen demand, and contributes to eutrophication. It also increases the amount of chlorine needed to disinfect wastewater.

Annual Average Design Flow (AADF) - Average of the daily flow volumes anticipated to occur over a calendar year.

Average Monthly Discharge Limit - The average of the measured values obtained over a calendar month's time.

Background Water Quality - The concentrations of chemical, physical, biological or radiological constituents or other characteristics in or of ground water at a particular point in time upgradient of an activity that has not been affected by that activity, [WAC 173-200-020(3)].

Background water quality for any parameter is statistically defined as the 95% upper tolerance interval with a 95% confidence based on at least eight hydraulically upgradient water quality samples. The eight samples are collected over a period of at least one year, with no more than one sample collected during any month in a single calendar year.

Best Management Practices (BMPs) - Schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the state. BMPs include treatment systems, operating procedures, and practices to control: plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. BMPs may be further categorized as operational, source control, erosion and sediment control, and treatment BMPs.

BOD_5 - Determining the five-day Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of organic material present in an effluent that is utilized by bacteria. The BOD5 is used in modeling to measure the reduction of dissolved oxygen in receiving waters after effluent is discharged. Stress caused by reduced dissolved oxygen levels makes organisms less competitive and less able to sustain their species in the aquatic environment. Although BOD_5 is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Bypass - The intentional diversion of waste streams from any portion of a treatment facility.

Categorical Pretreatment Standards - National pretreatment standards specifying quantities or concentrations of pollutants or pollutant properties, which may be discharged to a POTW by existing or new industrial users in specific industrial subcategories.

Chlorine - A chemical used to disinfect wastewaters of pathogens harmful to human health. It is also extremely toxic to aquatic life.

Chronic Toxicity - The effect of a compound on an organism over a relatively long time, often 1/10 of an organism's lifespan or more. Chronic toxicity can measure survival, reproduction or growth rates, or other parameters to measure the toxic effects of a compound or combination of compounds.

Clean Water Act (CWA) - The federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, 97-117; USC 1251 et seq.

Compliance Inspection-Without Sampling - A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

Compliance Inspection-With Sampling - A site visit for the purpose of determining the compliance of a facility with the terms and conditions of its permit or with applicable statutes and regulations.

In addition it includes as a minimum, sampling and analysis for all parameters with limits in the permit to ascertain compliance with those limits; and, for municipal facilities, sampling of influent to ascertain compliance with the 85 percent removal requirement. Ecology may conduct additional sampling.

Composite Sample - A mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increased while maintaining a constant time interval between the aliquots).

Construction Activity - Clearing, grading, excavation, and any other activity, which disturbs the surface of the land. Such activities may include road building; construction of residential houses, office buildings, or industrial buildings; and demolition activity.

Continuous Monitoring - Uninterrupted, unless otherwise noted in the permit.

Critical Condition - The time during which the combination of receiving water and waste discharge conditions have the highest potential for causing toxicity in the receiving water environment. This situation usually occurs when the flow within a water body is low, thus, its ability to dilute effluent is reduced.

Date of Receipt - This is defined in RCW 43.21B.001(2) as five business days after the date of mailing; or the date of actual receipt, when the actual receipt date can be proven by a preponderance of the evidence. The recipient's sworn affidavit or declaration indicating the date of receipt, which is unchallenged by the agency, constitutes sufficient evidence of actual receipt. The date of actual receipt, however, may not exceed forty-five days from the date of mailing.

Detection Limit - See Method Detection Level.

Dilution Factor (DF) - A measure of the amount of mixing of effluent and receiving water that occurs at the boundary of the mixing zone. Expressed as the inverse of the percent effluent fraction, for example, a dilution factor of 10 means the effluent comprises 10% by volume and the receiving water 90%.

Distribution Uniformity - The uniformity of infiltration (or application in the case of sprinkle or trickle irrigation) throughout the field expressed as a percent relating to the average depth infiltrated in the lowest one-quarter of the area to the average depth of water infiltrated.

Early Warning Value - The concentration of a pollutant set in accordance with WAC 173-200-070 that is a percentage of an enforcement limit. It may be established in the effluent, ground water, surface water, the vadose zone or within the treatment process. This value acts as a trigger to detect and respond to increasing contaminant concentrations prior to the degradation of a beneficial use.

Enforcement Limit - The concentration assigned to a contaminant in the ground water at the point of compliance for the purpose of regulation, [WAC 173-200-020(11)]. This limit assures that a ground water criterion will not be exceeded and that background water quality will be protected.

Engineering Report - A document that thoroughly examines the engineering and administrative aspects of a particular domestic or industrial wastewater facility. The report must contain the appropriate information required in WAC 173-240-060 or 173-240-130.

Fecal Coliform Bacteria - Fecal coliform bacteria are used as indicators of pathogenic bacteria in the effluent that are harmful to humans. Pathogenic bacteria in wastewater discharges are controlled by disinfecting the wastewater. The presence of high numbers of fecal coliform bacteria in a water body can indicate the recent release of untreated wastewater and/or the presence of animal feces.

Grab Sample - A single sample or measurement taken at a specific time or over as short a period of time as is feasible.

Ground Water - Water in a saturated zone or stratum beneath the surface of land or below a surface water body.

Industrial User - A discharger of wastewater to the sanitary sewer that is not sanitary wastewater or is not equivalent to sanitary wastewater in character.

Industrial Wastewater - Water or liquid-carried waste from industrial or commercial processes, as distinct from domestic wastewater. These wastes may result from any process or activity of industry, manufacture, trade or business; from the development of any natural resource; or from animal operations such as feed lots, poultry houses, or dairies. The term includes contaminated storm water and, also, leachate from solid waste facilities.

Interference - A discharge which, alone or in conjunction with a discharge or discharges from other sources, both:

- Inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal; and
- Therefore is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent State or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including State regulations contained in any State sludge management plan prepared pursuant to subtitle D of the SWDA), sludge regulations appearing in 40 CFR Part 507, the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act.

Local Limits - Specific prohibitions or limits on pollutants or pollutant parameters developed by a POTW.

Major Facility - A facility discharging to surface water with an EPA rating score of > 80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Maximum Daily Discharge Limit - The highest allowable daily discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. The daily discharge is calculated as the average measurement of the pollutant over the day.

Maximum Day Design Flow (MDDF) - The largest volume of flow anticipated to occur during a one-day period, expressed as a daily average.

Maximum Month Design Flow (MMDF) - The largest volume of flow anticipated to occur during a continuous 30-day period, expressed as a daily average.

Maximum Week Design Flow (MWDF) - The largest volume of flow anticipated to occur during a continuous 7-day period, expressed as a daily average.

Method Detection Level (MDL) - The minimum concentration of a substance that can be measured and reported with 99 percent confidence that the pollutant concentration is above zero and is determined from analysis of a sample in a given matrix containing the pollutant.

Minor Facility - A facility discharging to surface water with an EPA rating score of < 80 points based on such factors as flow volume, toxic pollutant potential, and public health impact.

Mixing Zone - An area that surrounds an effluent discharge within which water quality criteria may be exceeded. The permit specifies the area of the authorized mixing zone that Ecology defines following procedures outlined in state regulations (chapter 173-201A WAC).

National Pollutant Discharge Elimination System (NPDES) - The NPDES (Section 402 of the Clean Water Act) is the federal wastewater permitting system for discharges to navigable waters of the United States. Many states, including the state of Washington, have been delegated the authority to issue these permits. NPDES permits issued by Washington State permit writers are joint NPDES/State permits issued under both state and federal laws.

pH - The pH of a liquid measures its acidity or alkalinity. It is the negative logarithm of the hydrogen ion concentration. A pH of 7 is defined as neutral and large variations above or below this value are considered harmful to most aquatic life.

Pass-Through - A discharge which exits the POTW into waters of the State in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation), or which is a cause of a violation of State water quality standards.

Peak Hour Design Flow (PHDF) - The largest volume of flow anticipated to occur during a one-hour period, expressed as a daily or hourly average.

Peak Instantaneous Design Flow (PIDF) - The maximum anticipated instantaneous flow.

Point of Compliance - The location in the ground water where the enforcement limit must not be exceeded and a facility must comply with the Ground Water Quality Standards. Ecology determines this limit on a site-specific basis. Ecology locates the point of compliance in the ground water as near and directly downgradient from the pollutant source as technically, hydrogeologically, and geographically feasible, unless it approves an alternative point of compliance.

Potential Significant Industrial User (PSIU) - A potential significant industrial user is defined as an Industrial User that does not meet the criteria for a Significant Industrial User, but which discharges wastewater meeting one or more of the following criteria:

a. Exceeds 0.5 % of treatment plant design capacity criteria and discharges <25,000 gallons per day or;
b. Is a member of a group of similar industrial users which, taken together, have the potential to cause pass through or interference at the POTW (e.g. facilities which develop photographic film or paper, and car washes).
   Ecology may determine that a discharger initially classified as a potential significant industrial user should be managed as a significant industrial user.

Quantitation Level (QL) - Also known as Minimum Level of Quantitation (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that the lab has used all method-specified sample weights, volumes, and cleanup procedures. The QL is calculated by multiplying the MDL by 3.18 and rounding the result to the number nearest to (1,2,or 5) x 10^n, where n is an integer. (64 FR 30417).
ALSO GIVEN AS:
The smallest detectable concentration of analyte greater than the Detection Limit (DL) where the accuracy (precision & bias) achieves the objectives of the intended purpose. (Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses in Clean Water Act Programs Submitted to the US Environmental Protection Agency December 2007).

Reasonable Potential - A reasonable potential to cause a water quality violation, or loss of sensitive and/or important habitat.

Responsible Corporate Officer - A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or have gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures (40 CFR 122.22).

Significant Industrial User (SIU) -

1) All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N and;
2) Any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling, and boiler blow-down wastewater); contributes a process wastestream that makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority* on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement [in accordance with 40 CFR 403.8(f)(6)].
   Upon finding that the industrial user meeting the criteria in paragraph 2, above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the Control Authority* may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with 40 CFR 403.8(f)(6), determine that such industrial user is not a significant industrial user.
   *The term "Control Authority" refers to the Washington State Department of Ecology in the case of non-delegated POTWs or to the POTW in the case of delegated POTWs.

Slug Discharge - Any discharge of a non-routine, episodic nature, including but not limited to an accidental spill or a non-customary batch discharge to the POTW. This may include any pollutant released at a flow rate that may cause interference or pass through with the POTW or in any way violate the permit conditions or the POTW's regulations and local limits.

Soil Scientist - An individual who is registered as a Certified or Registered Professional Soil Scientist or as a Certified Professional Soil Specialist by the American Registry of Certified Professionals in Agronomy, Crops, and Soils or by the National Society of Consulting Scientists or who has the credentials for membership. Minimum requirements for eligibility are: possession of a baccalaureate, masters, or doctorate degree from a U.S. or Canadian institution with a minimum of 30 semester hours or 45 quarter hours professional core courses in agronomy, crops or soils, and have 5,3,or 1 years, respectively, of professional experience working in the area of agronomy, crops, or soils.

Solid Waste - All putrescible and non-putrescible solid and semisolid wastes including, but not limited to, garbage, rubbish, ashes, industrial wastes, swill, sewage sludge, demolition and construction wastes, abandoned vehicles or parts thereof, contaminated soils and contaminated dredged material, and recyclable materials.

Soluble BOD_5 - Determining the soluble fraction of Biochemical Oxygen Demand of an effluent is an indirect way of measuring the quantity of soluble organic material present in an effluent that is utilized by bacteria. Although the soluble BOD_5 test is not specifically described in Standard Methods, filtering the raw sample through at least a 1.2 um filter prior to running the standard BOD_5 test is sufficient to remove the particulate organic fraction.

State Waters - Lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and watercourses within the jurisdiction of the state of Washington.

Stormwater - That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a storm water drainage system into a defined surface water body, or a constructed infiltration facility.

Technology-Based Effluent Limit - A permit limit based on the ability of a treatment method to reduce the pollutant.

Total Coliform Bacteria - A microbiological test, which detects and enumerates the total coliform group of bacteria in water samples.

Total Dissolved Solids (TDS) - That portion of total solids in water or wastewater that passes through a specific filter.

Total Suspended Solids (TSS) - Total suspended solids is the particulate material in an effluent. Large quantities of TSS discharged to a receiving water may result in solids accumulation. Apart from any toxic effects attributable to substances leached out by water, suspended solids may kill fish, shellfish, and other aquatic organisms by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids can screen out light and can promote and maintain the development of noxious conditions through oxygen depletion.

Upset - An exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limits because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

Water Quality-Based Effluent Limit - A limit imposed on the concentration of an effluent parameter to prevent the concentration of that parameter from exceeding its water quality criterion after discharge into receiving waters.

APPENDIX D – TECHNICAL CALCULATIONS

Several of the Excel® spreadsheet tools used to evaluate a discharger's ability to meet Washington State water quality standards can be found on Ecology's homepage at http://www.ecy.wa.gov/programs/eap/pwspread/pwspread.html.

Effluent and Receiving Water Critical Conditions

Facility:	SCRWRF			Design Case:	Reasonable Potential - low flo		
Receiving Water:	Spokane River above Green St						
	Effluent Data			**Receiving Water Data**			
CLICK HERE FOR INSTRUCTIONS	Annual Average Flow	Monthly Average Flow	Daily Maximum Flow	7Q10 Critical Flow	30Q5 Critical Flow	Harmonic Mean Flow	%flow for dilution
Flow (MGD)	8.00	8.50	12.00	370.33	518.46	1110.99	25
(cfs)	12.38	13.15	18.57	573.00			
Critical Temp (1DMax or 7DADMax) °C	20.00			18.10			
(°F)	68.0			64.6			
Critical Hardness (mg/L CaCO3)	120.00	Effluent Data		56.50	Receiving Water Data		
Critical pH (s.u.)	7.00	←		8.06	←		
Critical Alkalinity (mg/L as CaCO3)	100.00			55.00			
Enter own pH & Temp for Ammonia Criteria?	n			Enter own Dilution Factors (DFs)?		n	
	pH	Temp (°C)			Acute DF		
@ Acute Boundary					Chronic DF		
@ Chronic Boundary					Human Health (non C) DF		
					Human Health (Carcn) DF		
	@ Acute Boundary	@ Chronic Boundary	Whole River Dilution (@ 7Q10 Flow)	@ 30Q5 River Flow (non C)	@Harmonic Mean River Flow (Carcn)		
Dilution Factor	1.77	11.89	44.57	16.25	35.72		
(% effluent)	56.45	8.41	2.24	6.15	2.80		
Hardness	92.34	61.84	57.92	-	-		
Alkalinity	80.40	58.78	56.01	-	-		
Max pH (s.u.)	7.14	7.67	7.91	-	-		
Max Temp (°C)	19.17	18.26	18.14	-	-		
Max Temp (°F)	66.51	64.87	64.66	-	-		

Pollutant, Effluent, and Receiving Water Data

Facility	SCRWRF
Receiving Water	Spokane River above Green St
Design Case	Reasonable Potential - low flow

			Freshwater Quality Criteria		Metals Translators			Enter Effluent Data					Enter RW Data
Pollutant, CAS No. & Application Ref. No.	priority pollutant?	standard	acute	chronic	acute	chronic	Probability (0.95 - WQ Based; 0.5 - Human Health)	max effluent concentration (measured)	# of data points	Coefficient of Varation	#samples per month for compliance monitoring	50% percentile effluent conc for HH RPD, when n>10 (leave blank otherwise)	Ambient Concentration
			ug/L	ug/L				ug/L				ug/L	ug/L
AMMONIA unionized	N	WQ Stnd	21061.6	1689.4	0.0	0.0	0.95	8.0	12	0.6	12		0.02

Summary of Effluent Reasonable Potential Determination & Limits

Facility	SCRWRF
Receiving Water	Spokane River above Green St
Design Case	Reasonable Potential - low flow

POLLUTANT	priority pollutant?	standard	Maximum Expected (or 50%) Effluent Concentration, µg/L	Does reasonable potential exist?	Receiving Water: Upstream RW Conc., µg/L	Acute Boundary: RW Acute Criteria, µg/L	Acute Boundary: Conc @ Acute MZ Boundary, µg/L	Chronic Boundary: RW Chronic (or Human Health) Criteria, µg/L	Chronic Boundary: Conc @ Chronic (or Human Health) MZ Boundary, µg/L	Permit Limits: Daily Maximum Limit, µg/L	Permit Limits: Monthly Average Limit, µg/L
AMMONIA unionized	N	WQ Stnd	13.0	NO	0.02	21061.6	7.348	1689.4	1.112		

APPENDIX E – RESPONSE TO COMMENTS

The public notice that informed the public that a draft permit was available for review was published in the Spokesman Review on June 28, 2011. Ecology received comments on the draft permit following the 30-day public comment period. All comments and Ecology's responses are attached to this fact sheet as Attachment A.

APPENDIX F – REVISED TECHNICAL CALCULATIONS

Several of the Excel® spreadsheet tools used to evaluate a discharger's ability to meet Washington State water quality standards can be found on Ecology's homepage at http://www.ecy.wa.gov/programs/eap/pwspread/pwspread.html.

Commenter on the fact sheet noted a data entry mistake. The entry for maximum effluent concentration should have been 8000 ug/L instead of 8 ug/L. The corrected reasonable potential calculation for ammonia follows:

Pollutant, Effluent, and Receiving Water Data

Facility	SCRWRF
Receiving Water	Spokane River above Green St
Design Case	Reasonable Potential - low flow

			Freshwater Quality Criteria		Metals Translators			Enter Effluent Data					Enter RW Data
Pollutant, CAS No. & Application Ref. No.	priority pollutant?	standard	acute	chronic	acute	chronic	Probability (0.95 - WQ Based; 0.5 - Human Health)	max effleunt concentration (measured)	# of data points	Coefficient of Varation	#samples per month for compliance monitoring	50% percentile effluent conc for HH RPD, when n>10 (leave blank otherwise)	Ambient Concentration
			ug/L	ug/L				ug/L				ug/L	ug/L
AMMONIA unionized	N	WQ Stnd	21061.6	1689.4	0.0	0.0	0.95	8000.0	12	0.6	12		0.02

Summary of Effluent Reasonable Potential Determination & Limits

Facility	SCRWRF
Receiving Water	Spokane River above Green St
Design Case	Reasonable Potential - low flow

					Receiving Water	Acute Boundary		Chronic Boundary		Permit Limits	
POLLUTANT	priority pollutant?	standard	Maximum Expected (or 50%) Effluent Concentration, µg/L	Does reasonable potential exist?	Upstream RW Conc, µg/L	RW Acute Criteria, µg/L	Conc @ Acute MZ Boundary, µg/L	RW Chronic (or Human Health) Criteria, µg/L	Conc @ Chronic (or Human Health) MZ Boundary, µg/L	Daily Maximum Limit, µg/L	Monthly Average Limit, µg/L
AMMONIA unionized	N	WQ Stnd	13001.5	NO	0.02	21061.6	7339.2	1689.4	1093.3		

APPENDIX G

Guidance on Water Quality Based Effluent Limits Set Below Analytical Detection/Quantitation Limits

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, WA 98101

April 25, 2005

MEMORANDUM

SUBJECT: Guidance on Water Quality Based Effluent Limits Set Below Analytical Detection/Quantitation Limits

FROM: Cindi Godsey, NPDES Permits Unit
Michael Lidgard, Manager, NPDES Permits Unit
Kim Ogle, Manager, NPDES Compliance Unit

TO: NPDES Permits Unit Consistency Book

The purpose of this memorandum is to provide guidance to EPA Region 10 permit writers and compliance staff, for permitting, monitoring, and enforcement of water quality-based effluent limits set below the analytical detection/quantitation limit. This guidance is for effluent limits that are greater than zero but less than the minimum level (ML).

NPDES permits must include the water quality based effluent limit regardless of the proximity of the limit to the analytical detection level. Where the effluent limit concentration is below the analytical detection level for the pollutant of concern the following is recommended:

- The NPDES permit should include the most sensitive Method Detection Level (MDL) from an EPA approved analytical test method necessary for compliance monitoring. The analytical test method should be approved under 40 CFR 136, or other appropriate method if one is not available under 40 CFR 136. The permit should also identify the ML as the compliance level.

- The NPDES permit should state that any sample analyzed in accordance with a method having the appropriate MDL and ML and found to be below the ML will be considered in compliance with the permit limits unless other monitoring information indicates a violation.

- The permit should specify how samples should be reported. Suggested language: For purposes of reporting on the DMR for a single sample, if a value is less than the MDL, the permittee must report “less than {numeric value of the MDL}” and if a value is less than the ML, the permittee must report “less than {numeric value of the ML}.”

Where more than one sample is being considered, the permit should specify how effluent samples below the ML should be utilized for purposes of averaging. Suggested language: For purposes of calculating monthly averages, zero may be assigned for values less than the MDL, the {numeric value of the MDL} may be assigned for values between the MDL and the ML. If the average value is less than the MDL, the permittee must report "less than {numeric value of the MDL}" and if the average value is less than the ML, the permittee must report "less than {numeric value of the ML}." If a value is equal to or greater than the ML, the permittee must report and use the actual value. The resulting average value must be compared to the compliance level, the ML, in assessing compliance.

- Special conditions should be included in the permit which help ensure that the limits are being met and that excursions above water quality standards are not occurring. Special conditions could include: fish tissue sampling, sediment monitoring, limits/monitoring on internal wastestreams, or limits/monitoring for surrogate parameters.

RATIONALE

EPA's recommended approach in the *Technical Support Document for Water Quality-based Toxics Control*, EPA, March 1991 (TSD, chapter 5, section 5.7.3), includes:

- The NPDES permit should include the most sensitive analytical test method that should be used for compliance monitoring. The analytical test method should be approved under 40 CFR 136, or other appropriate method if one is not available under 40 CFR 136.

- The NPDES permit should state that any sample analyzed in accordance with the specified method and found to be below the compliance level will be considered in compliance with the permit limit unless other monitoring information indicates a violation.

- Sample results at or above the ML should be reported as the observed concentrations whereas sample results below the compliance level should be reported as less than this level.

- The compliance level cited in the permit must be clearly defined and quantified. For most NPDES permitting situations, EPA recommends that the compliance level be defined in the permit as the ML. The ML is the level at which the entire analytical system gives recognizable mass spectra and acceptable calibration points.

- Special conditions should be included in the permit which help ensure that the limits are being met and that excursions above water quality standards are not occurring. Special conditions could include: fish tissue sampling, limits/monitoring on internal wastestreams, or limits/monitoring for surrogate parameters.

The TSD does not recommend an approach for averaging multiple sample results below the ML. However, a memorandum entitled *Questions and Answers on the Great Lakes Water Quality Guidance, Set 2* (March 20,1996; James Hanlon, Deputy Director of the Office of Science and Technology), states:

> In the case of determining compliance with average limitations, permitting authorities shall use applicable State and Tribal procedures to average and account for monitoring data (see Procedure 8, Section A.4) and, ... Permitting authority may have various approaches for specifying how effluent samples below the LOQ should be regarded for purposes of averaging (e.g., equal to zero, equal to one-half the LOQ, etc.).

DEFINITIONS

Limit of quantization means the smallest amount of chemical that can be reliably quantitated.

Method Detection Limit means the minimum concentration of a substance (analyte) that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte (see 40 CFR 136 Appendix B).

Minimum Level means the concentration at which the entire analytical system must give a recognizable signal and an acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specified sample weights, volumes and processing steps have been followed (*Technical Support Document for Water Quality-based Toxics Control*, EPA, March 1991).

3/6/01

Total Maximum Daily Load

PCB and Chlordane

Ohio River

From the Point in Pittsburgh to the State Border

Beaver, Lawrence, Washington and Allegheny Counties

Table of Contents

	Page
Introduction	**2**
Background	**2**
TMDL Development	**3**
Source Assessment	**5**
TMDL Calculation	**12**
Recommendations	**16**
Monitoring	**17**
Public Participation	**17**

Appendix A - STORET retrieval of PCB and chlordane fish tissue data

Appendix B – Comment and Response

Appendix C - References

Introduction

Pennsylvania has conducted monitoring of fish tissue contaminants since 1976. Early efforts were comprised of special studies in major water-bodies as well as smaller waters with suspected sources of contaminants. Routine sampling for tissue contaminants began in 1979 with implementation of the EPA "CORE" monitoring network that mandated collection of whole fish samples. Because Pennsylvania wanted the fish tissue monitoring program to focus on protection of public health, we began sampling both the edible portion and whole body at one-half of the stations. In 1987, Pennsylvania began sampling the edible portion almost exclusively. In order to increase spatial coverage, the Department also began rotating sampling through its routine ambient monitoring network and provided both Department of Environmental Protection (DEP) and Fish and Boat Commission field biologists the opportunity to sample suspected problem areas.

Fishing is a wholesome, relaxing pastime, and fish are nutritious and good to eat. Some fish, however, may accumulate contaminants to levels that may be harmful to those who eat them over a long period of time. In an attempt to protect public health, the Commonwealth periodically (at least annually) issues fish consumption advisories based on monitoring data from a number of sources. Advisories are issued jointly by the Department of Health, the Fish and Boat Commission, and DEP. The list of advisories is published in the "Pennsylvania Summary of Fishing Regulations and Laws" which is provided to each fishing license buyer, and is also available from the Department in hard copy and through the Internet at http://www.dep.state.pa.us. In addition, the annual list and any individual advisories needed between lists are issued using press releases.

A number of Pennsylvania water bodies with fish consumption advisories were listed on the Clean Water Act Section 303(d) List of Impaired Waters for 1996. They were listed because long-term, unrestricted consumption of these fish could potentially lead to human health problems. This document addresses contamination of fish tissue in the Ohio River, Beaver Lawrence, Washington, and Allegheny Counties by PCB and chlordane.

Background

This Total Maximum Daily Load (TMDL) applies to the Ohio River (Stream Code 32317) from the point in Pittsburgh to the State border, listed in Basins 20-B, D and G (RMI 981 to 941). The River Mile and the Segment Id for the 303(d) List are as follows:

The point in Pittsburgh to Beaver River ID 9917 [20-G] RMI 981 – 955.5
The point from Beaver River and Raccoon Creek ID 9918 [20-B] RMI 955.5-949.29
The point from Raccoon Creek to Montgomery Dam ID 9918 [20-B] RMI 949.29-948
The point from Montgomery Dam to Ohio/PA State Line ID 9918 [20-D] RMI948-940.74

The Ohio River was included on the 1998 Section 303(d) list [with IDs 9917 and 9918] as a high priority for TMDL development. It should be noted that in the 1996 303(d) List SWP 20-E designation as a low priority was erroneous.

The first advisory for Ohio River was issued on December 12, 1979. The public was warned not to eat carp taken near Brunot Island due to PCB contamination (6.0 ppm). A statewide release on June 26, 1986 included the same advice for carp at the Dashields and Montgomery Locks and Dams due to chlordane levels of 0.40 ppm and 0.28 respectively, and for channel catfish at Dashields due to PCB concentrations of 2.45 and 3.43 ppm respectively. These advisories were re-issued a number of times in cooperation with ORSANCO and other states. The carp and channel catfish advice remained generally unchanged until application of the Great Lakes protocol for 1998. At that time, the downstream segment limit was changed to the Montgomery Lock and Dam. The 1998 “Do Not Eat” advice remains for carp and channel catfish. Since implementation of the Great Lakes protocol, the public is advised to eat no more than one meal per month (Group 3) of walleye, sauger, white bass and freshwater drum from the point in Pittsburgh to the Mongomery Lock and Dam (RM 31.2). The advisory issued by Ohio and West Virginia is in place for the remainder of the main stem Ohio River in Pennsylvania. In this reach, one meal per week is given for largemouth bass, small mouth bass, spotted bass and sauger. One meal per month advice applies to white bass, hybrid striped badd and freshwater drum. Flathead catfish and channel catfish are limited to six meals per year.

TMDL Development

Endpoint Identification

The overall goal of a TMDL is to achieve the "fishable/swimmable" goal of the federal Clean Water Act. Because consumption advisories are in place for a number of species for PCB and chlordane, these goals are not being met in this segment of the Ohio River.

The specific goal of a TMDL is to outline a plan to achieve water quality standards in the water body. For this segment of the Ohio River, the TMDL goal is for levels of PCB and chlordane in the water column to be equal to or less than the Commonwealth's water quality criteria. The criteria, found in the "Water Quality Toxics Management Strategy - Statement of Policy" (Chapter 16 of the Department's rules and regulations) are 0.00004 ug/L (micrograms per liter, equivalent to parts per billion) for PCB and 0.0005 ug/L for chlordane. Both of these compounds are probable human carcinogens, and these are human health criteria developed to protect against excess cancer risk. Specifically, the Department's water quality toxics management program controls carcinogens to an overall risk management level of one excess case of cancer in a population of 1 million (1×10^{-6}). Expressing this another way, the probability of an individual getting cancer is increased by a factor of 1 in 1 million.

Two means were employed in an effort to obtain readily available data on instream PCB and chlordane levels for comparison to the criteria. First, the Department's Southwest Field Office

searched for PCB and chlordane data in or upstream from the Ohio River fish consumption advisory segment. Second, data from the EPA Storage and Retrieval System (STORET) was obtained. An "Inventory" retrieval that would include data collected by all agencies using STORET was run for all areas around the Department's fish tissue sampling stations. For the Ohio River, the search was conducted using a six-mile radius around Water Quality Network Station 902 and a 15-mile radius around the fish tissue sampling station just below the Montgomery Lock and Dam. This station is WQF32317-032.0 (Ohio River at Montgomery Lock and Dam) and WQN Station # 902 (Ohio River at RMI 969.2 miles; Bridge off SR4025 in Allegheny County). No water column data were found near Montgomery. A number of data points collected at WQN Station # 902 (1970 and 1977) and at Montgomery (1970 and 1979) were found. All samples were less than detection except for one sample that showed PCB 1260 at 0.4 ug/l. In any event, these data do not represent current conditions.

As a means to compare current conditions to the water quality criteria, an estimated water column concentration was calculated based on the fish tissue concentrations and bioconcentration factors. The calculation involves dividing the average fish tissue concentration by the bioconcentration factor to obtain a projected water column concentration.

The equation is:

$$\frac{TC}{BCF} = WC \times 1000, \text{ where}$$

TC = Tissue Concentration in mg/kg (equivalent to mg/L)
BCF = EPA Bioconcentration Factor in L/kg
WC = Water Column Concentration (estimated) in mg/L
(multiply by 1000 to obtain (ug/L)

The average fish tissue concentration is the mean of all samples shown in the table below. A Storet data retrieval of all the PCB and chlordane fish tissue data for all the fish tissue sampling stations on the Ohio River are included in Appendix A. The average concentration is used for two main reasons. First, the fish tissue samples are composites. This means that the sample result represents the average tissue concentration in three to five individuals, and not an exact value. Second, use of an average value considers the natural variation in tissue burden found in wild fish populations. The PCB bioconcentration factor (BCF) of 31,200 from the EPA criteria development document (EPA 440/5-80-068, October 1980) was used. The chlordane BCF of 14,100 from the EPA criteria development document (EPA 440/5-80-027, October 1980) was applied. These BCFs were used because no Bioaccumulation Factors (BAFs) are available for statewide use. The use of the BCFs is consistent with the provisions of the Department's water quality toxics management strategy. Average PCB and chlordane tissue levels were determined for each species using all samples. An estimated water column concentration was then calculated for each compound for each species. These estimated water column concentrations were averaged for each compound in order to provide a single estimated water column concentration for each parameter for the segment.

Fish Tissue Data Used to calculate the TMDL for the Ohio River

Parameter	Fish Species	Number of Data Sets	Range of Years	Years
PCB	Walleye	4	1988 - 1997	1988, 1991, 1992, 1997
	White Bass	2	1989 - 1995	1989, 1995
	Drum	2	1990 - 1997	1990, 1997
	Carp	13	1985 - 1994	1985, 1988, 1989, 1990, 1991, 1992, 1994, 1995, 1997
	Channel Cat	22	1988 - 1997	1988, 1989, 1990, 1991, 1992, 1994, 1995, 1997
Chlordane	Carp	13	1985 - 1994	1985, 1988, 1989, 1990, 1991, 1992, 1994, 1995, 1997
	Channel Cat	22	1988 - 1997	1988, 1989, 1990, 1991, 1992, 1994, 1995, 1997

The average PCB levels in the Ohio River segment are carp – 2.14 mg/kg; walleye and sauger mg/kg –0.605; white bass – 0.735; freshwater drum –0.740 and channel catfish - 2.92 mg/kg. The estimated concentration of PCB in the water column is 0.04577 ug/L. The average chlordane concentration in carp is 0.24 mg/kg and channel catfish is 0.276 mg/kg. The corresponding estimated water column concentration for chlordane is 0.01830 ug/L**.**

These estimated concentrations exceed the applicable water quality criteria. These values most likely do not represent the actual existing instream concentrations due to the basis for the back-calculation. The back-calculations from tissue level to water column concentration were performed using data on species for which consumption advisories have been issued, i.e., fish with elevated tissue levels of these compounds. It must also be noted that the average tissue concentrations may be artificially elevated because of the use of one-half of the detection limit for data reported as less than detection. The actual concentration could lie anywhere between zero and the detection limit. The use of one-half of the detection limit is merely a means of obtaining a reasonable value to use in calculating the average. While the actual concentrations in the water column are not known, they are likely to be lower than the calculated estimates.

Source Assessment

The production and use of PCB in the United States was banned in July of 1979. While it is now illegal to manufacture, distribute, or use PCB in the United States, these synthetic oils were used in the past as insulating fluids in electrical transformers and other products, as cutting oils, and in carbonless paper. PCB was introduced into the environment while use was unrestricted, and occasional releases still occur. In addition, some permitted discharges and Superfund sites contribute PCB to surface water. Once in a waterbody, PCB becomes associated with solids particles and enters the sediments. PCB is very resistant to breakdown and thus remains in river and lake sediments for many years.

Chlordane is a man-made organochlorine compound that was widely used as a broad-spectrum agricultural pesticide before its use was restricted to termite control around building foundations. All uses of chlordane have been banned since April 1988. Chlordane may be introduced to surface waters through contaminated ground water or surface runoff, and is therefore a nonpoint source contaminant. Once in a waterbody, chlordane becomes associated with solids particles and enters the sediments. Fish are exposed to and accumulate PCB and chlordane from the water, through contact with or ingestion of sediments, and in the food they eat.

It should be noted that in the Southwest Region, the configuration of the listed streams (primarily the Allegheny, Monongahela and Ohio Rivers) consists of a series of Locks and Dams. Any PCB contaminated sediments tend to stay in the river pools rather than being washed out as they would be on free flowing streams. All known point source discharges of PCB or Chlordane in the Southwest region have been required to obtain an NPDES permit with water quality based effluent limits and a requirement of “not detectable” for limits lower than detection.

Two methods were employed in order to locate known sources of PCB or chlordane in the Ohio River. First, the Southwest Field Office searched for information on known existing or historical sources that might contribute PCB or chlordane in or upstream from the fish consumption advisory reach. Second, the EPA Permit Compliance System (PCS) database was searched for any major discharge permits containing PCB or chlordane as an effluent limitation. No major dischargers for either compound were found on the PCS.

Prior to 1980, no federal legislation existed which addressed past disposals of hazardous wastes. Therefore, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to address the hazards created from past disposals. Sites identified as possible sources of PCBs are to be remediated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which is commonly referred to as Superfund. The act deals with environmental response, providing mechanism for reacting to emergency situations and to chronic hazardous material releases. In addition to establishing procedures to prevent and remedy problems, it establishes a system for compensating appropriate individuals and assigning appropriate liability.

CERCLA required the Environmental Protection Agency (EPA) to develop criteria for prioritizing among sites potentially needing remediation. Those sites scoring high enough on the ranking system are included on the National Priorities List (NPL). Only NPL sites are eligible for EPA remedial action. Once a site on the NPL has been selected for remediation, a formal process must be followed to determine and implement appropriate actions. A Remedial Investigation/Feasibility Study (RI/FS) is done first. The conditions at the site must be determined, including the extent of contamination, migration offsite, and potential for human and environmental exposure. A series of specific remediation alternatives must be developed, including specification of costs, technical feasibility, and environmental impacts. Based on the RI/FS, a Record of Decision (ROD) is written by the EPA, which documents and justifies the selection of a particular cleanup option. This process must include substantial public and state participation. Following the ROD, the detailed engineering plans are prepared (the Remedial Design), and implementation (Remedial Action) can begin.

The Superfund Amendments and Reauthorization Act (SARA) of 1986 provided additional guidance for determining "how clean is clean" for the level of removal during a site cleanup. Cleanups must be protective of human health and the environment, be cost-effective, and use permanent solutions, including treatment and resource recovery, as much as practicable. Land disposal is discouraged.

The decision-making framework for the management of sediments has two major components: the remedial investigation and the feasibility study (RI/FS). For a Superfund site with contaminated sediments, the remedial investigation identifies the character of the sediments and the extent of contamination, among other information. The feasibility study includes an evaluation of all reasonable remedial alternatives, including treatment and non-treatment options.

Pennsylvania's Hazardous Sites Cleanup Act (HSCA) was created so that Pennsylvania could effectively fulfill their statutory responsibilities under CERCLA; recover costs incurred fulfilling those statutory responsibilities; and supplement CERCLA by creating a state program for cleanup of sites not included on the National Priorities List.

The following sites are identified as potential non-point sources of PCB to the Ohio River: the Breslube-Penn site, the former H.K. Porter site, the former Allis Chalmers site, the Texas Eastern Holbrook compressor station, and the Ohio River Park Site:

Former H.K. Porter Site

The H.K. Porter site is located in Hopewell Township, Beaver County on Shouse Run (stream code 36638, RMI 0.2 miles). Shouse Run is tributary to the Ohio River at RMI 966.2. PCB concentrations in the soils are documented to be as high as 130 mg/Kg, however no PCBs were detected in Shouse Run. This site is being addressed under the state's HSCA program.

The former H.K. Porter Drum Dump Site is located on approximately 17.5 acres of property situated ¼ mile west of the Ohio River and adjacent to State Route 51 (Rt. 51) in Hopewell

Township, Beaver County, Pennsylvania. One small stream, Shouse Run, transects the property, and is located at the toe of the disposal area, which contained between 1,500 and 2,000 rusted 55-gallon drums containing various hazardous wastes. Analytical results from the associated soils and wastes collected from October 1990 through January 1993 revealed the presence of lead and PCB at elevated concentrations.

In 1991, H.K. Porter excavated approximately 7,875 tons of non-hazardous wastes and 4,260 tons of hazardous wastes from the disposal area. In the late 1990s, DEP conducted additional cleanup activities under HSCA that included the excavation and off-site disposal of approximately 50,000 cubic yards of hazardous waste. DEP then installed a soil cover and revegetated the entire site. Therefore, the site does not represent a source of contaminated soil erosion to Four Mile Run or to the Ohio River.

Breslube-Penn Site

The Breslube-Penn site is located in Coraopolis, Allegheny County, Pennsylvania. The site is situated along Montour Run, which is a tributary to the Ohio River. The facility, identified by EPA identification number PAD089667695, site comprises approximately 11.1 acres and borders Montour Creek. The facility historically operated as a solvent recovery and oil recycling facility and currently is inactive.

Elevated levels of PCB have been found in soil and groundwater at a soil staging area and filter cake area, where soils and filter cake wastes from past remedial activities have been stockpiled on site. Sampling of this pile, which is 90 feet wide, 145 feet long and 30 feet high revealed an average PCB concentration of 52 mg/kg. The site may be an existing source of PCB to the Ohio River through contaminated soil erosion, but there is insufficient data to quantify its contribution.

The Breslube-Penn site is undergoing investigation and cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The members of the Breslube Joint Steering Committee have entered into an Administrative Order on Consent with the EPA to conduct a Remedial Investigation/Feasibility Study at the site (RI/FS). After approval and implementation of the RI/FS, remediation activities will be implemented.

Former Allis Chalmers Site

The Allis Chalmers site is located in Pittsburgh, Allegheny County on the North Bank of the Ohio River (RMI 979) across from Brunot island. During the 1970s EPA conducted an investigation and it was documented that a 30,000 gallon vault of PCBs was at this site. Based on information provided by EPA, the 30,000 gallon vault of PCB contaminated oil at this site has since been removed, and there is no evidence to suggest this is currently a source of PCB contamination in the Ohio River basin.

Texas Eastern Holbrook Compressor Station

The Texas Eastern Holbrook Compressor Station is located in Richhill Township, Greene County and is covered by NPDES permit PA0216593 in the Ohio River watershed (North Fork of Dunkard Fork Creek at RMI 1.96). This site was an historic nonpoint source of PCBs in the watershed. As a result of a statewide CO&A with Texas Eastern, this site and others were required to remove PCB contaminated soil, and to collect and treat contaminated groundwater. The facility currently discharges treated groundwater to Dunkard Fork Creek, an Ohio River tributary at River Mile 1.96, under National Pollutant Discharge Elimination System NPDES permit No. PA0216593 with "not detectable" limits, and the groundwater is treated with carbon. Because of the remedial actions conducted, the site no longer is a source of PCB contamination in the watershed.

Ohio River Park

This site is located approximately 10 miles downstream of Pittsburgh, Pennsylvania on the western end of Neville Island, which is situated within the Ohio River. This site has a NPL status of final. Remedial actions have been completed under CERCLA and a sports complex has been developed on the site, thereby covering any remaining contaminated soil that could serve as a potential nonpoint source of PCB. Therefore, this site is not a nonpoint source of PCB to the Ohio River.

Atmospheric Deposition: Development of the TMDLs for the Ohio River considers background pollutant contributions. The natural in-stream background concentration of chlordane is assumed to be zero because chlordane is a man-made product and there are no natural sources. PCB is also a man-made product and no natural sources of PCB load exists in the environment. Nonetheless, due to the pervasive use of PCBs prior to their ban in the late 1970s and their slow degradation rates, PCBs are now widespread in the environment. This pervasive distribution of PCBs in air, soil, and water effectively creates a background load of PCB in all water bodies. Atmospheric deposition can contribute to background concentrations of PCB in water bodies.

Atmospheric deposition of PCB plays a dominant role in PCB cycling in many freshwater systems. Monitoring conducted under the Integrated Air Deposition Network (IADN) and the Great Waters Program indicate that wet and dry deposition of PCB can vary greatly both regionally and by season. According to EPA's Lake Michigan Mass Balance (LMMB) Study, atmospheric transport and deposition of PCB provides about 82 percent of the total PCB load to Lake Michigan. Because PCB is no longer produced, the major source of PCB to the atmosphere is volatilization from sites where they have been stored, disposed, or spilled; from incineration of PCB-containing products; and, to a lesser extent, from PCB formation during production processes.

Although analysis predicts that atmospheric deposition may provide a significant source of PCB load to the water body, volatilization from the water column and sediments is likely to result in continuing PCB loss from the water body, thereby reducing, or negating, the atmospheric load. Hillery, et. al., (1998) found that the Great Lakes are currently experiencing a net loss of PCB. In

each of the five Great Lakes, the net deposition of PCB is believed to be insignificant because gas transfer out of the lakes counteracts the flow into the lakes from wet and dry deposition. Similar processes are likely to be occurring in Pennsylvania water bodies.

PCB air deposition values specific to Pennsylvania have not been identified. Therefore, no definitive data exists to document this as a source of PCBs to the impaired water.

Driving Directions: from Philadelphia to HK Porter Site:

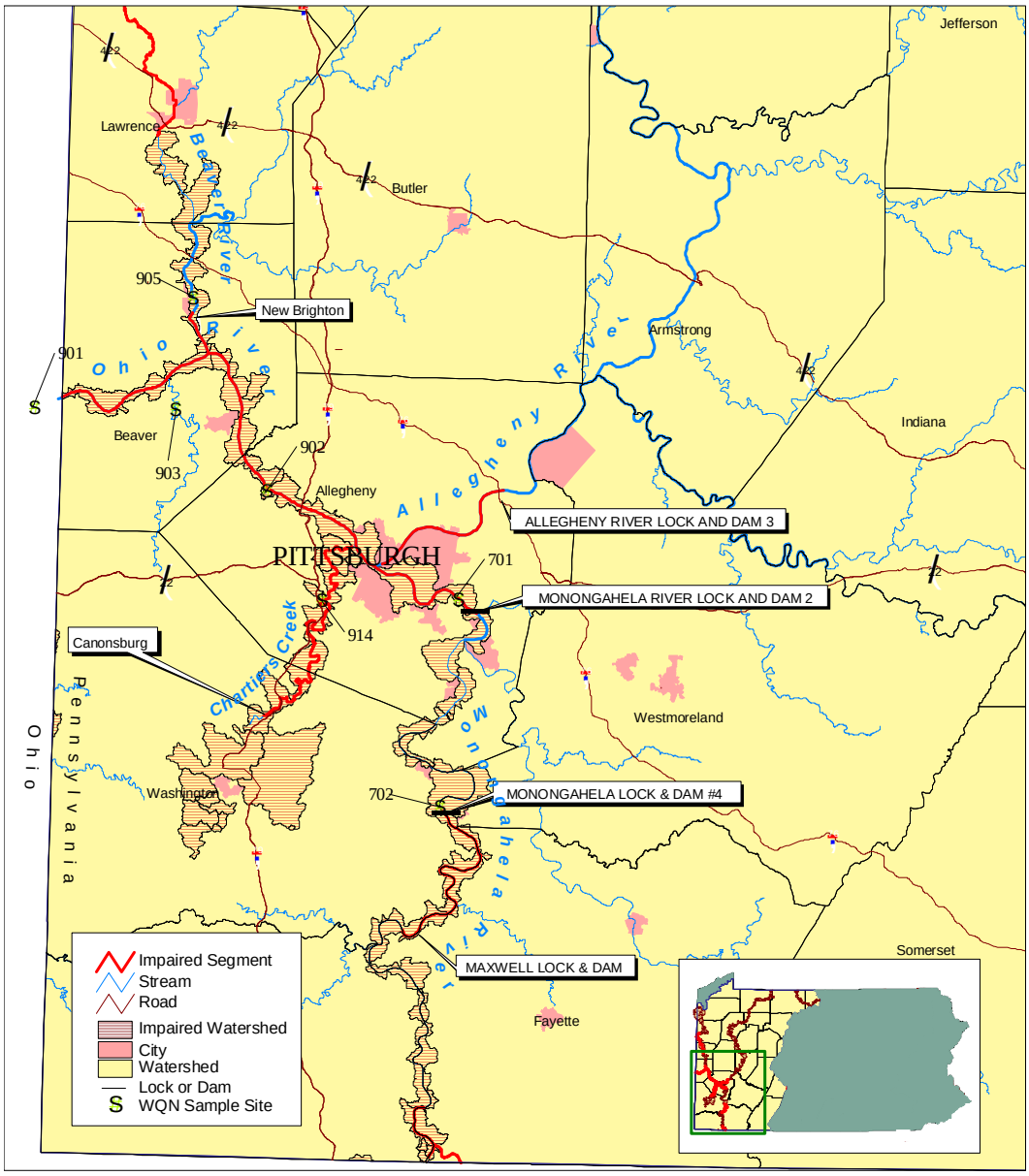
1. Take I-76 West to I-79, Exit No. 3 onto I-79 South
2. Take I-79 South to Exit 17, take Rt 51 North
3. Follow Route 51 North 12.0 miles to the Ambridge Bridge
4. Continue on Rt 51 North.
5. The site is on the left side of route 51 about 1.5 miles north of the Ambridge Bridge

Driving Directions from Philadelphia to Allis Chalmers Site:

1. Take I-76 West to I-79, Exit No. 3
2. Follow I-79 South to Exit 19, and take Rt 65 South about 6 miles
3. The site is on the right

Driving Directions from Philadelphia to Texas Eastern Holbrook Station:

1. Take I-76 West to Exit 8, Take I-70 West
2. Follow I-70 West to I-79
3. Take I-79 South to Exit 3, and get on Rt. 21 West
4. Follow Rt 21 West to Wind Ridge.
5. Stay on Rt 21 West for 1.5 miles past Wind Ridge and turn left at the last road before Ryerson Station.
6. The Compressor Station is about 0.5 miles up this road on the right



TMDL Calculation

Development of TMDLs includes consideration of background pollutant contribution, appropriate and/or critical stream flow, and seasonal variation.

Monitoring for Background Concentrations of PCBs

PCB concentrations in surface waters may be greater than zero in waters where no specific source, either point or nonpoint source, can be identified. Only site-specific data can be used for the TMDL calculations. However, because sufficient data does not exist for this particular

waterbody segment that would allow the selection of such a background value for TMDL calculation purposes, a value of zero was used. In order to verify this assumption, or to properly select a background concentration for calculating a TMDL, site-specific water quality monitoring for PCBs may be conducted at this site some time in the future.

If future background sampling were to identify PCB levels greater than zero for this segment, Pennsylvania would review and appropriately revise the TMDL. Currently, there is no approved and widely available analytical method for analyzing water column samples at the ultra low levels at which PCBs may be present. EPA method 1668-A may offer such capability, but is currently only approved for use in analyzing sewage sludge, is very expensive to run and of limited availability.

PCB and chlordane are probable human carcinogens. Carcinogenesis is a nonthreshhold effect, an adverse impact that may occur at any exposure greater than zero. Such an effect is often related to long-term exposure to low levels of a particular chemical or compound, rather than an immediate effect due to a short duration exposure to a high level. As noted earlier, the Department's water quality toxics management program uses a cancer risk level of 1×10^{-6} to protect human health. Attainment of this risk level is predicated on exposure that includes drinking 2 liters of water and ingesting 6.5 grams of fish per day over a 70-year lifetime. The Department uses harmonic mean flow as the appropriate design condition for dealing with exposure to carcinogens. This is a long-term flow condition that will, when applied to the Total Maximum Daily Load, represent long-term average exposure. Because seasonal increases and decreases in concentration are less important than the long-term exposure to a carcinogen, use of harmonic mean flow adequately considers seasonal variations in PCB and chlordane concentrations.

The calculation of the Ohio River TMDLs utilizes the water quality criteria and flow data from the U.S. Geological Survey (USGS) surface water discharge station 11.8 miles downstream from confluence of Allegheny and Monongahela Rivers [03086000]. The harmonic mean flow was calculated using the low flow yield method found in the Department's "Implementation Guidance - Design Stream Flows" (Document No. 391-2000-023, p 4). The Segment Qhm for the Ohio River is 20,500 cfs (based on ORSANCO's Report Appendix B – Critical Flow Values Montgomery Dam to Willow Island Dam.)

The Segment Qhm is used in calculating the Total Daily Maximum Load (TMDL) by multiplying it by the water quality criterion and a multiplier (0.00539) to convert from cfs x ug/L to lbs/day (pounds per day).

The PCB TMDL for the Ohio River is calculated as follows:

20500 cfs x 0.00004 ug/l = 0.82 cfs x ug/l x 0.00539 = 0.00442 lbs/day.

The chlordane TMDL is calculated as follows:

20500 x 0.0005 ug/l = 10.25 cfs x ug/l x 0.00539 = 0.0553 lbs/day.

The Total Maximum Daily Load of PCB for this segment of the Ohio River is 0.00442bs/day.. The chlordane TMDL is 0.0553 lbs/day.

Percent Reduction for Ohio River Basins 20-B, D and G

The goal of this TMDL is to achieve the water quality criteria in order to protect public health. In order to achieve this, the instream concentration must be reduced from the estimated current levels to the criteria. Percent reduction is calculated using the following formula:

% Reduction = (1 - TMDL Goal/ Existing Concentration) x 100.

The percent reduction for PCB is calculated as follows:

% Reduction = (1 - 0.00004/0.04577) x 100
% Reduction = (1 - 0.00087) x 100 = 99.91 %

Percent reduction for chlordane is:

% Reduction = (1 - 0.0005/0.0183) x 100
% Reduction = (1- 0.02732) X 100 = 97.27 %

Overall reductions of 99.9% for PCB and 97.3% for chlordane are needed to achieve the TMDL goal.

Margin of Safety (MOS)

Achievement of the TMDLs will generally ensure achievement of the water quality criteria. To account for uncertainties that may be associated with the TMDL calculations, the Department proposes to hold 10% of the TMDLs in reserve. Applying this 10% margin of safety results in a PCB MOS of 0.000442 lbs/day and the chlordane MOS of 0.005525 lbs/day. The remaining load is available for allocation to all sources for the Ohio River segment.

Wasteload Allocations (WLAs) and Load Allocations (LAs)

There is no data available on PCB or chlordane concentrations upstream of the segment of the Ohio River from Basins 20-B, D and G.

Since the former point sources identified in the Source Assessment Section have ceased operations, there are no known point source discharges of PCBs in the Ohio River watershed other than those identified in the TMDL reports for Chartiers Creek. The NPDES source that was initially identified was Texas Eastern Holbrook Station (PA 0216593) is primarily from treated discharge of PCB contaminated ground water. However, this discharge flows into North Fork Dunkard Creek[Quad: Wind Ridge, PA] to Dunkard Creek to Wheeling North Fork Creek

[Quad: Majorsville, W-VA-PA] to Ohio River. This segment of the Ohio River watershed lies in West Virginia and not in Pennsylvania. Therefore, the PCB load contributed by this point source is not considered. The PCB load is contributed primarily by nonpoint sources and may be introduced to surface water through contaminated ground water, surface run-off, or contaminated sediment. The Source Assessment notes that once in a water body, PCB becomes associated with soil particles and enters the sediments. Fish tissue contamination results from this sediment load.

Because of this and because there is no way to accurately quantify loadings from groundwater or erosion, the entire remaining PCB load of 0.00398 pounds per day is assigned to a Load Allocation for the instream sediment and tributary streams for the Ohio River segment Basins 20 –B, D and G.

Because there are no known point sources of Chlordane to this segment of the Ohio River, it is treated as a nonpoint source contaminant that may be introduced to surface water through contaminated ground water, surface runoff, or contaminated sediment. Chlordane also becomes associated with soil particles and enters the sediments once in a water body. Fish tissue contamination results from this sediment load. Because of this and because there is no way to accurately quantify loadings from groundwater or erosion, the entire TMDL for chlordane for the reach of the Ohio River is assigned to Load Allocation (LA) for the instream sediment. For the Ohio River segment from Basins 20-B, D and G, the chlordane Load Allocation (LA) is 0.04973 pounds per day.

TMDL Summary

The TMDLs for the Ohio River segment from Basins 20-B, D and G can be summarized as follows:

Ohio River From Basins 20-B, D and G				
Pollutant	**TMDL (lbs/day)**	**WLA (lbs/day)**	**LA (lbs/day)**	**MOS (lbs/day)**
PCBs	0.00442	0.0	0.00398	0.000442
Chlordane	0.0553	0.0	0.0497	0.00553

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TMDL Verification

The stated goal of this TMDL is to meet the PCB and chlordane water quality criteria for the protection of public health in this reach of the Ohio River. Another way to state the goal is to reach a point where fish consumption advisories are no longer needed because tissue levels of PCB and chlordane are no longer above the levels of concern.

The three agencies involved with the issuance of fish consumption advisories in Pennsylvania currently apply the "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory" (commonly referred to as the Great Lakes protocol) for issuance of consumption advisories due

to PCB. Following this method, meal-specific consumption advice is issued by species. The first level of consumption advice, eat no more than one meal per week, is issued when the tissue PCB concentration is 0.06 to 0.20 mg/kg. The upper limit for unrestricted consumption is 0.05 mg/kg. In order to verify the level of protection the PCB TMDL would provide, the estimated fish tissue concentration expected to accumulate at a water column concentration of 0.00004 ug/L was calculated. Reaching the PCB criterion would result in an estimated tissue concentration of 0.001 mg/kg, well below the 0.05 mg/kg level for unrestricted consumption.

Pennsylvania currently uses the U.S. Food and Drug Administration (FDA) Action Level of 0.3 mg/kg for issuance of advisories due to chlordane contamination. Achievement of the chlordane water quality criterion of 0.0005 ug/l would result in an estimated fish tissue concentration of 0.007 mg/kg, much lower than the Action Level. The consumption advisory could be lifted at that level.

This TMDL analysis estimates, based on back calculations from fish tissue concentration, that the concentration of PCBs in the receiving water exceeds water quality standards. The TMDL analysis also shows that the existing loads of PCBs need to be reduced. The source analysis identifies various sources of this contamination including Breslube-Penn, a Superfund site. For this TMDL and the specific superfund site identified, it was assumed that controls associated with remediation of the identified sites will result in the removal of the pathway that is associated with sediment loading to the water. This elimination of the surface runoff and sediment loading pathway may reduce the associated runoff of soil-bound PCBs.

The TMDL focuses on the amount of PCBs that the water body can receive and still maintain water quality standards while the Superfund/CERLA programs focus on meeting environmental goals by eliminating the pathways of exposure of pollutants. Together, these programs can meet the allocations/goals set in this TMDL. The collaboration of the Superfund program and the TMDL program to address the impacts of legacy pollutants, such as PCBs, is the next step in an on-going and complex process of meeting water quality standards through the remediation of contaminated sediments. The integration of two often-separate programs is necessary in situations such as this where a land-based source contributes to the contamination of a waterbody. The goal of the TMDL is to reduce PCBs in the water column to water quality standards levels. This is separate from the Superfund goal which is to eliminate the pathway of contamination and not necessarily the elimination of the pollutant. Superfund balances remediation with risk determinations of human health and feasability. The TMDL program does not - it is absolute in its goal to meet standards.

A TMDL is a planning tool that may change over time as the data improves and the watersheds change. As additional data are collected the identified sources of PCBs are confirmed, a determination will be made as to whether this new data is significant and a TMDL revision is necessary. In some instances the final decision on remediation methods at the Superfund sites have not yet been made. While it is expected that this TMDL will serve as a decision tool for those remediation plans, it may be found that the removal of the sediment/runoff pathway may not be feasible or acceptable for other reasons. If this should be the case, the TMDL would be

reopened and the allocations re-distributed, but still meeting the total allowable load from all sources, to take into consideration the final remediation plan. However, it is important at this time to provide a goal that is based on the need to meet water quality standards to serve as a focal point for site plan development.

Recommendations

The use of both PCB and chlordane has been banned in the United States, so there should be no new point sources to which controls can be applied. There are no known additional sources of PCB and chlordane to the Ohio River segment other than the ones identified above. PCB and chlordane present in the main stem of Ohio River are believed to reside primarily in the sediment due to historical use and improper disposal practices.

Generally, the levels of PCB and chlordane are expected to decline over time due to the bans on use through natural attenuation. Examples of processes in natural attenuation are covering of contaminated sediments with newer, less contaminated materials, and flushing of sediments during periods of high stream flow.

Natural attenuation may be the best implementation method because it involves less habitat disturbance/destruction then active removal of contaminated sediments. Mechanical or vacuum dredging removes the habitat needed by certain benthic macroinvertebrates. In addition some of these organisms will be killed during the dredging process. Suspension of sediments during dredging may also cause abrasive damage to the gills and/or sensory organs of benthic macroinvertebrates or the gills of fish. Suspended sediments can also affect the prey gathering ability of sight-feeding fish. In addition, active removal may cause resuspension of contaminated materials thus making PCB and chlordane available for additional uptake. This alternative is also the least costly option.

For the Ohio River segment outlined above, long-term natural attenuation is the best alternative. This approach provides reasonable assurance that the TMDL will be implemented.

More than ten Federal statutes provide authority to many EPA program offices to address the problem of contaminated sediment. These statutes include: the National Environmental Policy Act; the Clean Air Act; the Coastal Zone Management Act; the Federal Insecticide, Fungicide, and Rodenticide Act; the Marine Protection, Research, and Sanctuaries Act; the Resource Conservation and Recovery Act; the Toxic Substances Control Act; the Clean Water Act; the Great Lakes Water Quality Agreement of 1978, and the Comprehensive Emergency Response, Compensation, and Liability Act. These statutes do not include any type of sediment criteria or a cleanup standard for PCBs or chlordane. Therefore, a determination on whether to conduct remediation of contaminated sediments is not as simple as comparing the sediment concentration to a criteria or standard. Generally, areas with sediment concentrations of PCB of 50 ppm or greater are considered areas of high concentration or “hot spots” and are actively remediated.

EPA's Contaminated Sediment Management Strategy (CSMS), indicates, "Widespread, low levels of contaminants may favor natural attenuation, while geographically limited areas containing high levels of contaminants favor active remediation." Natural attenuation may include natural processes that can reduce or degrade the concentration of contaminants in the environment including biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biologic stabilization, transformation or destruction of contaminants, and the deposition of clean sediments to diminish risks associated with the site.

There are no known sediment data for the advisory portion of the receiving stream. With the ban on the production of chlordane and PCBs, the mitigation of there release into the environment as the result of the remedial actions being conducted, and the continued natural attenuation that is occurring in the receiving stream, it is believed the criteria for these pollutants in the water column will eventually be achieved and the goal of the TMDL for the receiving stream to be "fishable" will be met.

Monitoring

Pennsylvania will continue to monitor PCB and chlordane in fish from this reach of the Ohio River. Samples will be collected once every five years. The data will be used to evaluate the possible threat to public health and to determine progress toward meeting the TMDL. The consumption advisories will remain in place until the water quality criteria are achieved and advisories are no longer needed.

Public Participation

Notice of the draft TMDL for the Ohio River was published in the *Pittsburgh Post-Gazette*, a daily newspaper of approximately 1.2 million readers, on Friday October 6, 2000 (Section-Classifications 444 to 479) and in the PA Bulletin on September 29, 2000. A public meeting was held on November 14, 2000 at DEP's Southwest Regional Office, located at 400 Waterfront Drive, Pittsburgh, PA 15222 (Waterfront Rooms A & B) to discuss and accept comments on the proposed TMDL. The public comment period closed on November 29, 2000.

At the public meeting four people showed up. They were form the Army Corps of Engineers, a local watershed group and a USX attorney. Primarily, the following concerns were noted in our discussions:

a) Will the State be responsible for cleaning up the PCBs in the river sediment if "natural attenuation" approach is not acceptable?
b) How long will "natural attenuation" take in order to reduce PCBs to acceptable levels?
c) Will industries be required by EPA to sample for soils and groundwater to find any unknown existing sources of PCBs?

Additionally, "Friends of the Riverfront" furnished written comments on 11/28/00. their comments applied to Shenango River, Beaver River, Chartiers/Little Chartiers Creek,

Monongahela River and the Ohio River. Their comments centered on “implementation” issues of the TMDLs. These comments were addressed. Please refer to Appendix B for a copy of the letter and the response.

The Department considered all comments in developing the final TMDL, which is submitted to the Environmental Protection Agency (EPA) for approval. Notice of final TMDL approval will be posted on the Department website.

Appendix B

COMMENT AND RESPONSE ON THE PROPOSED PCB/CHLORDANE TMDL FOR THE OHIO RIVER

EPA Region III

Comment: General: The report notes that the major fate process for PCBs and chlordane is adsorption to soil and sediment organic matter. However, only contaminants moving to lower layers of the sediment may be effectively sequestered. Otherwise, the sediments may act as an environmental reservoir, and any hydrologic processes that disturb or scour sediments also act to redistribute contaminants. The dam structures should be included in the TMDL analysis as they may act to trap the majority of sediments from reaching the downstream impaired segments of the Ohio River. In addition, given that volatilization is a significant environmental transport process for dissolved PCBs, the presence of a dam or other feature that may increase aeration rates could act to decrease PCBs in the water column prior to the impaired segment.

Response: The comment suggests that instream concentrations of the contaminants may be less than expected because of possible resuspension in the water column and volatilization. There are no data to adequately characterize the water column concentrations and the TMDL states that estimating from fish tissue concentrations (as was done) likely over-estimates the water concentration. Because movement of the fish is prohibited to upstream of the dam, there is no reason to address concentrations of PCB or chlordane (even if there were data) that may exist above the dam.

Comment: TMDL Development/Endpoint Identification: PA DEP found that insufficient STORET data were available within a five-mile radius of the fish tissue sampling stations to estimate water column concentrations for PCBs or chlordane. The TMDL should specify whether PA DEP searched for STORET data in any other portions of the listed segment to support the water column concentration estimates. Also, the TMDL should specify the analytical detection limit for those results that were reported as less than detection and whether the analytical results were only for PCBs.

Response: The STORET search was designed to be representative of the fish advisory segment, and was intended to supplement the file search conducted by the Southwest Field Office. For the Ohio River, the search was conducted using a six-mile radius around Water Quality Network Station 902 and a 15-mile radius around the fish tissue sampling station just below the Montgomery Lock and Dam. The report has been revised to reflect this search, rather than stating that a five-mile radius was used in both instances. The data found were from 1970, 1977 and 1979. The STORET retrieval request included both PCB and chlordane. Only one detection, for PCB, was found and noted in the report to document the search. As noted, this data is not representative of current water quality conditions. Therefore, the detection limits are not relevant.

Comment: TMDL Development/Endpoint Identification: A table shows the range of years and the years of available fish tissue data for PCBs and chlordane in various fish species. Because the time frame is over ten years, the data may show a decreasing trend. An attempt should be made to evaluate time trending of PCB and chlordane levels in fish tissue.

Response: The Department does not believe trend information based on the limited sampling results would be meaningful in this TMDL document. The important factor is that fish consumption advisories are in place and the estimated water column concentrations exceed the criteria. This means that a TMDL must be developed.

Comment: TMDL Development/Endpoint Identification: The table also shows that the number of data sets are either the same or more than the number of years, suggesting that in one or more of the years listed, two or more sets of analytical data are available. The table should be modified to reflect the exact number of data sets available for each listed year followed by an explanation of how the tissue data was used to arrive at the arrive at the estimated water column concentrations.

Please consider listing the fish tissue data that were used to back-calculate the instream water concentration of PCBs or chlordane. This would help clarify whether the tissue concentrations were determined by averaging all data for both carp and channel catfish for each of the years identified. Did the state observe any changes in fish tissue concentrations from 1985 through 1997 that would support natural attenuation as the best alternative for the TMDL?

Response: Average PCB and chlordane tissue levels were determined for each species using all samples. An estimated water column concentration was then calculated for each compound for each species. These estimated water column concentrations were averaged for each compound in order to provide a single estimated water column concentration for each parameter for the segment. The report has been revised to include this explanation. A listing of the fish tissue data is included in the final TMDL as Appendix A. The back-calculation was done to provide an estimated water column concentration for comparison to the water quality criteria because no current data are available. The important point for the TMDL is that the data show the criteria are most likely exceeded making a TMDL necessary.

The Department does not believe trend information based on the limited sampling results would be meaningful in this TMDL document.

Comment: Source Assessment: PA DEP indicates that known point sources of PCBs or chlordane must obtain an NPDES permit, but does not identify these potential sources. The report notes that several potential nonpoint sources have been identified, but they are not listed. Furthermore, the report states that no data are available to quantify the potential nonpoint source loads. Non-detect readings for effluent, soil or ground water samples may not be sufficient to omit point or nonpoint sources from the TMDL analysis. Current testing techniques lack the precision necessary to accurately quantify levels that could ensure compliance with the water

quality criteria for PCBs. If the point sources can demonstrate they are no longer accepting any discharge potentially containing PCBs or chlordane, their removal from the TMDL can be justified. Otherwise, the TMDL analysis and allocation should be revisited to consider the impact of point sources. Also, the relevance of the statewide ground water and soil loading standards to the TMDL is not clear. They should have no effect on the assessment of attainment of the PCB or chlordane criteria.

Response: The report states in at least two places that there are no known point sources of PCBs or chlordane. Non-detect readings are the readily available data supporting the TMDL. In the absence of data, it is not correct to assume non-compliance with water quality standards and attempt to refine allocations.

Comment: A search of potential sites undergoing remediation under CERCLA, SARA TSCA or Pennsylvania's Hazardous Site Cleanup Act (HSCA) should be conducted to locate potential PCB or chlordane sources.

Response: The Department acknowledges EPA's assistance in looking for additional data, and added appropriate discussion in the Source Assessment section.

Comment: Source Assessment: This section provides a summary of CERCLA, SARA and HSCA in an apparent attempt to define the programs under which sediment remediation could occur. The TMDL implementation, however, relies on natural attenuation, so these discussions do not appear to be relevant.

Response: The discussions have been deleted as irrelevant.

Comment: Source Assessment: The report states, "Appropriate level of cleanup is difficult to determine. Removal of all contaminates is virtually impossible and exceedingly expensive. However, cleaning up to any other level raises issues of dose response, which links an amount of a contaminate to the resultant effect, which is difficult to accurately predict." The word "contaminate" is used here instead of "contaminant." The entire paragraph should be clarified, and may not be appropriate for this section.

Response: The paragraph has been deleted.

Comment: Wasteload Allocations and Load Allocations: Because there are three sites contaminated with PCBs, it is not sufficient to simply allocate to instream sediments given that theses are current or former nonpoint sources of PCBs. EPA recently assisted DEP in developing a PCB TMDL for Valley Creek that serves as a useful example of how to allocate when such sites are identified. The TMDL should be revised and PA DEP should contact applicable state/Federal agency personnel involved in the three sites. If possible, an approach similar to Valley Creek should be used. This approach is predicated on the existence of remedial actions that will ensure that sources of PCB contamination (land-based contaminated soil runoff or instream sediments) will be controlled so that applicable water quality standards will be attained

and maintained. If not, PA DEP must allocate to each of the three land-based sources as well as instream sediments. That allocation method must be scientifically defensible.

Response: DEP thanks EPA for providing the resources to gather additional file and literature data that allowed for increasing the information in the Source Assessment. Allocation to the potential sources was not made because there is limited information to use in such determinations.

Comment: TMDL Implementation: Implementation relies on natural attenuation of the contaminated sediment. Existing fish tissue or sediment data demonstrating that this process is ongoing would support the reasonable assurance section of this TMDL.

Response: The Department used existing and readily available and has revised the TMDL where appropriate.

Comment: Sediment Remediation: This section provides background information on the federal statutes and regulations that address sediment contamination and appears to have been pasted from another document without editing. This section should be revised to include only information relevant to this TMDL. The document indicates that a number of "criteria have been evaluated in order to determine the appropriate remedial actions for the four sites of concern." Throughout the TMDL, there is no mention or description of any four specific sites of concern.

Response: The Department agrees and has revised the TMDL accordingly.

Comment: Sediment Remediation: The last paragraph states that there are no known "hot spots" in the advisory segment where sediment samples exceed 50 mg/kg. This suggests that sediment samples have been collected, but there is no mention of such sampling throughout the document.

Response: There are no known sediment data for the advisory portion of the receiving stream and the report is revised to state that.

Comment: Monitoring: This section states that fish tissue monitoring will continue once every five years. First, other EPA-approved for comment TMDLs include monitoring of fish tissue every two years. Secondly, this section does not specify which fish species will be monitored and for what parameters. Last, given that this TMDL segment is about 39.6 miles in length with several tributaries, the monitoring will require multiple locations. A consolidated fish tissue monitoring program for the whole Ohio river watershed may be appropriate.

Response: Pennsylvania's fish tissue monitoring program is generally based on a five-year sampling rotation. Two particular streams, currently under No Kill regulations, are monitored every two years. This TMDL is for PCB and chlordane. Both of these compounds are included in the parameter list for the Department's routine monitoring program. Any monitoring will

attempt to target the species for which consumption advisories are in place, although obtaining target species is not always possible.

Appendix C

References

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