BRUCE - FYI

MEMORANDUM OF AGREEMENT
FOR THE
SPOKANE RIVER PHOSPHORUS MANAGEMENT PLAN

Following years of study, it is now recognized that the strict control of phosphorus discharges to the Spokane River from all point-source dischargers is necessary to protect the water quality of the river and Long Lake and the beneficial uses of these resources.

The water quality regulatory agencies have the ultimate responsibility for issuing and enforcing wastewater discharge permits to accomplish this protection. In December, 1987, these agencies proposed the establishment of an individual phosphorus discharge allocation for each discharger. However, the dischargers were allowed one year in which to establish an alternative to the agencies' proposal. The attached plan is the dischargers' alternative to the immediate allocation of the maximum daily phosphorus loading previously proposed.

The management plan alternative is hereby endorsed by the regulatory agencies and they agree to continue participation in and support of the plan. The individual point-source dischargers (municipal and industrial) hereby endorse the plan and agree to implement its control measures.

ENDORSEMENTS/DATE:

[signature]	3/28/89	United States Environmental Protection Agency Region X
[signature] for Joe Nagel	4/19/89	State of Idaho Department of Health & Welfare Division of Environmental Quality
[signature]	3/31/89	State of Washington Department of Ecology
[signature]	3/30/89	City of Spokane, WA
[signature]	4/24/89	City of Coeur d'Alene, ID
[signature]	4/24/89	City of Post Falls, ID
[signature]	4/24/89	City of Rathdrum, ID
[signature]	4/24/89	Hayden Area Regional Sewer Board
[signature]	3.28.89	Liberty Lake Sewer District
[signature]	3-28-89	Inland Empire Paper Company, Inc.
[signature]	3-28-89	Kaiser Aluminum & Chemical Corp.
[signature]	3-29-89	Spokane Industrial Park

SPOKANE RIVER PHOSPHORUS MANAGEMENT PLAN

I. PREAMBLE

A. As a cooperative effort to cost-effectively and equitably manage the phosphorus loading to the Spokane River, the individual point-source dischargers (municipal and industrial) have agreed to adopt and implement a regional management plan. This plan, as an alternative to immediate allocation of maximum allowable daily phosphorus loadings to the individual dischargers, is endorsed by the various regulatory agencies and relies on their continued participation and support. All permits issued to the participating dischargers will therefore incorporate the pertinent portions of this management plan.

II. PARTICIPANTS

A. Municipalities participating in this plan include Spokane, Liberty Lake, Post Falls/Rathdrum, Coeur d' Alene, and the Hayden Area Regional Sewer Board.

B. Industries include Inland Empire Paper Co., Kaiser Aluminum and Spokane Industrial Park

C. Regulatory agencies include U.S. EPA (Region 10), Washington Department of Ecology (WDOE), and Idaho Department of Health and Welfare, Division of Environmental Quality (DEQ).

III. GOAL AND OBJECTIVES

A. The overall goal of this regional plan is to set forth a series of prioritized phosphorus reduction measures to adequately control phosphorus loading in the Spokane River at its discharge to Long Lake.

B. More specifically, the following objectives have been established by the dischargers and regulatory agencies:

1. Establish a program that endeavors to maintain the total maximum daily phosphorus load (TMDL) to Long Lake during a median river flow condition from June through October at a rate not to exceed 259 kg per day. This rate has been demonstrated to be consistent with the state water quality standard of 25μg/L of total phosphorus.

2. Equitably distribute responsibility for point source phosphorus control and any benefits resulting from its removal to all point-source dischargers to the Spokane River upstream from Long Lake.

3. Identify a series of phosphorus removal measures that could be effective in reducing phosphorus loading to Long Lake within 12 months from determination of need.

4. Implement individual control measures sequentially, as needed, to continually protect water quality.

5. Support management of non-point discharges for reduction in phosphorus loading.

6. Postpone the need for allocation of maximum allowable daily phosphorus loadings to individual dischargers until a management plan approach is unable to meet the Long Lake TMDL.

IV. MANAGEMENT PLAN DESCRIPTION

A. Introduction

1. The regional management plan consists of a series of structural and non-structural phosphorus reduction measures to be implemented by both the municipal and industrial dischargers. It will be monitored by a Technical Advisory Committee (TAC), established with representation by each discharger and regulatory agency, and is designed to promote near- and long-term solutions to the control of total phosphorus loading to Long Lake.

B. Specific Elements

1. Phosphorus Management Measures

The phosphorus loading control measures may include, but may not be limited to, the following:

a. A required removal rate at individual municipal discharges, in an established order of priority and at the time of need.
b. The total industrial discharge will be limited to a bubble allocation.
c. Point-source reduction as a result of a regional ban of phosphate detergents.
d. Non-point reduction as a result of implementation of better resource management techniques, agricultural BMP's, or through the control of phosphate fertilizers.

C. Implementation Measures

1. Implementation of Municipal Measures

b. The management plan recognizes that Spokane has been removing phosphorus for many years, and will continue to operate with a discharge permit that requires at least 85% removal.

b. As the need for further phosphorus reduction is identified, the other municipalities will sequentially implement phosphorus removal, at rates of at least 85%.

c. The sequence for initiating treatment will be determined so that the discharger with the greatest daily total phosphorus load is required to treat first.

d. Although the treatment sequence may be altered, based on actual conditions at the time (as identified by the TAC), the following sequence is now anticipated:

   1. Coeur d' Alene
   2. Post Falls/Rathdrum
   3. Liberty Lake
   4. Hayden Area Regional Sewer Board

e. Since current computer model simulations indicate the need for implementation of the next measure as soon as possible, Coeur d' Alene will continue with its plans to have a removal facility in operation by April 1991, with a discharge permit requiring at least 85% removal.

2. <u>Implementation of Industrial Measures</u>

a. All dischargers and regulatory agencies agree to immediately grant a bubble allocation of permitted phosphorus loading to the three major industrial dischargers.

b. This aggregate loading will not exceed 25 kg/day of phosphorus. While the individual permits will specify a maximum loading for each industry, no penalties will be assessed for exceedance of these individual loadings as long as the total bubble is not exceeded.

c. Any unused discharge allowance within the bubble will be available for consideration in the management plan until actually used by industry.

d. The bubble allocation will not be altered until such time as all of the municipalities have been required to implement 85% phosphorus removal. At this time, Spokane Industrial Park agrees to adopt such phosphorus removal measures as specified as Best Available Technology (BAT) by the regulatory agencies.

e. Following this action, the bubble will still remain in effect, but the limit will be reduced by the amount achieved in BAT treatment of the Spokane Industrial Park effluent.

3. Triggering Mechanism for Implementing Structural Measures

a. The basis for the implementation schedule of structural measures will be the predicted Long Lake phosphorus load for median flow from June through October, as determined from the available computer models of the Spokane River and Long Lake.

b. The threshold level of permitted Long Lake phosphorus loading is adopted as 259 kg/day. When the model results indicate that the structural measures implemented to that point in time no longer achieve this level, the next phosphorus removal action will be triggered.

c. The TAC will attempt to identify realistic implementation schedules in advance, so that the next measure can be in operation within 12 months after projection of need.

d. Since the model results are sensitive to the assumption of non-point source loadings to the system, all parties agree to use the 1985 levels, unless it can be clearly demonstrated by in-stream water quality monitoring that these levels have been altered.

e. If, after implementation of all sequenced municipal and industrial treatment measures, the TMDL is still exceeded, then a review of all dischargers (municipal and industrial) will be made to determine the next most appropriate reduction measures.

4. Monitoring Program

a. Each point-source discharger is responsible for the monitoring and reporting of its effluent and influent discharge concentrations and loadings.

b. The TAC will recommend to the regulatory agencies a set of standards related to sampling frequency and quality assurance, such that all discharges are monitored in a consistent manner.

c. The regulatory agencies will be responsible for whatever monitoring program is necessary to assess water quality in Long Lake, and to assess any changes in non-point source loadings within the basin. Any proposed changes to the previously accepted values of non-point source loads will be discussed with the TAC.

5. Equitable Cost/Benefit Distribution

a. All dischargers of phosphorus to the Spokane River share responsibility for its management, and each discharger has a responsibility for phosphorus removal from its discharge to provide for protection of water quality while allowing regional growth.

b. The management plan recognizes the overall cost/benefit to the region if only one reduction measure is initiated as needed.

c. Those dischargers incurring costs for phosphorus control prior to initiation of this management plan include Spokane, Inland Empire Paper Co., Kaiser Aluminum, and Spokane Industrial Park (by restriction of phosphorus-producing tenants).

d. Those municipal dischargers that temporarily avoid removal costs as a result of the "management-as-needed" approach will contribute proportionately to the operating costs of phosphorus removal facilities at the dischargers that (i) initiate removal as a result of the management plan, or (ii) enhance removal following adoption of the management plan.

e. The formula to be used for such cost-sharing will be approved by the TAC.

6. New Point Source Dischargers

a. Under the plan, no new point sources of phosphorus (other than participants to this plan) to the Spokane River will be permitted, unless an existing discharger agrees to remove an additional amount of phosphorus sufficient to offset the new source.

b. The TAC is responsible for reviewing any such agreement, and making its recommendations to the appropriate regulatory agency.

7. Non-Structural Measures

a. The TAC will initiate a program to determine the cost-effectiveness and desirability of a regional phosphate ban. If a ban is deemed to be beneficial to the region, the TAC will develop an implementation program, and will propose this plan to the appropriate legislative or administrative bodies.

b. The TAC will also examine potential controls on phosphorus loading from non-point sources, and as a long-term management measure, will recommend a course of action to reduce such loading.

V. TECHNICAL ADVISORY COMMITTEE

A. Description

1. The TAC has the responsibility for monitoring and directing the implementation of this management plan.

2. It will be formed immediately after the adoption of this plan, and will include one representative from each point source discharger and from each regulatory agency.

3. Meetings will be held, at a minimum, on a quarterly basis to assess the results of management measures, and to schedule implementation of new measures.

4. The committee members will obtain resolutions of intent and/or approvals, as appropriate, from their respective entities, to implement the management plan, or to make any necessary future changes in the plan.

B. Summary of Responsibilities

1. The TAC will recommend the order of priority for initiation of various management measures, and will assure that the proposed measures and implementation schedules are more specifically developed or refined, as necessary.

2. It will review the agencies' model results, and predict when threshold TMDL would be exceeded and new management measures would be needed.

3. It will recommend all technical criteria for the dischargers' monitoring program.

4. It will review and approve the basis for the equitable allocation of treatment costs to those dischargers that have not yet been required to remove phosphorus.

5. It will review any future applications for point-source discharge permits, and assess whether such discharges can be accommodated.

6. It will initiate efforts to assess the benefits of a regional phosphate ban, and monitor the success of such implementation, if recommended.

7. It will support a program to reduce non-point source phosphorus loadings.

VI. RESPONSIBILITIES OF REGULATORY AGENCIES

A. The regulatory agencies are ultimately responsible for issuing and enforcing wastewater discharge permits to protect water quality. Their primary responsibility, relative to this management plan, is their continued cooperation and support of the plan through the permit process and their participation in the TAC.

B. More specific responsibilities include the following:

1. To issue discharge permits which consider the intent of the management plan, specifically IV.C.1., 2., 3., and 4.

2. To maintain and run the necessary computer models and assess changes in Long Lake TMDL based on these analyses.

3. To monitor in-stream and Long Lake water quality, as necessary, to assess the performance of the management plan and changes in non-point source loadings.

4. To revise individual discharge permits as necessary, after TAC recommendations concerning the need for initiation of the next priority removal measure.

5. To continually judge the acceptability of the management plan and its implementability and ease of enforcement.

6. To specify all technical criteria for the dischargers' monitoring program.

7. To act on requests for new discharge permits.

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Draft

Total Maximum Daily Load To Restore and Maintain Dissolved Oxygen In the Spokane River and Lake Spokane (Long Lake)

Submittal Report

by
Ken Merrill and Bob Cusimano

Water Quality Program
Olympia, Washington 98504-7710

October 2004

Waterbody Numbers:
WA-54-1010 (QZ45UE), WA-54-1020 (QZ45UE),
WA-57-1010 (QZ45UE)

Publication No.

printed on recycled paper

Table of Contents

Introduction

Section 303(d) of the federal Clean Water Act mandates that the state of Washington establish Total Maximum Daily Loads (TMDLs) for surface waters that do not meet water quality standards, designed to protect, restore and preserve water quality, after application of technology-based pollution controls. The U.S. Environmental Protection Agency (EPA) has established regulations (40 CFR 130) for setting TMDLs. The Spokane River and the Spokane Valley aquifer are a critical resource to the region and play a major role in the settlement and economic development of the area (Figure 1). The river has had an intricate history of providing the population with a subsistence fishery, hydropower and electivity, irrigation water, recreation, aesthetic enjoyment and serves as the regions major conduit for wastewater disposal from cities and industry. Continued population growth in the area will inevitably demand more of the regions water resources. The river is also an important cultural and natural resource for Native American tribes.

Under the Clean Water Act, every state has its own water quality standards designed to protect, restore, and preserve water quality. The state's water quality standards consist of both (1) designated uses, such as supporting cold-water biota, contact recreation, and providing a drinking water supply, and (2) criteria, usually numeric, required to achieve those uses. When a lake, river or stream fails to meet the water quality standards after application of required technology-based controls, the Clean Water Act requires the state to place the water body on a list of "impaired" water bodies and to prepare an analysis called a Total Maximum Daily Load.

The goal of a TMDL is to ensure that the impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the sources that cause them. The TMDL determines the amount of a given pollutant that can be discharged to the water body and still meet standards; this is called the loading capacity. The TMDL also allocates that load among the various sources, both point and non-point.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the cause of the water quality problem or its loading capacity. The sum of the individual allocations and the margin of safety must be equal to or less than the loading capacity.

Nutrient enrichment and eutrophication of Lake Spokane has been one of the major water quality concerns for the area over the last 30 years (Cunningham, 1969; Soltero et al., 1973-86; Singelton, 1981; Wagstaff and Soltero, 1982). The discharge of nutrients and organic carbonaceous waste (BOD) both affect dissolved oxygen concentrations. Eutrophication (due to excess nutrients) increases plant growth and decreases dissolved oxygen due to plant respiration and decay of the organic material produced. Direct loading of BOD from point and nonpoint sources also decreases dissolved oxygen through direct decay of the organic waste. The load assessment and modeling work described in a Technical Report by Cusimano (February 2004) uses the new CE-QUAL-2E model to link these impacts on dissolved oxygen and establishes the technical basis for this TMDL. Electronic links to the technical documents are provided on Ecology's Spokane TMDL Web Site at:

> http://www.ecy.wa.gov/programs/wq/tmdl/watershed/spokaneriver/dissolved_oxygen/technical.html.

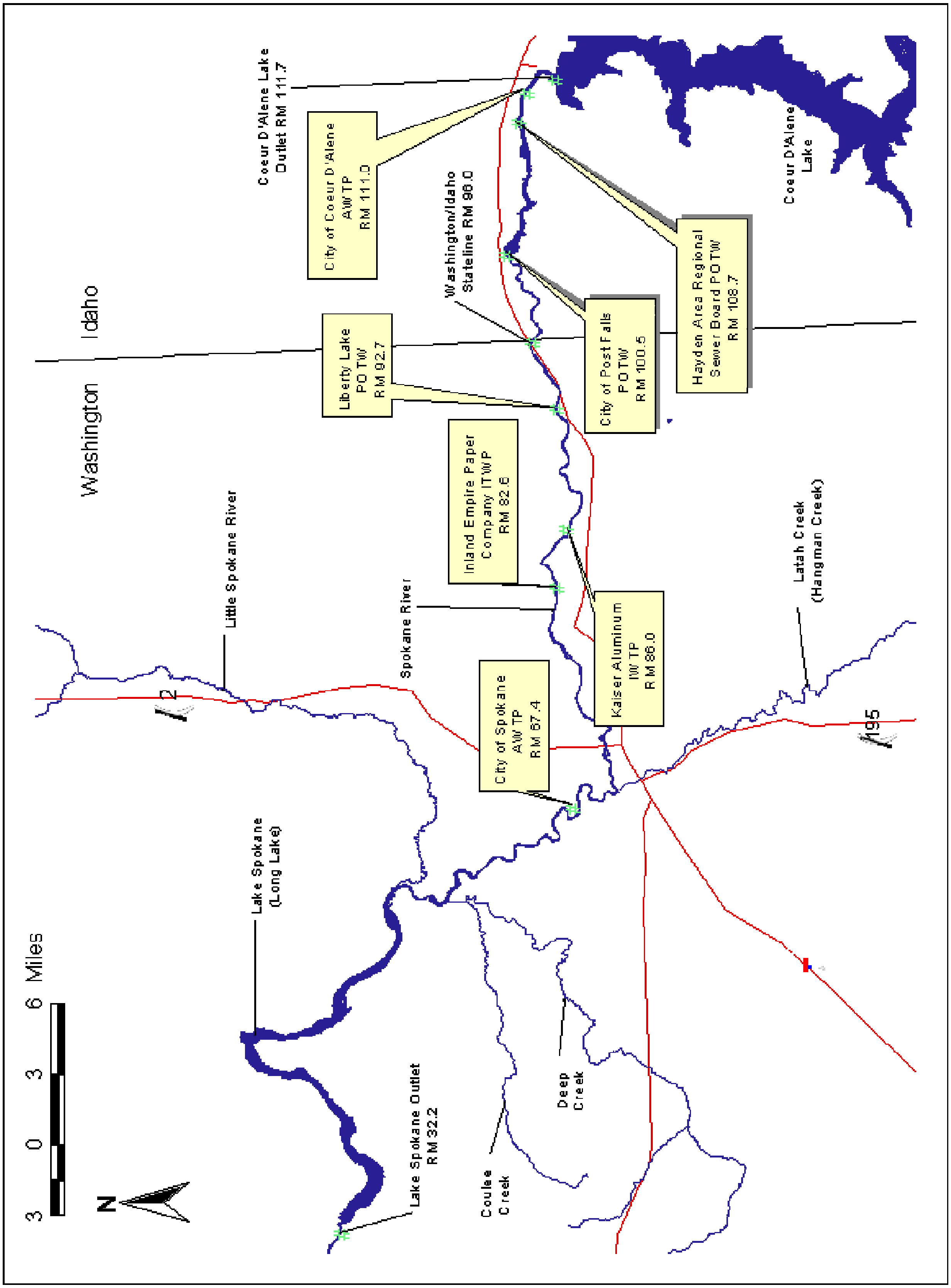


Figure 1. Site Map of Upper Spokane River, Lake Spokane, and Lake Coeur d' Alene with main stem dischargers.

The Spokane TMDL will establish Washington State's plan for future management of organic and nutrient pollutants in the river that affect dissolved oxygen, cause excessive algae blooms and contribute to degradation of downstream water quality on the Spokane Indian Reservation. This TMDL requires much more stringent control of phosphorus loading and will supersede the existing Spokane River Phosphorus TMDL. The existing phosphorus TMDL originally adopted as a Phosphorus Management Plan in 1989 has since been demonstrated as not being adequately protective of water quality. Management of these pollutants according to this TMDL will result in restoration and protection of existing and designated uses stipulated in Washington's water quality standards.

Development of this TMDL began in 1998 with the draft study plan presented to the Spokane River Phosphorus Technical Advisory Committee. An extensive public participation process was employed by Ecology to develop this TMDL. Appendix A lists some of the opportunities provided for input and involvement for interested and affected parties in this watershed to participate in development of this TMDL. In addition to the listing in Appendix A the department has hosted numerous informal meetings and discussion with interested parties to discuss various topics related to this TMDL. Input to the Department from the Spokane River dischargers, environmental groups, Tribal government, local citizens, Idaho Department of Environmental Quality and the Environmental Protection Agency resulted in modification of the original study plan, model design, and this proposed TMDL.

In addition to the mandatory components of a TMDL, the general purposes of this document are to:

- Summarize the results of a technical assessment, which evaluated various loading pollutant scenarios and the resultant impact on dissolved oxygen.
- Summarize actions recommended for meeting water quality standards.
- Summarize monitoring that should be used to track TMDL implementation and determine progress toward attaining water quality standards.

A Detailed Implementation Plan (DIP) will be developed within a year of TMDL approval by EPA, to expand the initial implementation strategy into a working plan. Further public input will be sought to help prepare the DIP, which will identify how, when, and where voluntary restoration activities will be implemented. Details of a monitoring plan to track implementation and measure progress toward improved water quality will be developed. The Washington State Department of Ecology (Ecology) and other entities will provide technical assistance and seek additional funding for these activities.

Components of the TMDL

The five components of a TMDL, as required by the Clean Water Act and applied to this TMDL, are described below:

Total Loading capacity - The total loading capacity is the maximum amount of pollutant that a water body can receive and assimilate without violating water quality standards. The loading capacity is allocated between waste load allocations (WLA) for point sources of pollution, load allocations (LA) for loading from nonpoint pollution sources (NPS) combined with natural background loading, and a margin of safety (MOS). The maximum loading capacity for the upper Spokane River and Lake Spokane was determined by the amount of allowable increase in the nutrient load (phosphorus, carbonaceous biochemical oxygen demand, and ammonia) above the estimated natural conditions without causing a violation of the dissolved oxygen (DO) criteria. The most critical portion of the waterbody was found to be in the deepest segment of Lake Spokane near the dam (segment 188) where the DO criteria stipulated for Washington's Lake Class requires no more than 0.2 mg/L decrease in dissolved oxygen from natural conditions. The CE-Qual-W2 Version 3.1 dynamic model was used as the tool to assess loading capacity under varying conditions and determine the maximum assimilative capacity while meeting the WQ standards.

Total Loading Capacity = LA (natural background loading + nonpoint pollution sources) + WLA (point sources pollution) + MOS

Natural Conditions - Washington water quality standards (WAC 173-201A-020) define "Natural conditions" or "natural background levels" as "*surface water quality that was present before any human-caused pollution. When estimating natural conditions in the headwaters of a disturbed watershed it may be necessary to use the less disturbed conditions of a neighboring or similar watershed as a reference condition*". For this TMDL, "natural conditions" were estimated by making certain assumptions about boundary conditions and man-caused influences on water quality (at the Idaho border and at the mouth of the tributaries). These conditions were then run as the NO SOURCE scenario with the CE-QUAL-W2 model to obtain a reference dissolved oxygen condition for the river and lake (absent pollutant loading from human activities). A more thorough description of these assumption and model output are included in Cusimano (2004). Some of the more important assumptions used in determining the natural condition under the "NO SOURCE" modeling scenario included:

1) Existing dams operating under 2001 hydraulic conditions will not change. After analyzing the period from 1968-2001, Cusimano determined that Spokane River flow in 2001 had a probability of one of the overall driest years to be expected out of ten and therefore used it as the TMDL design year.
2) Estimates of natural background water quality for the tributaries were made using nitrate, phosphorus, and ammonia data collected from the West Branch of the Little Spokane River upstream from Eloika Lake in 1987 (Soltero et al., 1988). Background nutrients for the Spokane River were derived from actual data collected from the outlet of Lake Coeur d' Alene during the Cusimano study and modeled to predict it's change in quality between the lake outlet and the state border using the uncalibrated 2001 Idaho reach CE-Qual-W2 model. Valley Aquifer input to the model used average aquifer water quality as measured during the time of the load assessment study.

The model estimates of natural conditions using the previously described assumptions showed that the river would likely meet the dissolved oxygen criteria (8.0 mg/L) from the state border to Lake Spokane except during hottest part of the year in the water-losing reach upstream of Sullivan Road (RM 88). This river reach has flows dropping below 100 cfs during a dry year in a relatively shallow streambed resulting in the saturation point of oxygen in water to fall near criteria. Natural Conditions estimated for Lake Spokane show that algal productivity would be relatively low and a water column dissolved oxygen profile in the lower stratified end of the reservoir would be characteristic of a meso-oligotrophic (moderately low productivity) lake. In Lake Spokane, and similar to Lake Coeur d' Alene, it's source water, the lake's lowest cold water stratum (hypolimnion) would normally be expected to decline somewhat below 8.0 mg/L depending on the duration of summer stratification and the strength of natural sediment oxygen demand.

Load allocations (LA) – Load allocations are assigned to the Spokane River where it enters Washington from Idaho (boundary condition) and also to the mouths of the tributaries; Hangman Creek (Latah Creek), Coulee Creek, and Little Spokane River. These load allocations are comprised of loading associated with natural conditions plus the nonpoint pollution sources. Load allocations for this TMDL are based on the estimated natural background load and the allowable increase in nonpoint pollution that would not cause an oxygen depletion to exceed 0.2 mg/L from the natural condition. TMDLs for Little Spokane and Hangman (Latah) Creek are under development, which may better differentiate the amount of nutrient loading in these tributaries that is naturally occurring from that which is man-caused. Other sources of direct nonpoint pollutant loading were determined to be insignificant to the dissolved oxygen depletion because of the relatively porous geology of the Spokane Valley allows infiltration and the abnormally dry hydraulic design year meant that there was very little precipitation generated runoff.

Wasteload allocations (WLA) – The wasteload allocation is the amount of receiving water's loading capacity that may be allocated to point sources of pollution. Modeling results indicate that oxygen depletion caused by less than a third of the existing nonpoint pollutant load is enough to cause a 0.2 mg/L decline in DO. As a result, there is no capacity available for point source waste loads that would further contribute to increases in nutrient concentrations during the critical period (April 1 through October 31). A point source discharge would be allowable if the discharge did not contribute to an increase in the river concentration of nutrients under the total loading scenario needed to meet the DO criteria (see below). This might be accomplished by meeting the in-stream target concentrations at end-of pipe during the critical season. Otherwise, other seasonal alternatives to river discharge will be needed.

Margin of safety - Federal regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between loads and water quality. However, because the TMDL requires that point sources not contribute to any change in target instream concentrations, a safety factor subtracted from WLAs of essentially zero appear unnecessary. There is a very small safety factor associated with the proposed tributary LAs since actual DO declines used to establish the LAs were rounded from values ranging between 0.1995 mg/L in the most stringent example to 0.18 mg/L under slightly less critical conditions. This essentially equates in a 0.3% to 10% margin of safety.

Seasonal variation - Seasonal variation, or the changes in loading rates due to changing conditions associated with the annual change in seasons, has been accounted for by sampling seasonal events and using the dynamic model, CE-Qual-W2 Version 3.1 to determine the most critical dissolved oxygen conditions and pollutant loading. Dissolved oxygen in lakes and rivers is typically at greatest concern in the summer when stream flows are lowest, the water is the warmest, gas-holding capacity is reduced, growing conditions for algae are optimal, and thermal stratification of lakes becomes well established. Because the CE-Qual-W2 model can continually simulate the changing hydraulic, climatic, biological and chemical conditions in the river and lake, it is a good tool for evaluating seasonality of dissolved oxygen. Using the model it was determined that water quality plays a role in lake dissolved oxygen beginning at onset of thermal stratification (near April 1st) and ending with the end of the growing season near the end of October.

Background Information

The upper Spokane River, upstream of Long Lake Dam (Lake Spokane Dam) drains over 6,000 square miles of land in Washington and Idaho. Most of the people in the watershed live in the Spokane metropolitan area. However, the incorporated area of Liberty Lake east of Spokane and the cities of Coeur d'Alene and Post Falls in Idaho are rapidly growing in population.

The Spokane River flows west from Lake Coeur d'Alene in Idaho, across the state line to the city of Spokane. From Spokane, the river flows northwesterly to its confluence with the Columbia River at Lake Roosevelt. The focus of the TMDL extends from the Stateline Bridge at approximately river mile[1] (RM) 96.0 to Lake Spokane Dam at RM 33.9.

There are five hydroelectric dams downstream from the outlet of Lake Coeur d' Alene including Post Falls, Idaho (RM 100.8) that regulates the water levels of Lake Coeur d' Alene and significantly influences the hydrodynamics of the river downstream, Upriver Dam (RM 79.9), Monroe Street Dam (RM 73.4), Nine-Mile Dam (RM 57.6), and Lake Spokane Dam (RM 33.9). The Washington dams are run-of-the river types except Lake Spokane Dam (Long Lake dam), which creates Lake Spokane (Long Lake), a 24-mile long reservoir.

There are a seven wastewater discharges to the main stem of the Spokane River between Lake Spokane and Lake Coeur d' Alene discharging a summer average of approximately 75 million gallons per day (116 cfs). In Washington, beginning at Spokane and moving upstream they include the Spokane WWTP, Inland Empire Paper, Kaiser Aluminum, and Liberty Lake Sewer District. Discharges in Idaho include Post Falls, Hayden Sewer District, and the city of Coeur d' Alene.

Water Quality Criteria

The Spokane River water quality classifications and dissolved oxygen criteria are:

Portion Of Study Area	Classification	Dissolved Oxygen Criterion
Lake Spokane or Lake Spokane (from Lake Spokane Dam to Nine Mile Bridge)	Lake Class	No measurable decrease from natural conditions.
Spokane River (from Nine Mile Bridge to the Idaho border)	Class A	Dissolved oxygen shall exceed 8.0 mg/L. If "natural conditions" are less than the criteria, the natural conditions shall constitute the water quality criteria.

In addition, the Spokane River has the following specific water quality criteria (Ch. 173-201A-130 WAC):

Spokane River from Lake Spokane Dam (RM 33.9) to Nine Mile Bridge (RM 58.0).
Special conditions:

(a) The average euphotic zone concentration of total phosphorus (as P) shall not exceed 25 ug/L during the period of June 1 to October 31.

Ecology has recently revised the surface water quality standards (effective August 1, 2003). The class-based system of organizing the standards was changed to a use-base system. However, the changes are not effective for federal Clean Water Act programs (i.e., the TMDL program) until they are approved by the U.S. Environmental Protection Agency (EPA). It is not anticipated that the new aquatic life dissolved oxygen criteria will change the discussion presented in this document. However, the TMDL may be revised if site-specific criteria are developed or uses changed under a use attainability analysis (UAA). Such changes to water quality standards are subject to formal rulemaking procedures established in the Washington's Administrative Procedures Act and in federal regulations.

Water Quality Resource Impairment

The Spokane River and Lake Spokane (Long Lake) has had a long history of water quality problems associated with the discharge of municipal and industrial wastes. Toxic algae blooms occurring in Lake Spokane in the 1970's resulted in a court-ordered establishment of a phosphorus TMDL. The existing phosphorus TMDL focused on preventing excessive blue-green algae blooms by requiring Spokane and others to implement 85 percent phosphorus removal. Subsequent years of excessive algae blooms in the Lake (Figure 2) and depressed oxygen levels measured in the lake and river with more severe conditions predicted by modeling has demonstrated the existing phosphorus TMDL does not adequately protect water quality (Figure 3). Reoccurring violations of water quality standards resulted in some waterbody segments of the Spokane River being included on Ecology's 1998 and proposed 2002/04 303(d) list of impaired waterbodies.

Waterbody Name	Parameter	Old WBID	New WBID	96 List	98 List	2002/04
Lake Spokane (Long Lake)	Dissolved Oxygen	WA-54-1010	QZ45Ue			X
Spokane River	Total Phosphorus	WA-54-1020	QZ45UE	X	X	X
Spokane River	Dissolved Oxygen	WA-54-1010	QZ45UE	X		X
Spokane River	Dissolved Oxygen	WA-57-1010	QZ45UE	X	X	X

The Spokane River downstream of Long Lake Dam also violates state and tribal water quality standards with DO recently reported below 3.0 mg/L near the mouth of the Spokane River attributed to decomposition of summer algal biomass (Lee et al., 2003). Recent continuous monitoring of the river below Long Lake Dam by the Spokane Tribe shows depressed oxygen levels with recurring minimums below 4.0 mg/L (Butler, 2004)

Recent combined point source pollutant loads of carbonaceous organic waste (BOD5) discharged to the Spokane River is about half of what is currently allowable under existing NPDES permits. Phosphorus loading from point sources in recent years has been only about two-thirds of what is currently allowed by NPDES permits based on the existing phosphorus TMDL and Spokane River Phosphorus Management Plan.

Along with the existing problems, several requests for approvals of facility plans to expand wastewater discharge to the river has required Ecology to investigate the causes of water quality violations and establish a TMDL that is protective of all designated beneficial uses. A TMDL for the river and lake was identified as a high priority during the 1998 water quality scoping process for the Spokane Water Quality Management Area (Knight, 1998). Subsequent modeling of the river/reservoir system has confirmed that dissolved oxygen is significantly depleted

Figure 2. Blue-green algae blooms on Lake Spokane in Fall 2001

by anthropogenic (human-caused) pollution sources under existing conditions and that approved/permitted loads would cause dissolved oxygen to approach zero throughout colder water portions of the stratified Lake Spokane (Figure 3). Evaluation of the existing phosphorus TMDL has also shown that it is not effective at adequately protecting beneficial uses in Lake Spokane (Cusimano, 2004).

The Eastern Regional Office requested that the Environmental Assessment Program assess the dissolved oxygen and nutrient loading to Lake Spokane, and if needed, update the phosphorus (P)-attenuation model developed for the river in the mid 1980s (Patmont et al., 1985).

Nutrient enrichment and eutrophication of Lake Spokane has been one of the major water quality concerns for the area. The two project requests were linked because nutrient loading and organic waste (BOD) both affect dissolved oxygen concentrations. Eutrophication (due to excess nutrients) increases plant growth and decreases dissolved oxygen due to plant respiration and decay of the organic material produced. Direct loading of BOD from point and nonpoint sources also decreases dissolved oxygen concentrations. Both of these water quality issues can be exacerbated during periods of low river flow and warm temperatures, especially in the deep, slow-moving water segments of the river system like Lake Spokane. The results of this study and modeling resulted in the proposed allocations for both BOD and nutrients to mitigate the impact of these pollutants on dissolved oxygen.

Seasonal Variation

Dissolved oxygen (DO) and excess productivity are seasonal issues in the Upper Spokane River and Lake Spokane. Dissolved Oxygen declines occur during critical summer conditions when water warms, physical reaeration declines with low stream flows, and growing conditions for primary productivity (plants and algae) are favorable. This seasonality is exhibited in graphical representation of data collected from the Spokane River at the state line and DO in Lake Spokane (Figures 4 and 5). The CE-Qual-W2 model is a dynamic model used to assess seasonal changes in pollutant loading, and many more variables, as it continually predicts changes in various parameters of concern at any given time or place for the modeled period.

The critical season for controlling dissolved oxygen in the reservoir is dependant on timing of lake stratification. Hypolimnion (bottom stratum) becomes isolated from the rest of the reservoir beginning in the spring and lasting for up to 150 days (i.e.: there is no mixing between this bottom layer and upper layers of the lake). This means that the organic loading present in the water at the time of stratification combined with sediment oxygen demand and settling organic detritus cause significant declines in the hypolimnetic DO until it displaced during fall flushing. Algae blooms in the upper reservoir and depressed dissolved oxygen in the metalimnion (middle interflow stratum) of the lower reservoir are directly impacted by pollutant loading that occurs during the growing season typically June-October. The impact of nutrient loading is more pronounced during low flow years because it allows the nutrients to become more concentrated and the travel time through the shallower upstream end of the reservoir is longer, allowing more time to grow algal.

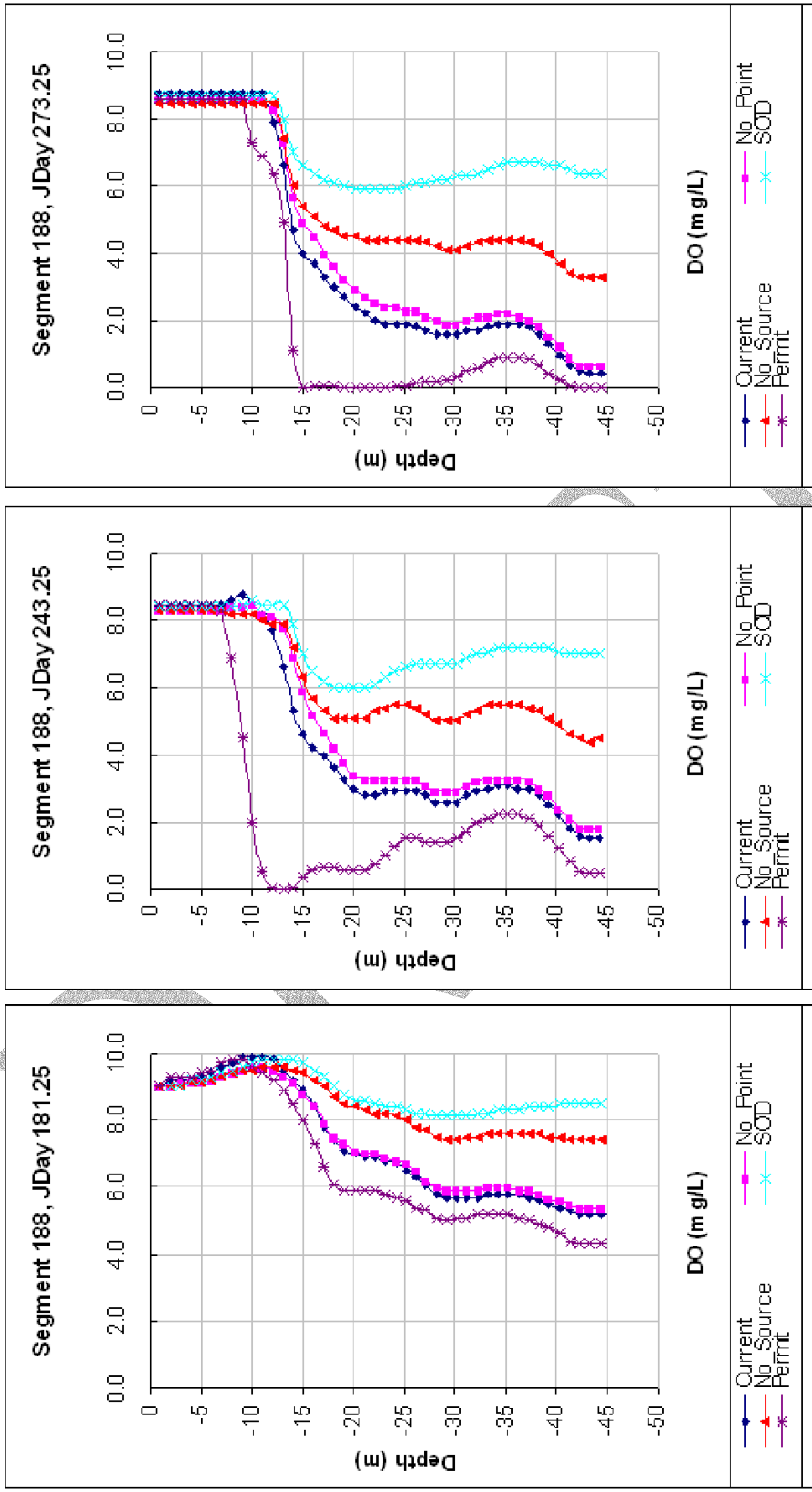


Figure 3. Model predicted dissolved oxygen profiles for Lake Spokane at model segments 188 for the CURRENT, NO-POINT, NO-SOURCE, PERMIT, and SOD scenarios on Julian days 181.25 (Jun 15), 243.25 (Sep 1), 273.25 (Oct 1)

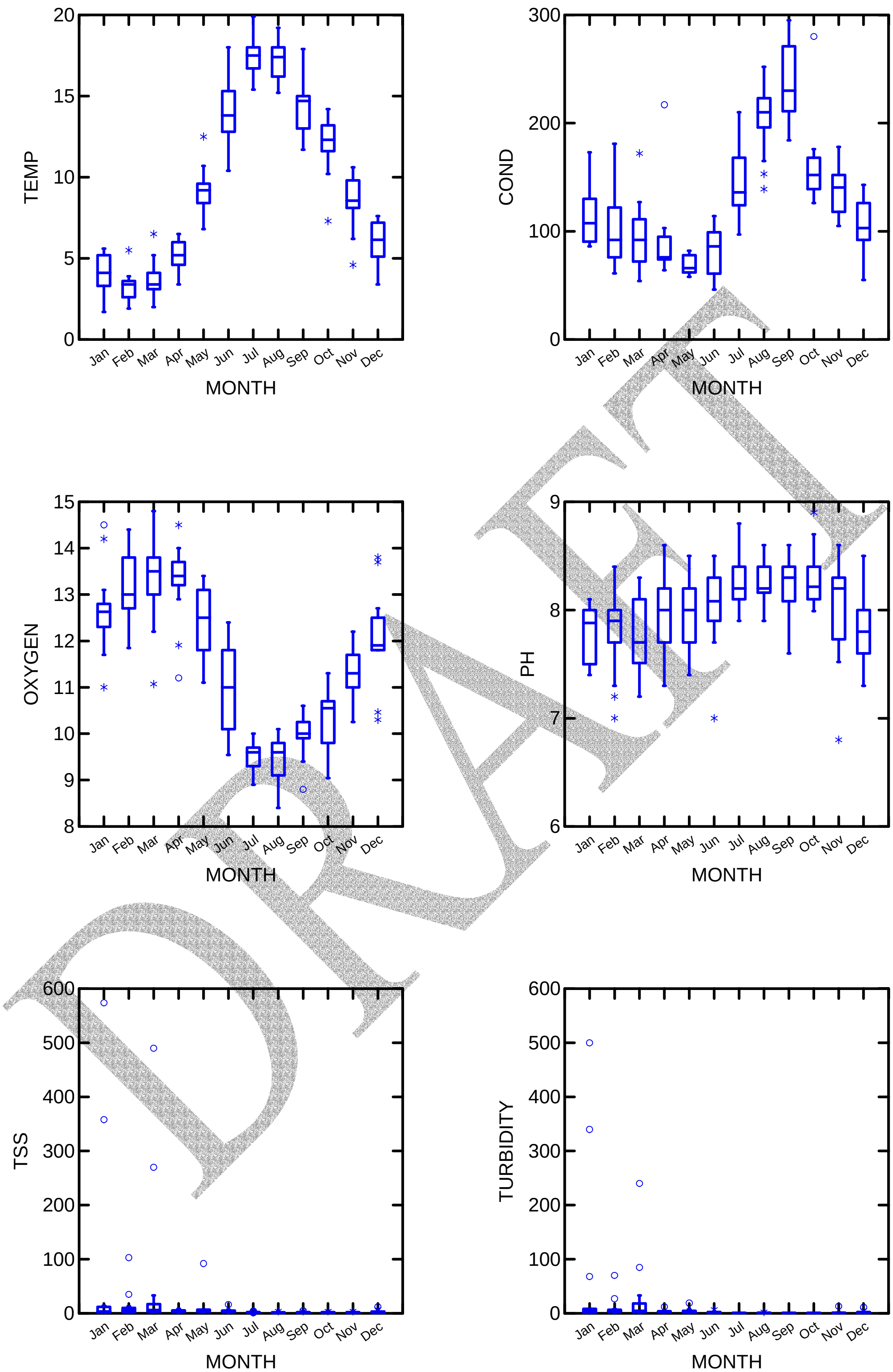


Figure 4. Seasonal trends in Spokane River ambient data at Idaho state line (Cusimano, 2004)

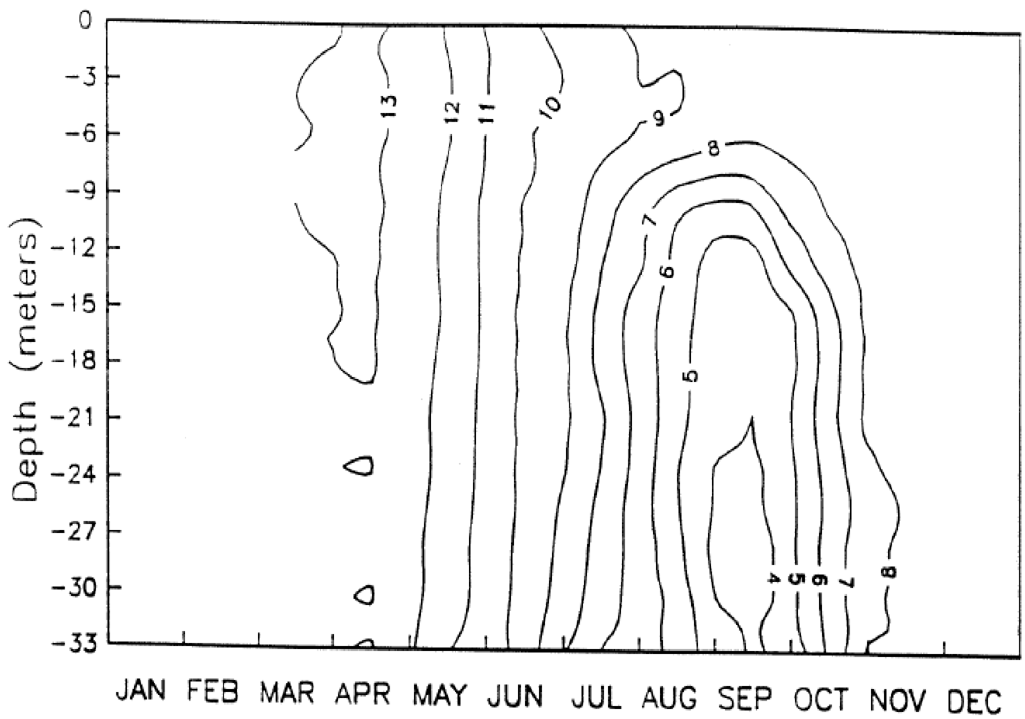


Figure 5. Seasonal trends in dissolved oxygen near Long Lake Dam (model segment 188) during 1991 to 33 meters of the 46 meter water depth (Soltero, 1993)

Technical Analysis

Ecology developed a Quality Assurance Project Plan (Cusimano, 1999) to conduct sampling and modeling of the river/lake system. After doing preliminary modeling and fieldwork, Ecology chose to use the capabilities of the CE-QUAL-W2 Version 2 model developed by the U.S. Army Corps of Engineers. The CE-QUAL-W2 Version 2 model was preferred due to its application in other reservoirs and the available support. During 2000, the model was upgraded to Version 3.0 (now 3.1). The newer version includes modifications that enable simulations of river systems and a number of hydraulic structures (e.g., weirs, spillways, tainter gates, and pipes). In the fall of 2000, Ecology contracted with the U.S. Army Corps of Engineers (through a joint cost share grant) to have Tom Cole, Corps scientist and primary developer of the model, apply the model to the Spokane River and Lake Spokane. The Corps collaborated with Scott Wells, Professor of Engineering at Portland State University to apply the model to 1991 and 2000 conditions. Subsequent to the 1991 and 2000 model calibration, the NPDES permittees collected additional ambient and effluent data during 2001 and contracted directly with Scott Wells to apply the model to 2001 conditions. Subsequent evaluations determined that the 2001 was more characteristic of a 1-in-10 drier year that should be used as the critical TMDL design year and that it should be used it as the final model calibration year.

The CE-Qual-W2 model was created to simulate Lake Spokane and the Upper Spokane River as a tool for assessing different pollutant loading scenarios in development of this TMDL. The model is considered state-of-the-science at this time.

The Cusimano load assessment report analyzed five basic loading scenarios (Figure 3).

1. **CURRENT**: A base case defined as 2001 conditions for the study area from the state line through Lake Spokane. Since this was the calibration year and TMDL critical design year. The model predictions versus actual data are very similar. Dissolved oxygen profiles exhibit marked decline in interflow zone and then a continued decline with each scenario where organic loading from upstream is available.

2. **NO-POINT**: The CURRENT case without point source loads. The associated point source flow was kept in the model, but the loads were reduced to reflect groundwater constituent concentrations. The state line boundary conditions were set at those found in 2001, which were affected by Idaho point source dischargers, i.e., the effects of the Idaho point sources were not removed for the NO-POINT scenario. (See Spokane River Model: Boundary Conditions and Model Setup 2001, Annear et al., 2001.)

3. **NO-SOURCE**: The NO-POINT case with tributary and upstream river boundary concentrations set at estimated natural conditions. Tributaries and upstream river nutrient (nitrate, phosphorus, ammonia) concentrations were set to natural conditions based on data collected by Soltero et al. (1988) at the inlet to Eloika Lake in the Little Spokane and/or data from the outlet of Lake Coeur D'Alene collected as part of this study. The average Lake Coeur D'Alene ultimate CBOD as measured by the dischargers in 2001 of 1.4 mg/L was used to set the maximum CBOD at Latah Creek (Hangman Cr.) and the Little Spokane River. All other constituents were the same as 2001 conditions. The non-calibrated 2001 CE-QUAL-W2 model of the Idaho portion of the river from the outlet of Lake Coeur D'Alene to the state line was used to estimate upstream boundary conditions for the NO-SOURCE scenario (i.e., Idaho point and nonpoint sources were removed). Coulee Creek water quality

constituents were the same as those used for Latah Creek.

4. **SOD**: The NO-SOURCE case with the maximum sediment oxygen demand set 0.25 g O_2 m^{-2} per day, which is a value that has been historically used to define an oligotrophic system (Welch, 1980).

5. **PERMIT**: The CURRENT case with point source daily concentrations increased to provide a monthly average value equal to the monthly average BOD5 permit limits (e.g., The city of Spokane AWTP 2001 monthly average BOD5 calculated from the daily record provided by the city was 5.6 mg/L, and the monthly average permit limit for BOD5 was 30 mg/L. Each 2001 daily model input file value was increased from the reported value plus the difference between the monthly average permit value and the actual monthly average value). Concentrations of soluble reactive phosphorus, ammonia, and nitrate were set at estimated upper 10^{th} percentile effluent values based on the 2001 measured values (i.e., adding the difference between the monthly average and estimated upper 10^{th} percentile value to the data record listed in the model input files). Kaiser Aluminum does not have a BOD5 permit limit, and daily values were set at estimated upper 10^{th} percentile effluent concentrations for BOD5, soluble reactive phosphorus, ammonia, and nitrate.

   In addition, the phosphorus loading for the PERMIT scenario was limited such that the total loading would not exceed the target total phosphorus concentration for Lake Spokane used to establish the original TMDL (i.e., an average euphotic zone total phosphorus concentration of 25 ug/L). The target phosphorus concentration was estimated by a series of trial-and-error model runs based on adjusting the phosphorus stoichiometry associated with the point sources CBOD values and averaging the total predicted phosphorus concentration in the upper 10 meters of the lake for the June-October period. The upper 10 meters of the lake was assumed to approximate the maximum euphotic zone.

Subsequent modeled scenarios were also tested after the Cusimano Report was completed to evaluate effects of different treatment scenarios along with changing trends affected by a higher minimum river flow as follows:

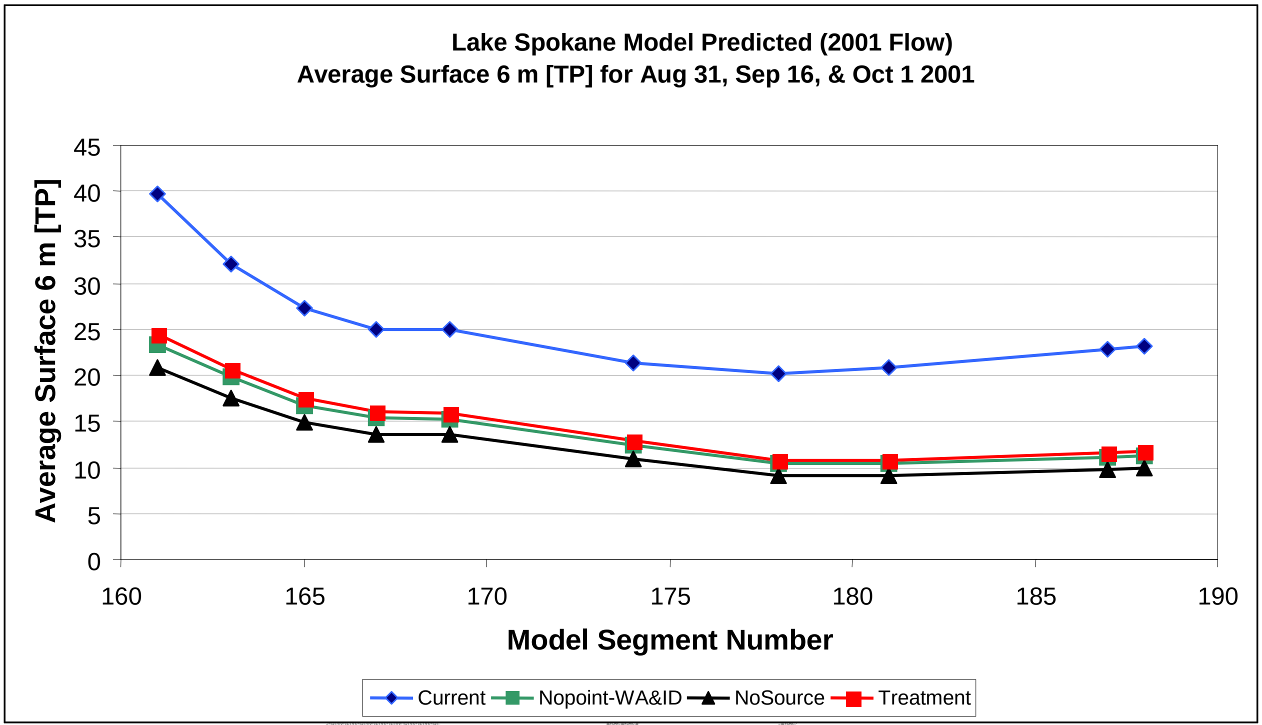
1. **NO-POINT WA&ID** – A scenario where Idaho point sources were also removed along with the WA NO-POINT case. The uncalibrated model for the Idaho reach in conjunction with the Ecology model was used to estimate changes in downstream river quality with loading from all of the WA and ID point sources pollution removed, but no changes to flow. This was performed to try to quantify the effects of the ID dischargers from the WA dischargers.
2. **Treatment** – Used the Current 2001 case except effluent quality was improved for all dischargers so that total phosphorus concentration was 0.020 mg/L TP, 0.1 mg /L NH3 and 2 mg/L CBOD. This was a test that showed that effluents of high quality would still cause more than a 0.2 mg/L decrease in DO from the NO POINT WA&ID scenario with out any change in nonpoint sources.

Flow Augmentation – Based on recommendations made by the 2514 watershed planning group and the FERC Relicensing Fisheries Work Group, the previously analyzed 2001 nutrient loading scenarios were modeled with additional flow added to the 2001 hydraulic conditions below Post Falls Dam. Minimum flow was altered so that it never dropped below 745 cfs at Post Falls gage and then forced to remain there through September (Figures 6, 7, and 8).

   a. Current (2001 loads for point sources and Tributaries)
   b. No-Point – WA&ID (all point sources removed)
   c. No Source – Estimate of natural water quality conditions

d. Treatment – Same as Current except effluent quality was set for all point sources at 0.020 mg/L TP, 2 mg/L CBOD, and 0.1 mg/L NH3

Figure 6. Comparison of model predictions for Lake Spokane total phosphorus over reservoir length during 2001 flows and augmented minimum flows (745 cfs @ Post Falls).
(Current = 2001 existing conditions, Nopoint WA&ID =. All point source pollutants removed, NoSource = Natural Background, Treatment = highest level of effluent treatment – 20 ug/L TP).



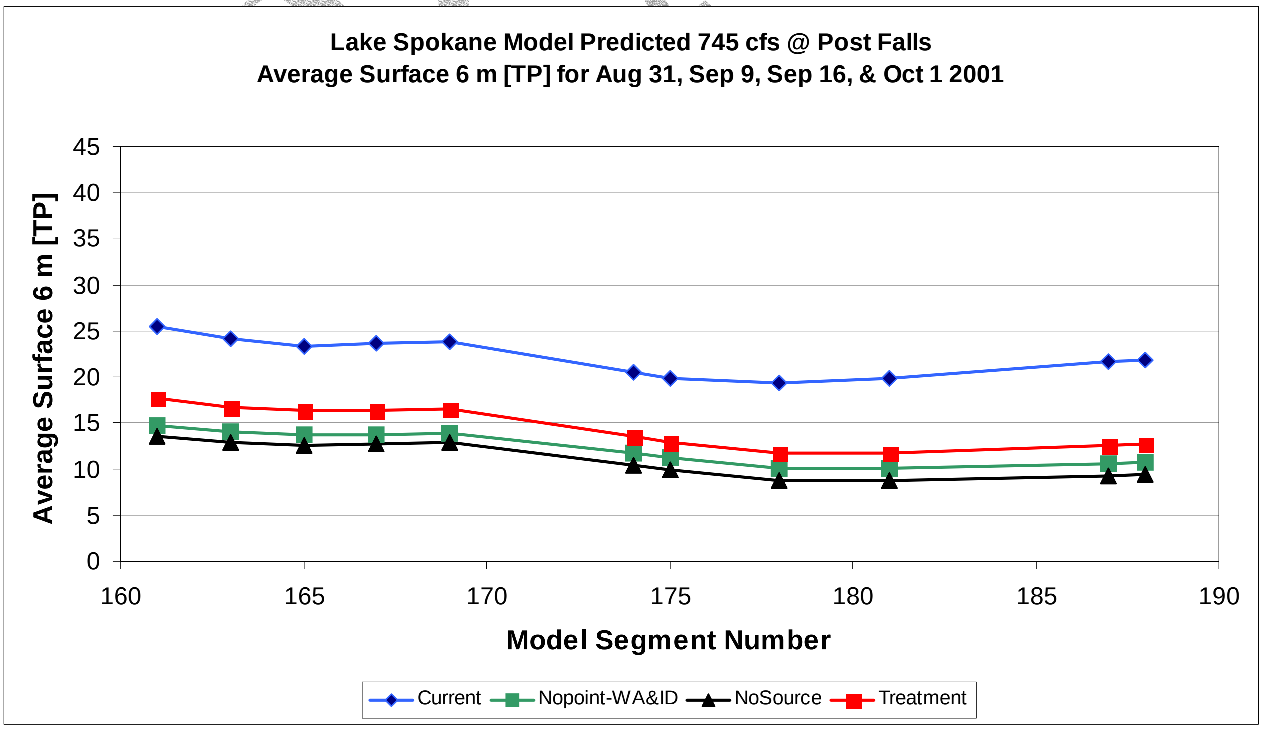
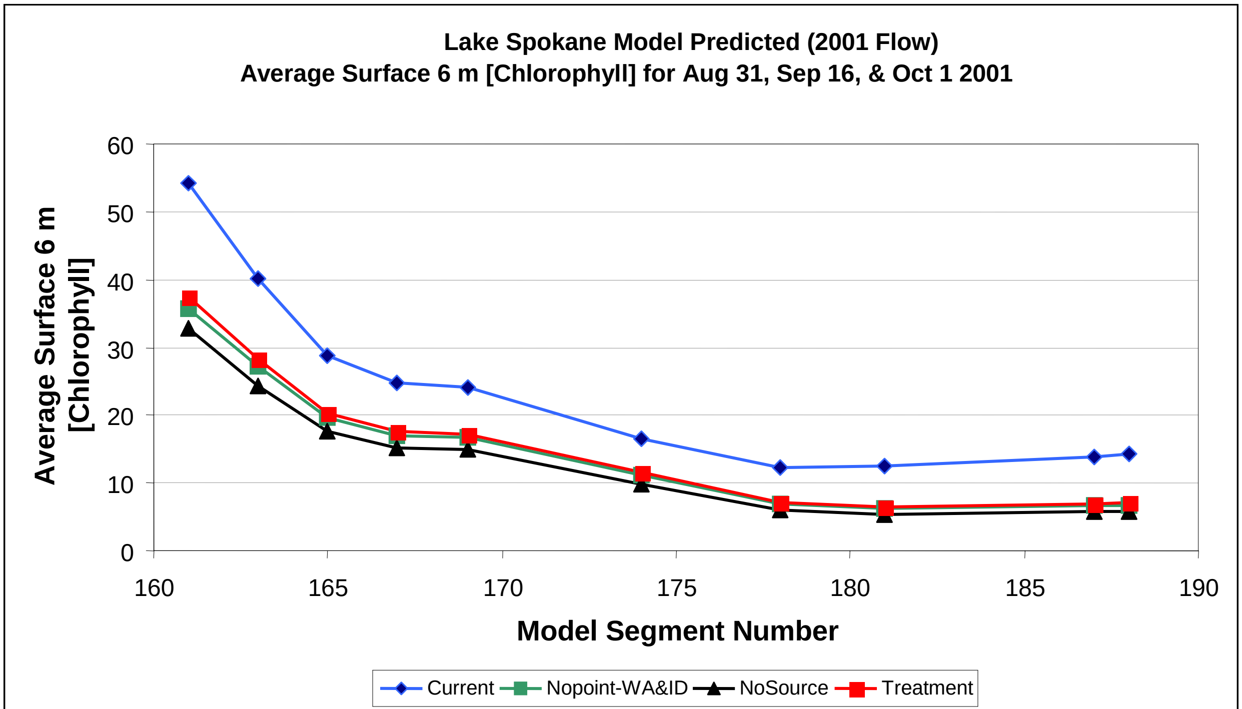


Figure 7. Comparison of model predictions for Lake Spokane algal productivity over reservoir length during 2001 flows and augmented minimum flows (745 cfs @ Post Falls).
(Current = 2001 conditions, Nopoint WA&ID =. All point source pollutants removed, NoSource = Natural Background, Treatment = highest level of effluent treatment – 20 ug/L TP).



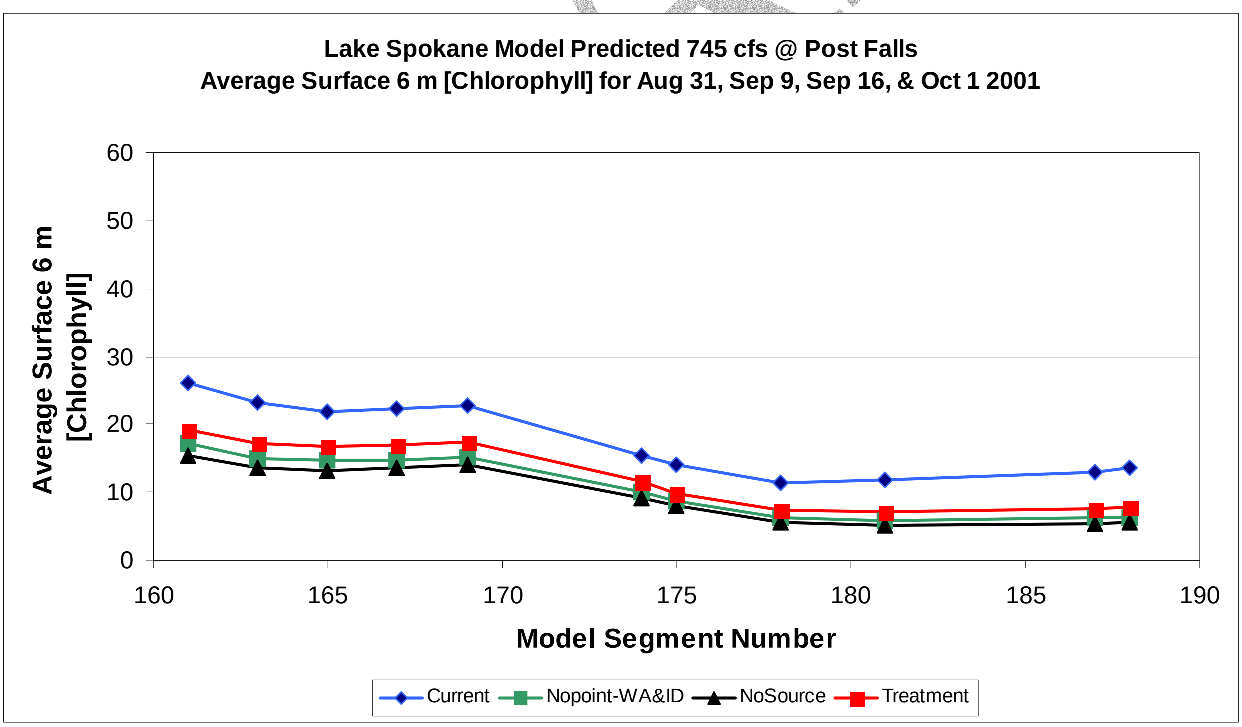
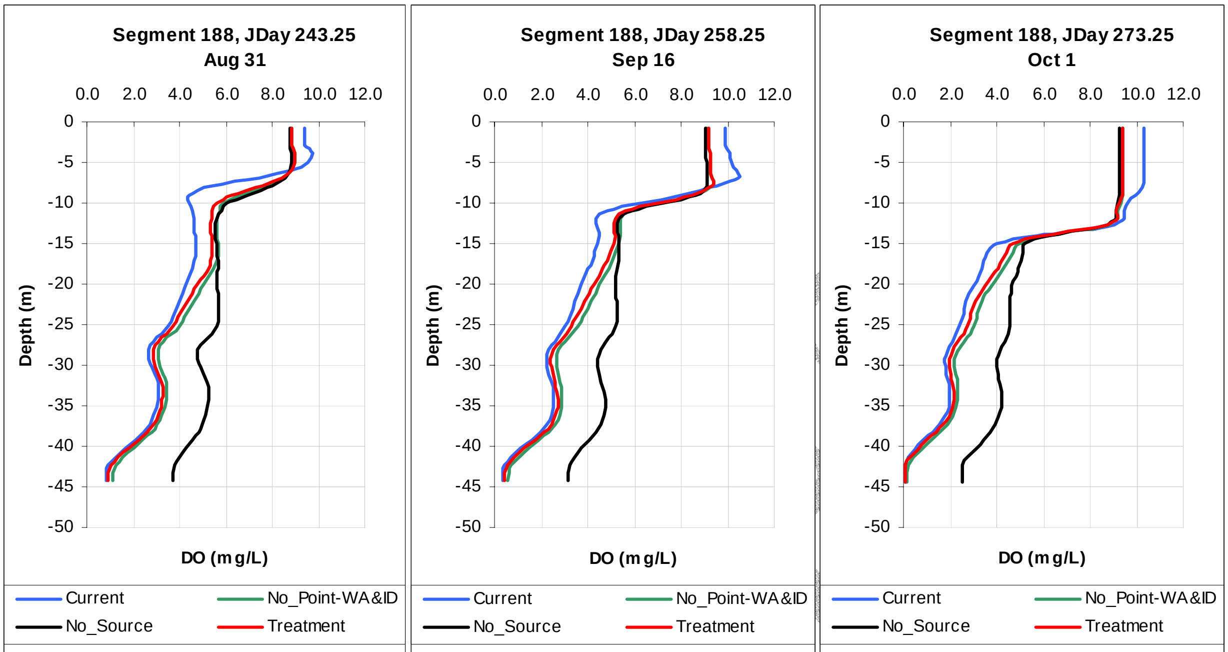
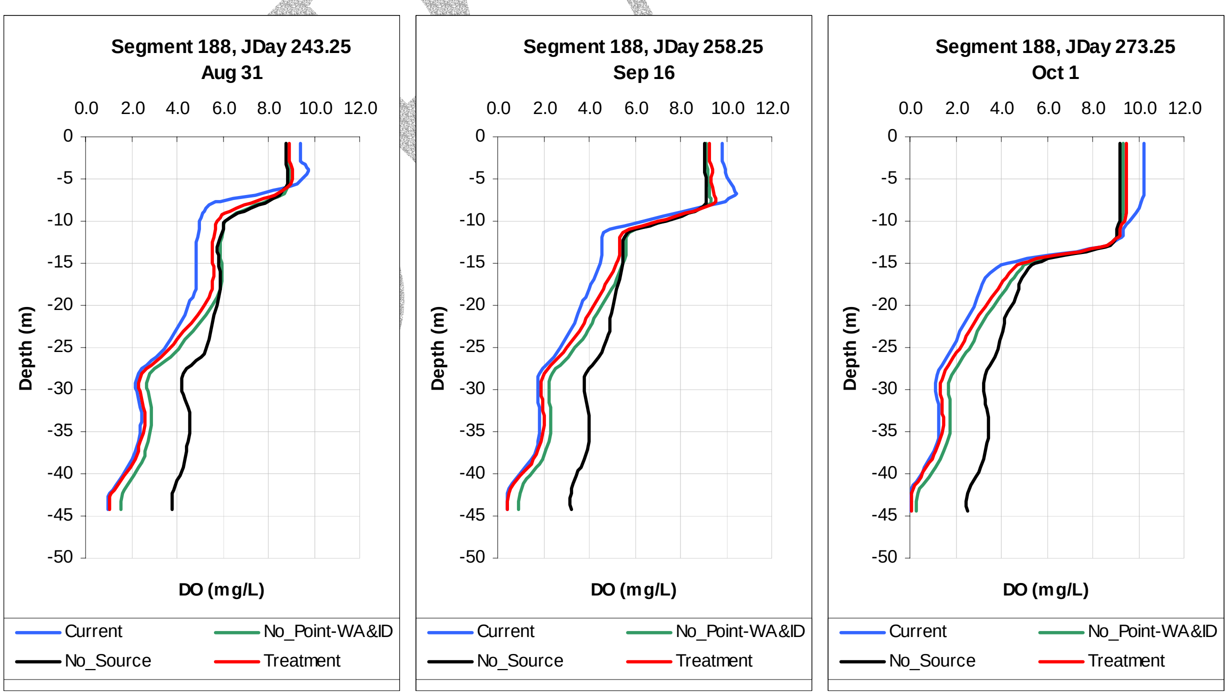


Figure 8. Comparison of model predictions for Lake Spokane dissolved oxygen (DO) near Dam (segment 188) during 2001 flows and augmented minimum flows (745 cfs @ Post Falls).
(Current = 2001 conditions, Nopoint WA&ID =. All point source pollutants removed, NoSource = Natural Background, Treatment = highest level of effluent treatment – 20 ug/L TP).

2001 Flows



Augmented Minimum Flow (745 cfs @ Post Falls)



Supporting Documents

This TMDL relies primarily on the work described in the report entitled, Spokane River and Lake Spokane (Long Lake) Pollutant loading Assessment for Protecting Dissolved Oxygen (Cusimano, 2004). This technical report contains an extensive listing of references, reviews and evaluations that were used to support development of the study and model. These are part of the administrative record for this TMDL. Several documents were also generated in the process of developing and calibrating the model and gathering data. The major supporting documents and their role in the TMDL/model development were as follows: :

1. Annear et al. (2001) and Slominski et al. (2003) provide data used to develop the CE-QUAL-W2 model, background information on the CE-QUAL-W2 model, and model boundary conditions and model setup for simulating the Spokane River system in Washington.
2. Berger et al. (2002 and 2003) discusses the model calibration results.
3. Cusimano (2003) provides information on data sampling stations and locations, methods, data quality objectives and analytical procedures, sample collection and field measurement methods, sampling and quality control procedures, and data quality results for data collected by Ecology
4. Wells et al. (2003) discusses the non-calibrated model set-up for simulating the Idaho portion of the Spokane River.
5. Berger et al. (2004) discusses changes made to the Spokane River model calibration since the original calibration of the model discussed in the model development reports. The results presented in the final load assessment report were based on the final calibrated model completed January 22, 2004.

These reports are available on Ecology's Spokane River TMDL web site at:

http://www.ecy.wa.gov/programs/wq/tmdl/watershed/spokaneriver/dissolved_oxygen/technical.html

Conclusions of Technical Report and TMDL

A summary of the important conclusions identified in the TMDL and supporting technical report are presented below. More in depth discussion can be found in the load assessment report (Cusimano, 2004).

- DO criteria in Lake Spokane and portions of the Spokane River are not met during the critical conditions.
- Lake Spokane suffers from algae blooms during the critical periods of warm weather and low flow. Along with contributing to oxygen demand, algae blooms also adversely affect aesthetics, boating, and other recreational uses of the Lake.
- Low DO conditions in the Lake contribute to violations of the Spokane Indian Tribe's water quality standards.
- Algal production significantly contributes to DO depletions beyond criterion during critical conditions in the River and Lake.
- Phosphorus has the most significant impact on algal production in the Lake and River, but DO is also impacted by BOD and ammonia.

- Both point source and nonpoint sources of pollutant loading contribute to violations of WQ criterion
- DO in the hypolimnion (bottom strata of the lake) is most impacted by nonpoint pollution with some additional impact from point sources
- Point Sources of nutrients cause the majority of the DO depletion in the Lake Spokane interflow zone (metalimnion) during the summer.
- Current nonpoint pollutant loading alone, contributes nutrients in excess of the loading needed to prevent excessive DO depletion (<0.2 mg/L decrease from “natural conditions”).
- Managing pollutant loads as proposed to protect Lake DO will also protect the river DO.
- Reducing BOD and phosphorus loads will likely reduce sediment oxygen demand over time allowing for improved DO in the hypolimnion of the lake (currently applied as MOS).
- The Effluent Treatment scenario using effluent quality of 20 ug/L TP resulted in a 0.44 mg/L decrease in DO in the worst spot (segment 188) and an average of 0.22 mg/L decrease from the NoPoint scenario in portions of the water column where DO was already below 8.0 mg/L..
- Maintaining higher minimum flows to around 700 cfs in the river can significantly reduce phosphorus concentrations and phytoplankton productivity in the upper part of Lake Spokane. However, significant immediate changes in same-season dissolved oxygen were not predicted in the lower lake strata (hypolimnion) as previously predicted using regression models developed for Long Lake in the 80’s (Patmont et al., 1987). It is anticipated that any DO changes due to reduced productivity will likely be delayed at least a year and exhibited as gradual changes in future SOD and hypolimnetic DO as unoxidized organic matter decrease in the sediment.

Total Loading Capacity

The total allowable loading capacity is based on the amount of CBOD, phosphorus, ammonia that can be assimilated by Lake Spokane without causing greater than a 0.2 mg/L decrease in dissolved oxygen from natural conditions in the most critical portion of the lake. The baseline estimate of natural DO was determined from the NO SOURCE model scenario. The allowable decrease from natural conditions was calculated as an average difference from the natural profile for water column model layers predicted to have natural DO of less than 8.0 mg/L. The natural condition load is comprised of the large volume, but naturally low nutrient concentrations received from Lake Coeur d' Alene, the Spokane Valley – Rathdrum Prairie Aquifer (≈500 cfs) entering the river downstream of Liberty Lake, and the Little Spokane River (over half of the summer flow is from ground water, ≈250 cfs). Natural loading from surface water in the Little Spokane River and Hangman Creek is less significant during a dry year such as 2001 because of the decreased volume. The total load capacity was then determined by performing an incremental addition to each of the surface water tributary "natural condition" loads by a small percentage (NPS Pollution) until the average allowable 0.2 mg/L decrease was achieved.

Lake Spokane's total maximum daily load (TMDL) for each month during the critical period of April 1 through October 31 was then calculated as the sum of the Spokane River load at Nine Mile Dam and the Little Spokane River load near the mouth (Table 1). The river upstream of Nine Mile Dam to the Idaho Stateline will meet the DO criteria when conditions of the TMDL are met.

Load Allocations

The load allocations for this TMDL includes both natural background loading plus the amount of loading from nonpoint pollution sources that will not cause more than 0.2 mg/l decrease from the estimated natural condition dissolved oxygen concentrations. Table 2 below contains the monthly Tributary Load Allocations (LA) in yellow as determined using the natural tributary loading plus an allowable nonpoint source (NPS) pollutant load. The allowable NPS load was modeled as described above by incrementally increasing a percentage of each "natural condition" tributary loading (NO SOURCE) until an average decrease of 0.2 mg/L from natural conditions DO was derived for the hypolimnion of Lake Spokane near the dam (segment 188). This method of calculation showed that during the period June – October only about 8.5 lbs per day of phosphorus can be allowed above the natural background loading. Total tributary loadings (natural condition + nonpoint pollutant source loading) will need to be reduced by approximately 20 percent to comply with the TMDL.

Lake Spokane Total Loading Capacity by Month

(Total Lake Load = 9Mi + LSR based on model estimates)

	NOSOURCE + NPS						Nonpoint Pollution Source (NPS) (9 Mi+LSR)			% Reduction from 2001 Current Load to TMDL (Natural + NPS)		
	TP	CBOD	NH3	TP	CBOD	NH3	TP	CBOD	NH3			
monthly average	mg/L	mg/L	mg/L	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	TP	CBOD	NH3
APR	0.006	0.906	0.011	311.2	46470	562.6	23.6	5093.4	10.6	51%	44%	30%
MAY	0.006	0.897	0.015	635.4	102845	1746.3	41.2	11106.3	19.7	36%	37%	9%
JUN	0.006	0.914	0.016	240.6	37334	644.8	15.3	3358.5	7.7	49%	40%	1%
JUL	0.005	0.719	0.016	105.6	13836	303.5	6.7	943.9	2.5	61%	47%	11%
AUG	0.006	0.594	0.015	71.4	7532	194.7	4.4	446.6	0.9	67%	55%	35%
SEP	0.006	0.759	0.015	85.6	10274	200.4	5.9	727.6	1.6	69%	59%	41%
OCT	0.006	3.16	0.031	130.4	20044	295.6	10.1	1850.8	8.3	70%	53%	35%
Apr-May avg	0.006	0.90	0.013	473.3	74657.7	1154.4	32.4	8099.8	15.1	42%	40%	16%
Jun-Oct avg	0.006	1.23	0.019	126.7	17803.9	327.8	8.5	1465.5	4.2	62%	48%	22%

	CURRENT 2001 CONDITIONS (9Mi+LSR)							Natural Conditions = NOSOURCE (9Mi + LSR)					
	Flow	TP	CBOD	NH3	TP	CBOD	NH3	TP	CBOD	NH3	TP	CBOD	NH3
monthly average	(cfs)	mg/L	mg/L	mg/L	lbs/day	lbs/day	lbs/day	mg/L	mg/L	mg/L	lbs/day	lbs/day	lbs/day
APR	6150	0.012	1.616	0.016	636.2	82876	805.0	0.006	0.807	0.011	287.5	41377	552.0
MAY	13748	0.009	1.434	0.017	988.6	164418	1927.6	0.005	0.800	0.015	594.3	91739	1726.6
JUN	4900	0.011	1.525	0.016	468.1	62310	648.3	0.006	0.831	0.016	225.3	33975	637.1
JUL	2309	0.014	1.346	0.018	272.9	25912	342.1	0.005	0.669	0.016	98.9	12892	301.1
AUG	1519	0.017	1.320	0.024	216.9	16725	301.0	0.005	0.559	0.015	67.0	7085	193.8
SEP	1623	0.021	1.837	0.025	279.0	24871	340.2	0.006	0.705	0.015	79.7	9547	198.8
OCT	2422	0.021	2.108	0.023	429.5	42573	457.2	0.006	0.901	0.014	120.3	18193	287.3
Apr-May avg	9949	0.011	1.525	0.016	812.4	123647	1366.3	0.005	0.80	0.013	440.9	66558	1139.3
Jun-Oct avg	2555	0.017	1.627	0.021	333.3	34478	417.8	0.006	0.73	0.015	118.2	16338	323.6

Table 1. Lake Spokane Total Loading Capacity by month with comparison to estimates of 2001 and Natural Condition loadings. Total Lake load was derived as the sum of natural condition and allowable nonpoint pollution source loads (NPS) for Spokane River near 9 Mile Dam (9Mi) combined with Little Spokane River near the mouth (LSR).

					Current conditions LOAD						Natural conditions LOAD						LOAD Allocat (Natural+NPS)			% Reduction from current to get to Natural + NPS		
Hangman = CURRENT 2001 CONDITIONS					TP	CBOD	NH3	Hangman = NOSOURCE			TP	CBOD	NH3	Hangman = NOSOURCE+NPS			TP	CBOD	NH3			
LA MONTH	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	TP	CBOD	NH3
APR	135.83	0.1011	3.8	0.040	74.0	2782.2	29.5	0.0204	1.40	0.007	14.9	1025.0	5.4	0.0230	1.64	0.007	16.9	1200.7	5.4	77%	57%	82%
MAY	92.86	0.0788	3.8	0.018	39.4	1902.0	8.8	0.0191	1.40	0.007	9.5	700.7	3.7	0.0217	1.64	0.007	10.9	820.9	3.7	72%	57%	58%
JUN	29.15	0.0760	3.8	0.021	11.9	597.1	3.2	0.0184	1.40	0.007	2.9	220.0	1.2	0.0210	1.64	0.007	3.3	257.7	1.2	72%	57%	65%
JUL	10.52	0.0609	3.4	0.021	3.5	193.8	1.2	0.0184	1.40	0.005	1.0	79.4	0.3	0.0210	1.64	0.005	1.2	93.0	0.3	65%	52%	77%
AUG	6.66	0.0436	2.7	0.005	1.6	98.5	0.2	0.0184	1.40	0.005	0.7	50.3	0.2	0.0210	1.64	0.005	0.8	58.9	0.2	52%	40%	0%
SEP	6.38	0.0456	3.1	0.005	1.6	106.3	0.2	0.0184	1.40	0.005	0.6	48.1	0.2	0.0210	1.64	0.005	0.7	56.4	0.2	54%	47%	0%
OCT	12.74	0.0452	3.2	0.005	3.1	219.8	0.3	0.0191	1.40	0.005	1.3	96.2	0.3	0.0217	1.64	0.005	1.5	112.6	0.3	52%	49%	0%
Apr-May avg	114.35	0.090	3.80	0.029	56.74	2342.07	19.19	0.020	1.40	0.007	12.24	862.87	4.52	0.022	1.64	0.007	13.87	1010.79	4.52	76%	57%	76%
Jun-Oct avg	13.09	0.054	3.25	0.011	4.33	243.08	1.03	0.019	1.40	0.005	1.31	98.79	0.43	0.021	1.64	0.005	1.49	115.73	0.43	65%	52%	59%
Coulee = CURRENT 2001 CONDITIONS					TP	CBOD	NH3	Coulee = NOSOURCE			TP	CBOD	NH3	Coulee = NOSOURCE + NPS			TP	CBOD	NH3			
LA MONTH	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day			
APR	35.47	0.1011	3.8	0.040	19.3	726.6	7.7	0.0204	1.40	0.007	3.9	267.7	1.4	0.0230	1.64	0.007	4.4	313.6	1.4	77%	57%	82%
MAY	24.25	0.0788	3.8	0.018	10.3	496.7	2.3	0.0191	1.40	0.007	2.5	183.0	1.0	0.0217	1.64	0.007	2.8	214.4	1.0	72%	57%	58%
JUN	7.62	0.0760	3.8	0.021	3.1	156.0	0.8	0.0184	1.40	0.007	0.8	57.5	0.3	0.0210	1.64	0.007	0.9	67.3	0.3	72%	57%	65%
JUL	2.75	0.0609	3.4	0.021	0.9	50.6	0.3	0.0184	1.40	0.005	0.3	20.7	0.1	0.0210	1.64	0.005	0.3	24.3	0.1	65%	52%	77%
AUG	1.73	0.0436	2.7	0.005	0.4	25.6	0.0	0.0184	1.40	0.005	0.2	13.1	0.0	0.0210	1.64	0.005	0.2	15.3	0.0	52%	40%	0%
SEP	1.66	0.0456	3.1	0.005	0.4	27.6	0.0	0.0184	1.40	0.005	0.2	12.5	0.0	0.0210	1.64	0.005	0.2	14.7	0.0	54%	47%	0%
OCT	3.33	0.0452	3.2	0.005	0.8	57.4	0.1	0.0191	1.40	0.005	0.3	25.1	0.1	0.0217	1.64	0.005	0.4	29.4	0.1	52%	49%	0%
Apr-May avg	29.86	0.090	3.80	0.029	14.82	611.63	5.01	0.020	1.40	0.007	3.20	225.34	1.18	0.022	1.64	0.007	3.62	263.97	1.18	76%	57%	76%
Jun-Oct avg	3.42	0.054	3.25	0.011	1.13	63.46	0.27	0.019	1.40	0.005	0.34	25.79	0.11	0.021	1.64	0.005	0.39	30.21	0.11	65%	52%	59%
Little Spokane = CURRENT 2001 CONDITIONS					TP	CBOD	NH3	Little Spokane = NOSOURCE			TP	CBOD	NH3	Little Spokane = NOSOURCE + NPS			TP	CBOD	NH3			
	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day			
APR	590.21	0.0442	2.5	0.050	140.5	7953.1	160.1	0.0271	1.40	0.007	86.1	4453.7	23.3	0.0297	1.64	0.007	94.5	5217.2	23.3	33%	34%	85%
MAY	540.99	0.0408	2.5	0.028	119.1	7289.8	80.7	0.0257	1.40	0.007	75.0	4082.3	21.4	0.0284	1.64	0.007	82.7	4782.1	21.4	31%	34%	73%
JUN	426.06	0.0382	2.5	0.008	87.7	5741.2	19.1	0.0251	1.40	0.007	57.6	3215.1	16.8	0.0277	1.64	0.007	63.6	3766.2	16.8	27%	34%	12%
JUL	372.04	0.0244	1.3	0.005	49.0	2586.8	10.0	0.0172	1.29	0.005	34.5	2586.8	10.0	0.0196	1.51	0.005	39.4	3034.7	10.0	20%	-17%	0%
AUG	353.72	0.0245	1.3	0.009	46.8	2440.4	16.5	0.0152	1.11	0.005	29.1	2122.6	10.2	0.0173	1.30	0.005	33.1	2484.9	10.2	29%	-2%	38%
SEP	352.16	0.0266	1.7	0.006	50.5	3165.2	11.9	0.0180	1.36	0.005	34.1	2586.2	9.5	0.0205	1.60	0.005	39.0	3027.5	9.5	23%	4%	20%
OCT	379.44	0.0273	1.7	0.005	55.8	3476.8	10.2	0.0191	1.40	0.005	39.0	2863.3	10.2	0.0217	1.64	0.005	44.4	3354.1	10.2	20%	4%	0%
Apr-May avg	565.60	0.043	2.50	0.039	129.79	7621.45	120.40	0.026	1.40	0.007	80.57	4268.01	22.36	0.029	1.64	0.007	88.62	4999.67	22.36	32%	34%	81%
Jun-Oct avg	376.68	0.028	1.69	0.007	57.94	3482.08	13.56	0.019	1.31	0.006	38.85	2674.80	11.35	0.021	1.54	0.006	43.89	3133.49	11.35	24%	10%	16%
Stateline = CURRENT 2001 CONDITIONS					TP	CBOD	NH3	Stateline = NOSOURCE			TP	CBOD	NH3	Stateline = NOSOURCE + NPS			TP	CBOD	NH3	Negative reductions caused by differences in very low levels of modeled and measured NH3 at Stateline		
	avg Flow	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day	avg TP	avg CBOD	avg NH3	lbs/day	lbs/day	lbs/day			
APR	4777.76	0.0107	1.8	0.007	276.4	46353.8	180.3	0.0070	1.24	0.011	179.1	31910.2	271.5	0.0076	1.44	0.011	194.5	37060.6	271.5	30%	20%	-51%
MAY	10949.88	0.0084	1.8	0.005	495.8	106235.7	295.1	0.0070	1.24	0.010	415.1	73030.3	614.5	0.0076	1.44	0.010	450.4	84816.5	614.5	9%	20%	-108%
JUN	3243.12	0.0084	1.8	0.006	146.8	31464.7	110.7	0.0068	1.28	0.012	119.4	22359.7	207.4	0.0074	1.47	0.012	129.6	25762.0	207.4	12%	18%	-87%
JUL	842.72	0.0095	1.9	0.012	42.9	8596.3	52.2	0.0063	1.33	0.012	28.5	6057.5	53.9	0.0068	1.51	0.012	30.9	6872.4	53.9	28%	20%	-3%
AUG	240.03	0.0132	2.2	0.009	17.0	2813.9	11.3	0.0058	1.44	0.013	7.5	1867.4	16.4	0.0063	1.62	0.013	8.1	2091.9	16.4	52%	26%	-45%
SEP	629.80	0.0113	2.6	0.006	38.4	8859.9	18.7	0.0062	1.64	0.015	20.9	5561.2	52.1	0.0068	1.86	0.015	23.2	6327.9	52.1	39%	29%	-179%
OCT	1681.74	0.0099	2.2	0.005	90.0	19942.1	45.3	0.0070	1.62	0.016	63.5	14728.4	144.4	0.0078	1.87	0.016	70.3	16991.0	144.4	22%	15%	-219%
Apr-May avg	7863.82	0.010	1.80	0.006	386.09	76294.75	237.68	0.007	1.24	0.010	297.07	52470.2	443.0	0.008	1.44	0.010	322.47	60938.57	442.99	16%	20%	-86%
Jun-Oct avg	1327.48	0.010	2.14	0.007	67.05	14335.39	47.65	0.006	1.46	0.014	47.96	10114.8	94.8	0.007	1.67	0.014	52.44	11609.03	94.85	22%	19%	-99%

Table 2. Spokane River and Tributary Load Allocations (LA) for nutrients necessary to prevent violations of the dissolved oxygen criteria in Lake Spokane

Waste Load Allocations

The total nutrient loading capacity of Lake Spokane is consumed by just a portion of the existing nonpoint pollutant source load combined with the natural condition load. There is no reasonable assurance that NPS can or will be reduced to achieve the load allocation. Therefore, no assimilative capacity is left for point source pollutant loading that would cause or contribute to an increase in river concentrations of pollutants during the critical period (April 1 – October 31). Discharges of treated effluent to the river that meet the target river concentrations at end-of-pipe for phosphorus, CBOD, and ammonia, in each of the applicable river reaches will not cause or contribute to violation of applicable water quality standard. Therefore, a concentration-based wasteload allocation is allowable as long as these target instream concentrations are met. The target concentrations for several reaches of the river constitute the WLAs for each reach and were calculated by the model with the Natural Condition + NPS scenario when the DO criteria is met in Lake Spokane.

Instream concentrations as predicted by the model under the NOSOURCE + Nonpoint Source Pollution (NPS) scenario used to develop the Tributary Load Allocations

	NH3	TP	CBOD
Upstream of Liberty Lake	0.014	0.0092	1.99
Upstream of Kaiser	0.020	0.0087	1.76
Upstream of IEPC	0.017	0.0086	1.37
Upstream of Spokane WWTP	0.030	0.0082	1.18

1) The values above represent the average Jun-Oct period from segments upstream of the point source discharges.
2) All other surface sources should receive these concentrations or the average of these concentrations

There are many small direct and indirect discharges to the Spokane River that may occur as the result of rainfall and snowmelt events. These discharges are regulated by NPDES permits for runoff from construction sites greater than one acre, runoff from industrial activities and discharges from the municipal storm sewer system. Typically, significant discharges from these facilities will not occur during the critical period and none did during TMDL monitoring in 2001. However, discharges from these facilities may occur during the critical period in some future year. This TMDL presumes that implementation of the best management practices identified in each of these permits will not cause or contribute to violation of water quality standards during the critical period. Therefore, the WLA for these permittees (during the critical period) is the concentration-based WLA identified above. Monitoring of these discharges and an evaluation of BMP effectiveness over time will determine if this presumption is correct or needs to be modified.

Margin of Safety

Because this TMDL requires that point sources not contribute to any change in target instream concentrations, a safety factor applied to a WLA of essentially zero appear to be unnecessary. There is a very small safety factor associated with the proposed tributary LAs since actual average DO declines used to establish the LAs were rounded from values ranging between 0.1995 mg/L on the most critical day of the summer in the most stringent model segment. Other days in the critical summer months had declines down to 0.18 mg/L. This essentially equates in a 0.3% to 10% margin of safety around the critical summer time.

Summary Implementation Strategy

The Summary Implementation Strategy (SIS) is required with a proposed TMDL under the requirements of a memorandum of agreement with US EPA. The SIS should provide a clear, concise, and sequential presentation of concepts which will meet the allocations of the TMDL.

Schedule

The proposed schedule is targeted at removing the largest controllable sources of Lake Spokane nutrient contributions as quickly as possible (Figure 9) so that significant changes in water quality are realized quickly and allow time to observe Lake DO response while developing reuse projects. The compliance schedule requires interim treatment plant upgrades by the existing wastewater dischargers to meet the state-of-the-science phosphorus removal by achieving average effluent phosphorus concentrations of 50 ug/L or less (Figure 10). The compliance schedule would allow until the end of 2008 for these upgrades to be completed. The interim compliance schedule for treatment plant upgrades need not be delayed while developing a detailed implementation plan and should begin immediately with approval of the TMDL.

Compliance with the final WLAs and LAs will allow the maximum length compliance schedule allowed under state WQ standards (10 years, ending January 2016). The TMDLs being developed for Hangman Creek (Latah Creek) and the Little Spokane River will develop plans to implement best management practices for control of nonpoint sources in those major tributary watersheds by 2006/07. A detailed implementation plan will also be needed by no later then the end of 2005 for developing seasonal alternatives river discharges for point source such as water reclamation and reuse and/or other wastewater treatment techniques to meet the very low end-of-pipe concentrations-based WLA.

Strategies to Achieve TMDL Load Allocations for Nonpoint Sources

The major tributary watersheds of Hangman Creek (Latah Creek) and the Little Spokane River are in the process of developing a TMDL for each. The resulting TMDLs and implementation strategies will be coordinated with the Spokane TMDL.

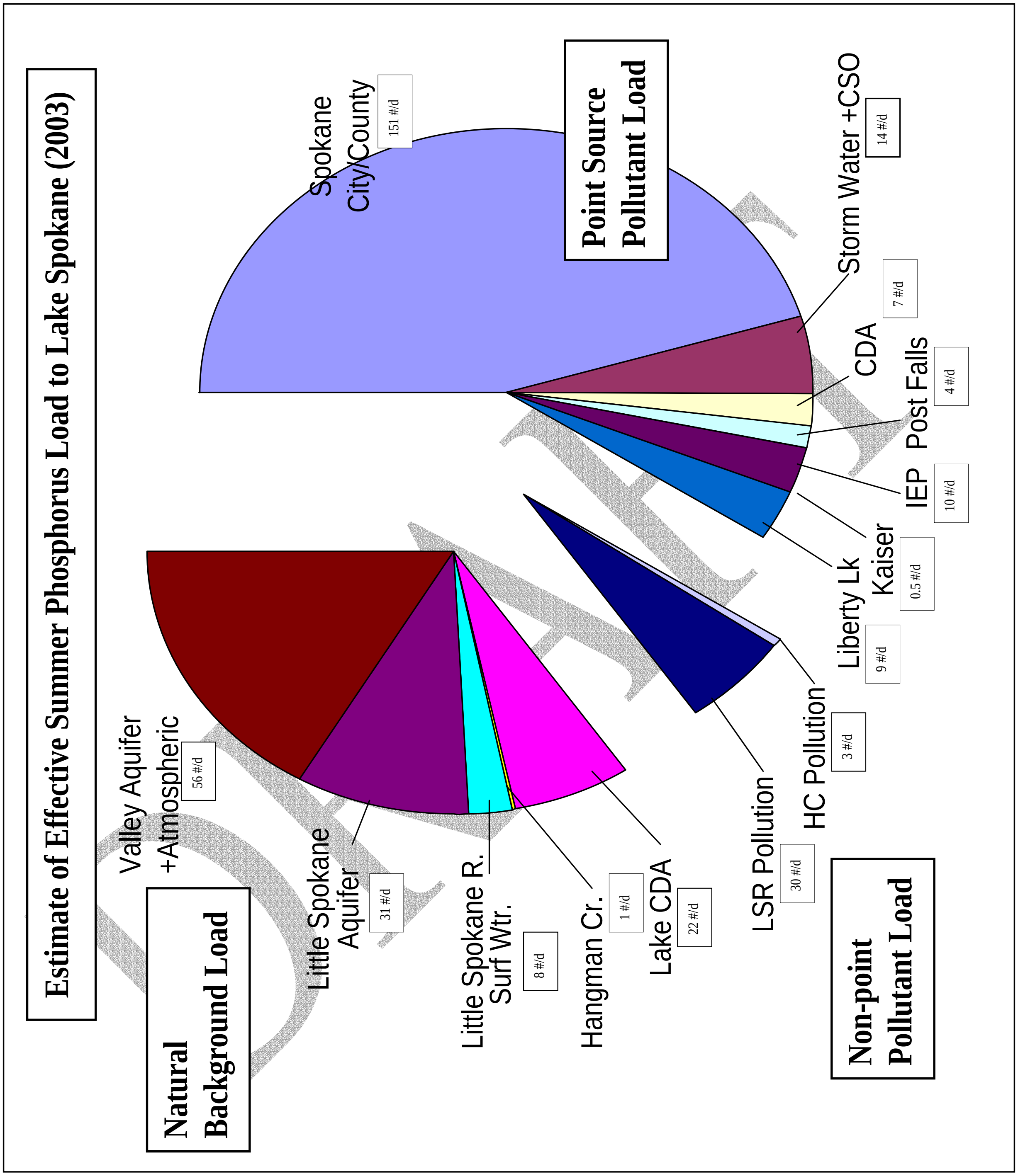
Strategies to Achieve TMDL Wasteload Allocations for Point Sources

It is anticipated that it will take a combination of several strategies described below, to ultimately achieve compliance with the TMDL.

1. Control influent wastewater volume and quality through conservation and waste management

Reduction of the volume and pollution concentration of influent into treatment plants can improve efficiency and lower resulting discharge loading for a given population. Influent flow reduction strategies include I/I (influent & infiltration) control and water conservation. Pollutant reduction strategies vary. Because phosphorous is a pollutant of concern in the Spokane River DO TMDL, control of phosphate content in household and commercial products which reach the sewer can reduce phosphorous treatment requirements. Industrial discharge of high strength organic wastewater without pretreatment or the import of high strength sludges can also affect nutrient loads in the effluent.

Figure 9. Estimate of 2003 effective summer (June – October) phosphorus loading to Lk Spokane using natural condition estimates from CE-Qual-W2 and attenuated point source loadings estimated from the P- attenuation model for a 1-in-10 low flow year.



YR	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
TMDL Schedule	TMDL Approval	**Phase I - Interim Nutient Removal**				**Phase 2 - Final TMDL Goal - Meet DO Criteria**						
w/ existing WQ criteria						0.2 mg/L DO decrease from natural mostly by phosphorus control						
Point Sources	Planning for Max TP removal and reuse		Construction		MAX TP removal in-place	Meet natural background conc or Imp Reuse - Lake Monitor - Complete UAA						
Nonpoint Sources	Tributary TMDLs completed with Imp Plan			Begin Implement BMPs		Complete implement BMPs w/ monitoring and adaptive approach						

Estimates of Phosphorus Loading Reduction (2003 Pt Src flows)

	Existing Avg TP load Summer 2003			Max TP removal Load @ 50 ug/L- all to river			Load at TP Final goal @ 10 ugL to River	
Discharger	**#/day**	**Flow MGD**		**#/day**	**Flow MGD**		**#/day**	**Flow MGD**
CDA	6.9	3.2		0.4	3.2		0.1	3.2
Hayden	seaonal land app			seaonal land app			early spring P removal?	
Post Falls	4.1	2.1		0.4	2.1		0.1	2.1
Liberty Lake	9.1	0.7		0.1	0.7	If effluent TP meets instream target conc. - effluent TP loading can increase with effluent flow as long as in-stream conc. does not increase	0.0	0.7
Kaiser	0.1	0.1 (Outfall 02+03)		3.2	16*		1.3	16.0
IEP	9.8	4.8*		1.1	4.8		0.2	4.8
Spokane City/Cnty	151.0	36.5		14.5	36.5		2.9	36.5
Spokane CSO&Storm	14.2			CSO elim & SW mgmt plans			Reduce / Elim CSO & SW	
Tot. PS Load**	**195.2**			**19.7**			**4.6**	conc-based limt
Tributary Load (Natural+NPS)	150.8	YR 2001		150.8	YR 2001	≈ 20% reduction in trib loads needed to meet TMDL	127.0	YR 2001
Total Load**	346.0	NA		170.5	NA		127.0	

* Includes all cooling water

** with estimated P attenuation

Point Source compliance schedule implemented via common Administrative Order then rolled into all individual permits within 2 years

Figure 10. Summary - Spokane R. Proposed TMDL and Phosphorus Loading Reduction Strategy (9-20-04)

Strategies:

A. Municipal NPDES permit holders will adopt specific plans with measures to investigate and control inflow and infiltration (I/I) into municipal sewer systems.

B. Municipal NPDES permit holders will conduct water audits and adopt water conservation measures including ordinances and rate structures to induce reductions in household and commercial water use by their customers. Industrial users shall be required to invest in water reuse technology (membrane systems) as is economically achievable to eliminate dilute high-volume discharges.

C. Municipal NPDES permit holders with require commercial/industrial users of their collection system to use phosphate reduced/free products where possible and/or provide on-site pretreatment of high strength phosphorus and organic wastes before disposal to the sewer. There shall be audits of the larger wastewater dischargers to review all waste disposal practices to the sewer. These will include industries such as commercial laundries, hospitals, and metal finishers using phosphoric-based cleaners.

D. To prevent unnecessary pollutant loading to the river, the city of Spokane and Spokane County shall immediately cease the import of domestic septage, municipal sludges, or any other hauled wastewater from outside of Spokane County unless it is to alleviate an immediate emergency.

E. Industrial NPDES permit holders will conduct internal water audits to reduce internal water use, maximize reuse of industrial effluent, and eliminate phosphate-containing products where possible.

F. Spokane County will adopt an ordinance to ban the sale of phosphate containing dishwashing detergent and other phosphorus based cleaning aids designed for disposal to the sewer.

2. Reclamation and Reuse

RCW 90.46.005 states: "[T]he people of the state of Washington have a primary interest in the development of facilities to provide reclaimed water . . . . To the extent reclaimed water is appropriate for beneficial uses, it should be so used . . . ." In the case of the Spokane River, this mandate is also an opportunity.

Reclaimed (or recycled) water is already used extensively at locations across the country, and would provide at least two significant benefits: First, water which is reclaimed for other purposes need not be discharged into the river, reducing the stress on the system.

Second, reclaimed water used locally substitutes for water which would otherwise be drawn from natural sources. Eliminating the need for such withdrawals enhances natural flows, including avoiding negative effects occurring upstream of the current discharge points. As municipalities and holders of state waste discharge permits are among those eligible to obtain water reclamation permits (see, e.g., RCW 90.46.030(4)), this option is available to all point source dischargers on the Spokane River.

Pursuant to RCW 90.46, the Washington State Departments of Health and Ecology issued the *Water Reclamation and Reuse Standards* (publication #97-23, hereafter Standards) (http://www.ecy.wa.gov/programs/wq/reclaim/standards.pdf) in September 1997. These standards identify various uses appropriate for reclaimed water and set the criteria to be met by water used for each such purpose. One significant use is for irrigation, where some of the same substances considered contaminants when dumped in a river serve a beneficial purpose instead. Strategies:

A. Municipal sewage treatment plants shall implement programs to provide reclaimed water of suitable quality for appropriate and available local uses.

B. Municipalities shall implement programs to use reclaimed water for all appropriate beneficial uses.

C. Land use planning shall require all major residential, commercial, industrial, and municipal development projects to include accommodation for appropriate reclaimed water uses.

D. Industrial dischargers shall develop their own reclamation facilities, contract to redirect their discharges into municipal reclamation facilities, or contract to substitute municipal reclaimed wastewater for industrial purposes.

3. <u>Alternative wastewater treatment to meet end-of-pipe WLA with discharge to the river</u>

The proposed interim reduction in point source phosphorus concentrations to 50 ug/L by 2008 was based on existing treatment plant performance at some New York Watershed wastewater treatment plants (Dibble pers com, 2004), existing performance of the Upper Occoquan Sewer Authority treatment plant (WEF, 1998), and a technical report describing proven phosphorus removal efficiency using membrane bioreactors (Lorenz, 2002). These interim reductions are necessary to provide a significant reduction in phosphorus loading to the lake and allow time for monitoring to assess the lake and river responses to the nutrient reductions. The vertical continuously cleaning, dual sand filter systems used in New York appear to be achieving phosphorus concentrations very near to those necessary to meet the final concentration-based WLA (<10 ug/L annual avg TP).

Strategies:

The NPDES permit dischargers shall evaluate new and available technologies for reducing phosphorus and other nutrient pollution including operating pilot projects to determine suitability and cost effectiveness.

4. <u>Combined Sewage Overflow and Stormwater Control</u>

The pollutant loading from combined sewage overflow (CSO) and stormwater was determined to be insignificant during an unusually dry year similar to the TMDL design condition. However, the pollutant loading will continue to be reduced through the exiting requirement in the city of Spokane's NPDES permit to implement the approved CSO elimination plan. The plan requires that all CSO outfalls will be in compliance by 2017 with state CSO regulations (WAC 173- 245) which require no more than an average of one CSO discharge event per outfall per year.

City of Spokane's stormwater discharges are now regulated by the Municipal Stormwater requirements and EPA rules require operators of municipal separate storm sewer systems (**MS4s**) to develop and implement a ***stormwater management program*** that:

- Reduces the discharge of pollutants to the "maximum extent practicable."
- Protects water quality.
- Satisfies appropriate requirements of the Clean Water Act.

5. Flow Augmentation

As previously discussed, increased river flow above the critical design low flows can significantly improve upper lake phosphorus concentrations and algal productivity. A combination of increased flow and reduced nutrient load may result in large improvements in water quality.

Strategies:

Methods for augmenting minimum flows in the Spokane River should be explored by the municipalities, watershed planning units, and Avista Dam relicensing advisory groups. These considerations should include options for altering existing Coeur d' Alene lake level management and the feasibility of actively managing aquifer/river exchanges for maximizing potential aquifer storage and ground water discharge to the river in the summer.

Monitoring

Under WAC § 173-220-210, any discharge authorized by a permit is subject to monitoring requirements as may be reasonably required by Ecology. The MOA, EPA Guidelines, and TMDL Guidance Document require detailed monitoring plans where implementation will be phased in over time. All permits must require effluent and ambient monitoring necessary to show that the effluent limits are being met and re-opener clauses allowing Ecology to modify or revoke the permit if the permit limits or the permittee fail to attain specified targets. 40 CFR § 122.44. *See also* WAC §§ 173-220-180, -190.

Monitoring for the Spokane River dissolved oxygen TMDL shall include the following with the details to be completed in the detailed implementation plan (DIP) for monitoring:

A. An ambient water quality monitoring program of the Spokane River, its tributaries, and Lake Spokane must be established to monitor critical conditions and include collection and analysis of physical, chemical and biological data with quality assurance and control programs to assure scientifically valid data. The monitoring shall be designed to assess the most critical locations and time of year for efficacy of point source nutrient load reductions and nonpoint source cleanup strategies. Reports will be made public through section 305(b) reports.

B. The TMDL Detailed Implementation Plan will establish a series of milestones for the implementation of the strategies identified in Part 3 above. Ecology will develop and circulate a quarterly report that indicates levels of progress for each party that is charged with responsibilities for implementation.

References Cited

Annear, R.L, C.J. Berger, S.A. Wells, and T. Cole, 2001. Upper Spokane River Model: Boundary Conditions and Model Setup. (1991 and 2000) Technical Report EWR-04-01. Department of Civil Engineering, Portland State University, Portland, OR.

Berger, C.J., R.L. Annear, S.A. Wells, and T. Cole, 2002. Upper Spokane River Model: Model Calibration. (1991 and 2000) Technical Report EWR-01-02. Department of Civil Engineering, Portland State University, Portland, OR.

Berger, C.J., R.L. Annear, S.A. Wells, and T. Cole, 2003. Upper Spokane River Model: Model Calibration 2001. Technical Report EWR-01-03. Department of Civil Engineering, Portland State University, Portland, OR.

Berger, C.J., R.L. Annear, S.A. Wells, and T. Cole, 2004. Review of Spokane River Model for Washington Department of Ecology. Technical Report EWR-01-04. Department of Civil Engineering, Portland State University, Portland, OR.

Butler, C., 2004. Personal Communication. Spokane Tribe of Indians

Cunningham, R.K. and R.E. Pine, 1969. Preliminary Investigation of the Low Dissolved Oxygen Concentrations that Exist in Long Lake, Located near Spokane, Washington. Washington State Water Pollution Control Commission, Technical Report No. 69-1.

Cusimano, R.F., 1999. Spokane River and Lake Spokane TMDL Study for Biochemical Oxygen Demand and Update of the Phosphorus Attenuation Model. Final Quality Assurance Project Plan. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA.

Cusimano, R.F., 2003. Data Summary: Spokane River and Lake Spokane (Long Lake) Pollutant Loading Assessment for Protecting Dissolved Oxygen. Publication Number 03-03-023. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. http://www.ecy.wa.gov/biblio/0303023.html

Cusimano R. F., 2004. Spokane River and Lake Spokane (Long Lake) Pollutant Loading Assessment Report for Protecting Dissolved Oxygen. Publication Number 04-03-006. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA http://www.ecy.wa.gov/pubs/0403006.pdf

Dibble, L., 2004. Unpublished Data. Delaware Engineering.

Knight, D.T., 1998. Watershed Approach to Water Quality Management Needs Assessment for the Spokane Water Quality Management Area (WRIA 54-57). Washington State Department of Ecology, Water Quality Program, Spokane, WA.

Lee, C., B. Scofield, D. Pavlik, and K. Fields, 2003. Lake Roosevelt Fisheries Evaluation Program - 2000 Annual Report. Dept. of Natural Resources, Spokane Tribe of Indians. Wellpinit, WA, 99040.

Lorenz, W, T. Cunningham, and J. Penny, 2002. Phosphorus Removal in a Membrane Reactor System: A Full-Scale Demonstration Study. Water Environment Federation Paper 2002.

Patmont, C.R., G.J. Pelletier, and M.E. Harper, 1985. Phosphorus Attenuation in the Spokane River. Project Completion Report. Contract No. C84-076. Harper-Owes, Seattle, WA Prepared for Washington State Department of Ecology, Olympia, WA. Publication No. 85-e28. http://www.ecy.wa.gov/biblio/85e28.html

Patmont, C.R., G.J. Pelletier, L. Singleton, R. Soltero, W. Trial, and E. Welch, 1987. The Spokane River Basin: Allowable Phosphorus Loading. Final Report. Contract No. C0087074. Harper-Owes, Seattle, WA. Prepared for State of Washington State Department of Ecology, Olympia, WA. Publication No. 87-e29.

Singleton, L.R., 1981. Spokane River Wasteload Allocation Study. Supplemental report for phosphorus allocation. Publication No. 81-15. Washington State Department of Ecology, Olympia, WA.

Slominski, S., Annear, R.L, C.J. Berger, and S.A. Wells, 2003. Upper Spokane River Model: Boundary Conditions and Model Setup 2001. Department of Civil Engineering, Portland State University, Portland, OR.

Soltero, R.A., A.F. Gasperino, and W.G. Graham, 1973. An Investigation of the Cause and Effect of Eutrophication in Long Lake, WA. 0.W.R.R. Project 143-34-IOE-3996-5501. Completion Report. Eastern Washington State College, Cheney, WA.

Soltero, R.A., A.F. Gasperino, and W.G. Graham, 1974. Further Investigation as to the Cause and Effect of Eutrophication in Long Lake, WA. Project 74-025A. Completion Report. Eastern Washington State College, Cheney, WA.

Soltero, R.A., A.F. Gasperino, P.H. Williams, and S.R. Thomas, 1975. Response of the Spokane River Periphyton Community to Primary Sewage Effluent and Continued Investigation of Long Lake. Project 74-144. Completion Report. Eastern Washington State College, Cheney, WA.

Soltero, R.A., O.M. Kruger, A.F. Gasperino, J.P. Griffin, S.R. Thomas, and P.H. Williams, 1976. Continued Investigation of Eutrophication in Long Lake, WA: Verification Data for the Long Lake Model. WDOE Project WF-6-75- 081. Completion Report. Eastern Washington State College, Cheney, WA.

Soltero, R.A., D.G. Nichols, G.A. Pebles, and L.R. Singleton, 1978. Limnological Investigation of Eutrophic Long Lake and its Tributaries Just Prior to Advanced Wastewater Treatment with Phosphorus Removal by Spokane, WA. Project 77-108. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., D.G. Nichols, G.P. Burr, and L.R. Singleton, 1979. The Effect of Continuous Advanced Wastewater Treatment by the City of Spokane on the Trophic Status of Long Lake, WA. WDOE Project 77-108. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., D.G. Nichols, and J.M. Mires, 1980. The Effect of Continuous Advanced Wastewater Treatment by the City of Spokane on the Trophic Status of Long Lake, WA, During 1979. Project 80-019. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A. and D.G. Nichols, 1981. The Recent Blue-Green Algal Blooms of Long Lake, Washington. In: The Water Environment: Algal Toxins and Health. Plenum Pub.

Soltero, R.A., D.G. Nichols, and J.M. Mires, 1981. The Effect of Continuous Advanced Wastewater Treatment by the City of Spokane on the Trophic Status of Long Lake, WA. Contract No. WF81-001. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., D.G. Nichols, and M.R. Cather, 1982. The Effect of Continuous Advanced Wastewater Treatment by the City of Spokane on the Trophic Status of Long Lake, WA. Contract No. WF81-001. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., D.G. Nichols, and M.R. Cather, 1983. The Effect of Seasonal Alum Addition (chemical phosphorus removal) by the City of Spokane's Advanced Wastewater Treatment Plant on the Water Quality of Long Lake, Washington, 1982. City of Spokane Contract No. 414-430-000-534.40-3105. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., D.G. Nichols, M.R. Cather, and K.O. McKee, 1984. The Effect of Seasonal Alum Addition (chemical phosphorus removal) by the City of Spokane's Advanced Wastewater Treatment Plant on the Water Quality of Long Lake, Washington, 1983. City of Spokane Contact No. 414-430-000-534.40-3105. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., M.R. Cather, K.O. McKee, and B.G. Nichols, 1985. Variable Initiation and Termination of Alum Addition at Spokane's Advanced Wastewater Treatment Facility and the Effect on the Water Quality of Long Lake, Washington, 1984. City of Spokane Contract No. 414-430-000-501.34-3105. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., M.R. Cather, K.O. McKee, K.R. Merrill, and D.G. Nichols, 1986. Variable Initiation and Termination of Alum Addition at Spokane's Advanced Wastewater Treatment Facility and the Effect on the Water Quality of Long Lake, Washington, 1985. City of Spokane Contract No. 414-430-000- 501.34-3105. Completion Report. Eastern Washington University, Cheney, WA.

Soltero, R.A., L.A. Campbell, K.R. Merrill, R.W. Plotnikoff, and L.M. Sexton, 1988. Water Quality Assessment and Restoration Feasibility for Eloika Lake, WA. Department of Biology, Eastern Washington University, Cheney, WA.

USGS, 1989. Hypolimnetic Concentrations of Dissolved Oxygen, Nutrients, and Trace Elements in Coeur D'Alene Lake, Idaho. Water-Resources Investigations Report 89-4032. U.S. Geological Survey, Boise, ID.

Wagstaff, W.H. and R.A. Soltero, 1982. The Cause(s) of Continued Hypolimnetic Anoxia in Lake Spokane, Washington Following Advanced Wastewater Treatment by the City of Spokane. Final Progress Report, Contract No. 82-031. Report submitted by Eastern Washington University, Department of Biology, Cheney, WA. to Washington State

Department of Ecology, Olympia, WA. Publication No. 82-31. http://www.ecy.wa.gov/biblio/8231.html.

WEF – Water Environment Federation, 1998. Using Reclaimed Water to Augment Potable Water Resources. Joint Task Force of Water Environment Federation and American Waterworks Association. Alexandria, VA 22314-1994.

Welch, E.B., 1980. Ecological Effects of Waste Water. Cambridge University Press.

Wells, S.A., R.L Annear, and C.J. Berger, 2003. Upper Spokane River Model in Idaho: Boundary Conditions and Model Setup for 2001. Technical Report EWR-02-03. Department of Civil Engineering, Portland State University, Portland, OR.

Appendix A

• Appendix A – Public Involvement Opportunities - Spokane River TMDL to restore and maintain dissolved oxygen

- **May 1999**: **Draft Study Plan submitted and discussed with Spokane River Phosphorus Technical Advisory Committee (TAC) for review and comment**. Suggested that Idaho modeling might be integrated with the WA effort and worked with EPA for supplemental funding of Idaho dischargers to finish their effort

- **July 1999**: Final Draft of study plan QAPP again submitted to **Spokane River Phosphorus TAC** with another request for review and comment

- **October 1999**: **Meeting with City of Spokane wastewater staff** discussing many discharge issues including, CSO, stormwater, river monitoring, and DO modeling

- **April - September 2000**: **Public Workshop for presentation of preliminary QUAL2E model** sensitivity test results with agencies and dischargers – continued sampling surveys

- **August 2000**: **Provided written response back to City of Spokane** on the general and technical comments received from them following the workshop.

- **November 2000**: **Public Workshop to provide them an updated TMDL timeline and allow Tom Cole (COE) to present overview of the new CE-Qual-W2 model** and provide opportunities for discussions of WQ issues.

- **Spring 2001: Dischargers request delay in model development to allow for another year** of calibration sampling to be conducted in 2001

- **February 2002**: **Ecology provided CE-Qual-W2 modeling training** to consultants and staff of the dischargers and Ecology.

- **March 2002**: **Public announcement and formal comment period for Ecology's Spokane River Study/Data Summary Report** with appended COE model development report. The reports were made available on website. Draft copy of model made available to public upon request.

- **April 1, 2002**: **Comment period closed on draft data summary report** and initial model development reports.

- **June 2002**: **Public Workshop and formal review of draft interim technical memo** and interim model results for input on potential loading scenarios

- **October 2002**: Water Quality Program Manager and Section Manager **privately meet with City of Spokane Directors of Public Works and Wastewater Management** to discuss local concerns about TMDL process

- **December 2002: Public Workshop to review 2001 data and model WQ predictions**. Discuss previously submitted comments and resolution. Begin discussion about organization of a facilitated TMDL advisory group

- **January 2003: Meeting with City, County, and Liberty Lake, wastewater management and staff to explain potential impacts of new water quality standards, TMDL**, and discuss the process of conducting a use attainability analyses

- **February 2003**: **Public workshop for organization of advisory group**, develop preliminary work agenda, and review UAA process

- **February 2003**: **Meeting with Dischargers Group to review UAA process and discuss scope of work**

- **February 2003**: Municipal wastewater managers meeting organized by Spokane Valley to discuss Spokane regional WW planning. **Ecology presented preliminary WQ model results, discussed implications, and possible solutions in detail with all municipalities present.**

- **March 2003**: Review and comment on UAA scope of work from sponsors

- **March 2003**: Pre-Meeting with the dischargers/UAA sponsors followed by a **Public meeting with interim-Advisory Group and UAA sponsors to discuss TMDL and UAA process**

- **May 2003**: **First official Advisory Group meeting** outline of tasks with incorporation for UAA as appropriate

- **June 2003**: **Conduct Public Workshop and distribute draft Dissolved Oxygen Pollutant Loading Assessment Technical Report for formal public comment**

- **October 2003**: **Distribute formal response to comments on technical report** but, mistakenly omitted City of Spokane comments. Electronically distributed document to Advisory Group and other commenters

- **November 2003**: **UAA forum for dischargers arranged by Ecology** to discuss process for UAA and interaction with TMDL process

- **January 2004**: **Meeting with EPA and Ecology staff** to discuss TMDL for DO and permitting questions

- **February 2004**: **Final Response to Comments on Load Assessment Technical Report** with addendum distributed to Advisory Group and commenters.

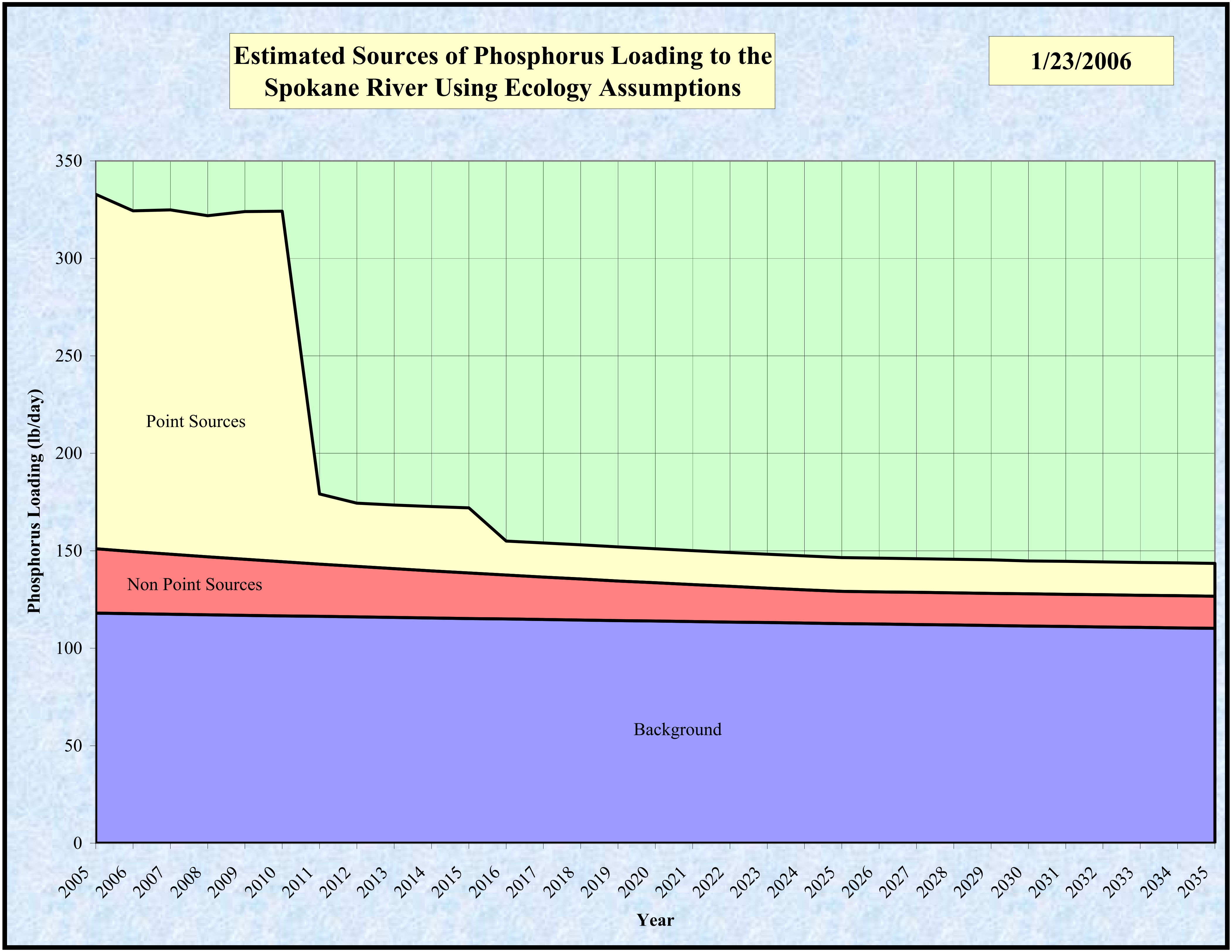
- **February 2004**: **Spokane River model with final calibration made available on web site along with PSU technical review report.**

- **February 2004**: **Final Load Assessment Technical Report was published**

- **May 2004**: **Meeting conducted at the Airport Ramada Inn without public notification with dischargers, certain politicians, and EPA** to discuss implications of TMDL and coordination of the UAA process

- **Advisory Group Meetings held** to develop and discuss proposed TMDL submittal report on May 18, 2004, June 22, 2004, July 27, 2004, August 31, 2004, October 5, 2004

This Page Intentionally Blank
To Enable
Two-Sided Printing


Estimated Sources of Phosphorus Loading to the Spokane River Using Ecology Assumptions
1/23/2006
Phosphorus Loading (lb/day)
350
300
250
200
150
100
50
0
Point Sources
Non Point Sources
Background
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
Year

1/23/2006

ECOLOGY ESTIMATED SOURCES & TREATMENT/REMOVAL STRATEGIES FOR SPOKANE RIVER PHOSPHORUS--PAGE 1/2

Item	Begin	End	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Natural Background Phosphorus Load																																	
Valley Aquifer + Atmospheric (lb/day)			56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00	56.00
Valley Aquifer P reduction from STEP program	%/yr =	0.50%	56.00	55.72	55.44	55.16	54.89	54.61	54.34	54.07	53.80	53.53	53.26	53.00	52.73	52.47	52.20	51.94	51.68	51.43	51.17	50.91	50.66	50.40	50.15	49.90	49.65	49.40	49.16	48.91	48.67	48.42	48.18
Little Spokane aquifer (lb/day)			31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00	31.00
Little Spokane surface water (lb/day)			8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Hangman Creek surface water (lb/day)			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lake Coeur d'Alene (lb/day)			22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
P loading to river from natural background (lb/day)			118.00	117.72	117.44	117.16	116.89	116.61	116.34	116.07	115.80	115.53	115.26	115.00	114.73	114.47	114.20	113.94	113.68	113.43	113.17	112.91	112.66	112.40	112.15	111.90	111.65	111.40	111.16	110.91	110.67	110.42	110.18
Non Point Phosphorus Load																																	
Target reduction % in # years	50%	20																															
Little Spokane River pollution (lb/day)	%/yr =	3.406%	30.00	28.98	27.99	27.04	26.12	25.23	24.37	23.54	22.74	21.96	21.21	20.49	19.79	19.12	18.47	17.84	17.23	16.64	16.08	15.53	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Little Spokane River to achieve % reduction in 20 yrs																																	
Hangman Creek pollution (lb/day)	%/yr =	3.406%	3	2.90	2.80	2.70	2.61	2.52	2.44	2.35	2.27	2.20	2.12	2.05	1.98	1.91	1.85	1.78	1.72	1.66	1.61	1.55	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Hangman Creek to achieve % reduction in 20 years																																	
P loading to river from non-point sources (lb/day)			33	31.88	30.79	29.74	28.73	27.75	26.80	25.89	25.01	24.16	23.33	22.54	21.77	21.03	20.31	19.62	18.95	18.31	17.68	17.08	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50
Spokane County New Regional POTW																																	
pilot studies & prepare master wastewater mgmt plan	1/1/06	12/31/06																															
Plan, design & construct for final limits	1/1/07	12/31/11																															
Issue initial NPDES permit (5 yr)	1/1/12	12/31/16																															
Reissue NPDES permit (5 yr)	1/1/17	12/31/21																															
Reissue NPDES permit (5 yr)	1/1/22	12/31/26																															
Reissue NPDES permit (5 yr)	1/1/27	12/31/31																															
Reissue NPDES permit (5 yr)	1/1/32	12/31/36																															
Operate under final limits	1/1/12																																
Total Valley flow (MGD)			7.50	7.80	8.10	8.40	8.95	9.50	10.05	10.23	10.40	11.24	12.08	12.92	13.76	14.60	14.84	15.08	15.32	15.56	15.80	16.10	16.40	16.70	17.00	17.30	17.69	18.06	18.45	18.84	19.26	19.68	20.13
Total Valley flow reduction after conservation (MGD)	%/yr =	1.00%	7.43	7.72	8.02	8.32	8.86	9.41	9.95	10.13	10.30	11.13	11.96	12.79	13.62	14.45	14.69	14.93	15.17	15.40	15.64	15.94	16.24	16.53	16.83	17.13	17.51	17.88	18.26	18.66	19.06	19.49	19.92
Valley flow to County POTW (MGD)										8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	12.00	12.00	12.00	12.00	12.00	12.00
County effluent to other than river discharge (MGD)	%/yr =	100.00%								8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	12.00	12.00	12.00	12.00	12.00	12.00
County discharge to river (MGD)										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P concentration of POTW effluent (ug/L)										50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
P loading to river from new County POTW (lb/day)										0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Valley flow diverted to Spokane POTW (MGD)										2.13	2.30	3.13	3.96	4.79	5.62	6.45	6.69	6.93	7.17	7.40	7.64	7.94	8.24	8.53	8.83	9.13	9.51	5.88	6.26	6.66	7.06	7.49	7.92
City of Spokane POTW																																	
Operate under admin extended NPDES	1/1/04	12/31/05																															
Reissue NPDES permit (5 yr)	1/1/06	12/31/10																															
Reissue NPDES permit (5 yr)	1/1/11	12/31/15																															
Reissue NPDES permit (5 yr)	1/1/16	12/31/20																															
Reissue NPDES permit (5 yr)	1/1/21	12/31/25																															
Reissue NPDES permit (5 yr)	1/1/26	12/31/30																															
Reissue NPDES permit (5 yr)	1/1/31	12/31/35																															
pilot studies & prepare master wastewater mgmt plan	1/1/06	12/31/06																															
Plan, design & construct POTW for interim limits	1/1/07	12/31/11																															
Operate under interim limits	1/1/12	12/31/15																															
Compliance schedule to achieve final limits	1/1/06	12/31/15																															
Plan, design & construct other tools to achieve final limits	1/1/07	12/31/15																															
Operate under final limits	1/1/16																																
Spokane flow to Spokane POTW (MGD)			30.11	30.56	31.02	31.47	31.96	32.44	32.93	33.41	33.90	34.42	34.95	35.47	36.00	36.52	37.08	37.65	38.21	38.78	39.34	39.95	40.56	41.16	41.77	42.38	43.01	43.66	44.31	44.97	45.65	46.33	47.03
Spokane City flow reduction after conservation (MGD)	%/yr =	1.00%	29.80	30.25	30.70	31.16	31.64	32.12	32.60	33.08	33.56	34.08	34.60	35.12	35.64	36.15	36.71	37.27	37.83	38.39	38.95	39.55	40.15	40.75	41.35	41.96	42.58	43.22	43.87	44.52	45.19	45.87	46.56
North County flow to Spokane POTW (MGD)			2.40	2.64	2.88	3.12	3.36	3.60	3.74	3.88	4.02	4.16	4.30	4.38	4.46	4.54	4.62	4.70	4.74	4.78	4.82	4.86	4.90	4.94	4.98	5.02	5.06	5.10	5.14	5.18	5.22	5.26	5.30
Sp Co north county flow reduction after conservation (MGD)	%/yr =	1.00%	2.38	2.61	2.85	3.09	3.33	3.56	3.70	3.84	3.98	4.12	4.26	4.34	4.42	4.49	4.57	4.65	4.69	4.73	4.77	4.81	4.85	4.89	4.93	4.97	5.01	5.05	5.09	5.13	5.17	5.21	5.25
Valley flow to Spokane POTW (MGD)			7.43	7.72	8.02	8.32	8.86	9.41	9.95	2.13	2.30	3.13	3.96	4.79	5.62	6.45	6.69	6.93	7.17	7.40	7.64	7.94	8.24	8.53	8.83	9.13	9.51	5.88	6.26	6.66	7.06	7.49	7.92
Airway Heights flow to Spokane POTW (MGD)			0.31	0.37	0.43	0.48	0.54	0.59	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total flow to Spokane POTW (MGD)			39.91	40.96	42.00	43.04	44.36	45.68	46.89	39.05	39.84	41.33	42.81	44.24	45.67	47.10	47.98	48.85	49.69	50.52	51.36	52.30	53.24	54.18	55.11	56.05	57.10	54.15	55.22	56.31	57.43	58.56	59.73
City effluent to REUSE (MGD)	%/yr =	1.00%	0.40	0.80	1.22	1.63	2.06	2.50	2.94	3.30	3.67	4.05	4.43	4.83	5.24	5.66	6.08	6.51	6.94	7.38	7.82	8.26	8.71	9.17	9.63	10.09	10.56	11.00	11.44	11.89	12.34	12.80	13.27
City discharge to river (MGD)			39.52	40.15	40.78	41.41	42.30	43.18	43.95	35.75	36.17	37.28	38.38	39.41	40.43	41.45	41.90	42.34	42.75	43.15	43.54	44.04	44.53	45.01	45.49	45.96	46.55	43.15	43.78	44.42	45.08	45.76	46.46
P concentration of POTW discharge (ug/L)			450.00	450.00	450.00	450.00	450.00	450.00	50.00	50.00	50.00	50.00	50.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
P loading to river from Spokane POTW (lb/day)			148.40	150.79	153.16	155.50	158.86	162.16	18.34	14.92	15.09	15.56	16.02	3.29	3.37	3.46	3.50	3.53	3.57	3.60	3.63	3.68	3.72	3.76	3.80	3.84	3.88	3.60	3.65	3.71	3.76	3.82	3.88
P loading to river from Spokane CSO & Stormwater (lb/day)	% red/yr=	0.50%	14.00	13.93	13.86	13.79	13.72	13.65	13.59	13.52	13.45	13.38	13.32	13.25	13.18	13.12	13.05	12.99	12.92	12.86	12.79	12.73	12.66	12.60	12.54	12.48	12.41	12.35	12.29	12.23	12.17	12.11	12.05
Total P loading to river from City of Spokane sources (lb/day)			162.40	164.72	167.02	169.29	172.58	175.81	31.93	28.43	28.54	28.94	29.33	16.54	16.56	16.58	16.55	16.52	16.49	16.46	16.43	16.40	16.38	16.36	16.33	16.31	16.30	15.95	15.94	15.94	15.93	15.92	15.92

1/23/2006 18:20

ECOLOGY ESTIMATED SOURCES & TREATMENT/REMOVAL STRATEGIES FOR SPOKANE RIVER PHOSPHORUS--PAGE 2/2

Item	Begin	End	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Liberty Lake Sewer & Water District																																	
Operate under admin extended NPDES	1/1/04	12/31/05																															
Reissue NPDES permit (5 yr)	1/1/06	12/31/10																															
Reissue NPDES permit (5 yr)	1/1/11	12/31/15																															
Reissue NPDES permit (5 yr)	1/1/16	12/31/20																															
Reissue NPDES permit (5 yr)	1/1/21	12/31/25																															
Reissue NPDES permit (5 yr)	1/1/26	12/31/30																															
Reissue NPDES permit (5 yr)	1/1/31	12/31/35																															
Complete current POTW upgrade	1/1/05	12/31/05																															
Operate current upgrade	1/1/06	12/31/09																															
pilot studies & prepare master wastewater mgmt plan	1/1/06	12/31/06																															
Plan, design & construct POTW for interim limits	1/1/07	12/31/09																															
Operate under interim limits	1/1/10	12/31/15																															
Compliance schedule to achieve final limits	1/1/06	12/31/15																															
Plan, design & construct other tools t achieve final limits	1/1/07	12/31/15																															
Operate under final limits	1/1/16																																
Flow to LLSWD POTW (MGD)			0.81	0.92	1.04	1.15	1.19	1.23	1.27	1.31	1.35	1.36	1.38	1.39	1.41	1.42	1.43	1.44	1.45	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.56	1.57	1.58	1.59
Flow to LLSWD POTW after conservation (MGD)	%/yr =	1.00%	0.80	0.91	1.03	1.14	1.18	1.22	1.26	1.30	1.34	1.35	1.36	1.38	1.39	1.41	1.42	1.43	1.44	1.45	1.46	1.47	1.48	1.49	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.56	1.57
LLSWD effluent to REUSE (MGD)	%/yr =	1.00%	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.07	0.08	0.10	0.11	0.12	0.14	0.15	0.17	0.18	0.20	0.21	0.22	0.24	0.25	0.27	0.28	0.30	0.31	0.33	0.35	0.36	0.38	0.39
LLSWD discharge to river (MGD)			0.80	0.90	1.02	1.12	1.16	1.19	1.21	1.24	1.27	1.27	1.27	1.27	1.27	1.27	1.26	1.26	1.25	1.25	1.25	1.24	1.24	1.23	1.23	1.22	1.22	1.21	1.20	1.20	1.19	1.19	1.18
P concentration of POTW discharge (ug/L)			1558	233	233	233	233	50	50	50	50	50	50	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
P loading to river from LLSWD POTW (lb/day)			10.43	1.76	1.98	2.17	2.25	0.50	0.51	0.52	0.53	0.53	0.53	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Inland Empire Paper																																	
Operate under admin extended NPDES	1/1/04	12/31/05																															
Reissue NPDES permit (5 yr)	1/1/06	12/31/10																															
Reissue NPDES permit (5 yr)	1/1/11	12/31/15																															
Reissue NPDES permit (5 yr)	1/1/16	12/31/20																															
Reissue NPDES permit (5 yr)	1/1/21	12/31/25																															
Reissue NPDES permit (5 yr)	1/1/26	12/31/30																															
Reissue NPDES permit (5 yr)	1/1/31	12/31/35																															
pilot studies & prepare master wastewater mgmt plan	1/1/06	12/31/06																															
Plan, design & construct for interim limits	1/1/07	12/31/08																															
Operate under interim limits	1/1/09	12/31/15																															
Compliance schedule to achieve final limits	1/1/06	12/31/15																															
Plan, design & construct other tools to achieve final limits	1/1/13	12/31/15																															
Operate under final limits	1/1/16																																
Flow to IEP WWTP (MGD)			4.66	4.27	3.89	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
P concentration of POTW discharge (ug/L)			217	217	217	100	100	100	100	100	100	100	100	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
P loading to river from IEP WWTP (lb/day)			8.43	7.73	7.04	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Kaiser																																	
Operate under admin extended NPDES	1/1/04	12/31/05																															
Reissue NPDES permit (5 yr)	1/1/06	12/31/10																															
Reissue NPDES permit (5 yr)	1/1/11	12/31/15																															
Reissue NPDES permit (5 yr)	1/1/16	12/31/20																															
Reissue NPDES permit (5 yr)	1/1/21	12/31/25																															
Reissue NPDES permit (5 yr)	1/1/26	12/31/30																															
Reissue NPDES permit (5 yr)	1/1/31	12/31/35																															
pilot studies & prepare master wastewater mgmt plan	1/1/06	12/31/06																															
Plan, design & construct for interim limits	1/1/07	12/31/08																															
Operate under interim limits	1/1/09	12/31/15																															
Compliance schedule to achieve final limits	1/1/06	12/31/15																															
Plan, design & construct other tools to achieve final limits	1/1/07	12/31/15																															
Operate under final limits	1/1/16																																
Flow from Kaiser WWTP (MGD)			6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49	6.49
P concentration of POTW discharge (ug/L)			11.73	11.73	11.73	11.73	11.73	11.73	11.73	11.73	11.73	11.73	11.73	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
P loading to river from Kaiser WWTP			0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Total P loading to river from all natural background (lb/day)			118.00	117.72	117.44	117.16	116.89	116.61	116.34	116.07	115.80	115.53	115.26	115.00	114.73	114.47	114.20	113.94	113.68	113.43	113.17	112.91	112.66	112.40	112.15	111.90	111.65	111.40	111.16	110.91	110.67	110.42	110.18
Total P loading to river from all non-point sources (lb/day)			33.00	31.88	30.79	29.74	28.73	27.75	26.80	25.89	25.01	24.16	23.33	22.54	21.77	21.03	20.31	19.62	18.95	18.31	17.68	17.08	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50	16.50
Total P loading to river from all point sources (lb/day)			181.89	174.85	176.67	175.03	178.39	179.87	35.99	32.51	32.63	33.02	33.42	17.48	17.50	17.52	17.49	17.46	17.43	17.40	17.36	17.34	17.32	17.29	17.27	17.25	17.23	16.89	16.88	16.87	16.86	16.86	16.85
GRAND TOTAL P LOADING FROM ALL SOURCES (lb/day)			332.89	324.44	324.90	321.93	324.01	324.23	179.13	174.47	173.43	172.71	172.01	155.01	154.00	153.01	152.01	151.02	150.06	149.13	148.22	147.34	146.48	146.20	145.92	145.65	145.39	144.79	144.53	144.28	144.03	143.78	143.54
Total P Loading from point and non-point (lb/day)			214.89	206.72	207.46	204.77	207.12	207.61	62.79	58.40	57.64	57.18	56.75	40.02	39.27	38.55	37.80	37.08	36.38	35.70	35.05	34.42	33.82	33.79	33.77	33.75	33.73	33.39	33.38	33.37	33.36	33.36	33.35
% P loading from natural background of Grand Total			35.4%	36.3%	36.1%	36.4%	36.1%	36.0%	64.9%	66.5%	66.8%	66.9%	67.0%	74.2%	74.5%	74.8%	75.1%	75.4%	75.8%	76.1%	76.4%	76.6%	76.9%	76.9%	76.9%	76.8%	76.8%	76.9%	76.9%	76.9%	76.8%	76.8%	76.8%
% P loading from non-point sources of Grand Total			9.9%	9.8%	9.5%	9.2%	8.9%	8.6%	15.0%	14.8%	14.4%	14.0%	13.6%	14.5%	14.1%	13.7%	13.4%	13.0%	12.6%	12.3%	11.9%	11.6%	11.3%	11.3%	11.3%	11.3%	11.3%	11.4%	11.4%	11.4%	11.5%	11.5%	11.5%
% P loading from point sources of Grand Total			54.6%	53.9%	54.4%	54.4%	55.1%	55.5%	20.1%	18.6%	18.8%	19.1%	19.4%	11.3%	11.4%	11.4%	11.5%	11.6%	11.6%	11.7%	11.7%	11.8%	11.8%	11.8%	11.8%	11.8%	11.9%	11.7%	11.7%	11.7%	11.7%	11.7%	11.7%
% decrease point source P loading from year 2005				3.9%	2.9%	3.8%	1.9%	1.1%	80.2%	82.1%	82.1%	81.8%	81.6%	90.4%	90.4%	90.4%	90.4%	90.4%	90.4%	90.4%	90.5%	90.5%	90.5%	90.5%	90.5%	90.5%	90.5%	90.7%	90.7%	90.7%	90.7%	90.7%	90.7%
Total P loading to river from all point sources (lb/day)			181.89	174.85	176.67	175.03	178.39	179.87	35.99	32.51	32.63	33.02	33.42	17.48	17.50	17.52	17.49	17.46	17.43	17.40	17.36	17.34	17.32	17.29	17.27	17.25	17.23	16.89	16.88	16.87	16.86	16.86	16.85
% decrease point source P loading from year to year				3.9%	-1.0%	0.9%	-1.9%	-0.8%	80.0%	9.7%	-0.4%	-1.2%	-1.2%	47.7%	-0.1%	-0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	2.0%	0.1%	0.0%	0.0%	0.0%	0.0%

This Page Intentionally Blank
To Enable
Two-Sided Printing

DRAFT
Spokane County Conservation District
Non-Point Source Program

Program Outline

The Non-Point Source Program is focused on the reduction of phosphorus levels in the surface waters of the Little Spokane River and Hangman Creek watersheds. The programs listed below provide a basic outline for a scope of work to be conducted by the Conservation District once a contract is agreed upon and completed by the appropriate cooperators.

1. **Soil Sampling Study** – A comprehensive soil sampling study is needed to further evaluate various potential sources of phosphorus. The sampling would include unimproved roads, fields, streambanks, ditches, lawns, and others. This evaluation will better define phosphorus levels across the watershed and assist in prioritization of effective implementation efforts.

   Schedule: Begin Winter/Spring of 2006 (6 months – final report)

2. **Identify Critical Source Areas** – Current TMDL efforts, previous inventory and monitoring efforts in the Little Spokane and Hangman Creek will help in identifying critical areas for implementation activities. The soil sampling results will provide further insight.

   Schedule: Summer/Fall of 2006

3. **Implement Conservation Tillage pilot project** – implementing/encouraging conservation tillage/direct seeding systems could provide a significant reduction in phosphorus in the Hangman Watershed. Decreased erosion to streams will help reduce phosphorus and other parameter violations.

   Schedule: Spring 2006 – setup program and begin awareness campaign to watershed residents (preparation for fall work). Setup project specific monitoring.

4. **Implement BMP Cost-Share Programs** – Various BMPs will be cost-shared with local watershed residents to address resource issues on their property (list below is not all inclusive). The Conservation District has limited funds for some existing programs.
   - SRF Cost-Share Program
   - Shorelines (riparian buffers)
   - Livestock (fencing, off-creek watering)
   - Agricultural (sediment basins, grassed waterways, filter strips)

   Schedule: Spring 2006 (set up programs and begin to solicit projects with local residents)

5. **Implement Shoreline Stabilization Program** – This program will be designed to prevent and stop erosion where applicable. It is important to prevent accelerated erosion to improve water quality.

Schedule: Fall/Winter 2006 (projects may need re-prioritization due to soil sampling data and phosphorus levels)

6. **Education/Awareness Program** – An education/awareness program will be key to providing program information as well as watershed conditions and stewardship benefits.
   Schedule: Spring 2006 (this will always be a program component)

7. **Program Coordination –** The non-point source program will coordinate funding and implementation activities with local agencies and stakeholders. This includes working across county and state boundaries where necessary. It will coordinate various TMDL, and watershed planning efforts in the watersheds.
   Schedule: Coordination efforts are already underway. Additional efforts will begin in the spring of 2006 or sooner.

8. **Adaptive Management –** The Non-Point Source Program must be re-evaluated on a periodic basis. This will provide for objective review of effectiveness, current direction, and future implementation activities.
   Schedule: First evaluation period would be in five years (2011).

9. **Status Reports –** The Non-point Source Program will provide quarterly and Annual Progress Reports (with presentation). The SCCD will provide these reports to an Oversight Board (members chosen by the Dischargers Group).
   Schedule: As required

10. **Finances/Contract** – The Spokane Conservation District will administer the Non-Point Source Program and direct all implementation activities. Direct payments from dischargers and/or stakeholders should be based on a biannual schedule (January and June).
    Schedule: Biannual (January & June 2006-2011) – 1st review period
    - 300K in January 2006
        - Soil Sampling Study
        - Develop Program Structure (scope of work, goals, milestones, deliverables,)
        - Implement Direct Seed Pilot Project (spring 2006). This would be the first part of a five year program)
    - 1 million dollars in 2007
    - 2 million dollars in 2008 (SRF Cost Share Program)
    - 1-2million dollars in 2009 (dependent upon success and need)
    - 1-2 million dollars in 2010 (dependent upon success and need)
    - 1-2 million dollars in 2011 (dependent upon success and need)
    - 2011 – Progress review

Spokane River TMDL Collaboration

Monitoring Workgroup Report

December 14, 2005

Introduction

The Spokane River TMDL Collaboration aims to develop an Implementation Plan to significantly improve water quality in the Spokane River. Discussions point toward a strategy that will employ not only major improvement in point source discharge treatment technology, but also efforts to reduce non-point source pollution, reduce point source influent through water conservation, divert treated water discharge to re-use applications, and possibly employ river aeration. Such a strategy could take 10 to 20 years to implement. Measurement of results and documentation of the impact of various water quality improvement actions is critical to assuring the success of a TMDL Implementation Plan since success will likely be the sum of many small pollutant reductions that achieve the goal of improved water quality.

The Collaboration's Full Group formed a special purpose task force called the Monitoring Workgroup; this is the preliminary draft report of that Workgroup meant to provide a basis for discussion. The Monitoring Work Group is charged with devising an outline of a multi-year, on-going Spokane River monitoring effort that provides a continuous flow of good-quality data and analysis that guides the TMDL Implementation Plan. This document should be considered the first edition of this outline so that the Full Group can have a basis for discussion about whatever monitoring program it decides to include in the Implementation Plan.

The Workgroup focused on several areas and divided their information-gathering and report into five sections: Monitoring Principles and Management, Current Monitoring Programs, Core TMDL Implementation Monitoring Program, Special Studies, and Modeling. In addition the past monitoring and sampling activities undertaken in the Hangman Creek and Little Spokane River watersheds are detailed in Appendix C.

I. Monitoring and Modeling Principles and Management

Continuity and consistency are two important and fundamental "principles" to appropriately construct and operate a long-term Spokane River Collaboration Monitoring and Modeling Program. The Program, built on existing river monitoring and modeling efforts, is expected to be continuous throughout the estimated 20-year term of the Spokane River Collaboration's implementation of strategies to meet the TMDL regulation.

Data
Monitoring activities should include both "effectiveness" monitoring of specific actions (such as site-specific non-point efforts) and "trend analysis" to answer the global question "What is the Health of the River?" Different standards for data might be applied in different circumstances. The Monitoring Workgroup recommends generally uniform standards for data quality with the full understanding that this may likely cost more. The utility of being able to use the same good data for a variety of purposes, including modeling, outweighs the extra cost and serves to enhance the credibility of the overall monitoring effort which will guide or influence many significant, high value decisions. Similarly, uniform quality assurance/quality control methods are recommended whenever practical.

Management
The Monitoring Workgroup recommends that one well-qualified and experienced manager be hired by the Spokane River Collaboration Full Group to manage the on-going Spokane River Collaboration Monitoring Program. Administratively, the Monitoring Workgroup recommends the manager be housed in the Department of Ecology Spokane Regional Office. Ecology would be responsible for using standard government methods to pay the manager, handle monitoring funds and provide an administrative structure for the selection of contractors and management of contracts. Alternatively, the manager could be attached to the City of Spokane or Spokane County.

The manager should receive program guidance, including the prioritization of study efforts, the selection and scaling of effectiveness monitoring activities, model improvement and model runs, budget development and approval, and the periodic reporting of all monitoring data and modeling information, from a designated sub-group of the existing Full Group or its long-term successor. The manager would be available to present information to all Spokane River Collaboration participants and the public and would be responsible for assuring the monitoring, study and modeling aims and interests of the collective Full Group are timely met within budget limits.

Further, the manager would establish and enforce the Spokane River Collaboration Monitoring Program's standards, Quality Assurance/Quality Control methods, and monitoring protocols. The manager would also coordinate the running of the Spokane River model to assure its currency and efficient use. The manager, as advised by his/her Collaboration sub-group advisory group, would coordinate with both Washington and Idaho State environmental officials and the Environmental Protection Administration.

Budget
Based on very preliminary assessment, the Monitoring Workgroup suggests that this manager would need an annual budget of about $285,000 to support the Collaboration Monitoring Program basic trend analysis effort. Larger effectiveness monitoring actions and specific biological, hydrological or other types of studies, are not included in this estimate.

II. Current Monitoring Programs

One of the needs for a TMDL monitoring program is to avoid duplication of effort. In order to facilitate development of an ongoing program of monitoring for TMDL implementation, the Monitoring Workgroup investigated existing monitoring efforts on the Spokane River. These existing monitoring programs are summarized in Table 1.

Table 1. Summary of Current Monitoring Programs

	Parameters	Sites	Frequency	Notes
Spokane County Groundwater	Drinking water inorganics – metals, VOC's	45 – 50 25 monitoring wells, 2 nested sites	Quarterly	
C d'A Basin Environmental Monitoring	Nutrients, general inorganics, metals	Coeur d'Alene Lake outlet	8 times per year	Sampling targets outlet conditions rather then exact dates
Coeur d'Alene Lake Monitoring	Nutrients, general inorganics, metals	Spokane River at Outlet, near Post Falls, at Stateline	Quarterly	Part of USGS C d'A lake monitoring: ends fall 2006
Ecology Freshwater Monitoring	Nutrients[a], general inorganics[b], fecal coliform	Spokane River at State Line, Bowl and Pitcher, Hangman and Little Spokane	Monthly	
Little Spokane River Monitoring	POCD Nutrients, general inorganics SCCD General inorganics, nitrogen species	Up to 8 main stem 3 tributaries	Monthly during study periods	POCD 1998-99, SCCD 2001-02 sampling periods Different analysis packages used by various programs
Latah Creek Monitoring	Nutrients, general inorganics, coliform bacteria, some metals	4 main stem 2 tributaries	Variable – high flow events and some base flow	Different analysis packages used by various programs.
Avista FERC License	To be determined	To be determined	To be determined	Avista is willing to coordinate with the TMDL Implementation effort to avoid duplication of effort.
Discharger Compliance Monitoring	See attached for selected dischargers	Coeur d'Alene City of Spokane		

[a] = ammonia, nitrate plus nitrite, total phosphorus, soluble reactive phosphorus, total nitrogen
[b] = conductivity, oxygen, pH, suspended solids, temperature, turbidity

Spokane County Groundwater Monitoring

Spokane County Monitors quarterly 45 – 55 wells that draw water from the Spokane Valley Aquifer as part of a Coordinated Monitoring Program. Under this Program, Spokane County collects and has samples analyzed for drinking water compliance for cooperating water purveyors. This cooperation provides support for collecting samples for the County's monitoring of 25 specially installed Wellhead Protection "early warning" wells. In addition to the 25 dedicated monitoring well sites, samples are collected from 20 to 30 water supply wells. Except for about 10 water supply wells with an extensive monitoring history, the water supply wells sampled vary depending on the cooperating purveyors compliance needs. Locations for the "permanent" sampling sites are shown on the map in Appendix A. Several of the dedicated monitoring wells are located near the river in losing (Barker Road) and gaining (Sullivan Road) reaches. The variable sample locations are selected from the more than 100 public water supply well fields drawing water from the Spokane Valley Aquifer.

Appendix B includes a list of parameters analyzed. Due to cost considerations field duplicates are collected infrequently. However, extensive laboratory QA/QC measures are followed. These include laboratory duplicates and blanks and spiked sample analysis.

Laboratory costs for this program range from $40,000 to $50,000 per year depending on the number and type of drinking water compliance samples collected. Sample collection requires 2 people for 3 days each quarter for a total of 24 worker days per year. An additional worker day per quarter is needed for preparation of equipment obtaining sample bottles and labeling. This brings the total staff time to 28 worker days per year. Data management is not included in the above estimates.

This program is funded by a combination of Water Purveyor contributions and Aquifer Protection Area funding. The shrinking APA funding due to changes in the District boundaries last year put the APA portion of this package on shaky ground. The program is needed to document water quality changes brought about by septic tank elimination so it will remain in some form through the duration of the STEP program, but maintaining the current level of effort may require lobbying.

Coeur d'Alene Basin Environmental Monitoring Program

The BEMP program only runs the lake outlet station at Coeur d'Alene. Other funding gives the discharge record just below Post Falls Dam (Spokane River near Post Falls gage at McGuire Park). EPA has just approved funding to install an Acoustic Doppler Velocity Meter station with optical backscatter (for computation of sediment transport) and real-time data transmission at the lake outlet station. That should be fully operational by this summer (2006).

BEMP sampling at the lake outlet occurs eight times per year. The sampling frequency is not fixed; the program is after description of the important features of the hydrograph in relation to lake elevation changes, i.e., stable pool in winter and summer, filling and drawdown transient conditions, and (if lucky) migration of extreme event inflow plumes through the lake.

Samples are collected for analysis of dissolved and total Cd, Pb, Zn, Fe, and Mn along with hardness. Nutrients include dissolved ammonia, nitrite+nitrate, ortho-P, and P as well as total P and N. Suspended-sediment concentration is also determined.

Coeur d'Alene Lake Monitoring Program

The Coeur d'Alene Lake monitoring program was established as part of the "outside the box" clean up effort. The primary goal of this monitoring effort is to identify recent trends in Lake quality to help craft an updated Lake Management Plan. An update of the Lake Management Plan approved by both the U.S. Geological Survey and the Coeur d'Alene Tribe is one of the prerequisites for "delisting" the Lake from Superfund designation. The Lake Monitoring Program expands the Basin Environmental

Monitoring Program by adding several lake sampling sites and a Stateline site on the Spokane River. The sampling frequency and parameters covered are the same as for the Basin Environmental Monitoring program. Only the Stateline station would be of value to a river-monitoring network.

The Lake Monitoring Program was funded as part of the EPA grant to the state of Idaho dedicated to funding planning and clean up efforts outside the 21 square mile Bunker Hill Superfund site. Funding was limited to three years and monitoring will be finalized in 2006.

Ecology Freshwater Monitoring Program

The Washington State Department of Ecology (Ecology) has conducted monthly water quality monitoring at hundreds of stream stations throughout the state for nearly 50 years. The Freshwater Monitoring Unit (FMU) has active ambient monitoring stations on the Spokane River at the Stateline with Idaho (station number 57A150), at Riverside State Park (54A120), near the mouth of Hangman Creek (56A070), and near the mouth of the Little Spokane River (55B070). All of these stations have been sampled regularly for greater than 10 years. FMU collects samples monthly by water year (October through September).

Measured indicators of water quality include the following:

- ammonia
- conductivity
- fecal coliform bacteria
- flow (at most stations)
- nitrate plus nitrite
- nitrogen, total
- oxygen
- pH
- phosphorus, soluble reactive
- phosphorus, total
- suspended solids
- temperature
- turbidity

FMU occasionally samples other constituents, as well, to meet special needs.

A detailed explanation of our stream monitoring program along with specific methods and quality control procedures may be found in our annual reports (e.g., Hallock 2003a) and Quality Assurance Monitoring Plan (Hallock 2003b), as well as on the World Wide Web (http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html).

Hallock, D. 2003a. *River and Stream Ambient Monitoring Report for Water Year 2002*. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. Publication No. 03-03-032, 17 pp. + appendices.

Hallock, D. 2003b. *Quality Assurance Monitoring Plan*. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. Publication No. 03-03-200, 28 pp.

Avista

Currently Avista is undergoing re-licensing for its Spokane River Hydroelectric Project. Currently defined water quality problems associated directly with the project are limited to Total Dissolved Gas below the spillways at Post Falls and the Long Lake installations. Additional parameters for study may be identified as the 401 certification by the States of Washington and Idaho progresses. Avista is willing to participate as cooperator in any monitoring effort that evolves out of the TMDL work that will help them satisfy their license requirements.

Little Spokane River

The Pend Orielle Conservation District conducted monitoring of five sites on the Little Spokane River and one site on the West Branch of the Little Spokane River from October 1998 through September 1999. Samples were collected monthly and were scheduled to correspond with monthly sampling performed by Ecology Environmental Assessment Program staff at four additional Little Spokane River sites.

The primary water quality component of this project was intended to evaluate possible nitrate/nitrite inputs from recent housing developments on Deadman and Little Deep Creeks. Monthly sampling began in January of 2001 above and below the developments. Deadman Creek was sampled at Bruce Road and Shady Slope Road. Little Deep Creek was sampled at Colbert Road and Little Spokane Drive. The monthly downstream water quality samples were inconclusive because springs immediately upstream of the Shady Slope Road sample site were found to have significantly high nitrate levels

The site near the confluence with the Spokane River (Rutter Parkway Bridge) is part of the Department of Ecology Freshwater Monitoring Program.

Latah (Hangman) Creek

Beginning in 1968 the USGS periodically sampled Latah Creek at State Line and Spokane River confluence stations.

The Spokane County Conservation District (SCCD) began extensive water quality sampling in the Hangman Creek watershed in 1994. In 1994, the SCCD completed a watershed management plan for Hangman Creek that has guided SCCD water quality sampling programs. Recently the SCCD expanded the program to include water quality sampling to evaluate the ground water/surface water interactions along the main stem.

The site near the confluence with the Spokane River (Marne Bridge) is part of the monthly Department of Ecology Freshwater Monitoring Program. Additional Details of this effort are included in Attachment C.

Discharger Monitoring Summary

The following summarizes the discharge monitoring requirements of some of the current discharges in comparison with the proposed "core" monitoring parameters.

Discharger: City of Coeur d'Alene			
Core Parameter	Sampled	Frequency	Sample Type
Ammonia	Yes	1 - 2 / week	24 hr Composite
BOD5	Yes	3 / week	24 hr Composite
CBODU**	No		
Conductivity			
Dissolved Oxygen			
flow	Yes	Continuous	Recorder
nitrogen, total			
nitrate plus nitrite			
pH	Yes	Daily	Grab
phosphorus, total	Yes	3 / week	24 hr Composite
phosphorus, soluble reactive,			
suspended solids	Yes	3 / week	24 hr Composite
temperature	Yes	7 / week	Grab

Discharger: City of Spokane			
Parameter	Sampled	Frequency	Sample Method
Ammonia	Yes	7 / week	24 hr Composite
BOD5	Yes	7 / week	24 hr Composite
CBODU**	No		
Conductivity	No		
Dissolved Oxygen	Yes	7 / week	Grab
flow	Yes	Continuous	Recorder
nitrogen, total	No		
nitrate plus nitrite	Yes	1 / week	24 hr Composite
pH	Yes	Continuous	Recorder
phosphorus, total	Yes	7 / week	24 hr Composite
phosphorus, soluble reactive,	Yes	7 / week	24 hr Composite
suspended solids	Yes	7 / week	24 hr Composite
temperature	Yes	7 / week	Grab

Discharger: Liberty Lake Wastewater Treatment Facility			
Core Parameter	Sampled	Frequency	Sample Type
Ammonia	yes	1 every 2 weeks	Composite
BOD5	yes	1 / week	Composite
CBODU**	no		
Conductivity	no		
Dissolved Oxygen	yes	daily	Grab
flow	yes	continuous	
nitrogen, total	no		
nitrate plus nitrite	no		
pH	yes	2/day	Grab
phosphorus, total	yes	1/week	Composite
phosphorus, soluble reactive,	no		
suspended solids	yes	4/week	Composite
temperature	yes	daily	Grab

Discharger: Post Falls Wastewater Treatment Facility			
Core Parameter	Sampled	Frequency	Sample Type
Ammonia	Yes	2/Week	24 hr Composite
BOD5	Yes	2/Week	24 hr Composite
CBODU**	No		
Conductivity	No		
Dissolved Oxygen	Yes	1/Daily	Grab
flow	Yes	Continuous	Recorder
nitrogen, total	Yes	1/Monthly	24 hr Composite
nitrate plus nitrite	Yes	1/Monthly	24 hr Composite
pH	Yes	1/Daily	Grab
phosphorus, total	Yes	1/Week	24 hr Composite
phosphorus, soluble reactive,	No		
suspended solids	Yes	2/Week	24 hr Composite
temperature	Yes	1/Daily	Grab

III. Core TMDL Implementation Monitoring Program

Introduction

The Spokane River TMDL Collaboration Monitoring Workgroup is proposing that the Spokane River TMDL implementation plan include a "core" water quality monitoring program. The goal of the core monitoring program is to assess current conditions and trends in water quality as improvements in wastewater treatment and mitigation of non-point sources occur over time. The following is a brief description of the monitoring plan.

Core Monitoring Program

The monitoring program will be composed of existing point source permit required effluent monitoring and both existing and new river and tributary sampling station monitoring.

Currently, Ecology's Freshwater Monitoring Unit (FMU) has active ambient monitoring stations on the Spokane River (see Figure 1) at the Stateline with Idaho (station number 57A150 at river mile - RM 96.0), at Riverside State Park (54A120 at RM 66.0), near the mouth of Hangman Creek (56A070 at RM 72.4), and near the mouth of the Little Spokane River (55B070 at RM 56.4). All of these stations have been sampled regularly for greater than 10 years and will continue to be included in the "core" monitoring plan for TMDL implementation. In addition, we are proposing to add monitoring stations in ID at the outlet of Lake Coeur d'Alene (RM 111.7) and just downstream of Post Falls Dam (RM 100.1) and in WA at Barker Road Bridge (90.4), Monroe Street Bridge (RM 73.1), Ninemile Bridge RM 58.1), and just downstream of the Lake Spokane Dam (RM 32.2). [Note: River Miles are approximate.]

All permitted point sources are currently required to monitor some water quality parameters. In order to better assess the water quality conditions and trends in the river, we recommend that their permits included daily or at a minimum weekly monitoring of the following parameters during March through October:

- ammonia
- CBODU*
- BOD5
- conductivity
- flow
- nitrate plus nitrite
- nitrogen, total
- oxygen
- pH
- phosphorus, soluble reactive
- phosphorus, total
- suspended solids
- temperature

* CBODU collected every other month April through October (i.e., 4 times per season)

River and tributary samples will be collected monthly by water year (October through September).

Measured indicators of water quality will include the following:

- ammonia
- CBODU*
- conductivity
- carbon (total and dissolved)
- flow
- nitrate plus nitrite
- nitrogen, total
- oxygen
- pH
- phosphorus, soluble reactive
- phosphorus, total
- suspended solids
- temperature

*CBODU collected every other month April through October (i.e., 4 times per season)

Ecology's sampling methods and quality control procedures will be followed (Hallock 2003b). A detailed explanation of Ecology's stream monitoring program along with specific methods and quality control procedures can be found on the World Wide Web at http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html.

Hallock, D. 2003b. *Quality Assurance Monitoring Plan*. Washington State Department of Ecology, Environmental Assessment Program, Olympia, WA. Publication No. 03-03-200, 28 pp.

IV. Summary of Special Studies

At its first meeting the Monitoring Workgroup identified several areas that may need additional data and thus fit into the category of "special study." The results of the various modeling scenarios will be a key factor in determining whether additional data is needed. Potential areas of study include:

- Determining the impact of aerobic phosphorus release from sediment on algal productivity,
- Refining the estimates of sediment oxygen demand (SOD) of Lake Spokane,
- Refining estimates of parameters used to predict dissolved oxygen concentrations within the Spokane River,
- Developing an improved understanding of ground water contribution of phosphorus,
- Conducting an evaluation of meteorological conditions on Lake Spokane,
- Monitoring Lake Spokane to assess progress toward water quality goals will be accomplished through in depth studies.
- Evaluating the phosphorus load from stormwater runoff and combined sewer overflows, and
- Conducting effectiveness monitoring of non-point mitigation efforts.

Aerobic Phosphorus Release & Phytoplankton Dynamics
Recent discussions have raised concerns about the potential causes of high algal productivity in the upstream end of Lake Spokane and how the CE QUAL W2 model is representing them.. One potential source of phosphorus not included in the model could be the aerobic release of phosphorus from lake bottom sediment. An evaluation of the aerobic release rate of phosphorus from the sediment would help determine the importance of this mechanism as a source of phosphorus for algal growth and subsequently a source of biological oxygen demand (BOD).

Sediment Oxygen Demand Verification
Sediment oxygen demand is a required input of the CE QUAL W2 model. The current calibration was accomplished by back calculating SOD and did not use site-specific SOD data. This is viewed by many as a short-fall of the model. However, the model developers believe it is the most accurate way of setting SOD values for a within year or season calibration in order to use the model to predict the impacts of pollutants for the critical period. Site-specific evaluation of SOD in Lake Spokane may provide some insight into the assumed SOD values and the potential for recovery as pollutants are reduced.

Stormwater / CSO Phosphorus Assessment
As point source loads of phosphorus are better controlled non-point sources become a more significant fraction of the remaining phosphorus load. Given the limited data for phosphorus concentrations in forms of concern in direct storm water and combined sewer overflow discharges, an effort to increase the knowledge of the loading accounted for by storm water and combined sewer overflow (CSO) sources.

It is anticipated that efforts to reduce contaminant loading from stormwater and CSO discharges will accelerate in the next few years. As load reduction measures are developed and implemented effectiveness monitoring of pilot projects for each BMP should be conducted before full-scale implementation.

River Mile 60 – 75 Dissolved Oxygen Assessment

The current model over-predicts the dissolved oxygen concentrations between river miles 60 and 75 in the vicinity of the City of Spokane. Data from downstream of the Spokane advanced wastewater treatment plant (AWTP) show that the period when the model over-predicts oxygen concentrations correlates with a period when the nitrate and ammonium loads from the AWTP had increased. This suggests that the model predictions for dissolved oxygen in the river may not be as sensitive to nitrate and ammonium loads as the true system. One explanation for this lack of sensitivity is that the parameters used to simulate the sensitivity of algal growth to nutrients need adjustments. Additional data and studies would be required to further refine these parameters.

Groundwater Impacts on River Quality

Recent work by the USGS indicates that during summer low flow periods over half of the Spokane River stream flow entering Lake Spokane originated in from the Spokane Valley Aquifer. Consequently, groundwater phosphorus comprises a significant fraction of the summer time phosphorus load into Lake Spokane. The importance of ground water phosphorus not withstanding the model does not rely on specific phosphorus data for ground water; it uses an "average" value based on aquifer wide historic data. A study of ground water phosphorus would provide more precise phosphorus input for the model. However, because of the chemical equilibrium changes as groundwater moves to the river it also will be important to conduct surface water surveys upstream and downstream of the major groundwater input zones.

Weather Studies

Wind velocity over the surface of Lake Spokane is a factor in the CE QUAL W2 that may impact model results. Calibration runs of the model rely on limited meteorological data. While long term weather data collected at stations around Lake Spokane would provide the best resolution of this data shortage, short-term studies of wind velocity and direction performed over one or two seasons would greatly improve the data base.

Lake Spokane Monitoring

The effect of load reductions on Lake Spokane quality is expected to be a long-term process. This being the case initiating lake monitoring at this time is not likely to provide information beyond the base line conditions identified during model calibration. It is proposed that an in depth assessment of lake quality be initiated in about five years. The sampling program for this effort will be coordinated with the five-year permit cycle for wastewater dischargers. Year long assessment cycles would be conducted at about five year intervals until results indicate that lake quality goals have been met or the Implementation Teams deems further monitoring unnecessary. Results from each Lake assessment cycle should be incorporated into discharge / monitoring requirements in subsequent discharge permit renewals.

BMP Assessment Monitoring for Non-stormwater / CSO sources

The non-point assessment is expected to identify a number of contaminant sources that need elimination or reduction. Monitoring of the non-point BMP's can occur at two levels, small scale effectiveness monitoring of selected test sites and watershed scale assessment of large scale application of control measures. Generally effectiveness monitoring of test sites will precede watershed scale evaluation. Core monitoring program sites on Latah Creek and the Little Spokane River may be used as part of watershed scale BMP assessments. Specific sites and BMP's to be evaluated will depend on the results of non-point source studies.

V. Modeling

Modeling of the Spokane River will continue to be an integral part of managing Spokane River water quality. Currently the CE-QUAL-W2 model is being used to predict necessary reductions in pollutant loads to meet water quality standards. Modeling will continue to be used to evaluate potential effects of planned implementation measures, assess the effectiveness of completed implementation actions, and show where additional data collection would aid decision-making. Modeling will integrate the data gathered from core monitoring and special studies and is an essential element of adaptive management.

Modeling resources are needed in two areas:

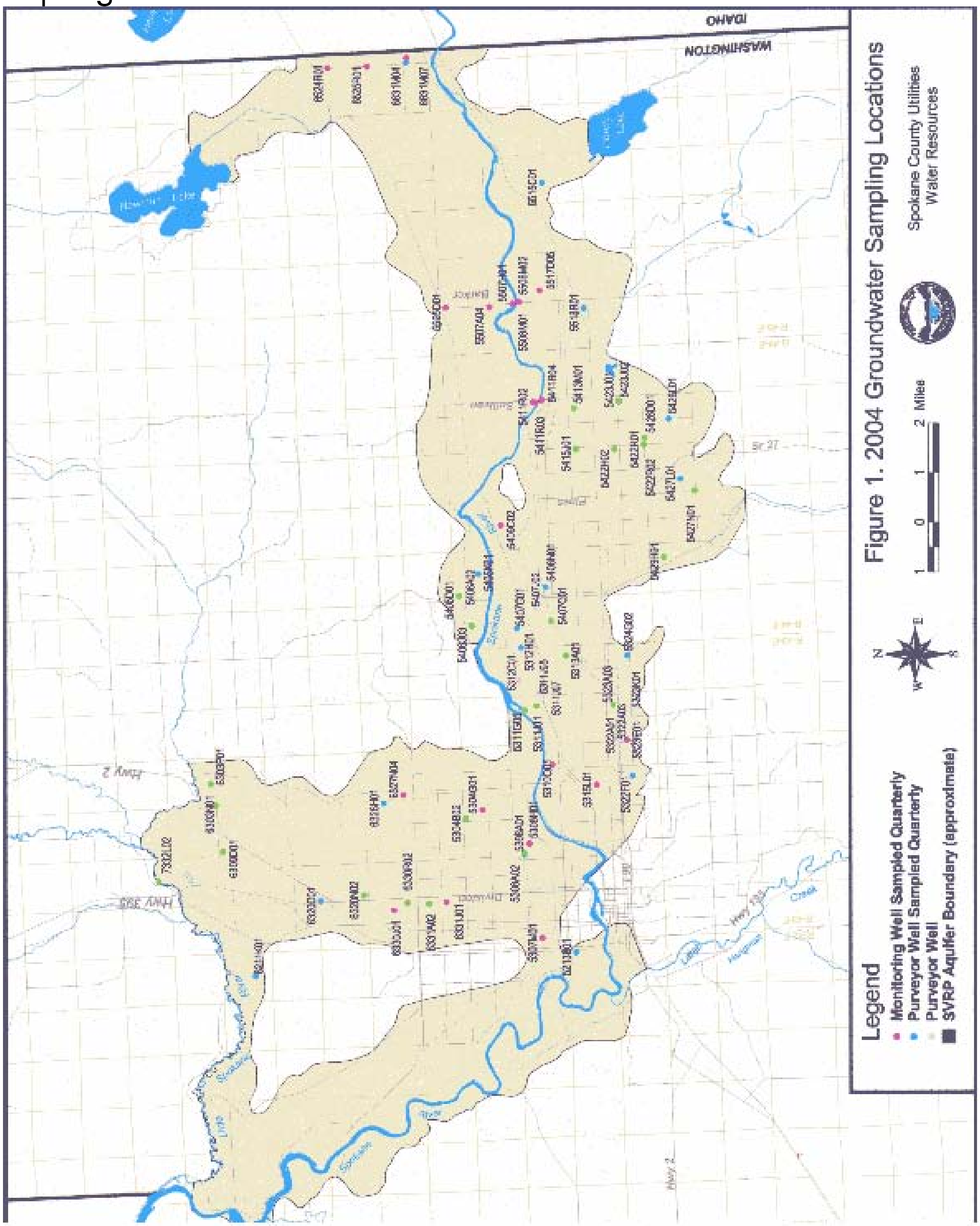
- Model development. Changes to the model structure may be desired to improve simulation of some biogeochemical processes. This work would most likely be contracted to Portland State University; $15,000 per year is included in the budget for this purpose.

- Model runs. The Spokane River water quality manager (described in Section 1 of this document), advised by a subgroup of the existing Full Group or its long-term successor, will no doubt want to make future model runs with different input values (for example, differing pollutant loading scenarios and possibly different streamflows). This work could be done by the water quality manager, if the person is recruited with these skills in mind, or by other modeling personnel at the Department of Ecology, Environmental Assessment Program. The current budget assumes the latter option, assuming 0.2 FTE of a senior-level scientist or engineer at a cost of approximately $20,000/year.

Appendix A: Physical and Inorganic Analytical Parameters—Spokane County Coordinated Monitoring Program

Analyte	EPA Method	Reporting Limit
Arsenic	200.8	0.00100 mg/L
Cadmium	200.8	0.00100 mg/L
Calcium	200.7	0.250 mg/L
Chloride	300.0	0.400 mg/L
Chromium	200.8	0.00100 mg/L
Copper	200.8	0.00100 mg/L
Fluoride	340.2	0.100 mg/L
Iron	200.7	0.150 mg/L
Lead	200.8	0.00100 mg/L
Magnesium	200.7	0.500 mg/L
Manganese	200.8	0.00100 mg/L
Mercury	245.1	0.00100 mg/L
Ortho-phosphate phosphorous	365.2	0.00200 mg/L
Potassium	200.7	2.00 mg/L
Sodium	200.7	0.250 mg/L
Sulfate	300.0	0.800 mg/L
Total Dissolved Solids	160.1	10 mg/L
Total Nitrate+Nitrite	353.2	0.010 mg/L as N
Total Phosphorus	365.2	0.00500 mg/L
Zinc	200.8	0.0100 mg/L
Temperature		
Specific Conductance		
pH		

Appendix B: Spokane County Coordinated Monitoring Program Sampling Sites



Appendix C: Summary of Hangman and Little Spokane Watershed Water Quality Sampling

Summary of Hangman Watershed Water Quality Sampling
Water quality sampling has been conducted by several agencies to evaluate Hangman Creek.

United States Geological Survey

The USGS has collected miscellaneous surface water quality samples at two areas, one near the mouth of Hangman Creek and the second at a station near the Stateline. Along with the miscellaneous surface water samples, the USGS has collected sediment samples, ground water samples, and suspended sediments at the gage near the mouth (Station 12424000). The suspended sediment results are published in the USGS annual Water Resources Data for Washington reports. The other miscellaneous sampling results are available from the USGS web site: http://waterdata.usgs.gov/wa/nwis/qwdata.

The Hangman Creek water samples from near Tensed, Idaho, were collected from September 1976 through May 1989. The samples were field data that consisted of air and water temperature and conductivity. Of the 35 samples collected, eight exceeded the Ecology standard of 18 °C, with the maximum value at 27.0 °C on August 10, 1981.

Hangman Creek near Station 12424000 was sampled at three different locations, Hangman Creek near Spokane, WA; Hangman Creek at Spokane, WA; and Hangman Creek at mouth at Spokane, WA. Hangman Creek near Spokane had two samples collected from February 1968 through June 1968. Hangman Creek at Spokane had 18 samples collected from April 1977 through August 2000. Hangman Creek at mouth at Spokane had 108 samples collected from October 1972 through October 1980. Not all parameters were analyzed for every sample.

The USGS grouped their samples into the following categories (1968 through 2000):

- Information – agency and laboratory codes
- Biological – bacteria and other biological samples
- Nutrients – ammonia, phosphate, etc.
- Organic – generally pesticides and fertilizers
- Major inorganics – Ca^{2+}, Mg^{2+}, Cl^{-}, SO_4^{2-}, K^{+}, Na^{+}, HCO_3^{-}
- Minor and trace inorganics – mostly trace metals, etc.
- Physical property – temperature, conductivity, DO, etc.
- Radiochemicals - radioruthenium
- Sediment - turbidity

The number of samples for each of the parameter groups varies along with the number of parameters analyzed (Table 1). For all surface water samples, four parameters exceeded Washington State water quality standards; temperature (27 exceedances), pH (14 exceedances), turbidity (14 exceedances), and dissolved oxygen (two exceedances).

Table 1: Parameter Group Summary of USGS Data near the Mouth

Parameter Group	First Date	Last Date	Number of Samples			Number of Values		
			HCA	HCN	HCM	HCA	HCN	HCM
Information	10-10-78	8-30-00	17	NR	32	117	NR	63
Biological	10-10-72	4-3-00	NR	NR	33	NR	NR	64
Nutrients	2-20-68	4-3-00	11	2	91	55	2	695
Organic	10-10-72	4-3-00	NR	NR	22	NR	NR	22
Major inorganics	2-20-68	4-3-00	10	2	36	62	24	215
Trace inorganics	2-20-68	4-3-00	10	2	5	95	4	176
Physical Property	2-20-68	8-30-00	18	2	108	123	19	782
Radiochemicals	9-23-80	9-23-80	NR	NR	1	NR	NR	1
Sediment	5-19-80	9-23-80	NR	NR	10	NR	NR	46

Notes:
1. HCA is USGS sample site 12424000, Hangman Creek at Spokane, WA.
2. HCN is USGS sample site 12423980, Hangman Creek near Spokane, WA.
3. HCM is USGS sample site 12434003, Hangman Creek at Mouth at Spokane, WA.
4. NR is not reported.

Spokane County Conservation District

The SCCD has conducted extensive water quality sampling in the Hangman Creek watershed since 1994. In 1994, the SCCD completed a watershed management plan for Hangman Creek that has guided SCCD water quality sampling programs.

The SCCD has recently included water quality sampling to evaluate the ground water/surface water interactions along the main stem. The details of the water quality projects are provided below.

Hangman Creek Management Plan (SCCD, 1994)

In 1994, the SCCD completed a watershed management plan for Hangman Creek. The plan provides information on the watershed characteristics, soils, general land uses in the watershed, land ownership, flow data, fauna and flora, water quality problems, and best management practices. In order to address water quality problems associated with Hangman Creek, the management plan included a Water Quality Monitoring Plan to:

1. document existing levels of suspended sediment, selected nutrients, bacterial contamination, and other water quality parameters in the Hangman Creek watershed,
2. quantify the effectiveness of erosion-reducing BMPs on water quality, and
3. compare water quality samples collected during different seasons to help quantify the contribution of bank erosion versus agricultural runoff to water quality impairment.

Hangman (Latah) Creek Water Quality Monitoring Report (SCCD, 1999)

The water quality report completed in 1999 summarizes water quality monitoring at six stations over a three-year period from October 1, 1994 through September 30, 1997. The stations monitored were:

1. Hangman Creek at the Idaho State Line
2. Little Hangman Creek
3. Rattler Run Creek at the mouth
4. Hangman Creek at Bradshaw Road
5. Rock Creek at Jackson Road
6. Hangman Creek at Keevy Road

Routine water quality samples were taken at five sites, along with selected samples during high flow events to characterize the water quality of the Hangman Creek watershed (Tables 2 and 3). A sixth site, Hangman Creek at Keevy Road, was moved to Bradshaw Road, and only had a minimal number of samples taken. Discharge measurements, or discharge values estimated from stage measurements, were routinely taken along with the water quality sample. All monitored stations exceeded one or more of either the Washington State Class A Water Quality standards or EPA recommended standards (Table 4).

Routine water quality samples were taken at the two subwatersheds, along with selected samples during high flow events to characterize the water quality of the two small tributaries to Hangman Creek (Tables 5 and 6). The data were evaluated using the U.S. EPA paired watershed study design, as outlined in EPA circular 841-F-93-009. The data from the study suggest that the BMPs used did reduce the total suspended sediment concentration by more than 10 percent. Even with the improvement in total suspended sediment data, all monitored stations exceeded one or more of either the Washington State Class A Water Quality standards or EPA standards (Table 7).

Hangman Creek Sediment Discharge Reports (SCCD, 2000b, 2002)
To evaluate sediment sources and loads from the Hangman Creek watershed to the Spokane River, a suspended sediment and bedload measurement project was completed. The SCCD, in conjunction with the USGS, monitored both suspended sediment and bedload at the mouth of Hangman Creek from water year 1998 through 2001.

The stream stations monitored by the SCCD were:

1. Hangman Creek at the mouth near the Marne Bridge
2. Hangman Creek at Bradshaw Road
3. Rock Creek at Jackson Road

Table 2: Summary Laboratory Statistics for the 1999 Water Quality Report

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
Total Suspended Solids (mg/l)	Minimum	2	2	<2	2	<2
	Maximum	810	4,640	10,540	3,170	7,565
	Mean	124	833	626	378	632
	Median	24.0	208	29.0	42.5	84.8
Turbidity (NTU)	Minimum	1.1	1.5	0.4	0.6	0.3
	Maximum	195	900	850	750	885
	Low Median	12.5	5.6	3.6	3.6	4.0
	High Median	50.0	129	92.0	90.0	116
Fecal Coliform (colonies/ 100 ml)	Minimum	3	3	<1	6	<1
	Maximum	2,400	1,400	14,300	3,800	1,700
	Geometric Mean	53	58	87	69	63
	% > 200	16	24	30	15	27
Nitrate NO_3 (mg/l as N)	Minimum	0.05	0.09	0.27	0.14	0.08
	Maximum	5.68	13.4	15.5	5.76	12.0
	Mean	1.71	2.70	5.88	1.91	3.22
	Median	1.32	0.95	4.65	1.22	1.70
Nitrite NO_2 (mg/l as N)	Minimum	0.001	<0.001	<0.001	0.001	<0.001
	Maximum	0.015	0.098	0.083	0.020	0.028
	Mean	0.004	0.010	0.016	0.005	0.009
	Median	0.003	0.006	0.011	0.005	0.008
Ammonia (mg/l as N)	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum	0.10	0.10	3.24	0.18	0.46
	Mean	0.03	0.04	0.32	0.03	0.06
	Median	0.01	0.01	0.09	0.01	0.01
Total Phosphorus (mg/l)	Minimum	0.04	0.04	0.15	0.04	0.04
	Maximum	0.80	0.96	10.5	4.27	5.70
	Mean	0.15	0.17	0.72	0.48	0.42
	Median	0.10	0.13	0.42	0.10	0.12

Notes:
1. Mean and median values include samples from high flow events, which may skew the results. The number of high flow events sampled was not uniform for all stations.
2. For turbidity, the low median is for flows less than 100 (10 for Rattler Run Creek) cfs and the high median is for flows greater than 100 (10 for Rattler Run Creek) cfs. Only turbidity values that were paired with discharge measurements were used in the low/high flow evaluation. At some sites, turbidity measurements were taken without any discharge estimation.
3. NTU is Nephelometric Turbidity Units.

Table 3: Summary Field Statistics for the 1999 Water Quality Report

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
pH (units)	Minimum	6.63	6.50	6.49	7.53	6.52
	Maximum	7.86	8.15	8.84	9.52	8.70
	Mean	7.34	7.41	7.96	8.25	7.79
	Median	7.39	7.38	8.05	7.16	7.79
Conductivity (μS)	Minimum	45.1	97.0	120	82.9	94.6
	Maximum	247	316	532	339	357
	Mean	104	212	352	198	219
	Median	120	199	374	173	202
Dissolved Oxygen (mg/l)	Minimum	4.9	3.5	7.6	6.0	6.7
	Maximum	11.7	13.2	13.7	14.0	18.5
	Mean	8.6	8.4	10.7	9.6	10.5
	Median	8.7	9.0	10.5	9.5	10.5
Temperature (°C)	Minimum	-0.5	0.4	-0.6	0.3	-0.7
	Maximum	22.8	21.9	19.3	23.8	24.7
	Mean	10.6	9.1	7.9	12.0	8.1
	Median	8.0	7.1	6.5	12.8	5.2

Notes:
1. Values include samples from high flow events, and may skew the results. The number of high flow events sampled was not uniform for all stations.
2. Temperature data are for grab samples only. Continuous temperature recorders were installed at some sites, but the data recorded by the continuous temperature recorders are not included here.

The USGS determined the average daily suspended-sediment load at the Marne Bridge site near the confluence of Hangman Creek and the Spokane River. The SCCD estimated the average daily bedload discharge at the Marne Bridge site. The annual total bedload and suspended sediment discharged for water years 1998 through 2001 ranged from 4,740 to 189,000 tons per year (Table 8). Along with the sediment sampling, a low flow water quality sampling run was completed at 18 sites within the watershed to characterize the base flow water type along the Hangman Creek main stem.

Table 4: Summary of Exceedances for the 1999 Water Quality Report

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
Turbidity Low Flows	Exceedances	NA	7	7	1	6
	Number of Samples	NA	19	41	16	44
Turbidity High Flows	Exceedances	NA	6	6	14	46
	Number of Samples	NA	10	10	23	63
Fecal Coliform	Percent > 200 col/100 ml	16	24	30	15	27
Nitrate NO_3	Exceeds EPA Limit	0	1	14	0	3
	Number of Samples	25	25	57	27	59
Nitrite NO_2	Exceeds EPA Limit	0	1	2	0	0
	Number of Samples	25	25	57	27	59
Ammonia	Exceedances	0	0	4	0	0
	Number of Samples	24	24	47	19	50
Total Phosphorus	Exceeds EPA Limit	10	18	57	14	34
	Number of Samples	25	25	57	29	61
pH	Exceedances	0	0	8	5	3
	Number of Samples	25	25	53	23	58
Dissolved Oxygen	Exceedances	7	8	1	6	7
	Number of Samples	19	20	51	25	57
Temperature	Exceedances	7	5	1	11	14
	Number of Samples	25	30	76	33	88

Notes:

1. NA is not applicable. Turbidity values from Hangman Creek at the Idaho State Line were used as background values to establish the limits for the rest of the sample sites.
2. For turbidity, the low flows are less than 100 (10 for Rattler Run Creek) cfs and the high flows are greater than 100 (10 for Rattler Run Creek) cfs.
3. The number of temperature exceedances is for grab samples only. Continuous temperature recorders were installed at some sites, but the exceedances recorded by the continuous temperature recorders are not included here, see the original report Section 4.1.4.
4. For nitrate, nitrite, and total phosphorus, the EPA recommended limits are used. No Washington State Standards for these parameters are presently contained in the Water Quality Standards for Surface Waters of the State of Washington.

Table 5: 2000 Subwatershed Improvement Report Laboratory Summary Statistics

Parameter		Southern Watershed	Northern Watershed Channel	Northern Watershed Ditch	Northern Watershed Composite
Total Suspended Solids (mg/l)	Minimum	<2	<2	<2	<2
	Maximum	3,568	2,923	5,105	3,408
	Mean	193	151	471	244
	Median	22	18	37	13
Turbidity (NTU)	Minimum	1.8	0.6	1.4	0.8
	Maximum	768	825	760	638
	Mean	81	88	112	58
	Median	18	45	50	7
Fecal Coliform (colonies/ 100 ml)	Minimum	5	0	0	<1
	Maximum	1,410	61	11	1,400
	Geometric Mean	37.4	5.4	7.7	11.6
	% > 200	15	0	0	14
Nitrate NO_3 (mg/l as N)	Minimum	0.45	0.74	1.00	0.60
	Maximum	16.2	8.74	8.74	8.72
	Mean	3.77	3.13	3.67	3.24
	Median	2.99	2.31	3.41	1.76
Nitrite NO_2 (mg/l as N)	Minimum	<0.001	<0.001	<0.001	0.001
	Maximum	0.026	0.015	0.015	0.024
	Mean	0.005	0.005	0.005	0.007
	Median	0.005	0.005	0.005	0.006
Ammonia (mg/l as N)	Minimum	<0.01	<0.01	<0.01	<0.01
	Maximum	0.41	0.08	0.08	1.03
	Mean	0.04	0.02	0.02	0.09
	Median	0.02	0.01	0.02	0.02
Total Phosphorus (mg/l)	Minimum	0.09	0.06	0.08	0.04
	Maximum	1.50	0.54	0.54	2.44
	Mean	0.35	0.18	0.21	0.25
	Median	0.27	0.14	0.17	0.16

Notes:
1. Mean and median values include samples from high flow events, which may skew the results. The number of high flow events sampled was not uniform for all sites.
2. NTU is Nephelometric Turbidity Units.

Bedload discharge samples from the upper reaches of the watershed were insignificant. At the Rock Creek Jackson Road site, the bedload sediment discharge was 24 grams at a discharge of 540 cfs. Sampling at Rock Creek and Hangman Creek at Bradshaw Road suggest that there is little bedload discharge from the upper watershed at low and moderate flows. In the lower reach (Hangman Creek at Marne Bridge), both moderate and high flows had significant bedload sediment discharges. The data suggest there is little bedload movement for flows less than approximately 216 cfs at the mouth of Hangman Creek. The highest bedload sediment discharge was 15,212 grams at a discharge of 5,300 cfs.

Table 6: 2000 Subwatershed Improvement Report Field Summary Statistics

Parameter		Southern Watershed	Northern Watershed Channel	Northern Watershed Ditch	Northern Watershed Composite
pH (units)	Minimum	6.80	6.90	6.89	7.50
	Maximum	8.29	8.46	8.55	8.25
	Mean	7.78	7.80	7.98	7.76
	Median	7.85	7.81	8.07	7.75
Conductivity (μS)	Minimum	64	69	66	130
	Maximum	422	417	381	419
	Mean	305	284	269	314
	Median	326	324	304	334
Dissolved Oxygen (mg/l)	Minimum	4.5	6.1	9.3	4.5
	Maximum	12.2	13.6	12.8	12.7
	Mean	9.4	10.3	11.2	9.8
	Median	10.0	11.1	11.3	10.1
Temperature (°C)	Minimum	0.1	0.0	0.0	0.0
	Maximum	15.8	14.1	14.1	13.7
	Mean	6.3	5.5	5.4	5.1
	Median	5.5	4.3	4.2	3.9

Notes:
1. Values include samples from high flow events, and may skew the results. The number of high flow events sampled was not uniform for all sites.

The suspended sediment accounted for the majority of the total sediment discharged from the watershed. Generally, the higher the average annual flow rate, the higher the suspended sediment percentage. The suspended sediment is derived from both stream bank and agricultural field erosion. However, it is suspected to be primarily from field, road, and ditch erosion. The suspended sediment concentrations, as opposed to the bedload samples, were significant in the upper reaches of the watershed.

Water quality samples were taken at 18 sites on a single day along the main stem of Hangman Creek. The water samples were taken to evaluate low flow water quality (Table 9) and to characterize the ground water input to the creek.

Trilinear diagrams were used to evaluate trends in the composition of the streamflow at the sampling points along Hangman Creek (Figure 1). The trends evaluate changes in the major dissolved cations (calcium, magnesium, and sodium plus potassium) and the major anions (chloride, sulfate, and bicarbonate). The diagrams illustrate the major dissolved ionic constituents in milliequivalents expressed as the percentages of the total cation or anion milliequivalents.

Table 7: Summary of Exceedances for the 2000 Subwatershed Improvement Report

Parameter		Southern Watershed	Northern Watershed Channel	Northern Watershed Ditch	Northern Watershed Composite
Turbidity > 50 NTU	Exceedances	21	19	19	11
	Number of Samples	56	40	38	33
Fecal Coliform	Percent > 200 col/100 ml	15	0	0	14
Nitrate NO_3	Exceeds EPA Limit	1	0	0	0
	Number of Samples	31	13	12	23
Nitrite NO_2	Exceeds EPA Limit	0	0	0	0
	Number of Samples	31	13	12	23
Ammonia	Exceedances	0	0	0	0
	Number of Samples	26	7	6	23
Total Phosphorus	Exceeds EPA Limit	34	13	14	18
	Number of Samples	35	17	16	23
pH	Exceedances	0	0	1	0
	Number of Samples	35	19	17	20
Dissolved Oxygen	Exceedances	6	3	0	2
	Number of Samples	32	17	15	19
Temperature	Exceedances	0	0	0	0
	Number of Samples	53	27	24	35

Notes:

1. Turbidity values were considered an exceedance if greater than 50 NTU. Background turbidity values are not known for the project watersheds. The 50 NTU limit value was assumed for exceedances and is not based on any regulatory limit.
2. The temperature values are for site visits only. Continuous temperature recorders were not installed at any site.
3. For nitrate, nitrite, and total phosphorus, the EPA recommended limits are used. No Washington State Standards for these parameters are presently contained in the Water Quality Standards for Surface Waters of the State of Washington.

Table 8: Bedload and Suspended Sediment Annual Summary

Year	Annual Bedload (tons)	Annual Suspended Sediment Load (tons)	Total Annual Sediment Load (tons)	Average Annual Discharge (cfs)
1998	5,100	35,200	40,300	166
1999	14,000	175,000	189,000	315
2000	12,300	83,000	95,300	273
2001	1,310	3,430	4,740	83.7

Notes:

1. Suspended sediments were estimated by the USGS from automated samples.
2. Bedload estimations were by the SCCD using regression equations developed from sample results and USGS flow data. The regression equation uses USGS daily average flow as the predictive input.

Table 9: Summary of Exceedances for the 2001 Low Flow Sampling

	Total Phosphorus (μg/l)	Fecal Coliform (colonies /100ml)	pH (units)	Dissolved Oxygen (mg/l)	Temperature (°C)
Stateline	63	59	7.21	7.14^{e}	12.6
HC at Tekoa	79	28	7.94	11.49	16.3
HC at Marsh Rd	64	46	7.70	10.05	16.0
Cove Creek	100	190	7.65	10.32	13.1
HC at Roberts Rd	77	16	7.86	9.41	17.6
Rattler Run Creek	256^{e}	310^{e}	7.81	9.24	13.8
HC at Bradshaw Rd	97	16	8.00	7.61^{e}	18.4^{e}
HC at Keevy Rd	58	2	8.64^{e}	11.55	19.2^{e}
HC u/s Rock Ck	72	7	9.23^{e}	16.64	20.4^{e}
Rock Creek	35	790^{e}	9.15^{e}	8.37	19.9^{e}
HC u/s California Ck	74	4	8.93^{e}	10.21	18.8^{e}
California Ck	95	290^{e}	8.34	10.23	16.0
HC at HV Golf Course	32	19	8.52^{e}	13.90	20.7^{e}
HC at Grunte Home	41	17	8.18	10.86	20.3^{e}
HC at Yellowstone	29	3	8.29	10.75	21.2^{e}
HC u/s Marshall Ck	32	2	7.83	10.58	20.5^{e}
Marshall Ck	65	1600^{e}	7.56	7.56^{e}	17.5
USGS Gage site	22	65	8.17	12.56	18.2^{e}

Notes:

1. Total Phosphorus is not listed on the 1998 Ecology 303(d) list, but exceedances of EPA recommended levels have been documented in previous SCCD sampling within the Hangman Creek watershed.
2. Fecal coliform was considered an exceedance if greater than 200 colonies per 100 ml sample. Not enough samples were obtained to adequately characterize the geometric mean for exceedances.
3. HC is Hangman Creek.
4. u/s is upstream.
5. HV is hangman Valley.
6. e indicates an exceedance of Ecology water quality standards, except for total phosphorus which is an EPA recommended limit.
7. There were no exceedances for nitrate, nitrite, or ammonia.
8. Two ammonia samples had corresponding pH values greater than 9.00. The exceedances criteria are dependent on pH, and the pH limit used in the calculation of exceedances is 9.00. For the samples with pH values greater than 9.00, extrapolations were used to estimate the limits.

The trilinear plot uses two equilateral triangles, one for cations and the other for anions. Each vertex represents 100 percent of a particular ion or group of ions. The composition of the water with respect to cations is indicated by a point plotted in the cation triangle, and the composition with respect to anions by a point plotted in the anion triangle. The coordinates at each point add to 100 percent.

The trilinear diagram constitutes a useful tool in water-analysis interpretation. Applications of the diagram are used to evaluate whether a particular water may be a mixture of others, or if two solutions of different concentrations are mixed. The results of this sample set indicate that the water in Hangman Creek is predominantly a calcium-bicarbonate water type. Sodium plus potassium quantities were estimated based on the other major ion concentrations and the field conductivity by the EWU Limnology Laboratory. No significant mixing trends were apparent using the major ions (Figure 8).

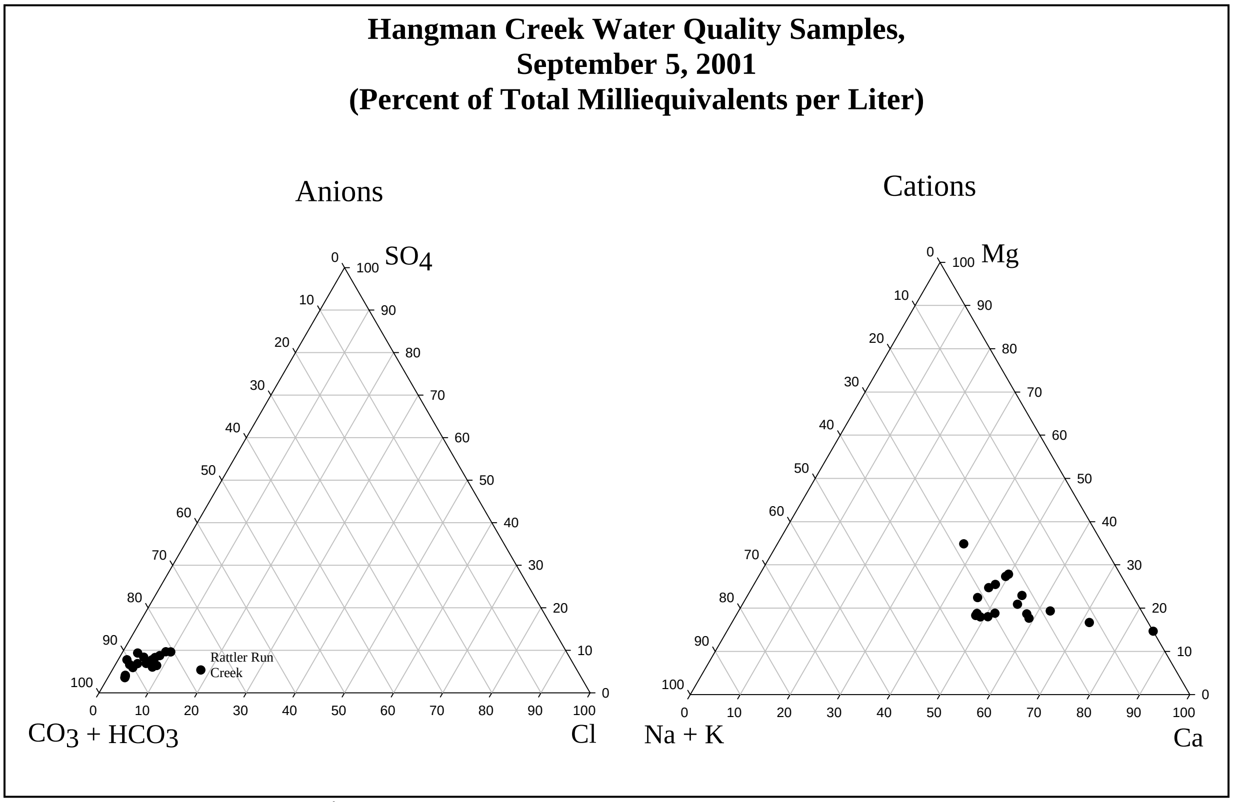


Figure 8: Hangman Creek Major Ion Percentages

<u>Washington State Department of Ecology</u>

Ecology samples two sites on Hangman Creek for their River and Stream Water Quality Monitoring network. The sites are sampled for fecal coliform bacteria, DO, pH, TSS, temperature, total persulfate nitrogen, total phosphorus, and turbidity. The two sites are located at the mouth (station 56A070) and near Bradshaw Road (station 56A200). The first sampling at the mouth was on 10-10-72 and is ongoing. The Bradshaw Road site was first sampled on 10-5-98 and was last sampled on 9-13-99. The data are available from the Ecology web site, www.ecy.wa.gov.

Summary of Little Spokane River Watershed Water Quality Sampling

Pend Oreille Conservation District Data

Little Spokane Water Quality Assessment (undated report, probably from 2000)

The POCD conducted monitoring of five sites on the Little Spokane River and one site on the West Branch of the Little Spokane River from October 1998 through September 1999. Samples were collected monthly and were scheduled to correspond with monthly sampling performed by Ecology EAP staff at four additional Little Spokane River sites.

No summary tables were provided in the report. The narrative section on phosphorus is copied below:

> *Though there is no State Criteria for total phosphorus concentrations, the US Environmental Protection Agency suggests surface waters should remain below 100 μg/L to limit excessive algae and aquatic macrophyte growth. There were four instances where Little Spokane water samples exceeded this amount: in February at sites LS5 (112 μg/L), LS6 (127 μg/L) and 55B82 (106 μg/L) and in March at site LS5 (103 μg/L). While these concentrations exceed the EPA's recommendation, they occurred during winter months and probably did little to accelerate eutrophication.*

Spokane County Conservation District

The Little Spokane River Watershed Plan Development, A Compilation of Project Results, (2001 – 2002)

The primary water quality component of this project was intended to evaluate possible nitrate/nitrite inputs from recent housing developments on Deadman and Little Deep Creeks. Monthly sampling began in January of 2001 above and below the developments. Deadman Creek was sampled at Bruce Road and Shady Slope Road. Little Deep Creek was sampled at Colbert Road and Little Spokane Drive. The monthly downstream water quality samples were inconclusive because springs immediately upstream of the Shady Slope Road sample site were found to have significantly high nitrate levels (Table 10 and 11).

Chemical Parameters Measured during the Macro Invertebrate Sampling

A summary of the physical and chemical parameters measured during the macro invertebrate sampling is provided in Table 13. The water temperatures ranged from a low of 0.0°C to a high of 23.5°C, the pH ranged from a low 5.7 to a high of 9.4, the conductivity ranged from a low of 32 μS to a high of 414 μS, and the dissolved oxygen ranged from a low of 5.9 mg/l to a high of 14.5 mg/l. The embededdness ranged from a low of 22 percent to a high of 63 percent. The water velocity ranged from a low of 0.5 feet per second to a high of 5.0 feet per second, and the water depth ranged from a low of 0.14 feet to a high of 2.10 feet.

Table 10: Deadman Creek Monthly Sampling Results 2001-2002.

Parameter		Deadman at Bruce Road	Deadman upstream of outfall and springs	Spring upstream of Kaiser outfall	Kaiser outfall	Spring upstream of Hwy. 2	Deadman at Shady Slope Road
Nitrate (NO_3) (mg/l as N)	Maximum	0.23	0.98	1.74	1.54	3.61	1.03
	Minimum	0.08	0.20	1.65	1.43	1.52	0.44
	Mean	0.14	0.53	1.70	1.47	3.09	0.82
Nitrite (NO_2) (mg/l as N)	Maximum	0.001	0.001	0.006	0.003	0.001	0.006
	Minimum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Mean	0.001	0.001	0.006	0.002	0.001	0.002
Ammonia (mg/l)	Maximum	0.03	0.04	0.03	0.08	0.52	0.04
	Minimum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Mean	0.015	0.025	NA	NA	0.14	0.025
Kjeldahl N (mg/l)	Maximum	0.52	0.31	0.06	0.12	2.40	0.39
	Minimum	0.19	0.10	0.04	0.05	0.01	0.12
	Mean	0.28	0.19	0.04	0.08	0.51	0.20
Temperature (°C)	Maximum	16.7	19.0	11.1	12.8	17.6	16.3
	Minimum	0.0	7.6	11.0	11.2	14.2	4.8
	Mean	9.1	12.6	11.1	12.0	15.8	10.4
pH (units)	Maximum	7.46	8.24	7.82	8.35	8.05	8.31
	Minimum	6.33	7.30	7.45	7.80	7.84	7.73
	Mean	NA	NA	NA	NA	NA	NA
Conductivity (µS)	Maximum	210	392	426	335	616	414
	Minimum	158	103	115	310	540	232
	Mean	84	245	361	323	597	339
Dissolved Oxygen (mg/l)	Maximum	12.96	10.40	3.88	11.59	9.63	12.76
	Minimum	4.53	7.73	3.49	9.69	8.23	9.53
	Mean	7.45	9.26	3.75	10.64	9.10	10.91

Notes:
1. Not all sample sites were sampled the same number of times. The Kaiser outfall was dry several times.
2. Sample results of less than detectable were not included in the averages.
3. mg/l as N is milligrams per liter as Nitrogen.

Table 11: Little Deep Creek Monthly Sampling Results 2001-2002.

Parameter		Little Deep Creek at Colbert Road	Little Deep Creek at Little Spokane Drive
Nitrate (NO_3) (mg/l as N)	Maximum	0.50	0.96
	Minimum	0.11	0.22
	Mean	0.28	0.49
Nitrite (NO_2) (mg/l as N)	Maximum	0.001	0.006
	Minimum	<0.001	<0.001
	Mean	0.001	0.002
Ammonia (mg/l)	Maximum	0.05	0.02
	Minimum	<0.01	<0.01
	Mean	0.03	0.01
Kjeldahl N (mg/l)	Maximum	0.56	0.54
	Minimum	0.20	0.12
	Mean	0.32	0.22
Temperature (°C)	Maximum	16.4	16.0
	Minimum	0.0	2.6
	Mean	7.5	9.7
pH (units)	Maximum	7.87	8.34
	Minimum	6.06	7.60
	Mean	NA	NA
Conductivity (μS)	Maximum	151	440
	Minimum	88	132
	Mean	114	304
Dissolved Oxygen (mg/l)	Maximum	13.62	12.95
	Minimum	6.14	9.43
	Mean	10.96	11.04

Notes:
1. Sample results of less than detectable were not included in the averages.
2. mg/l as N is milligrams per liter as Nitrogen.

Seepage Runs

The seepage run water quality results for Deadman Creek and Little Deep Creek are shown in Tables 14 and 15. Deadman Creek water temperatures ranged from a low of 11.1°C to a high of 14.1°C, the pH ranged from a low 6.82 to a high of 8.03, the conductivity ranged from a low of 40.9 μS to a high of 752 μS, and the dissolved oxygen ranged from a low of 3.39 mg/l to a high of 10.0 mg/l. Deadman nitrates ranged from a low of 0.05 mg/l to a high of 7.86 mg/l, the nitrite ranged from a low of less than 0.001 mg/l to a high of 0.001 mg/l, the total Kjeldahl nitrogen ranged from a low of 0.06mg/l to a high of 0.47 mg/l, and ammonia ranged from less than 0.01 mg/l to a high of 0.06 mg/l.

Table 13: Summary of Macro Invertebrate Sample Site Parameters

Parameter		Fall 2000		Spring 2001		Fall 2001		Spring 2002	
		Value	Site	Value	Site	Value	Site	Value	Site
pH (units)	Maximum	8.5	5	9.0	21	8.0	14,24	9.4	9
	Minimum	7.0	26	7.0	17	5.7	15	5.7	19
Conductivity (µS)	Maximum	366	14	311	15	414	16	296	24
	Minimum	52	15	55	23	48	15	32	15
DO (mg/l)	Maximum	14.5	26	10.0	13	13.05	24	12.8	2
	Minimum	9.4	27	5.9	24	7.14	22	8.0	16
Salinity (ppt)	Maximum	0.2	14	0.1	Note 2	0.2	16,14	0.1	Note 6
	Minimum	0.0	Note 1	0.0	Note 3	0.0	Note 4	0.0	Note 7
Temperature (°C)	Maximum	7.6	25,26	23.5	21	9.6	10	20.6	21
	Minimum	0.0	17	9.5	23	4.1	24	7.9	23
Embededdness (percent)	Maximum	62	19	63	24	62	13,22	55	7
	Minimum	28	21	22	17	24	2	22	21
Velocity (fps)	Maximum	3.0	5	3.0	2	3.0	8	5.0	23
	Minimum	0.5	22	0.5	22	0.5	Note 5	1.1	22
Depth (feet)	Maximum	1.94	22	2.10	5	1.94	13	1.91	13
	Minimum	0.26	27	0.27	20	0.14	17	0.32	23

Notes:

1. Sites 8, 15, 17, 19, 22, and 23.
2. Sites 2, 15, 17, 18, 22, 23, and 27.
3. Sites 1, 4, 5, 7, 8, 9, 10, 12, 13, 14, 16, 19, 20, 21, 24, 25, and 26.
4. Sites 15, 17, 21, 22, and 23.
5. Sites 14, 17, 21, and 22.
6. Sites 7, 15, 16, 17, 18, 19, 21, 22, and 23.
7. Sites 1, 2, 4, 5, 8, 9, 10, 12, 13, 14, 20, 24, 25, 26, and 27.
8. DO is dissolved oxygen.
9. mg/l is milligrams per liter.
10. ppt is parts per thousand.
11. fps is feet per second.
12. The depth is the average sampling depth for the sample site.
13. All sampling was conducted by EWU.

Little Deep Creek water temperatures ranged from a low of 8.4°C to a high of 11.4°C, the pH ranged from a low 6.57 to a high of 7.76, the conductivity ranged from a low of 50.9 µS to a high of 419 µS, and the dissolved oxygen ranged from a low of 7.45 mg/l to a high of 10.8 mg/l. Little Deep Creek nitrates ranged from a low of 0.08 mg/l to a high of 0.57 mg/l, the nitrite ranged from a low of less than 0.001 mg/l to a high of 0.011 mg/l, the total Kjeldahl nitrogen ranged from a low of 0.06mg/l to a high of 0.31 mg/l, and ammonia ranged from less than 0.01 mg/l to a high of 0.01 mg/l.

Table 14: September 2002 Seepage Run Field Water Quality Results

River Mile	Site Name	Discharge (cfs)	Temperature (°C)		pH (units)	Conductivity (µS)
			Air	Water		
14.7	Deadman at Fire Station	2.18	16.1	12.5	6.82	40.9
11.1	Deadman at Mt. Spokane Rd.	2.04	16.4	14.1	7.15	78.0
5.8	Deadman at Bruce Rd.	1.41	17.4	13.4	7.50	125
3.6	Spring above RR	0.12	20.0	11.8	8.03	752
3.6	Deadman at RR crossing	1.24	14.8	12.9	7.68	201
2.1	Deadman u/s of Kaiser	2.10	14.9	13.0	7.67	265
2.1	Spring u/s of Kaiser outfall	NM	19.3	11.1	7.49	430
2.1	Spring u/s of Hwy 2	NM	17.2	12.1	7.58	601
0.4	Deadman at Shady Slope Rd.	10.1	20.1	11.6	7.80	386
11.5	Little Deep S-Fork at Big Meadow	0.41	15.1	8.4	6.57	50.9
10.4	Little Deep N-Fork at Big Meadow	0.11	14.0	9.9	6.82	126
8.3	Little Deep at Dunn Road	0.68	13.7	9.2	6.67	102
6.6	Little Deep at Woolard Road	0.31	21.8	9.7	6.85	103
5.4	Little Deep at Congleton Prop.	0.28	16.4	11.2	6.79	107
3.7	Little Deep in Colbert	0.15	20.7	11.4	6.96	108
0.0	Little Deep at Hargreaves Prop.	1.32	17.2	10.1	7.76	419

Notes:
1. The Kaiser outfall (DM-6B) was dry.
2. Deadman Creek seepage run was conducted on September 16, 2002
3. Little Deep Creek seepage run was conducted on September 30, 2002.

Washington State Department of Ecology Data

Ecology samples one long-term site in the Little Spokane River watershed for their River and Stream Water Quality Monitoring network. The sites are sampled for ammonia, conductivity, fecal coliform bacteria, DO, pH, TSS, temperature, nitrate plus nitrite, total nitrogen, soluble reactive phosphorus, total phosphorus, and turbidity. The long-term site is located at the mouth (station 55B070). Ecology has sampled at 13 other sites at various times (Table 16). The data are available from the Ecology web site, www.ecy.wa.gov.

Table 15: September 2002 Seepage Run Laboratory and Field Water Quality Results

Site Name	DO (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	TKN (mg/l)	Ammonia (mg/l)
Deadman at Fire Station	7.04	0.05	0.001	0.08	<0.01
Deadman at Mt. Spokane Rd.	6.26	0.10	0.001	0.11	0.02
Deadman at Bruce Rd.	5.02	0.06	<0.001	0.17	0.04
Spring above RR	7.65	7.86	0.001	0.06	0.02
Deadman at RR crossing	6.26	0.81	0.001	0.36	0.03
Deadman u/s of Kaiser	8.76	0.63	0.001	0.21	0.03
Spring u/s of Kaiser outfall	3.39	1.80	0.001	0.28	0.04
Spring u/s of Hwy 2	8.29	3.41	0.001	0.47	0.06
Deadman at Shady Slope Rd.	10.10	1.01	0.001	0.13	0.01
Little Deep S-Fork at Big Meadow	10.72	0.08	<0.001	0.31	<0.01
Little Deep N-Fork at Big Meadow	10.83	0.08	<0.001	0.15	<0.01
Little Deep at Dunn Road	9.97	0.08	<0.001	0.09	0.01
Little Deep at Woolard Road	10.21	0.10	0.011	0.10	<0.01
Little Deep at River Mile 5.4	10.61	0.10	0.001	0.11	<0.01
Little Deep in Colbert	10.77	0.09	0.001	0.13	<0.01
Little Deep at Hargreaves Prop.	7.45	0.57	<0.001	0.06	0.01

Notes:
1. The Kaiser outfall (DM-6B) was dry.
2. Deadman Creek seepage run was conducted on September 16, 2002.
3. Little Deep Creek seepage run was conducted on September 30, 2002.

Table 16: Ecology Sampling Sites for the Little Spokane River Watershed

Station code	Station name *link to monitoring results**	Type	Class	Last year sampled
55B070	Little Spokane R nr Mouth	long-term	A	2005
55B075	Little Spokane @ Painted Rocks	basin	A	1999
55B080	Little Spokane R nr Griffith Spring	basin	A	1991
55B082	Little Spokane R abv Dartford Creek	basin	A	1999
55B085	Little Spokane nr Dartford	basin	A	1966
55B090	Little Spokane R abv Wandermere	basin	A	1973
55B100	Little Spokane R abv Deadman Creek	basin	A	1994
55B200	Little Spokane @ Chattaroy	basin	A	1999
55B300	Little Spokane River @ Scotia	basin	A	2004
55C065	Deadman Cr nr Mouth	basin	A	1994
55C070	Peone (Deadman) Creek abv L Deep Cr	basin	A	2004
55C200	Deadman Cr@Holcomb Rd	basin	A	2004
55D070	Deer Cr nr Chattaroy	basin	A	1994
55E070	Dragoon Cr nr Chattaroy	basin	A	1994

* monitoring results may be obtained online at
http://www.ecy.wa.gov/apps/watersheds/riv/regions/state.asp