DEPARTMENT OF ECOLOGY
State of Washington

Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load

2010-2014 Implementation Report

July 2015
Publication no. [xx-xx-xxx]

Publication and Contact Information

This report is available on the Department of Ecology's website at
https://fortress.wa.gov/ecy/publications/SummaryPages/xxxxxxx.html

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Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load

2010-2014 Implementation Report

by
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Washington State Department of Ecology
Olympia, Washington

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Acknowledgements

The author of this report would like to thank the following people for their contribution to this study:

- The individuals listed below provided a wealth of information that made up the bulk of this report, such as their organization's implementation and monitoring activities, and monitoring data. These individuals also commented on review drafts of the report to help create a more robust report.
    - Avista Corp.: Meghan Lunney
    - City of Coeur d'Alene: Kris Holm
    - City of Post Falls: John Beacham
    - City of Spokane: Lynn Schmidt, Jeffery Donovan, Marcia Davis, and Doug Greenlund
    - Hayden Area Regional Sewer Board: Ken Windram
    - Inland Empire Paper Company: Doug Krapas
    - Liberty Lake Sewer and Water District: BiJay Adams
    - Natural Resources Conservation Service: Steve Sprecher
    - Spokane Conservation District: Walt Edelen, Rick Noll, and Ty Meyer
    - Spokane County: Ben Brattebo and Dave Moss
    - Stevens County Conservation District : Charlie Kessler
    - Spokane River Forum: Andy Dunau
    - Spokane River Stewardship Partners: Lisa Dally-Wilson
    - The Lands Council: Amanda Parrish
    - Washington State Department of Transportation: Greg Lahti and Jana Radcliff
    - Washington State Department of Ecology: Jim Ross, Tony Whiley, Elaine Snouwaert, Ellie Key, Pat Hallinan, Martyn Quinn, and Jean Parodi
- The Spokane Dissolved Oxygen TMDL advisory committee and the biennial report workgroup participants for helping with the report.
- Diane Dent and Robyn Dunlap for formatting and publishing the document.
- Dave Knight and Jim Bellatty for guidance and support.

Executive Summary

The Spokane River begins at the outlet of Lake Coeur d'Alene in Idaho and flows west through the city of Spokane, Washington (Figure ES-1). The river continues northwest through Lake Spokane, then west-northwest toward its confluence with the Columbia River. Lake Spokane is created by Avista Corporation's Long Lake Dam.

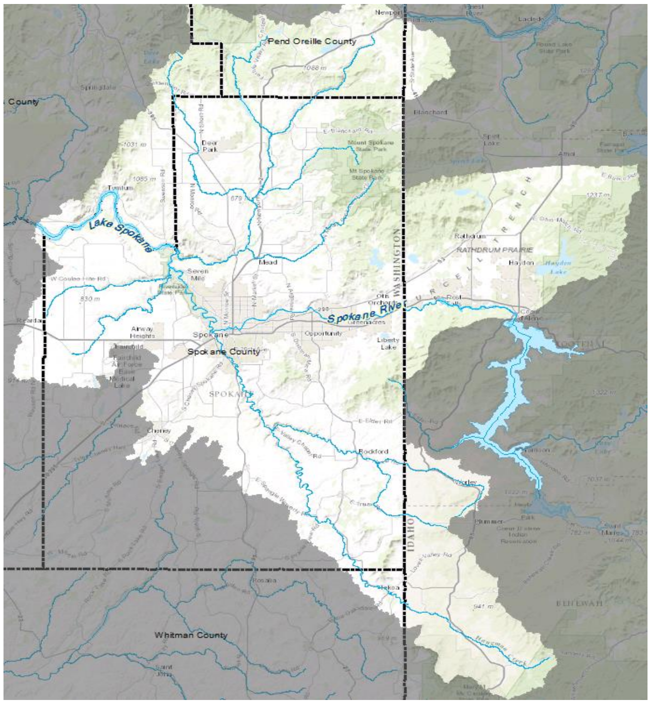


Figure ES-1. The Spokane River watershed

Low dissolved oxygen levels are common in the deeper parts of Lake Spokane (also referred to as Long Lake), and algae blooms have plagued the lake for decades. Scientific studies on the lake dating back to the 1970's indicated the lake contained too much phosphorus. These studies prompted the City of Spokane to take steps to reduce phosphorus and other nutrients discharged from their waste water treatment plant. Despite some water quality improvement resulting from those efforts, Lake Spokane still does not meet Washington State water quality standards for dissolved oxygen.

In 2010, the Environmental Protection Agency approved the Washington State Department of Ecology's (Ecology) Spokane River and Lake Spokane Dissolved Oxygen Water Quality Improvement Plan. This plan is also called a total maximum daily load or TMDL. The TMDL includes requirements for the following nutrient sources within Washington State:

- Point sources such as municipal wastewater treatment plants or industrial facilities that discharge treated water into the river. There are five point source dischargers in Washington on the Spokane River.

- Nonpoint source pollution that enters our waters from everyday activities such as over-application of fertilizer, poor management of livestock and pet waste, bare stream banks that erode, and failing septic systems. Most of the nonpoint source pollution comes from the tributaries (Hangman Creek, Coulee Creek, and the Little Spokane River) and the area around Lake Spokane.

- Avista received a portion of the responsibility because Long Lake Dam created the conditions that led to the dissolved oxygen problem.

Since 2000 several groups have completed approximately 200 projects to reduce nonpoint source pollution. The majority of the projects are in the Hangman Creek watershed and over a quarter are in the Little Spokane drainage. The types of projects completed include connecting homes with septic systems to a sewer; improving forest roads to reduce erosion; installing livestock best management practices such as covered manure facilities, fencing off waterways, etc.; converting to direct seeding or minimum till; planting riparian (stream bank) areas with trees and shrubs; and using various methods to protect streambanks from eroding. Almost half of the projects planted riparian areas and nearly a quarter of the projects converted conventional farming techniques to direct seed. Between 2010 and 2014, almost 19 miles of stream were planted and 13.6 square miles of farm fields converted to direct seeding or mulch till. Switching to direct seed methods saved an estimated 52,000 tons of soil.

Point source dischargers must significantly reduce the amount of nutrients from their facilities, and they are taking a variety of measures to get there. Between 2010 and 2014, facilities applied best management practices to optimize the treatment process. For example, they installed equipment or applied chemicals to enhance the treatment process, or reduced the amount of water used in their process. In addition, the dischargers are researching new technology to reduce phosphorus and other nutrients from their discharges in preparation for upgrading their facilities.

The cities of Spokane and Spokane Valley along with Spokane County are working to redirect runoff so it can infiltrate into the ground. In addition, the City of Spokane is burying large underground vaults that can store some stormwater until it can be treated at the wastewater treatment facility. The Washington State Department of Transportation is also an active partner in reducing stormwater from the highways, by performing maintenance and working with adjacent landowners to eliminate pollution sources entering the ditches and drains.

Multiple groups are collecting monitoring data from Lake Coeur d'Alene to Long Lake Dam. Some of the observations from the data are:

- Summer total phosphorus concentrations in the river are trending downward at the Idaho-Washington state line, Greene Street, Riverside State Park, and the riverine assessment point below Nine Mile Dam. Total phosphorus concentrations have not yet met the TMDL target at the assessment point, but the level is within 0.005 mg/L of attaining the goal.

- The two deepest and furthest downstream Lake Spokane monitoring sites continue to have the lowest dissolved oxygen levels. Years with higher flows, such as 2011, help keep dissolved oxygen levels in the bottom layer higher. Mean summer total phosphorus concentrations in the upper layer of the lake decline in a downstream direction, so concentrations are higher at Nine Mile and are lower by Long Lake Dam.

- Total phosphorus levels at the mouth of Hangman Creek have met the TMDL target three of the last five years during March through June. During July through October, only one out of five years met the TMDL allocation.

- The mouth of the Little Spokane River achieved the TMDL goal two years between 2010 and 2014 during the March through June time period. In July through October the Little Spokane River TMDL target was met four of the last five years.

- Groundwater quality appears to be experiencing a downward trend in total phosphorus, but the levels are higher than the allocation.

All of the activities to address point and nonpoint sources appear to have the desired effect of lowering nutrient levels in the river, lake, and groundwater. The steps outlined in existing compliance schedules and plans seem on target to achieve the TMDL targets. The focus for the years to come is to continue working on activities described in the plans or permits. At this time, Ecology does not detect any necessary alterations in implementation activities.

Recommendations for the next several years focus on monitoring efforts and include:

- Holding monitoring coordination meetings to identify data gaps, other things to monitor, if resources need refocused, etc.

- Sampling for phosphorus and other nutrients during springtime high flows. Understanding where high nutrient concentrations come from in the spring can pinpoint where implementation efforts should occur.

One pound of phosphorus can grow 700 pounds of algae.
- Knud-Hansen, 1994

- Monitoring groundwater along densely populated Lake Spokane shorelines, such as the Nine Mile community.

In the coming years, Ecology will continue to track implementation activities. Implementation partners will be able to generate an estimate of phosphorus reductions from installing nonpoint source best management practices by using a simple model. Dischargers will be developing engineering reports, and plans and specifications for new tertiary treatment. Timelines for installing treatment technology varies slightly among the dischargers, but the target to meet the final water quality-based effluent limits in 2021. A two-year data collection effort is anticipated to begin in 2021 as part of a ten-year assessment. Ecology anticipates discussing what the ten-year assessment will entail during future advisory group or recommended monitoring meetings.

Introduction

The 6,640 square-mile Spokane River watershed begins at the outlet of Lake Coeur d'Alene in Idaho and flows west through the city of Spokane, Washington (Figure 1). The river continues northwest through Lake Spokane, then west-northwest toward its confluence with the Columbia River. Downstream of Lake Spokane, the northern portion of the river flows through the reservation of the Spokane Tribe of Indians.

Lake Spokane, created by Avista Corporation's (Avista) Long Lake Dam, does not meet Washington State water quality standards for dissolved oxygen. In 2010, the Environmental Protection Agency approved the Washington State Department of Ecology's (Ecology) plan to improve the lake's water quality: The Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (TMDL) (Moore and Ross, 2010). To achieve compliance with the dissolved oxygen standard, the TMDL requires significant reductions in phosphorus concentrations.

One of Ecology's commitments in the TMDL is to write a report every two years (the biennial report) to document progress toward meeting the TMDL allocations. This document serves as the first two biennial reports, so it contains information about activities to reduce nutrients from 2010 through 2014. Information prior to 2010 is included to provide historical context. You may consider this document as a report card on the commitments described in the TMDL, the activities taking place to reduce phosphorus, and the progress made toward achieving water quality standards.

Background

Algae blooms and low dissolved oxygen levels in the lower depths of Lake Spokane (Long Lake) have existed for decades. Patmont et al. (1987) described water quality problems that occurred in the lake during the 1930s, 1960s, and beyond. During the 1970s, Eastern Washington University and others completed multiple studies on the lake. These studies indicated that removing phosphorus, particularly from the City of Spokane's wastewater treatment plant, would help improve the lake's water quality (Patmont et al., 1987). In December 1977, the City of Spokane completed an upgrade to their wastewater treatment plant to remove 85 percent of the phosphorus coming into the plant (Patmont et al., 1987). As a result, the lake's minimum dissolved oxygen concentrations in the summer of 1978 showed significant improvement (Cusimano, 2004).

Despite the improvement, algae blooms continued to occur and more point source dischargers began operating. This prompted a group of Lake Spokane homeowners to file a lawsuit. The lawsuit launched decades of study, modeling, phosphorus management planning (1989 Spokane River Phosphorus Management Plan, 1992 Total Phosphorus TMDL, 2010 Spokane River and Lake Spokane Dissolved Oxygen TMDL), and improvement actions.

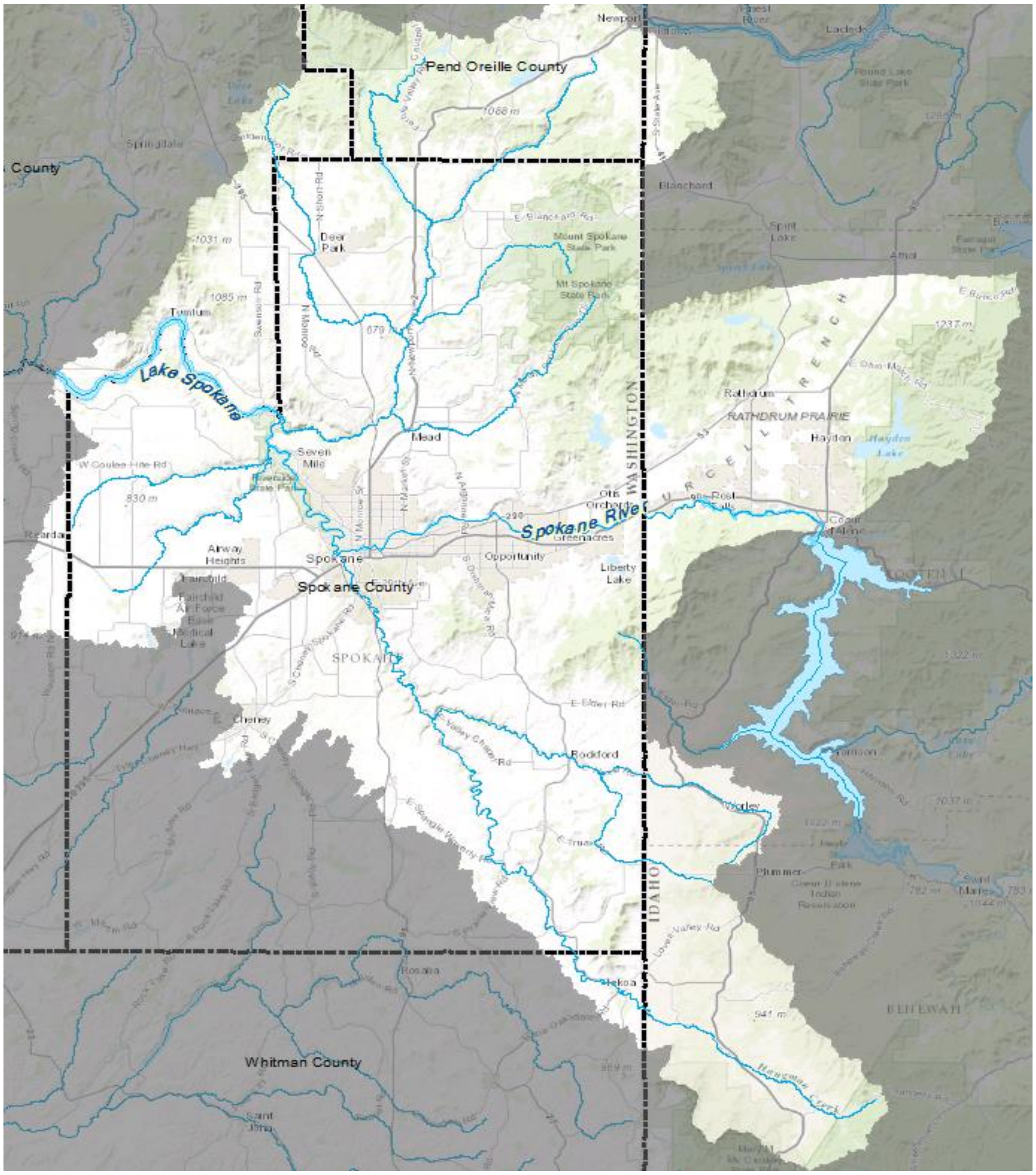


Figure 1: The Spokane River watershed covered by the dissolved oxygen TMDL

Figure 2 shows an improving trend in minimum volume-weighted dissolved oxygen levels in the hypolimnion, or the deepest parts of the lake from 1972 through 2011. Several actions described in the following pages likely contributed to the recent improvement shown in the graph, such as banning phosphorus in detergents and fertilizer, applying chemical-enhanced primary treatment, optimizing manufacturing processes, and operation of a new wastewater treatment plant. The graph shows we are on the correct path toward improving dissolved oxygen in the Spokane River and Lake Spokane, but we need to ensure activities continue in order to achieve water quality standards.

Within the next five years, entities discharging to the river in Washington will complete the installation of additional equipment to significantly lower nutrients in their discharges. Ecology also expects practices that reduce nutrients from nonpoint sources will be more widespread by

2020. In addition, dischargers in Idaho are expected to complete upgrades to lower nutrients from their facilities in the next seven years. We anticipate these steps will achieve the allocations in the TMDL and improve Lake Spokane's dissolved oxygen levels.

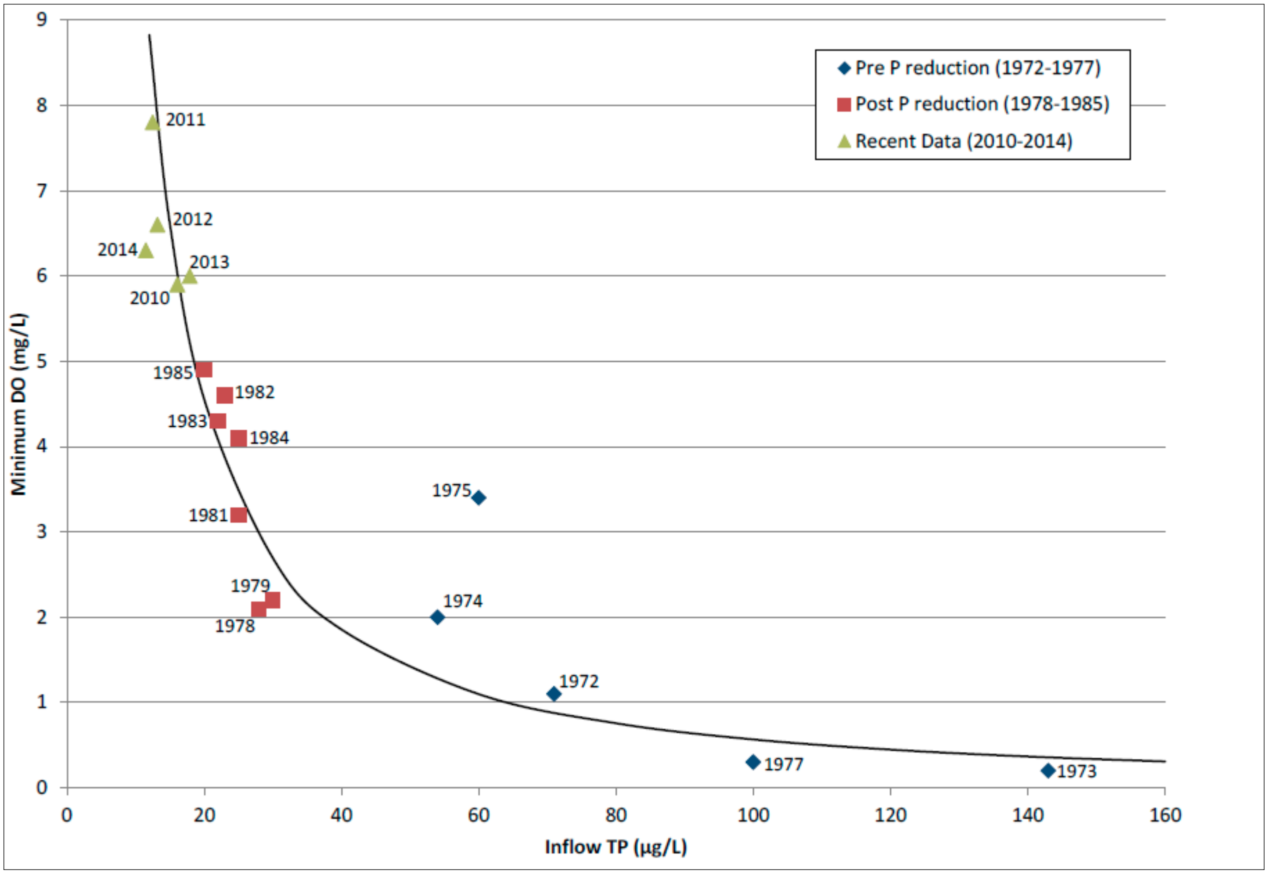


Figure 2: June-Oct volume weighted mean inflow TP concentration related to minimum volume weighted hypolimnetic DO concentrations (Avista, 2015)

Goals from the TMDL

The goal of the TMDL is to achieve the dissolved oxygen water quality standard in Lake Spokane. Achieving the allocations established in the TMDL for point sources and non-point sources, Avista's responsibility, and the assumptions for Idaho should result in the lake attaining the water quality standard.

For the Washington State point sources (municipal wastewater treatment plants and industrial dischargers), the seasonal (March through October) wasteload allocations are based on meeting a maximum monthly average total phosphorus concentration of 50 µg/L (micrograms per liter or parts per billion) within ten years (Moore and Ross, 2010). Ecology used discharge volume estimates to convert the nutrient concentrations into pounds per day (Table 1). Spokane County's new water reclamation plant is not included in Table 1 because they were required to meet a total phosphorus concentration of 42 µg/L at the time the facility began operating.

Idaho point sources to the Spokane River are included in the TMDL because federal law requires upstream states to comply with water quality standards of downstream states. Modeling for the TMDL showed that nutrients from the three Idaho dischargers affect dissolved oxygen levels in Lake Spokane. Ecology does not have authority to require reductions in Idaho, but we worked with the Environmental Protection Agency (EPA) who is responsible for issuing permits in Idaho. The permits would contain conditions that ensure compliance with Washington water quality standards. So, the TMDL assumed that Idaho wastewater treatment plants and stormwater combined would achieve the following nutrient reductions:

- 7.2 lbs/day phosphorus
- 497 lbs/day CBOD
- 94.4 lbs/day ammonia

Table 1. Wasteload allocations for Washington State point sources (Moore and Ross, 2010)

Point Source Discharge	2027 Projected Flow Rates (MGD) [1]	NH3-N		TP		$CBOD_5$ [2]	
		mg/L	lbs/day (WLA)	mg/L	lbs/day (WLA)	mg/L	lbs/day (WLA)
Liberty Lake	1.5	variable[3]	variable[3]	0.036	0.45	3.6	45.1
Kaiser[4]	15.4	0.07	9.0	0.025	3.21	3.6	462.7
Inland Empire Paper Company	4.1	0.71	24.29	0.036	1.23	3.6	123.2
City of Spokane	50.8	variable[3]	variable[3]	0.042	17.81	4.2	1780.6
Spokane County (new plant)	8	variable[3]	variable[3]	0.042	2.80	4.2	280.4
Stormwater[5]	2.36	0.05	0.98	0.310	6.1	3.0	59.1
CSO	0.12	1.0	1.0	0.95	0.95	30.0	30.0

Notes:

1- Actual, not projected flows, will determine compliance with wasteload allocations in NPDES permits.
2- NPDES permit limits will use $CBOD_5$ (as shown) rather than $CBOD_{ult}$ (as modeled).
3- Ammonia wasteload allocations vary depending on the season based on the following effluent concentrations (loading limits use these concentrations and the design flow):

Liberty Lake:
March-May, October: 0.71 mg/L
June-September: 0.18 mg/L

City of Spokane and Spokane County:
March-May, October: 0.83 mg/L
June-September: 0.21 mg/L

4- Wasteload allocations for Kaiser are lower than other dischargers due to non-contact groundwater, which is low in nutrients and comprises a significant portion of the facility's discharge.
5- Stormwater wasteload allocation is for Washington sources only and is based on average existing flows, not 2027 projected flows.

The TMDL assigned load allocations to nonpoint sources of pollution. The three tributaries (Hangman Creek, Coulee Creek, and the Little Spokane River) and the area surrounding Lake Spokane are the primary sources of nonpoint pollution to the river and lake. For nonpoint sources, the allocations were calculated using a critical, low-flow condition (Table 2). As with the point sources, the nonpoint allocations apply from March through October. In Hangman and Coulee creeks, the allocations vary by season and translate to the following reductions:

- 20 %: March – May
- 40 %: June
- 50 %: July – October

In the Little Spokane River, the allocation represents a 36 percent decrease in nutrients during the entire March through October critical season.

Table 2. Tributary and groundwater TMDL load allocations (Moore and Ross 2010)

Water Body and Season	2001 Flow (cfs)	Total Phosphorus		Ammonia (NH3-N)		CBOD	
		Allocation Concentration (mg/L) [1]	2001 Load Allocation (lbs/day)	Allocation Concentration (mg/L)	2001 Load Allocation (lbs/day)	Allocation Concentration (mg/L)	2001 Load Allocation (lbs/day)
Hangman Creek							
March– May Average	229	0.113	140.2	0.034	42.1	3.3	4102.1
June	31	0.044	7.5	0.012	2.1	2.8	479.0
July – October Average	9	0.030	1.4	0.009	0.4	2.3	107.9
Coulee Creek							
March– May Average	30	0.113	18.2	0.034	5.5	3.3	533.7
June	8	0.044	1.8	0.012	0.5	2.8	116.5
July – October Average	2	0.030	0.4	0.009	0.1	2.3	28.6
Little Spokane River							
March – May Average	565	0.034	102.5	0.035	106.2	2.1	6409.3
June	426	0.023	53.9	0.005	11.5	2.1	4828.2
July – October Average	364	0.016	32.2	0.006	11.0	1.5	2867.8
Groundwater – Upstream of Lake Spokane							
March – May Average	1946	0.0081	87	N/A	N/A	N/A	N/A
June	1583	0.0078	66	N/A	N/A	N/A	N/A
July – October Average	1165	0.0076	48	N/A	N/A	N/A	N/A
Groundwater / Surface Water Runoff – Lake Spokane Watershed							
March – May Average	588[2]	0.025	79	N/A	N/A	N/A	N/A
June	225[2]	0.025	30	N/A	N/A	N/A	N/A
July – October Average	180[2]	0.025	24	N/A	N/A	N/A	N/A

Notes:

1- Allocation concentrations are based on critical low flow conditions.
2- Reservoir correction flows in the water quality model. Flows are both positive and negative. The listed value is the average of positive inflows to the reservoir.

In the TMDL, Avista received a “responsibility” because they are not responsible for discharging nutrients, but their Long Lake Dam created the lake and conditions that contribute to the reservoir’s impairment. Avista’s task is to increase dissolved oxygen in the deeper parts of Lake Spokane from July 1 through October. The level of dissolved oxygen improvement required depends on the location and depth of the lake, as well as time of the year, but the required increase ranges from 0.1 to 1.0 mg/L.

In addition to allocations, the TMDL laid out a schedule containing milestones to indicate progress toward achieving the allocations. The schedule divided the milestones based on the number of years following approval of the TMDL.

Within first five years of implementation (2015):

- NPDES permittees will:
    - Achieve interim performance based limits in NPDES permits.
    - Complete a best management plan.
    - Start, continue, or complete target pursuit actions.
- Avista will develop a Dissolved Oxygen Water Quality Attainment Plan within two years following EPA approval of the TMDL, or 2012.
- Non-discharger groups will work to reduce nutrients from nonpoint sources.
- Ecology and others will monitor and assess nutrient levels.
- Ecology will develop dissolved oxygen/phosphorus TMDLs for the Little Spokane River and Hangman Creek.

Ten years after approval of the TMDL (2020):

- NPDES permittees in Washington will operate newly installed technology to meet their allocations. If necessary, they may be starting, continuing, or completing target pursuit actions.
- Avista will assess performance of the activities identified in their water quality attainment plan to improve dissolved oxygen.
- The riverine assessment point downstream of Nine Mile Dam, that also considers input from the Little Spokane River, will achieve a total phosphorus concentration of 10 μg/L.

Fifteen years after approval of the TMDL (2025):

- Between 11 and 26 percent of total suspended solids in Hangman Creek and the Little Spokane River tributaries will be reduced. To meet this goal, landowners in these tributary watersheds will need to apply 75 to 100 percent of the necessary best management practices.

A discussion of how we have performed in relation to these goals and timeline is presented in the Progress Report section on page 73.

Tributary TMDLs

The Spokane River and Lake Spokane TMDL established load allocations at the mouths of the three tributaries: Hangman Creek, Coulee Creek, and the Little Spokane River. As a result, Ecology must develop water quality improvement plans (also called Total Maximum Daily Loads or TMDLs) in order to divide the nutrient allocations from the dissolved oxygen TMDL at the tributary mouths among the various nutrient sources located upstream. For Coulee Creek, more study is needed to understand the nutrient contributions since little water quality data are available, but Ecology has initiated TMDLs on Hangman Creek and the Little Spokane River. Although there are some small point source discharges on these tributaries (mostly on Hangman Creek), the TMDL acknowledges the nutrients come mainly from nonpoint sources of pollution.

Below is a description of where Ecology is in the process to develop nutrient TMDLs on Hangman Creek and the Little Spokane River. In addition, general information is provided on what is being done to implement TMDLs for other water quality parameters. Additional information on implementation activities is discussed in the nonpoint source section of this document.

Hangman Creek / Latah Creek

The Environmental Protection Agency (EPA) approved the Hangman Creek TMDL for fecal coliform bacteria, temperature, and turbidity impairments in September 2009. An implementation plan followed in May 2011. Several implementation projects by the Spokane Conservation District, The Lands Council, the City of Spokane, the Coeur d'Alene Tribe, and the Washington Department of Transportation to reduce pollution from nonpoint sources have been completed or are underway. Many of these projects will also reduce nutrients that contribute to dissolved oxygen and pH impairments.

The dissolved oxygen and pH TMDL is currently on hold while Ecology works on water quality standards policy issues related to stagnant and intermittent flow conditions, which are in part a natural phenomenon in the watershed. The goal of the policy work is to better align the water quality standards with the natural conditions that would be present prior to human influence in the watershed. Once this work is completed the TMDL efforts for dissolved oxygen and pH will resume. For additional information on the TMDL see:
http://www.ecy.wa.gov/programs/wq/tmdl/HangmanCr/index.html

Little Spokane River

EPA approved a TMDL for fecal coliform bacteria, temperature, and turbidity impairments on the Little Spokane River and its tributaries in April 2012. Implementation partners, such as the Spokane and Pend Oreille County conservation districts, continue to implement best management practices for agriculture and septic systems in the watershed. The Lands Council is also working on riparian restoration projects. These implementation activities also address dissolved oxygen and pH impairments in the watershed. An implementation plan for bacteria, temperature, and turbidity will be developed in conjunction with the implementation plan for the future dissolved oxygen and pH TMDL.

The dissolved oxygen and pH TMDL is in development. A QUAL2K model, which Ecology will use to evaluate various scenarios, has been developed and calibrated. Current efforts are focusing on researching and determining the natural background levels of nutrients from nonpoint and groundwater sources for inputs to the model. Additionally, Ecology is exploring the development of a landscape model to distribute the phosphorus allocation assigned at the mouth throughout the sources in the watershed. While the complexity of systems in this watershed has slowed down the progress of the TMDL development, Ecology anticipates a draft TMDL in 2017. To keep apprised of the TMDL or read more information, visit: http://www.ecy.wa.gov/programs/wq/tmdl/littlespokane/index.html

Regional Activities

Banning the use of detergents and fertilizers with phosphorus began as a local effort to improve the water quality of Liberty Lake, but since that time, diverse groups united together to expand the bans beyond Liberty Lake and the Spokane watershed.

Laundry and Dishwasher Detergent Phosphorus Bans

Liberty Lake Sewer and Water District (LLSWD) led the way regionally and nationally with banning phosphorus in laundry detergents in 1989. Spokane County and the City of Spokane joined LLSWD and others to support a statewide ban that passed the Washington State legislature in1995, which was one year later than a nationwide ban adopted in 1994.

LLSWD became the first utility to ban phosphorus dishwasher detergents in 2005. A number of point source dischargers were instrumental in convincing the Washington State Legislature to adopt a phosphorus detergent ban in Spokane County three years later in July 2008. In July 2010, 16 years after the statewide ban on phosphorus laundry detergents, the Washington State Legislature extended the ban statewide on automatic dishwasher detergents containing phosphorus.

The detergent bans are important to municipal wastewater treatment plants because they reduce the amount of phosphorus entering their facilities, so there is less phosphorus to remove. The Liberty Lake Sewer and Water District detected a 16.84 percent decrease in the amount of phosphorus coming into their plant after the statewide ban (Adams, 2014). The ban appears to have also reduced the amount of phosphorus that enters the Spokane County Regional Water Reclamation Facility (SCRWRF) by about 20 percent below its influent design concentration of 7.2 milligrams per liter (mg/L). For homeowners on septic systems, these detergent bans helps to reduce the amount of phosphorus that may leach from drain fields and enter ground water.

Phosphorus Fertilizer Ban

In 2005, the LLSWD took steps to ban the use of fertilizer containing phosphorus within their boundaries. About three years later several community governments and groups from the Spokane area began working to establish a statewide ban on lawn fertilizers containing phosphorus: the Washington Lakes Protection Association (WALPA), Environmental Priorities Coalition, Scotts Miracle-Gro, Fred Meyer, LLSWD, Lake Whatcom, Avista, Inland Empire Paper, The Lands Council, Spokane Riverkeeper, and the City of Spokane. In the fall of 2010, The Lands Council proposed a phosphorus fertilizer ban as an environmental community priority for the 2011 Washington State legislative session (WALPA 2015).

In 2011 with the support of local stakeholders, the Washington State Legislature passed Engrossed Substitute House Bill (ESHB) 1489, which prohibits the application of fertilizers containing phosphorus to “land, including residential property, commercial property, and publicly owned land, which is planted in closely mowed, managed grass.” (ESHB 1489, 2015). That year, Governor Gregoire signed the bill into law but it did not become effective until January 1, 2013. The law only allows the application of fertilizers containing phosphorus under the following conditions:

- Establishing new grass.
- Repairing damaged grass during the growing season.
- Growing grass as part of a sod farm.
- Applying the fertilizer on pasture.
- Soil test results show a phosphorus deficiency.

The ban on phosphorus fertilizers decreases the amount of phosphorus that can leach into groundwater, or wash into rivers, lakes, or storm drains during rainstorms. This ban is particularly effective for homeowners with lawns along creeks, rivers, and lakes.

Nonpoint Source Activities

Nonpoint sources of phosphorus are generally those that flow over or through the ground before entering surface water. Because the pollutants do not enter water through pipes, the sources of the pollutants are difficult to locate. Chances are most people contribute to nonpoint source pollution while maintaining yards, washing cars, keeping pets or livestock, growing gardens or agricultural crops, or recreating near the water.

We can reduce the amount of nutrients we contribute by keeping lawn clippings, manure, and livestock out of surface water; and allowing water from property to soak into the ground rather than flowing onto streets or over the ground into ditches. To reduce nutrients from nonpoint sources, people need to apply best management practices (BMPs) such as composting lawn clippings instead of dumping them in the water; decreasing the amount of fertilizer on lawns, gardens, or crops; washing cars over lawns; keeping pet and livestock waste out of water; maintaining trees and shrubs along streams; etc.

To gather information on nonpoint sources of phosphorus in the Spokane watershed in both Idaho and Washington, Spokane County commissioned a study that began in 2009. The study led to the completion of the Spokane River Watershed Nonpoint Source Phosphorus Reduction Plan (NPS Plan) (GeoEngineers et. al) in December 2011. The plan characterizes the watersheds in both states, quantified nonpoint source loading by land use, prioritized BMPs people can adopt, and identified BMPs for each watershed. The NPS Plan helps guide where to target implementation activities.

More than ten groups are working to reduce nonpoint pollution in the Spokane basin. Among the groups are conservation districts; environmental non-profits; tribes; local, state and federal agencies; and private corporations. Some of the point source dischargers have taken steps to reduce their nonpoint source contributions along with reducing nutrients in their discharges. Working to reduce nonpoint pollution sources is challenging because the tools to compel people to change their practices are different from permitted activities. Typically the availability of incentives and cost-share programs help landowners decide to make needed improvements.

Since 2000, landowners and the groups described in the pages below have completed almost 200 projects to decrease the amount of phosphorus in the basin's waters. Over half of the projects are located in the Hangman Creek watershed, 57 projects are within the Little Spokane River watershed, and 26 projects are located in the Spokane River and Lake Spokane watersheds. The projects have addressed phosphorus in several different ways:

- 81 projects planted riparian areas (stream banks) with native trees and shrubs which helps reduce stream bank erosion. Approximately 19 miles of stream were planted.

- 50 projects applied BMPs to agricultural land. The majority of the BMPs were to convert from conventional tillage to direct seed. About 13.6 square miles are no longer conventionally tilled, saving an estimated 52,000 tons of soil.

- 29 projects installed fencing to keep livestock away from over a mile of surface water. Fencing livestock away from streams keeps manure, urine, and sediment out of the water.

- 15 projects reduced stormwater by directing runoff to areas where it can soak into the ground.

- 9 projects were installed to stabilize eroding shorelines.

An estimate of the amount of phosphorus removed by these projects is difficult to determine due to complex environmental interactions. To give you an idea of the complexity, the amount of phosphorus and other nutrients in a stream depends on how it entered surface water (from runoff, infiltration, or leaching); the season; whether the nutrient is dissolved or in particulate form; the amount and timing of rainfall; vegetated cover; amount of aquatic biota; and soils (Carpenter et al. 1998). In addition, despite groups' best efforts, some projects do not achieve the desired results. For example, high flows can wipe out planted areas that did not have time to become established, and plants can die.

As indicated above, activities to control nonpoint source pollution occur all over the landscape, from forests to farms and our own backyard. In addition to applying best management practices, groups are working to inform people on how to reduce their nutrient contribution, and others brought the issue to local and state governments to bring about change. The following pages first describe basin-wide nonpoint source reduction activities and then watershed-specific activities.

Basin-wide Activities

Spokane County
Since 1983, Spokane County has prioritized hooking up septic systems located over the aquifer to the sewer system. Between 1984 and 2001, the County connected 20,100 homes and businesses to the sewer (Moss 2015). In 2001, under an updated Comprehensive Wastewater Management Plan (CWMP), the County created the Septic Tank Elimination Program (STEP) with the goal to hook up all developed parcels in the STEP areas to the sewer by 2012. All the septic systems should be connected by the end of 2015. According to Moss (2015), since 2001 an estimated 18,500 homes and businesses in Spokane Valley and North Spokane were connected to the sewer. The County has up to 2,000 more connections complete, which will bring the total number of new sanitary sewer connections to 40,000 since 1984 (Moss, 2015). Spokane County's 2014 CWMP now focuses on extending sewer service to unsewered areas within the County's Urban Growth Area.

Requirements in the Shoreline Master Programs (SMP) are anticipated to help control nutrients from nonpoint sources of phosphorus. In SMPs, counties must plan for development while providing protections for shorelines so they are able to resist erosive forces of water as well as retain vegetation to filter and take up nutrients. Spokane County's comprehensive update to their SMP became effective in January 2013. An amendment to the SMP in 2014 included regulations for on-site septic systems within the 200-foot shoreline area.

City of Spokane
The City of Spokane has also participated in the STEP program, eliminating several thousand septic tanks. The City's objective was to intercept and connect all remaining on-site wastewater systems in the City's sanitary sewer service area and over the aquifer sensitive area. It was estimate that approximately 800,000 gallons of effluent a day would be intercepted and prevented from draining over the aquifer.

The City is planning to restore a section of Garden Springs Creek in Finch Arboretum. To improve fish passage and restore a natural flow regime, the plan is to remove a small dam and reconstruct a small section of the channel. Plans also call for planting shrubs and trees to create native riparian buffer. The City hopes to begin work on the creek in 2015.

The City installed five pet waste station with baggies at High Bridge Dog Park. City crews empty the dumpster weekly.

Forest Roads
Washington's forest practice rules (WAC 222) require large forest landowners to bring all of their roads into compliance with current state forest practice standards by October 31, 2016. They were required to submit Road Maintenance and Abandonment Plans (RMAPs) for accomplishing this by July 2006. RMAP work is designed to tackle the worst problems first (those most likely to cause harm to streams, fish habitat, or public safety) and is metered out in a generally "even flow" fashion during the ten year implementation period.

Each RMAP covers:

- Removing and/or replacing stream crossings that block fish passage.
- Preventing or limiting sediment delivery from the road network to streams.
- Repairing, maintaining or closing roads that run adjacent to streams.
- Minimizing interception of groundwater or surface water by roads.
- Correcting drainage or other possible problems in unstable or potentially unstable areas that could damage public resources or threaten public safety.

Landowners file annual RMAP progress reports with the Department of Natural Resources.

Small forest landowners (those who harvest on average less than two million board feet of timber per year) are required to bring their forest roads up to forest practice standards at the time they harvest their lands.

Inland Empire Paper Company
Inland Empire Paper Company (IEP) owns and manages approximately 100,000 acres of forestland in the Spokane River watershed, in both Washington and Idaho. IEP's forestry practices have always exceeded each state's Best Management Practices (BMP's), particularly with respect to water quality issues, forest road construction and maintenance, and reforestation. These modern forestry practices reduce or eliminate sediments, and the associated nutrients, delivered into water bodies. Some examples of these activities, practices, or projects include:

- By the end of 2015, IEP will complete its Road Maintenance and Abandonment Plan (RMAP) projects. Since 2001, IEP has spent well over $500,000 in reducing sediment delivery from forest roads, and improving fish passage on stream crossings. These projects included replacement of undersized culverts with bridges, streambank stabilization, abandonment of stream-adjacent parallel roads, gravelling roads, and outslope road-grading.

- IEP has been instrumental in cooperating and coordinating with neighboring landowners to remove cattle from the riparian areas of Fish Creek. (Fish Creek is in the Idaho portion of the Spokane River watershed. Fish Creek begins on the east side of Mt. Spokane and flows into Twin Lakes, north of Rathdrum, Idaho.) Sediment delivery from this non-IEP cattle operation was greatly reduced by fencing cattle away from streamside areas, stabilizing streambanks with rock and log structures, and planting vegetation on unstable slopes.

- Since 2001, IEP has managed forest recreation on its timberlands. Unmanaged recreation tends to damage roads during wet weather, contributing to road instability and sedimentation. IEP manages recreation with a comprehensive permit system that utilizes gate closures and forest patrols to control access. It has the added benefit of providing a platform for educating the public about water quality issues.

Since 1952, IEP has been a leader in reforestation techniques. Exposed soil on recently harvested areas or burned areas could potentially deliver sediment to adjacent streams. However, by leaving forested buffers along streams, planting or re-seeding promptly after harvest, and leaving soil layers undisturbed, sediment from the uplands has been eliminated.

Spokane Conservation District (SCD)

The SCD has several departments that work in concert to protect natural resources. The SCD's Water Resources Department completed 31 projects between 2010 and 2014 within Spokane County (Table 3) that will help reduce the amount of phosphorus entering Lake Spokane. Collectively, the projects included planting over 12,000 native trees and shrubs in about 15 miles of riparian area, fencing over a mile of stream, installing eight waste storage facilities and heavy use areas, etc. Nine of the 21 projects installed best management practices (BMPs) to prevent pollution from livestock operations. The Water Resources Department also provided technical assistance during several site visits.

The SCD's Production Agriculture Department also works to reduce phosphorus through direct seeding. Direct seeding is a farming practice where farmers plant the next crop into the existing stubble from a previous crop. This practice reduces the amount of soil that is lost from air and water erosion. This improves water quality because there is less sediment and associated nutrients entering surface water. The SCD established a direct seed equipment loan program so that farmers can apply for low interest loans to purchase farm equipment needed to transition to direct seeding. The SCD has been able to work with other conservation districts to extend the program beyond Spokane County. In 2012 and 2013, the SCD distributed about 3.9 million dollars throughout the program's entire area, with approximately 1.2 million spent in Spokane County. The SCD estimates the equipment is used on 26,000 acres within Spokane County, and primarily in the Hangman Creek watershed.

Several different types of equipment are necessary for direct seeding. For example, equipment to manage the amount of remaining residue or stubble is important so that the drills are able to penetrate through the residue into the underlying soil. Ecology categorized the list of equipment purchased throughout Eastern Washington using the conservation district's loan program (Figure 3). From this information, Ecology determined that farmers used the 3.9 million dollars loaned out to purchase 54 pieces of farm equipment for direct seeding. The high cost of this farm equipment makes loan programs such as the SCD's necessary to expand the amount of farmland under direct seed. Increasing direct seed acreage results in water quality improvement.

The SCD provides environmental education as an important element of our communication strategy for non-point source pollution, whether it is for children or adults. The SCD has partnered with the Franklin Conservation District to bring the following programs to Spokane-area schools:

- Wheat Week
- Water on Wheels
- Trout in the Classroom
- West Valley Outdoor Learning Center's 4th Grade Field Day
- Floods, Flowers, and Feathers
- WaterFest
- Kids in the Hills
- Earthday Events

Each program offers hands-on, interactive demonstrations and activities, while teaching the children about the importance of our natural resources, particularly soil and water. Each lesson is offered free of charge to K-12 schools in our area. These fun lessons are available to other groups, such as home-school groups and civil organizations like the Boy & Girl Scouts of America.

The SCD brings its message outside of the classroom and provides citizens with current and pertinent information in a variety of ways, including: our biannual newsletter and other publications; Web site; and our participation in the following public events:

- Spokane County Interstate Fair
- Ag Expo
- Southeast County Fair
- Water Festival
- Farm Forum
- The Secrets of Soil
- Spokane Youth Environmental Conference.

Table 4 shows the number of students and adults SCD's educational activities have reached during the past few years.

Table 3. Spokane Conservation District 2010-2014 BMP projects

Project Name	Type	Watershed	Waterbody	Date	Budget	# of plants	Description
Riparian Fencing Project	Riparian fencing		Spokane River/Mt. Spokane	2012	$8,000		800' riparian fencing in foothills of Mt. Spokane
Livestock BMP Project	Livestock BMPS		Spokane River/Mt. Spokane	2012			Implement roof/runoff system & heavy use area/drainage
Livestock BMP Project	Livestock BMPS		Spokane River/Mt. Spokane	2012			Install roof/runoff system, heavy use area, & waste storage facility
Livestock BMP Project	Livestock BMPS		Spokane River/Hangman	2012	$6,000		Installed heavy use area
Willow Warrior Project	Riparian planting	Hangman	Hangman Creek	2008 - 2014	$1000/yr	5000-6000/yr	Riparian planting of willow whips each year
Hangman Watershed Producers AWEP	Ag BMPs	Hangman	Entire Watershed	2010 - 2012	$1,200,000		Specialized EQIP program for watershed ag producers; many BMPs
Rock Creek Streambank Stabilization	Streambank stabilization	Hangman	Rock Creek	2010			Installed soil lifts along 450' of stream
Hangman Creek Streambank Stabilization	Streambank stabilization	Hangman	Hangman	2011	$60,000		Sloped streambanks along 1600' of the creek
Livestock BMP Project	Livestock BMPs	Hangman	Trib to Rock Creek	2012			Installed off-channel watering facility

Project Name	Type	Watershed	Waterbody	Date	Budget	# of plants	Description
Livestock BMP Project	Livestock improvement	Hangman	California Creek	2012	$8,000		Installed a high use area, roof runoff structure, & waste storage facility
Sediment Basins	Ag BMP	Hangman	Upland	2012	$4,000		Installed 2 sediment basins
Livestock BMP Project	Livestock improvement	Hangman	Hangman Creek	2012	$16,459		Implemented a high use area, roof runoff structure, & 3 waste storage facilities
Livestock BMP Project	Livestock BMPs	Hangman	Hangman	2014	$20,000		Installed waste storage facility
Livestock BMP Project	Livestock BMPs	Little Spokane	Wethey Creek	2010	$50,000		Riparian fencing and off-channel watering on 300’ of creek
Livestock BMP Project	Livestock BMPS	Little Spokane	Little Spokane River	2012			Implement a waste storage facility & heavy use area
Livestock BMP Project	Livestock BMPS	Little Spokane	Bear Cr.	2012			Install sub-surface drainage, heavy use area, waste storage facility, & riparian fencing (800')
Eloika Lake Weed Management Project	Aquatic weed mgt	Little Spokane	Eloika Lake	2012			Weed maintenance on 60 acres of Eurasian milfoil

Project Name	Type	Watershed	Waterbody	Date	Budget	# of plants	Description
Livestock Improvement Project	Livestock BMPS	Little Spokane	Little Spokane River	2012			Install sub-surface drainage, heavy use area, waste storage facility, & riparian fencing (400')
Eloika Lake Weed Management Project	Aquatic weed mgt	Little Spokane	Eloika Lake	2013	$35,000		Weed maintenance of Eurasian milfoil
Fish Barrier Removal Project	Fish barrier	Little Spokane	Otter Creek	2013	$80,000	600	Remove culverts & replace with free standing bridge, & replant riparian area
Fish Barrier Removal Project	Fish barrier	Little Spokane	Deadman Creek	2013	$80,000	700	Remove culverts & replace with free standing bridge, & replant riparian area
Lake Spokane Shoreline Project	Shoreline naturalization	Lower Spokane	Lake Spokane	2012	$20,000	250	Remove bulkhead, stabilize & naturalize the shoreline (approx 200')
Fish Barrier Removal Project	Fish barrier	Lower Spokane	Coulee Creek	2012	$80,000	300	FFFPP - remove old culverts & replace with free-standing bridge, & replant riparian area

Project Name	Type	Watershed	Waterbody	Date	Budget	# of plants	Description
Livestock BMP Project	Livestock BMPS	Lower Spokane	Deep Creek tributary	2013	$60,000	400	Installed heavy use area, sub-surface drainage, waste storage facility, 1/2 mi. of riparian fencing, off creek watering facility, & pasture management
Riparian planting	Riparian planting	Lower Spokane	Lake Spokane	2013	$200	120	Shoreline planting - next to bulkhead removal project
Barker Road Riparian Project	Riparian planting	Middle Spokane	Spokane River	2012	$400	12	Planted 12 ball & burlap pines for remediation of bridge work
Livestock BMP Project	Livestock BMPs	Spokane	Trib to Phileo Lake	2013	$5,000		Installed 500' of riparian fence
Riparian protection	Riparian	Spokane	Spokane River	2014	$40,000		Installed riparian fencing and cleaned up access

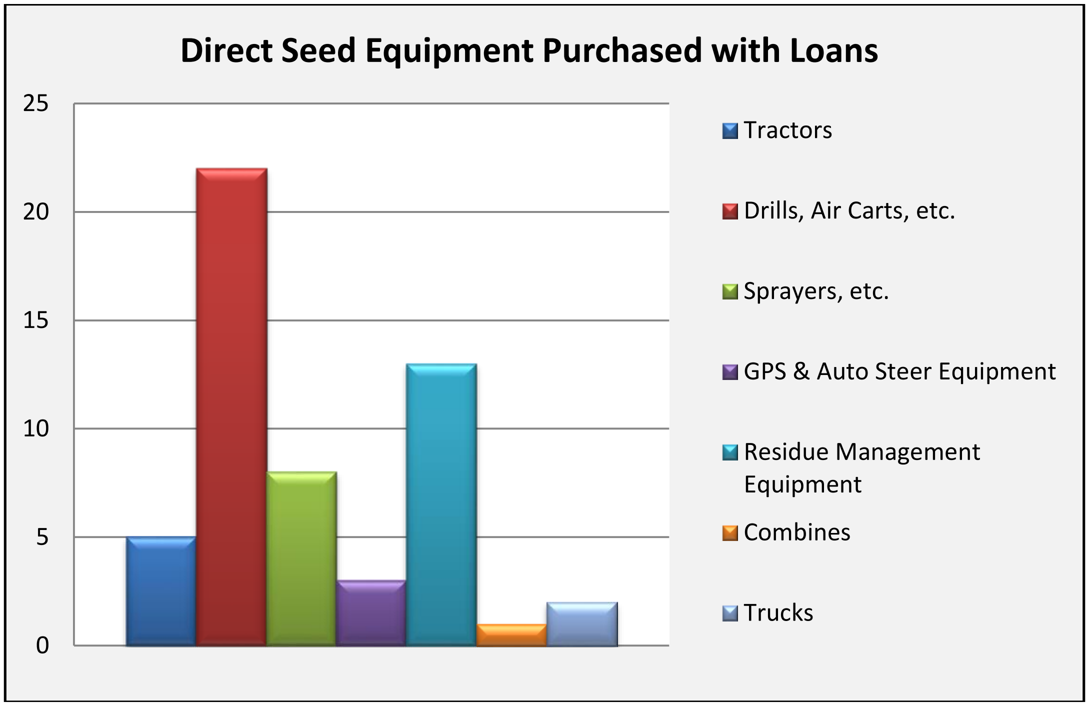


Figure 3. Direct seed equipment purchased throughout Eastern Washington using Spokane CD loans

Table 4. Spokane Conservation District's educational contacts between 2012 & 2015

	Number of Students and Adults Contacted		
Year	**2012-2013**	**2013-2014**	**2014-2015**
Classroom Lessons	5335	4055	3700
Special Events	1684	1066	1280

Spokane River Forum

The Spokane River Forum (SRF) keeps the public connected with the activities underway to meet the TMDL targets, as well as all the other issues affecting the Spokane River and Lake Spokane. The SRF continues to house all TMDL related information, as well as distribute meeting information to advisory group members and the public (see http://spokaneriver.net/category/dotmdl/). Another service the SRF provides is organizing public meetings to learn about and discuss activities to improve water quality of the Spokane River. Several times a month, the SRF distributes the Spokane River eNews to more than 2,700 people.

The SRF is an advocate for public access to the river, so they maintain and promote a Spokane River Water Trail web site and organize several kayak and canoe excursions on the river. Getting people on the Spokane River helps increase awareness about the river's water quality and the TMDL. When people are on the water, the SRF is able to educate people about best management practices they can use to reduce their phosphorus and nutrient inputs.

Along with seven other partners, the SRF helped launch an environment-friendly certification program, called EnviroStars. Local businesses that use practices to keep pollutants out of storm drains and the sewer can gain certification as an EnviroStar. People are able to tell if the products or services they purchase are environmentally friendly by EnviroStar signs displayed by the businesses.

Washington State Department of Ecology (Ecology)
Most implementation work performed by Ecology involves performing assessments; providing technical assistance to show people what compliance with water quality standards looks like; conducting education and outreach to children and adults; providing financial assistance for best management practices (BMPs) we know will improve water quality; and only when necessary, enforce water quality laws.

Ecology has continued tracking implementation activities performed by partners to implement the TMDL. The information is in a database and will be used to help identify where work has been done and needs to be done, what BMPs were installed, and help plan future effectiveness monitoring projects.

Watershed-Specific Activities

Lower Spokane (WRIA 54)

Stevens County Conservation District (Stevens CD)
In 2012, the Stevens CD initiated an active educational program involving one of Lakeside High School's science classes. The program's goal was to increase students' awareness of natural resources and explain how they can influence Lake Spokane's water quality. Stevens CD staff and invited speakers from agencies; organizations working to improve water quality; and conservation groups gave weekly presentations to the class from February through May 2012. Groups of students then designed a topic-specific presentation and activity based on what they learned, which they presented to the 6^{th} grade students.

At the beginning of the 2012-2013 school year, the Stevens CD and Northeast Tri-County Health District (NETCHD) gave presentations to high school science and seventh grade classes about watersheds and water quality. The focused high school science education program, described above, began again at the end of January 2013 and continued through May. The Stevens CD surveyed the high school students at the end of the year. The responses indicated the students learned new information that they shared with their family members. The CD also gained insight on how to improve the program in the future.

The educational program included outreach to adults as well. The Stevens CD wrote ten water quality-related articles that appeared in several local newspapers. The Stevens Public Utility District (PUD) adapted one article and mailed it to their customers who are located along much of Lake Spokane. In addition, Stevens CD staff made presentations at Lake Spokane Association meetings and hosted two meetings about septic tank maintenance and the NETCHD's repair and replacement loan program.

Outreach was not the only activity the Stevens CD worked on in 2012. The District also performed a water quality monitoring study to determine if septic systems are influencing the water quality of Lake Spokane. The Stevens CD monitored optical brighteners which are compounds added to laundry detergent. If the study shows brighteners are in Lake Spokane, then effluent from septic systems may be reaching the lake. April through October 2012 and May through June 2013, the Stevens CD sampled 20 near-shore sites (16 on the Stevens County side and 4 on the Spokane County side). The District also monitored fecal coliform bacteria, Secchi depths, water temperature, dissolved oxygen, pH, and specific conductance. The study showed that optical brighteners do not appear to be getting into the lake from septic systems. These results may be due to:

- Dilution from ground water or lake flows.
- The groundwater and surface water interface is not clearly defined.
- Several people using detergents without optical brighteners.
- The sandy soil may be better at filtering drain field effluent than thought.

Some sites found to have one or more high fecal coliform levels had waterfowl in the area prior to sampling.

The Stevens CD also works in the Chamokane Creek watershed, which enters the Spokane River just downstream of Long Lake Dam. The District completed some stream bank stabilization work along Chamokane Creek, and produced a water quality-focused newsletter that was sent to approximately 907 watershed residents.

In the coming years, the Stevens CD will be working on a composting education program and identifying solutions. The idea is to identify an easily accessible location where people can drop off livestock manure, yard debris, and other organic material. This action would move potential sources of nutrients to an appropriate location and prevent nutrient sources from stockpiling up.

The Lands Council (TLC)

The Lands Council (TLC), with help from volunteers, interns, and County Correctional work crews, has achieved significant work in the Lower Spokane River watershed. In WRIA 54, TLC has planted native riparian trees and other plants on two sites on Coulee Creek and two on Deep Creek. One of the sites on Deep Creek is also used to harvest coyote willow whips. In total, 1.2 miles of stream have been restored. In addition TLC has an ongoing partnership with the Stevens County Conservation District wherein TLC staff teaches Lakeside High School students about water quality and natural resources.

Washington State Department of Ecology (Ecology)

In the summer of 2014, the United States Geological Survey (USGS) and Ecology partnered on a study of groundwater and aquatic vegetation along Lake Spokane's shoreline below the Suncrest community. This study will determine if nutrients from on-site septic systems are leaching into ground water and impacting the lake. If they are, another study will be needed to evaluate how many nutrients enter the lake. The hope is that funding will become available for additional groundwater studies along other sections of the lake's densely populated shorelines.

Little Spokane River Watershed (WRIA 55) & Middle Spokane Watershed (WRIA 57)

The Lands Council (TLC)
The Lands Council (TLC), with help from volunteers and interns, has achieved significant work in Little Spokane River and Middle Spokane River watersheds. TLC and Gonzaga students worked together to enhance riparian areas of the Spokane River along Gonzaga University's campus in WRIA 57. In addition to riparian restoration, TLC also provides assistance to landowners in order to alleviate problems caused by beavers so that wetlands created by beavers are maintained. TLC staff and volunteers have assisted landowners in wrapping thousands of trees to deter beavers from felling in certain areas and have installed pond-leveling devices to minimize unwanted flooding at two sites in WRIA 55. The goal of maintaining beaver habitat by reducing landowner conflict is to reduce phosphorous as well. Beaver ponds have been shown to reduce annual discharge of total phosphorus by up to 21 percent (Correll, Jordan, and Weller, 2000). In 2015 TLC plans to add two more sites to its restoration work in WRIA 55 on Deadman Creek. TLC has developed an entire program to bring environmental science-based field trips and corresponding classroom lessons to many Spokane-area high schools. High schools participating in this program include Post Falls High School, The Community School, Bancroft School, On Track Academy, Mead Alternative High School, St. George's School, and Lewis & Clark High School

Hangman Creek Watershed (WRIA 56)

Coeur d'Alene Tribe (Tribe)
The Tribe worked with Avista Corporation to purchase approximately 650 acres along Hangman Creek to redirect the creek into old abandoned stream channels and create wetlands. The Tribe is also working on restoration projects along Sheep Creek, which is a tributary to Hangman Creek. For example, on one reach the Tribe installed structures that encourage beaver enhancement, but also help with flow control.

The Tribe also collaborated with the Idaho Department of Transportation on the Highway 95 widening project to revise designs for culverts, etc. so that reconnecting Hangman Creek to its floodplain would be possible at some point.

The Tribe and the Spokane Conservation District partnered to host breakfasts to educate farmers about the benefits of direct seeding. They had good attendance, so they will continue the breakfasts in the future. The Tribe has a farm primarily in the Hangman Creek watershed that is approximately 5000 acres. A goal is to convert some of the farm to direct seeding.

Inland Northwest Land Trust (INLT)
The INLT works to secure conservation easements designed to protect the land perpetually by limiting certain uses. Two easements exist in the Hangman Watershed, and two others are pending. The INLT relies on other groups in cooperation with the landowner to complete restoration or rehabilitation projects within the easements.

Within the Hangman Creek watershed, the INLT performed assessment and monitoring work, planted native riparian vegetation, conducted education outreach to landowners, and worked to secure future grants and easements.

Natural Resources Conservation Service (NRCS)
The NRCS, Spokane Conservation District, and Ecology partnered on the Agricultural Watershed Enhancement Program (AWEP). NRCS has $757,000 to spend in three years for the program. AWEP funding is only available within the Hangman Creek watershed, but in both Washington and Idaho. This funding has helped farmers convert 3000 acres of conventionally tilled land into direct seed, and over 2700 acres into mulch till. (Mulch till is using a harrow or roller in addition to direct seeding.) The funding has also been used for installing grassed waterways and fencing. AWEP is not the only program that can help pay for transitioning to direct seed. The Environmental Quality Incentives Program (EQIP) paid to convert approximately 3700 acres to direct seed.

In the Hangman Creek watershed a total of over 8,693 acres (approximately 13.6 squre miles) were converted to direct seed between 2010 and 2014. Research indicates that the erosion from these conservation practices is about 1 ton per acre annually compared to 7 tons per acre annually from conventional tillage. This equates to over 52,000 tons of soil retained in the converted direct seed fields.

NRCS also has programs for nutrient and pesticide management. The nutrient management program includes soil testing, development of a nutrient budget, and precision application. Overall, there have not been reductions in fertilizer use, but there is more strategic use of fertilizer affecting where it is applied.

The Lands Council (TLC)
The Lands Council (TLC), with help from hundreds of volunteers, interns, and County Correctional work crews, has achieved significant work in the Hangman Creek watersheds. In WRIA 56, TLC has restored riparian areas on 14 individual sites: six on California Creek, three on Rock Creek, one on Spring Creek, and four on Hangman Creek. In 2015 TLC plans to add two more sites to its restoration work in WRIA 56 on Hangman Creek. In addition to riparian restoration, TLC also provides assistance to landowners in order to alleviate problems caused by beavers so that wetlands created by beavers are maintained. On California Creek, TLC staff has assisted landowners in wrapping trees to deter beaver from felling which resulted in the creation of a series of beaver dams and wetlands. The goal of maintaining beaver habitat by reducing landowner conflict is to reduce phosphorous as well. Beaver ponds have been shown to reduce annual discharge of total phosphorus by up to 21 percent (Correll, Jordan, and Weller, 2000). TLC is committed to public education through targeted outreach activities. They have circulated 246 water quality educational brochures, completed 29 surveys on water quality knowledge, and connected with 120 landowners, including 39 who were willing to implement riparian restoration activities on their properties or farms in WRIA 56. TLC has developed an entire program to bring environmental science-based field trips and corresponding classroom lessons to many Spokane-area high schools, including Freeman High School.

Washington State Department of Ecology (Ecology)
Phosphorus tends to bond to soil, so Ecology is interested in understanding tillage practices in the Hangman watershed. Ecology staff looked at more than 400 farm fields and covered 600 road miles looking at erosion in conventionally tilled and direct seeded farmland. Research shows that direct seed can reduce soil erosion up to 95 percent, which is consistent with what Ecology staff observed. In conventionally tilled ground, they noticed water-formed channels, soil deposited at the base of slopes, and sediment entering streams. Water erosion was most evident on long and steep north-facing slopes with little crop residue cover.

During livestock operation assessments, Ecology looks for sites that have conditions revealed by scientific literature to cause water quality problems, such as stream banks that have little to no vegetation and are eroding. To conduct the assessments, staff stays on public property adjacent to streams and look for signs of pollution.

As a result of the tillage and livestock operation assessments, Ecology referred approximately nine nonpoint source agricultural operations to the Spokane or Pine Creek conservation districts for technical and financial assistance. The conservation districts then work with the landowners to help them adjust their practices to protect water quality. In turn, Ecology strives to help local conservation districts acquire funding so they can help farmers apply BMPs to improve water quality.

Washington State Department of Transportation (WSDOT)
To improve safety at the Cheney-Spokane and Highway 195 intersection, WSDOT installed a new highway interchange in the summer of 2013. At this location the highway and interchange are located with the Hangman Creek floodplain, and the steep vertical banks of Hangman Creek typically slough into the creek during high flows. To protect the interchange from Hangman Creek's erosive capabilities, WSDOT also completed 1000 feet of stream bank protection in 2013. The project included burying large rocks outside of the ordinary high water line, sloping the banks to a 3:1 slope using wrapped soil lifts, and planting a mixture of potted plants every six inches. Plant whips were installed in the fabric lifts and container plants were planted between the lifts. The banks were also seeded with native grasses. WSDOT plans to irrigate the plantings for three years to ensure the plants get established. The project required removing 17,000 cubic yards of soil, used 7500 cubic yards of rock, and cost over $600,000.

Permit Holder Activities

Stormwater

Prior to the 2010 to 2014 timeframe covered by this report, local and state governments were busy reducing the amount of stormwater entering the river. In 2008, Spokane County and the cities of Spokane and Spokane Valley published a regional stormwater manual to establish standards for stormwater design and management to project water quality, natural drainage systems and down-gradient properties as urban development occurs. Also in 2008, Spokane County built two stormwater facilities (Browne Mountain, and Price and Wall) designed to capture, filter, and infiltrate stormwater.

The state and local governments covered under stormwater permit issued by Ecology are the Washington State Department of Transportation, City of Spokane, City of Spokane Valley, and Spokane County.

Washington State Department of Transportation (WSDOT)
WSDOT has its own NPDES Municipal Stormwater Permit. The permit became effective on April 5, 2014, and will expire in 2019. As required by WSDOT's March 2012 permit, WSDOT performed discharge inventories within their right-of-way inside the NPDES Phase II coverage areas of the Spokane River dissolved oxygen and Hangman Creek multi-parameter TMDLs. The work occurred in 2012 through 2013 and included inventorying and mapping outfalls to surface waters, looking for illicit discharges to the system, and identification of potential nutrient sources.

In the Spokane River watershed, WSDOT surveyed Interstate 90 and highways 2, 195, 395, and 291 between the urban growth area boundary and the City of Spokane or City of Spokane Valley limits. Crews did not locate any possible illicit discharges but identified two sites in 2013 as potential nutrient sources. Further evaluation of the sites showed that increased nutrient loading was not an issue. WSDOT will be surveying newly reconstructed sections of highway within the Phase II area for any new discharge points.

In the Hangman Creek watershed, WSDOT inventoried highways 27, 274, 278, and 904. Crews identified several areas along the highways that could discharge to surface water. Closer examination of these discharge areas showed that ten discharges were due to agricultural operations, and approximately 61 sites would improve after WSDOT's highway maintenance. Where necessary, WSDOT is working with landowners adjacent to the discharges to eliminate pollutant sources. WSDOT also reported maintenance concerns or potential pollution sources outside their jurisdiction to either the relevant city or Ecology.

Eastern Washington Phase II Municipal Stormwater Permit
The City of Spokane, City of Spokane Valley, and Spokane County are covered under the Eastern Washington Phase II Municipal Stormwater Permit. Because Ecology reissues the

permits every five years, the following actions to address stormwater nutrient pollution listed in the dissolved oxygen TMDL applied when the permit became effective on August 1, 2014:

- Inventory stormwater outfalls.
- Develop a quality assurance project plan (QAPP) for monitoring phosphorus, ammonia, CBOD, and flow rates by August 2015.
- Monitor the stormwater for nutrients and flow rates.
- Develop and perform public education.
- Implement BMPs and monitor for effectiveness.

The municipal stormwater permit also includes:

- Beginning in August 2017, evaluate the monitoring results with respect to the stormwater TMDL Allocations.

- Developing an Action Plan as an adaptive management response if monitoring results indicate that the TMDL Allocations are exceeded.

The permit expires in 2019 at which time Ecology will reissue the permits.

City of Spokane
The City of Spokane is working to reduce its discharges to the Spokane River and Hangman Creek, and the City of Spokane Valley and Spokane County are working to eliminate their stormwater discharges. For example, Spokane County completed their Liberty Lake Outfall Elimination Project in 2014.

The City of Spokane completed an Integrated Clean Water Plan, which includes preliminary phosphorus, ammonia, and carbonaceous biochemical oxygen demand (CBOD) monitoring data in stormwater. The Plan proposes major stormwater management facilities for the Cochran Basin, which encompasses about half of the City's stormwater system (see more information below). The City has also holistically integrated its infrastructure upgrades with the stormwater system. Each time a street construction project is designed, reducing stormwater inputs to the MS4 or CSO is given priority. A few examples can be seen along Lincoln Street between 29th and 8th Avenue, High Drive, Broadway Avenue, Kendall Yards Olmstead Green, and Crestline. Several projects are planned to test the effectiveness of porous pavements on City streets and in parking lots in addition to numerous projects that will employ traditional swales and storm gardens.

City of Spokane Valley
The City of Spokane Valley finalized their 2014-2019 Stormwater Capital Improvement Plan in May 2013. The plan provides a framework for designing and constructing projects to reduce stormwater based on identified needs, problem areas, or permit requirements. To view the plan, visit: http://www.spokanevalley.org/filestorage/124/243/956/489/2014-2019_Stormwater_Capital_Improvement_Plan_(Summary_Report).pdf.

Spokane County
In 2014 Spokane County's plan to replace approximately a mile of concrete stormwater channel on Country Homes Boulevard was set in motion. Where there was once concrete is now an elaborate system of bio-infiltration swales, rain gardens, and a subsurface pipe that treats the stormwater and reduces pollutants. Spokane County is also in the midst of constructing a decant facility that will treat waste from street sweepers and vactor trucks used to clean out storm drains. The County's decant facility will be similar to the City of Spokane's completed decant facility. These facilities help improve water quality by properly treating and disposing material, nutrients, and other pollutants that would otherwise be flushed into the storm drain system and into the river. More about Spokane County's stormwater reduction efforts can be viewed at: http://www.spokanecounty.org/stormwater/content.aspx?c=2451.

Liberty Lake Sewer and Water District (LLSWD)
Although not required by a permit, the LLSWD takes an active role in reducing pollutants from stormwater. Under RCW 57.08.005(10), the LLSWD has the authority to provide for the reduction, minimization, or elimination of pollutants, including those contained in stormwater. The LLSWD conducted a stormwater management study in 1985 and later developed a Stormwater Management Plan in 1998. The LLSWD has established stormwater control and treatment requirements for development on private and public lands within the district boundaries that owners of those properties shall comply with during planning and construction on their property. In accordance with the LLSWD's Stormwater Resolution 26-13, a Stormwater Permit application form shall be completed by the owner and shall be accompanied by an engineered Stormwater Management Plan as well as an Erosion and Sediment Control Plan.

Other Activities
In 2013 Ecology published the *Eastern Washington Low Impact Development Guidance Manual.* The manual was a collaborative product of Spokane County, Ecology, the Washington Stormwater Center, Washington State University, and the Eastern Washington Phase II Municipal Stormwater Permittees. The purpose of the manual is to provide stormwater managers, site designers, and design reviewers with a common understanding of low impact development (LID) goals, objectives, design of individual practices, and flow reduction and water quality treatment that are applicable to eastern Washington.

Point Source Dischargers

By October 2011, the City of Spokane, Liberty Lake Sewer and Water District (LLSWD), Kaiser Aluminum (Kaiser), and Inland Empire Paper Company (IEP) received National Permit Discharge Elimination System (NPDES) permits from Ecology. All of these permittees have compliance schedules to meet TMDL targets for phosphorus, ammonia, and carbonaceous biochemical oxygen demand (CBOD) by 2021. Spokane River dischargers began researching technologies they could employ to achieve the reductions called for in the TMDL and their permits.

Ecology issued the first NPDES permit for Spokane County's new Regional Water Reclamation Facility at the end of November 2011. The County did not receive a compliance schedule to meet TMDL allocations because their facility was new, and they were required to meet water quality standards at the time the plant began operating.

In Idaho, the Environmental Protection Agency (EPA) issues the NPDES permits, and the Idaho Department of Environmental Quality certifies that the permits will achieve Idaho water quality standards. On September 30, 2014, the Environmental Protection Agency issued NPDES permits to the dischargers in Idaho (the City of Coeur d'Alene, Hayden Area Regional Sewer Board, and City of Post Falls). The permits became effective as of December 1, 2014. As in Washington, the Idaho dischargers received a compliance schedule to achieve limits for phosphorus, ammonia, and carbonaceous biochemical oxygen demand, but the timeline is slightly different than in Washington. The target date for Idaho dischargers is November 30, 2024; three years after Washington.

Details about Washington and Idaho dischargers and their efforts to reduce nutrients in their effluent are provided below.

Washington Dischargers

Inland Empire Paper Company (WA-0000825)

Since 2001, Inland Empire Paper Company (IEP) has embarked on a modernization program that has resulted in improvements to nearly every process within its facility using state-of-the art equipment. This significant investment into the phased modernization effort has raised IEP's status to one of the most modern newsprint facilities in the world. The following provides a summary of IEP's specific achievements that have resulted in improvements to the efficiency of its water treatment system and reducing nutrient levels in its discharge (Figure 4 and Appendix C):

1. Paper Machine #5 (2001) - IEP installed a modern energy-efficient paper machine that remains the newest of its kind in North America. The machine utilizes heat recovery and water reuse to minimize energy and water consumption.

2. Water Conservation Projects (2004 to present) - In 2004, IEP embarked on an aggressive on-going water conservation program. Numerous projects have been implemented, including: re-use of process water in various mill processes, re-use of water from the recycling of old newsprint, installation of water control devices on pump seals, and optimization of water intensive processes. Reducing the volumetric loading to the effluent treatment system increased the residence time within the system which resulted in greater treatment potential for removing biochemical oxygen demand (BOD), total phosphorus (TP), and ammonia (NH_3).

    a. Conustrenner (2004) – The conustrenner is a compact highly efficient self-cleaning fractionation filter. Approximately 1-1.4 million gallons per day (MGD) of primary treated water is diverted to the conustrenner for reclamation and reuse in the pulp mill processes, greatly reducing freshwater needs and volumetric loading to the water treatment system.

b. Pump Seals (2005 to 2007) – Flow limiting devices were installed on mechanical seal water lines for numerous pumps around the mill. These devices greatly reduced freshwater consumption to the process streams resulting in a substantial decrease in the volumetric loading to the water treatment system.

c. Retention Aid Carrier Water (2012) - IEP switched from using fresh water to reclaimed process water for its retention aid carrier water. This modification reduced treated effluent flow by approximately 100 gallons/minute.

d. Disk Filter Shower Water (2014) – IEP's #1 Disk Filter showers were changed from fresh water to reclaimed process water. This modification reduced treated effluent flow by approximately 200 gallons/minute.

3. MBBR #1 (2006) - IEP installed a 2.0 million gallon per day Moving Bed Biofilm Reactor (MBBR) for enhanced BOD removal. This system is currently achieving in excess of 50 percent BOD removal and has improved the efficiency of the overall water treatment system.

4. MBBR's #2 and #3 (2009) - IEP further improved the efficiency of its secondary water treatment system with the installation of two additional MBBR systems, providing IEP with the maximum amount of effective secondary treatment possible.

5. Surge control (2009) – IEP converted its existing 75 foot diameter clarifier to a surge control system to equalize hydraulic flow and BOD loadings to its secondary treatment system. This allows more uniform loading conditions to the water treatment system thereby reducing variability in the final effluent and providing process stability.

6. Elimination of Starch (2010) - IEP eliminated the use of cationic starch in the paper making process that was a large contributor of BOD and phosphorous loading to the water treatment system.

7. Chip segregation (2011) – IEP receives waste wood chips from local sawmills as a raw material supply for its paper making process. Chip species are separated and used only on grades where they are most effective, resulting in improved energy efficiency and bleaching. Reducing the bleaching needs of any specific paper type results in less BOD and TP loading to the water system, resulting in a lower final discharge concentrations of TP, NH_3, and BOD

8. Nutrient Optimization (2012 to present) – IEP's wood-based materials are deficient in nutrients such as phosphorus and nitrogen, so IEP actually needs to add these nutrients to its water treatment system for the health of the microorganisms that are responsible for BOD removal. IEP has been operating at lower nutrient targets in an effort to optimize the water treatment system operations for BOD, TP and NH3.

9. Stock Blending (2013) – Pulp mill modifications were implemented to allow for pulp specific blending. Targeting specific pulps has improved the bleaching efficiency and reduced the amount of dissolved material (BOD, TP) created during the reaction.

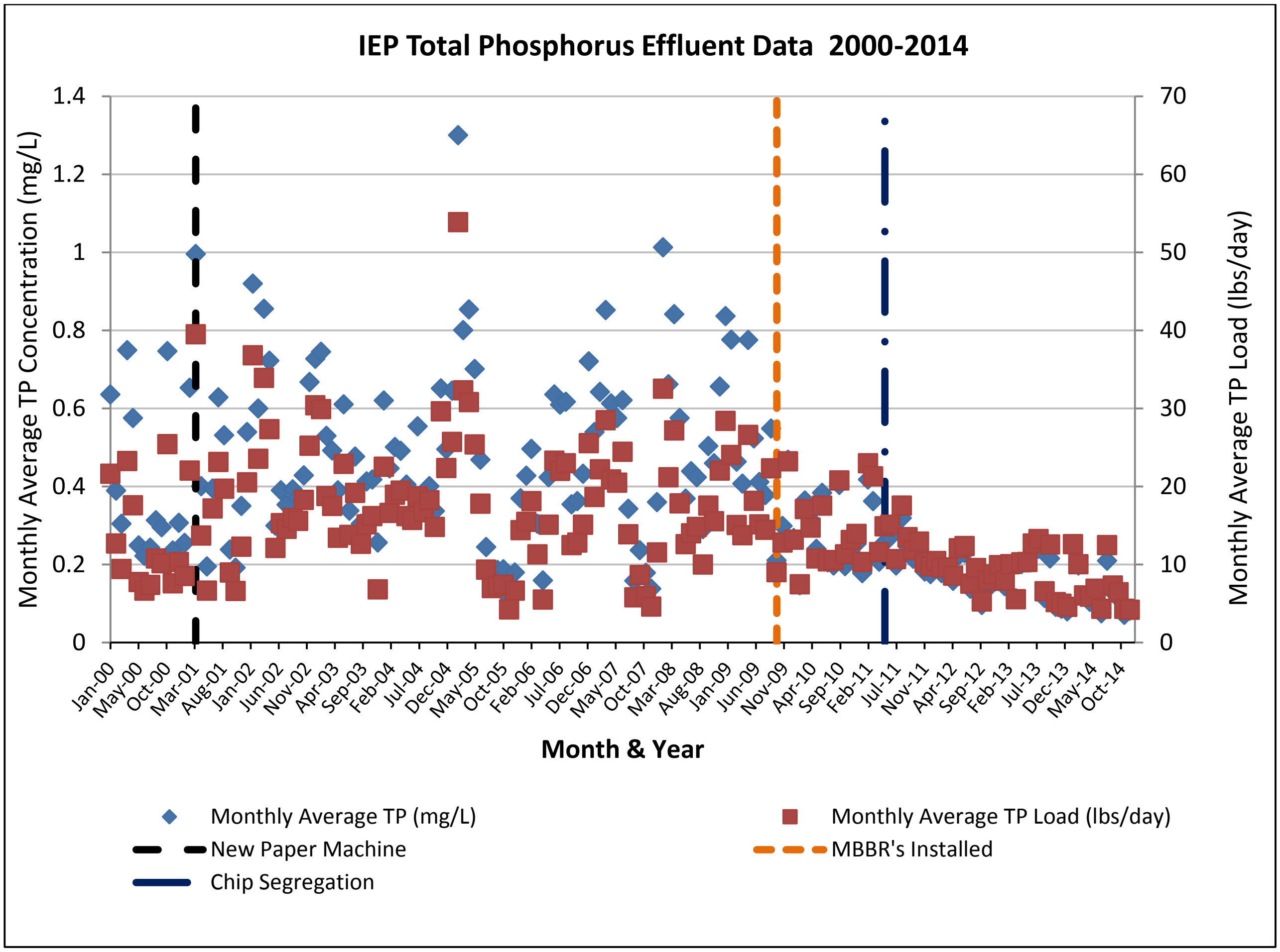


Figure 4. IEP's total phosphorus reductions from applying best management practices in the plant

Kaiser Aluminum (WA-0000892)
Kaiser's monitoring data shows that they are close to meeting the TMDL targets (Leber 2014). In 2012, daily total phosphorus concentrations were below 6 lbs/day with the exception of February. In 2013, the daily total phosphorus levels were below 4 lbs/day, and a majority of the time they were lower than 3 lbs/day. Kaiser's final water quality based effluent limit for total phosphorus is 3.21 lbs/day. Kaiser's average ammonia and carbonaceous biochemical oxygen demand (CBOD) levels are also below the final water quality based effluent limit. To see a presentation of the data, see: http://www.spokaneriver.net/wp-content/uploads/2014/03/Leber.Annual-meeting-DO-TMDL-2014.pdf.

Kaiser's 2012 and 2013 Seasonal average loads for total phosphorus, carbonaceous oxygen demand, and ammonia are below the final seasonal limits per July 1, 2014 Annual Status Report (Table 5).

Table 5: Kaiser seasonal performance compared to final effluent limits for each parameter

Seasonal (March 1 – October 31) Performance Comparison (lbs/day)			
Parameter	2012 Seasonal Average	2013 Seasonal Average	Final Seasonal Limitation
Total Phosphorus	2.34	1.47	3.21
Carbonaceous Biological Oxygen Demand	237	239	462.7
Ammonia	3.2	2.9	9.0

BMPs which Kaiser put into place that have resulted in reductions in phosphorus in their discharge include:

- Replaced phosphoric acid with sulfuric acid in the industrial wastewater treatment system.
- Discontinued use of phosphate detergents when the company ceasing production of coated coil.

The current BMP used by Kaiser is the reduction of discharge flows, which reduced the amount of non-contact cooling water used in the facility. Some equipment was converted to air cooled rather than water cooled. Kaiser estimates this BMP reduced peak seasonal water demand by ten to fifteen percent.

In the future, Kaiser will research BMPs related to their use of water treatment chemicals.

In March 2014, Kaiser requested Ecology modify their NPDES permit by allowing a delay in the engineering design report and installation of the technology upgrade. Kaiser would like additional time to explore integrating plans for PCB groundwater treatment with upgrades to the sewage treatment facility. Ecology agreed and began the modification process. The draft permit modification requires technology selection notification by July 1, 2016, an engineering report for treatment technology by January 1, 2017, and installation and operation of phosphorus treatment technology by January 1, 2019. The permit modification was finalized on November 18, 2014.

Liberty Lake Sewer and Water District (WA-0045144)

In an effort to improve the water quality of Liberty Lake, the Liberty Lake Sewer and Water District (LLSWD) constructed a wastewater collection and treatment facility in 1973 that replaced existing on-site septic systems. The treatment facility was completed in August 1982. The LLSWD completed minor modifications to the facility by replacing the aerobic digester blowers in 1998 and replacing the chlorination system with an ultraviolet disinfection system in 2002.

LLSWD was one of the first dischargers in the region to upgrade their facility to achieve enhanced phosphorous removal from its discharge to the river (Phase 1 upgrades) in anticipation of more restrictive limitations resulting from the TMDL waste load allocations. To achieve this removal, in 2006 the LLSWD converted their facility from an extended aeration process to a biological nutrient removal treatment process. This reduced the phosphorous discharge from 20-25 pounds per day prior to the upgrade to 3-4 pounds per day after the upgrade was complete. The facility now removes 91percent of the phosphorous that enters the plant today. Effluent data in Appendix C show the reductions in phosphorus, ammonia, and CBOD resulting from the addition of biological nutrient removal to the treatment process.

The design for Phase 2 of the facility upgrades is now complete. These upgrades include advanced tertiary treatment through chemical addition and membrane filtration. This additional treatment will further reduce phosphorous discharge to less than ½ pound per day. This will equate to better than 99 percent removal of phosphorous entering the plant. Depending on available funding, the upgrades are expected to be complete by March 2018.

In addition to the upgrades to the treatment facility, the LLSWD has installed reclaimed water mains in various locations in preparation for future water reuse projects. For example, they installed a new undercrossing of I-90 to allow LLSWD to supply reclaimed water to areas south of the freeway. In early 2014, the LLSWD Commissioners passed a resolution requiring new development to install “purple” pipe wherever it was expected to be beneficial.

Liberty Lake Sewer and Water District is a leader in the charge to reduce phosphorus in detergents and fertilizers:

- In December 1989, LLSWD passed Resolution 40-89 banning phosphorus in laundry detergent. A nationwide ban followed in 1993, while the State of Washington lagged a year behind with its ban in 1994. Twenty years later in January 2014, Proctor and Gamble announced a plan to eliminate all phosphates from its laundry detergent worldwide within the next two years. Proctor and Gamble products represent one quarter of the global detergent market.
- In July 2005, LLSWD passed Resolution 23-05 banning phosphorus in automatic dishwasher detergent. Bans in Spokane, Whatcom and Clark counties followed in 2008. Proctor and Gamble (makers of Cascade) silently and without “Green” marketing removed phosphorus from its detergent formulations in 2009. In Washington, a statewide ban took effect in 2010. There are now 16 states with bans against automatic dishwasher detergent containing phosphorous. All major detergent companies have now removed phosphorus from their formulations. Following the detergent ban in Spokane County the LLSWD has seen reductions of approximately 16 percent in Total Phosphorus in the influent to our reclamation facility (Figure 5.)

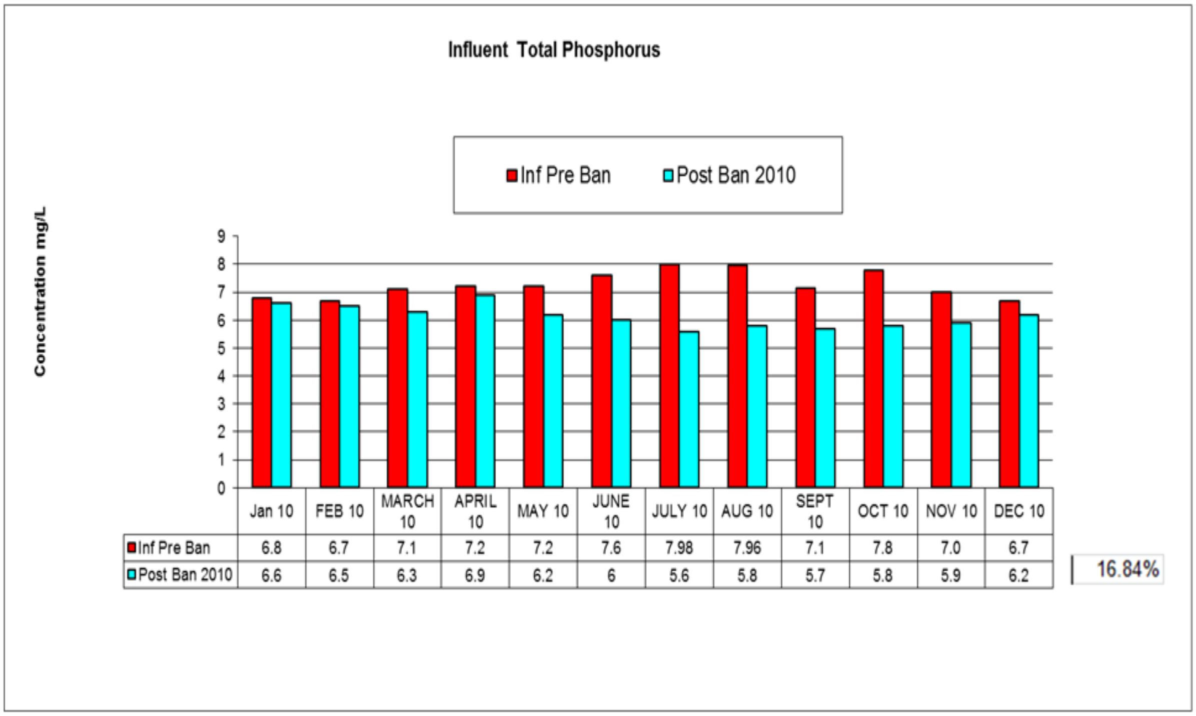


Figure 5. 2010 Total Phosphorus concentrations entering the Liberty Lake Sewer & Water District treatment facility

- In November 2005, the LLSWD passed Resolution 46-05 banning phosphorus in lawn fertilizer within the watershed of Liberty Lake. In June 2009. LLSWD amended the resolution (Resolution 18-09) banning phosphorus in lawn fertilizer district-wide. Two years later in 2011, Washington State passed "Clean Fertilizers, Healthier Lakes and Rivers" legislation (ESHB 1489) into law. Washington was the eighth state to pass fertilizer legislation. Now there are 11 states with bans against lawn fertilizer containing phosphorous. In response to these laws, companies that make fertilizers have reformulated their products.

- Since 2005, the LLSWD has partnered with Greenstone Homes to offer free bags of phosphorus free fertilizer. Figure 6 shows that in 2011, out of the 850 vouchers distributed, LLSWD patrons claimed 303 bags of fertilizer.

The LLSWD has protective measures in place to reduce and prevent nonpoint source pollution (i.e. stormwater), and are maintained and strengthened when possible including diversion/treatment of runoff, reduction of excessive lawn fertilization, community cleanup programs, promotion of smart/low impact development, and prevention of disruption of the watershed. Protection and prevention strategies are promoted in watershed studies, demonstration projects, environmental education programs, workshops, and newsletter/news article dissemination of information that explains the relationship between watersheds, water bodies, water quality, and human impacts to these resources. For example, since 1992 LLSWD performs an annual Beach and Leaf pickup within their boundary. Residents removed nearly

13,000 bags in 2013, which is the most removed since 2003 (Figure 7). This equates to 585 pounds of phosphorus removed from the watershed.

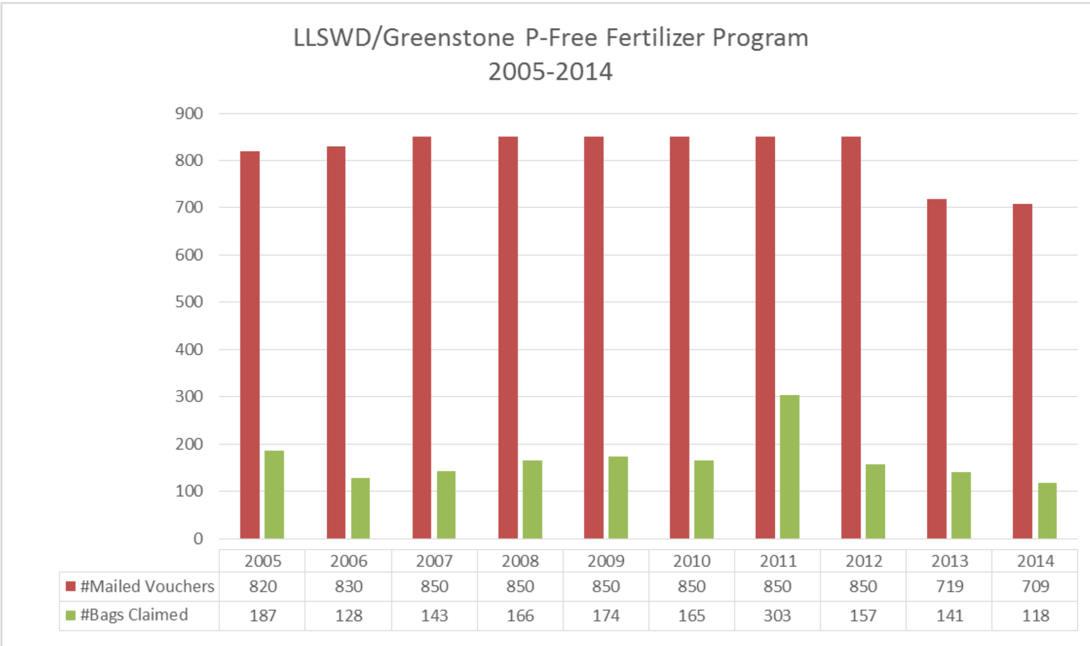


Figure 6. Liberty Lake Sewer & Water District phosphorus free fertilizer vouchers distributed and claimed

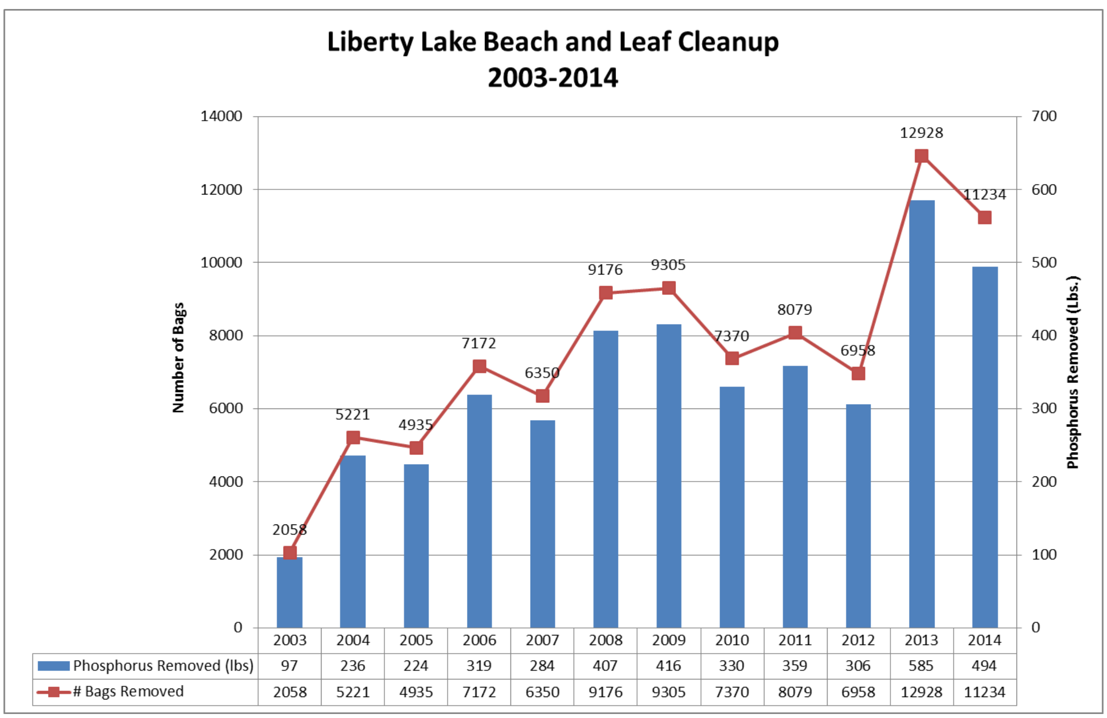


Figure 7. Bags of leaves removed during Liberty Lake Sewer & Water District's annual Beach and Leaf Pickup event

Spokane Riverside Park Water Reclamation Facility (RPWRF) (WA-002447-3)
The Riverside Park Water Reclamation Facility (RPWRF) is the Spokane community's oldest and largest water reclamation facility. The facility recycles about 34 million gallons of wastewater a day and returns the cleaned water to the Spokane River. The City of Spokane has a combined sewer system, where stormwater from about one third of the city enters the sanitary sewer pipes. The RPWRF can handle peak flows of up to 150 million gallons a day during storm or snowmelt events. RPWRF provides preliminary, primary, secondary, and phosphorus treatment and disinfection.

Phosphorus treatment known as chemically enhanced primary treatment (CEPT) has been tested since June 2011. With CEPT, the City adds alum as well anionic polymer ahead of the primary clarifiers to aid in solids and phosphorus removal (before, alum was only used in the secondary process for phosphorus removal). The use of CEPT has allowed the City to increase its treatment capacity while reducing phosphorus in its effluent. The technology increased total phosphorus removal from 30 percent to 70 to 80 percent, and reduced alum needs by 30% (Figure 8). Initially, CEPT was implemented as a short term pilot project, but with its success in reducing phosphorus levels, the City will continue to use CEPT as a treatment component year-round at RPWRF.

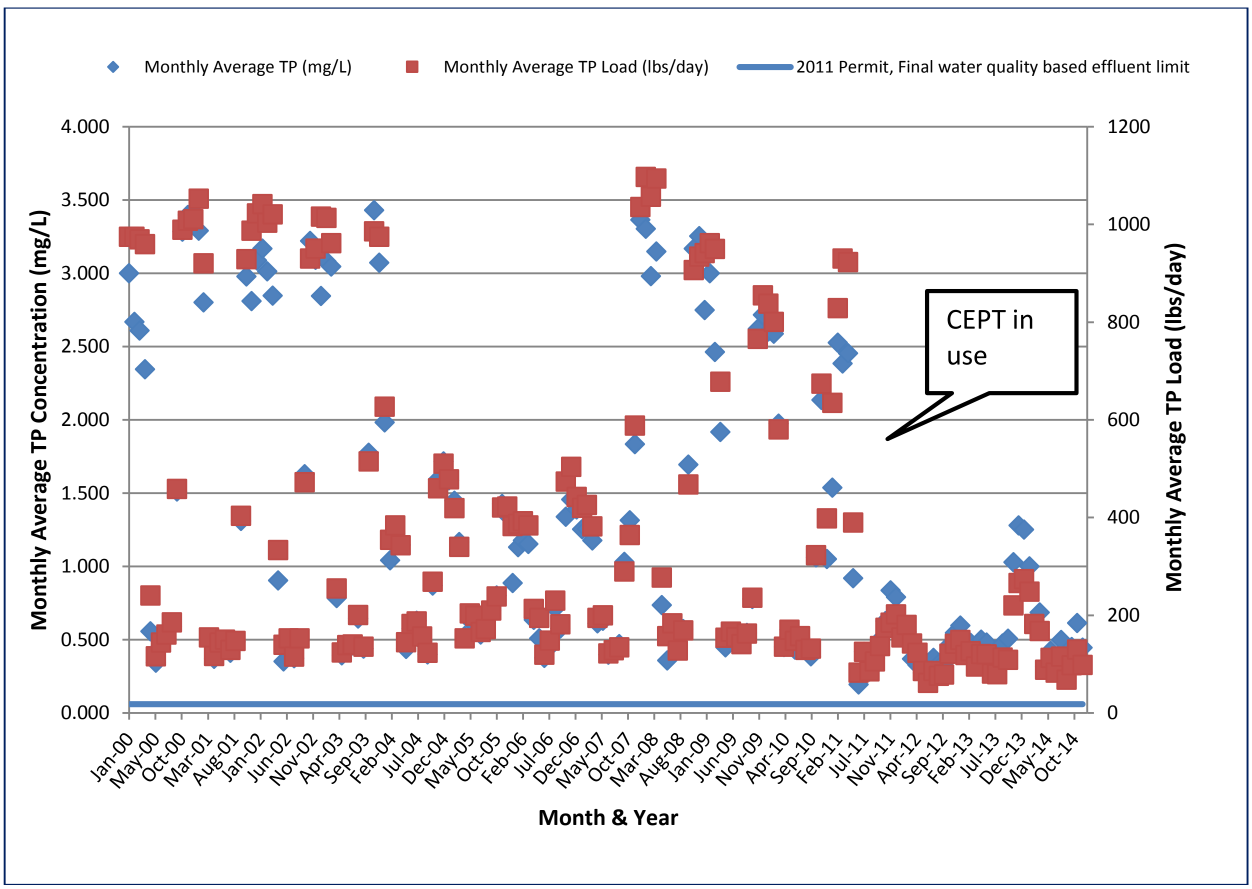
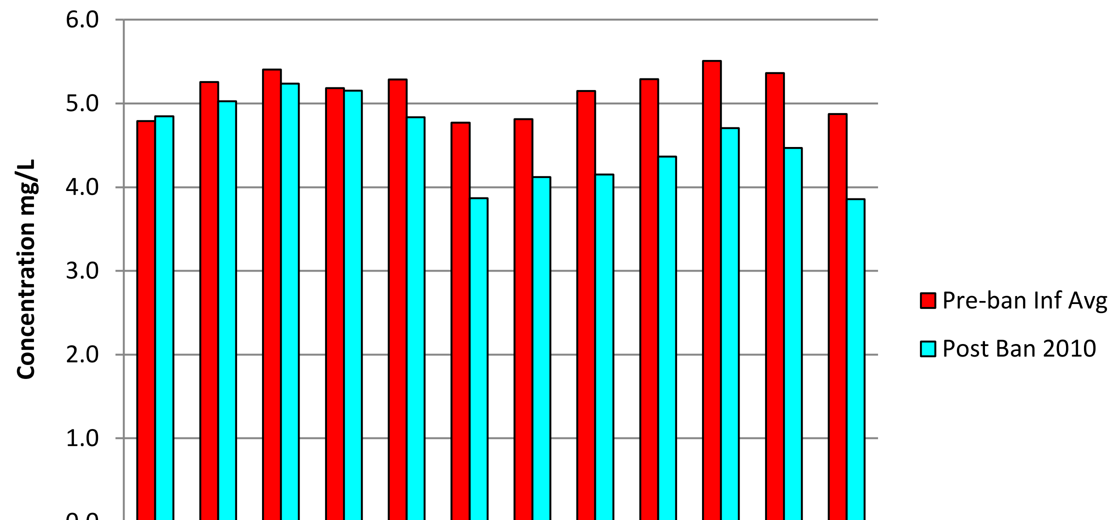


Figure 8. RPWRF total phosphorus effluent data 2000-2014

Planning and design work is under way to add additional treatment at the plant. This tertiary treatment level is often referred to as the Next Level of Treatment (NLT). Membrane technology will be used to further reduce pollutants like heavy metals, PCBs, and phosphorus; and to improve the quality of the water released to the River. The NLT Engineering Report and Facility Plan Amendment Number 3 can be found at https://my.spokanecity.org/publicworks/wastewater/treatment-plant. Additional pilot testing and final design is underway in preparation for construction and full-scale operation to meet the TMDL compliance schedule.

The City of Spokane participated in regional efforts to reduce phosphorus loading from laundry detergent, automatic dishwasher detergent, and fertilizer. Spokane County implemented a ban on dishwasher detergent with phosphorus in July 2008. Figure 9 below depicts the effects of the dishwasher phosphorus ban on RPWRF influent concentrations, comparing average concentrations before the ban (2006-2007) to after the ban in 2010. Annual average phosphorus influent concentrations reduced by 11.4 percent in 2010 compared to pre-ban average of 2006 and 2007. The average annual phosphorus concentration reductions further increased to 17.5 percent in 2011 and 23.7 percent in 2012, with an overall average reduction of 18.2 percent from 2010 to 2014.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pre-ban Inf Avg	4.8	5.3	5.4	5.2	5.3	4.8	4.8	5.1	5.3	5.5	5.4	4.9
Post Ban 2010	4.8	5.0	5.2	5.2	4.8	3.9	4.1	4.2	4.4	4.7	4.5	3.9

Figure 9. Phosphorus influent pre- and post- dishwasher detergent Ban

The Spokane County Regional Water Reclamation Facility came online in November 2011, taking some of the flow that originally went to RPWRF and potentially some of the higher phosphorus concentrations because flows are sanitary sewage only. Because the City has a combined sewer system, phosphorus concentrations in the wet months can be attributed to stormwater runoff as well as sanitary sewage. However, CSO and stormwater flows contain lower concentrations of phosphorus than sanitary sewer flows, about an average of 2 mg/L and 1 mg/L, respectively, based on recent sampling. August is typically the driest month of the year, so phosphorus concentrations can be primarily attributed to sanitary flows that month. Concentrations are 21 percent lower in the month of August 2010-2014 compared to the 2006-2007 average.

Combined Sewer System

The City's NPDES permit also includes conditions for their combined sewer overflows (CSOs). A CSO occurs when a combination of storm water and sewage exceed the capacity of the sewer system and flows into the Spokane River. The TMDL called for the following actions to reduce phosphorus from the CSOs:

- Monitor total phosphorus discharged from CSOs
- CSO Elimination Program

The City and Ecology agreed on a plan to reduce the frequency of CSOs. (See the City's 2013 Combined Sewer Overflow (CSO) Plan Amendment for more information: https://my.spokanecity.org/publicworks/wastewater/cso). The agreement allows for one overflow per outfall per year on a 20-year moving average for each of their 22 CSO outfalls. The City must meet this performance standard by Dec. 31 , 2017. Through mid 2014, the City had installed eight CSO control facilities, modified seven weirs, and removed four outfalls (Hendron 2014). The City has real-time information on the CSOs and monthly and annual reports online at the website above.

Integrated Clean Water Plan

The City developed an Integrated Clean Water Plan, which is a plan that addresses CSOs, stormwater, and wastewater treatment plant upgrades simultaneously. The purpose of the plan is to achieve a cleaner river faster through prioritization of projects based on their positive environmental impact to the river, using cost-effective and innovative approaches, and holistic integration with other infrastructure projects. More information and a copy of the plan can be found at https://my.spokanecity.org/publicworks/wastewater/integrated-plan.

Spokane County Regional Water Reclamation Facility (SCRWRF) (WA-0093317)

The Spokane County Regional Water Reclamation Facility (SCRWRF) was required to meet water quality standards when it became operational in December 2011. Data from the new facility shows that from March through October of 2013, the average amount of total phosphorus coming into the plant was 313 lbs/day and the average total phosphorus content of the effluent leaving the plant was 2.45 lbs/day. The average amount leaving the plant is well below the seasonal limit of 3.34 lbs/day and translates to more than a 99 percent reduction (Moss 2014). Ammonia levels in the facility's effluent were between 18 and 97 percent lower than the seasonal limits, depending on the specific permit limit season, and carbonaceous biochemical oxygen demand (CBOD) was lower than the lab detection limit of 2.0 mg/L. The County has been able to achieve these low nutrient levels using chemically enhanced primary treatment (CEPT) in combination with ultrafiltration membranes in a membrane bioreactor (MBR). Before Spokane County's facility was operational, all the wastewater went to the City of Spokane's RPWRF for treatment. (The County owns 10 MGD of capacity at the City's plant.) In January 2015, the Spokane County facility treated about 7.2 million gallons per day (MGD), and the County sent approximately 2.2 MGD to the City's plant (about 1.9 MGD from North Spokane and 0.3 MGD from the Valley) (Moss, 2015). Because Spokane County's new treatment facility is able to remove more phosphorus from wastewater than the City's current plant, the amount of phosphorus entering the river has decreased. According to Moss (2015), the SCRWRF's phosphorus removal is about an order of magnitude (10 times) better than if it were treated at Spokane's facility. Therefore, since December 2011, an estimated additional 30 pounds per day of phosphorus has been removed from the river during the critical season.

Spokane County also participated in regional efforts to reduce phosphorus loading from laundry detergent, automatic dishwasher detergent, and fertilizer. The state legislature implemented a ban on automatic dishwasher detergent with phosphorus in Spokane County in July 2008. These bans appear to have reduced the amount of phosphorus that enters the SCRWRF by about 20 percent below its influent design concentration of 7.2 mg/L.

Idaho Dischargers

City of Coeur d'Alene

Currently, the City of Coeur d'Alene is constructing upgrades in phases to achieve tertiary treatment (Keil 2014).

City of Post Falls

The Water Reclamation Facility operated by the City of Post Falls has been removing phosphorus via biological treatment since about 1996, in advance of a requirement to do so. The extended aeration system coupled with biological selector cells has historically removed phosphorus at levels above expected performance of a biological system.

In 1999 removal of phosphorus was included in a new NPDES permit. Since that time, other upgrades have been made to improve plant performance. For example, in 2005 and 2006 the oxidation ditches at the Water Reclamation Facility were upgraded to provide more consistent treatment.

In 2010 a new oxidation ditch was added to the Water Reclamation Facility which provides full nitrification/denitrification treatment and improves the reliability of nutrient removal processes. Although the existing extended aeration system had historically removed almost all ammonia-nitrogen, this upgrade enabled the removal of nitrate and the recovery of alkalinity lost through ammonia removal.

The City of Post Falls has included expected treatment requirements for its new NPDES permit in its 2013 Water Reclamation Master Plan. Elements of this plan, including flow equalization, are currently in design and on-schedule. The master plan includes tertiary treatment of effluent.

Hayden Area Regional Sewer Board

The Hayden Area Regional Sewer Board's (HARSB) plan to reduce nutrients includes flow equalization, biological nutrient removal, and tertiary treatment. In addition, HARSB's NPDES permit does not allow them to discharge to the Spokane River when flows are less than 2,000 cubic feet per second at Post Falls (Windram 2014).

Avista's Dissolved Oxygen Responsibility

Avista Corporation (Avista) owns and operates the Spokane River Hydroelectric Project (Project), which consists of five dams on the Spokane River, including Long Lake Hydroelectric Development (HED), which creates Lake Spokane. In June 2009, the Federal Energy Regulatory Commission (FERC) relicensed Avista's Spokane River Project for another 50 years. To relicense the project, Ecology issued a 401 Water Quality Certification, which FERC incorporated into Avista's license. Avista received certification from Ecology in 2009 that includes a schedule to comply with water quality standards.

Avista does not discharge nutrients into either the Spokane River or Lake Spokane. However, the impoundment creating Lake Spokane increases the residence time for water flowing down the Spokane River, and thereby influences the ability of nutrients contained in those waters to reduce dissolved oxygen (DO) levels. As such, Avista received a proportional level of responsibility for improving DO levels in Lake Spokane as identified in the DO TMDL. Therefore, per the schedule to comply with water quality standards in the FERC license, Avista was required to develop a water quality attainment plan for dissolved oxygen. Avista's Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (Avista and Golder, 2012) addresses improving its proportional level of responsibility as determined in the DO TMDL. (To view plan, see: http://www.avistautilities.com/environment/spokaneriver/resources/Documents/2012-0308.pdf.)

They completed an annual report of the company's 2013 activities, which can be read at: http://www.avistautilities.com/environment/spokaneriver/resources/Documents/Lake%20Spokane%20DOWQAP_2013%20Annuary%20Summary%20Rpt_1-31-14.pdf. The report includes water quality data from Avista's six monitoring sites and an update on the activities Avista is undertaking to improve dissolved oxygen in the lake. The activities range from educational brochures and events to riparian plantings, land purchases, and carp studies.

Monitoring

Monitoring Activities

Many entities monitor water quality in Lake Coeur d'Alene, the Spokane River, tributaries to the Spokane River, Lake Spokane, and groundwater. These entities include:

- Idaho Department of Environmental Quality (IDEQ)
- Coeur d'Alene Tribe
- City of Coeur d'Alene
- United States Geological Survey
- Hayden Area Regional Sewer Board (HARSB)
- City of Post Falls
- Ecology
- Liberty Lake Sewer and Water District (LLSWD)
- Kaiser Aluminum
- Inland Empire Paper
- Spokane County
- City of Spokane
- Avista

Figure 10 shows the sampling locations within the Spokane River Basin. Descriptions of the monitoring activities can be found in the following pages under the section of the watershed where they are performed, in Lake Coeur d'Alene, the Spokane River, Lake Spokane, or tributaries.

Lake Coeur d'Alene

The Idaho Department of Environmental Quality (IDEQ) and the Coeur d'Alene Tribe routinely monitor Lake Coeur d'Alene and surrounding watersheds for nutrients as part of implementing the Coeur d'Alene Lake Management Plan. The goal of the plan is to keep nutrients low so that the heavy metals in the lake's bottom sediments remain there. Among the many parameters IDEQ and the Tribe sample for are dissolved oxygen, nutrients, chlorophyll, cyanobacteria, and phytoplankton.

Spokane River

Idaho

The United States Geological Survey (USGS) samples the Spokane River at two streamgage locations in Idaho from water year (Oct. 1-Sept. 30) 2009 through 2013:

- Downstream of the outlet of Lake Coeur d'Alene (gage # 12417610) at Coeur d'Alene
- Near Post Falls (gage # 12419000)

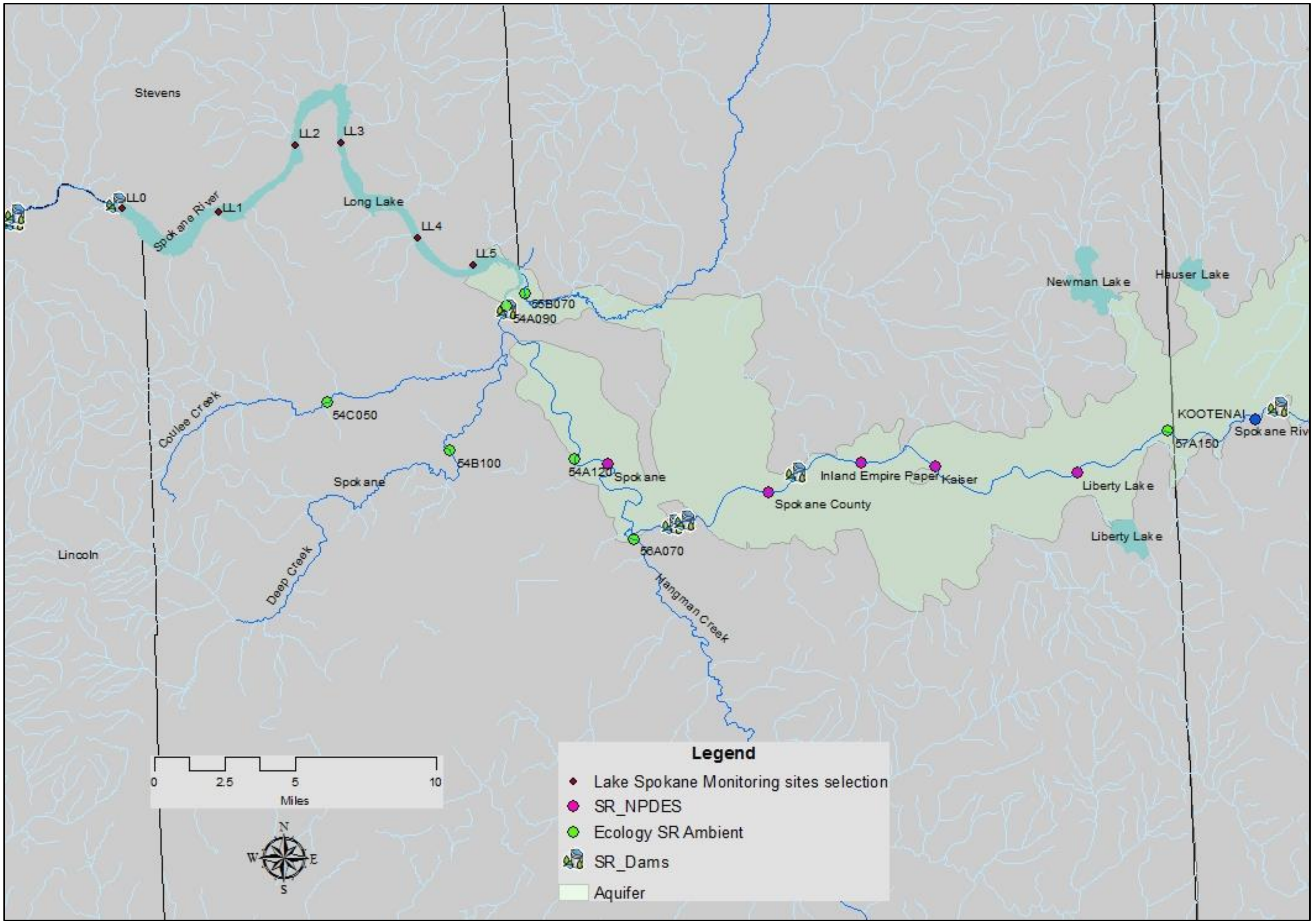


Figure 10. Spokane River basin monitoring locations

The USGS's purpose for sampling these locations is to determine concentrations, assess transport, and examine long-term trends of cadmium, zinc, lead, nitrogen, and phosphorus in the Coeur d'Alene basin (Clark and Mebane 2014).

Washington

Ecology maintains long term monitoring at several sites on the Spokane River beginning at the Lake Coeur d'Alene outlet and continuing down the river to below Nine Mile Dam (Table 6).

Table 6. WA Department of Ecology monitoring locations on the Spokane River*

http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html		
River Location	**Station #**	**Water Year****
Spokane River @ Lake Coeur d'Alene	57A240	2007-2010
Spokane River near Post Falls	57A190	2007
Spokane River @ Lake Coeur d'Alene	57A240	2007-2010
Spokane River near Post Falls	57A190	2007
Spokane River @ Stateline Bridge	57A150	1991-2014
Spokane River @ Sullivan Road	57A146	2009-2010
Spokane River @ Plante's Ferry Park	57A140	2008-2010
Spokane River below Monroe Street	57A125	2007-2008
Spokane River @ Sandifer Bridge	57A123	2009-2010
Spokane River @ Fort Wright Bridge	54A130	2009-2010
Spokane River @ Riverside State Park	54A120	1972-2014
Spokane River @ Nine Mile Bridge	54A090	2000, 2007-2010, 2014
Spokane River @ Long Lake	54A070	2007-2010

*Bolded sites represent locations monitored between 2010 and 2014.
**Water year begins October 1st and continues through September 30th.

Between 2010 and 2014, the Ecology Environmental Assessment Program sampled the river at ten locations (bolded in Table 6 above). Appendix A contains the field data for conductivity, pH, dissolved oxygen and temperature and the laboratory results for fecal coliform bacteria, ammonia nitrogen, nitrate and nitrite nitrogen, orthophosphorus, total suspended solids, total phosphorus, total persulfate nitrogen, and turbidity.

Most entities discharging to the river in Washington sample their effluent for nutrients and other constituents. Only Spokane County monitors the Spokane River for nutrients above and below their facility's outfall. The City of Spokane monitors two of their combined sewer overflows (CSOs) and two stormwater outfalls (Table 7). The City samples effluent from these pipes for total phosphorus, nitrate-nitrite, ammonia, total suspended solids, carbonaceous biochemical oxygen demand, and biochemical oxygen demand. Results of the sampling are also included in Appendix A.

Table 7. City of Spokane stormwater and combined sewer overflow monitoring sites

	Identification # / Basin	General Location	Dates sampled
Combined Sewer Overflow	http://www.spokanewastewater.org/(X(1)S(sfh2pabtwqkiifqljdhmqe55))/csoupdate.aspx#Monthly		
	6	0.25 miles upstream of the City's Riverside State Park Water Reclamation Facility	2013-2014
	34	Trent Bridge (from South Hill)	2013
Stormwater	http://www.spokanewastewater.org/(X(1)S(sfh2pabtwqkiifqljdhmqe55))/StormwaterDocs.aspx		
	Cochran Basin	north side of Spokane (5,300 acres)	2012-2014
	Washington Basin	north of Washington St Bridge (450 acres)	2013

Lake Spokane
Ecology published a data report on their May 2010 to October 2011 Lake Spokane nutrient monitoring effort. The report is a compilation of all Ecology's data from five monitoring stations on Lake Spokane, a site at the mouth of the Little Spokane River, and a lower Spokane River site. The monitoring effort achieved the data quality objectives for the study (Ross 2013). The report can be viewed at: https://fortress.wa.gov/ecy/publications/publications/1303029.pdf.

In accordance with its Dissolved Oxygen Water Quality Attainment Plan (DO WQAP), Avista has been completing baseline monitoring at six lake stations, LL0 through LL5, during May through October. Monitoring at prescribed depths throughout the water column at each station includes both in-situ sampling of water temperature, dissolved oxygen (DO), pH, conductivity, and water clarity as well as sample analyses for nitrate plus nitrite, total persulfate nitrogen (TN), soluble reactive phosphorus (SRP), total phosphorus (TP), chlorophyll-a, phytoplankton and zooplankton. The monitoring and sampling are conducted in accordance with the Quality Assurance Project Plan for Lake Spokane Baseline Nutrient Monitoring (TetraTech 2014).

Figure 11 shows the locations of the six monitoring stations within Lake Spokane. Station LL0 is located at a depth of 157-164 feet and is the farthest downstream in the reservoir. Station LL1 is located across from the Lake Spokane Campground and Boat Launch at a depth of about 111 feet. Station LL2 is down-reservoir from TumTum and Sunset Bay at a depth of about 85 feet. Station LL3 is just up-reservoir from Willow Bay at a depth of about 62-65 feet. Station LL4 is across from Suncrest Park and boat launch at a depth of about 29 feet. Station LL5 is the farthest up-reservoir, slightly up-reservoir from the Nine Mile Recreation Area on the north side of the river, at a depth of about 19 feet.

Longitudinally, Lake Spokane can be divided into three zones representing varying morphometric characteristics (Figure 11). The upper portion of the reservoir is considered to be the riverine zone and has the shallowest depths, fastest velocities characteristics similar to a large river. Station LL5 is within this riverine zone. Stations LL3 and LL4 are located within the transition zone of the reservoir, where the reservoir is changing from a riverine environment to a more lacustrine (lake) environment. Within the transition zone, depths are greater than in the riverine zone but the littoral areas (shallow areas where sunlight can reach the bottom) are still similar to that seen in the riverine zone. Stations LL0, LL1, and LL2 are located in the lacustrine zone of the reservoir where there is both littoral and deep water environments. Water depths in the lacustrine zone are much deeper than the rest of the reservoir.

The vertical structure of Lake Spokane is set up by thermal stratification, largely determined by its inflow rates and temperature, change in storage, climate, and location of the powerhouse intake. Within Lake Spokane's lacustrine zone, thermal stratification creates three layers (the epilimnion, metalimnion, and hypolimnion) that are generally present between late spring and early fall. The epilimnion is the uppermost layer, and the warmest due to solar radiation. The metalimnion contains the thermocline and is the transition layer between the epilimnion and the hypolimnion. The hypolimnion is the deepest layer and is present throughout the lacustrine zone.

Tributaries

Ecology has long-term monitoring sites near the mouths of the two major tributaries to the Spokane River: Hangman Creek and the Little Spokane River (Table 8). Beginning in October 2013, Ecology began monitoring Deep and Coulee creeks, but this monitoring is scheduled to end September 2015. Data from these stations is included in Appendix A.

Table 8. WA Department of Ecology Spokane River tributary monitoring locations*

http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html		
Tributary Location	**Station #**	**Water Year****
Little Spokane River near mouth	55B070	1994-2014
Hangman Creek @ mouth	56A070	1995-2014
Deep Creek at Garfield Road bridge	54B100	2014
Coulee Creek at N Brooks Road	54C050	2014

*Bolded sites represent locations monitored between 2010 and 2014.
**Water year begins October 1st and continues through September 30th.

Groundwater

Both the City of Spokane and Spokane County monitor groundwater wells for nitrate and total phosphorus. The City of Spokane monitors seven drinking water wells (Electric, Parkwater, Nevada, Grace, Hoffman, Central, and Ray Street). All of these wells are sampled once a year toward the end of July with the exception of Ray Street, which is monitored quarterly. Spokane County Water Resources Program monitors groundwater from 49 wells scattered throughout the County. The City of Spokane produces yearly drinking water reports which can be found at: https://my.spokanecity.org/publicworks/environmental/documents/.

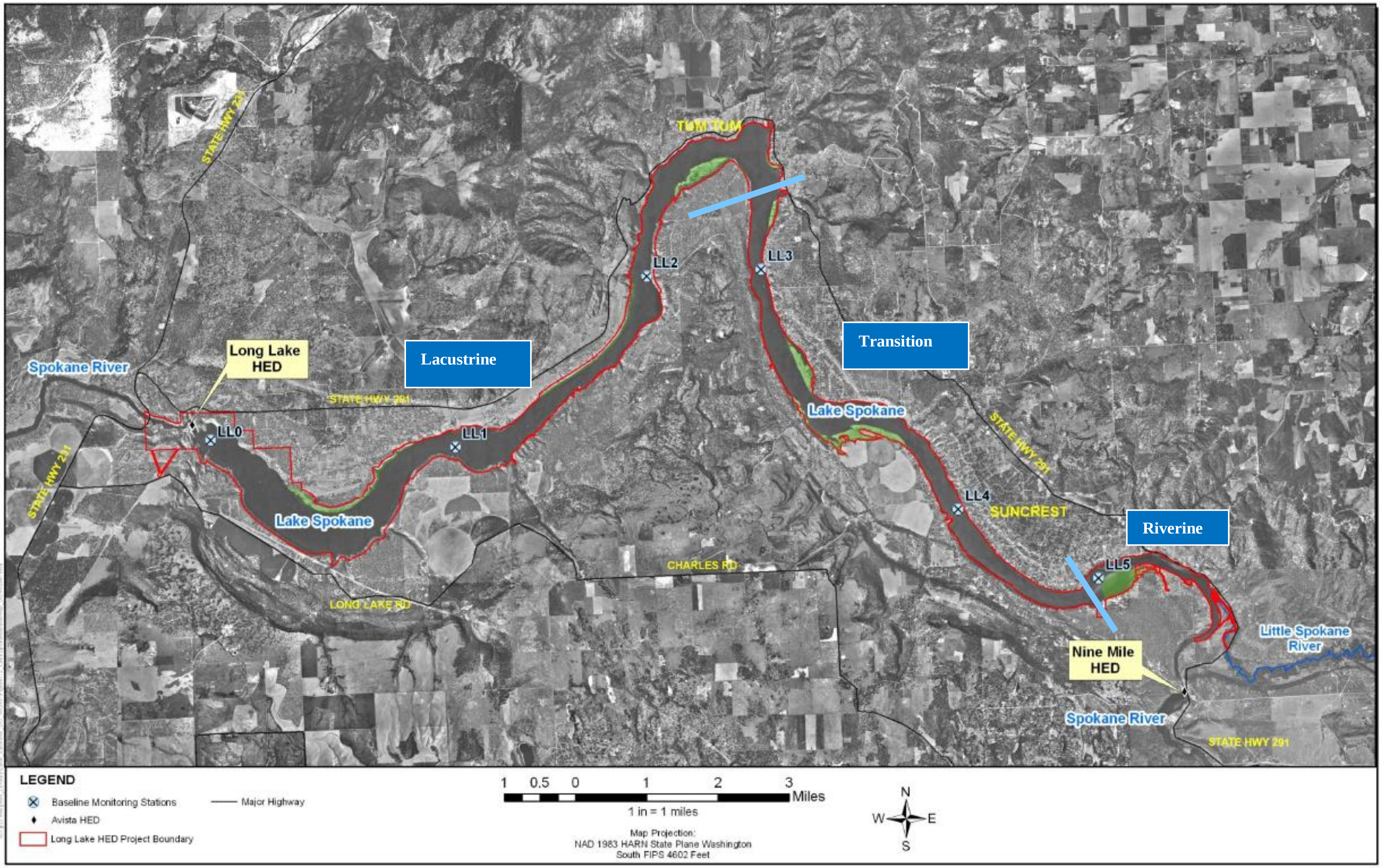


Figure 11. Lake Spokane morphometric zones and monitoring stations

Temperature, Precipitation, and Flow Data

Comparing temperature, precipitation, and flows that occurred during 2010 through 2014 with those from the TMDL critical year (2001) is important to determine the level of water quality improvement. Ecology gathered temperature and precipitation data from the National Weather Service's Spokane airport weather station: http://www.wrh.noaa.gov/otx/climate/lcd/lcd.php (Appendix X).

The highest temperature for each month was recorded, and then an average of each calendar year was calculated. Likewise, monthly total precipitation amounts were averaged over each year. Average high temperatures in 2010 and 2014 are similar to 2001 (72.4°F), whereas 2011 and 2013 were cooler (Figure 12). The only year warmer than our critical year 2001 was 2012 at 73.25°F.

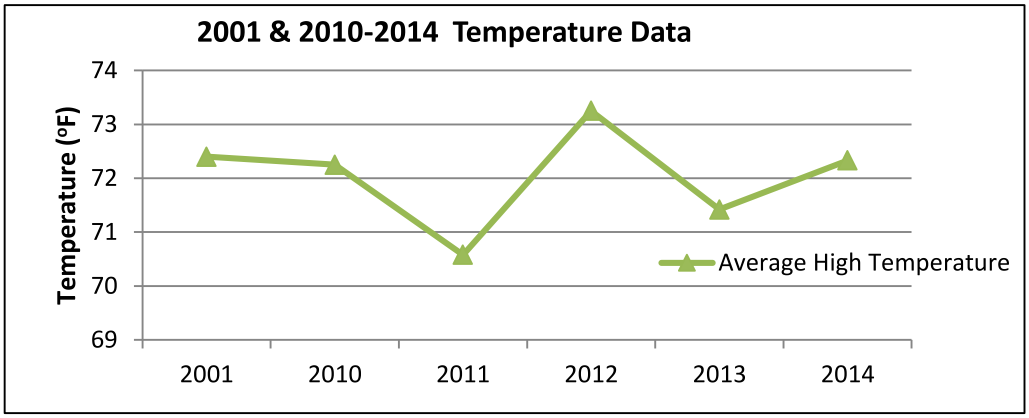


Figure 12. Temperature data from the Spokane Airport for the TMDL critical year and 2010-2014

Monthly precipitation (including rain and snow) data was added up for each calendar year. The only year to have less precipitation than 2001 was 2013 (Figure 13). In 2001, the total amount of precipitation was 13.72 inches, and 2013 had 2.36 fewer inches at 11.36. All other years we experienced more precipitation than 2001. The maximum was in 2012 with 21.32 inches of precipitation.

Flows of the Spokane River have been altered by a license and new Washington State rule:

- In June 2009 when the Federal Energy Regulatory Commission (FERC) issued Avista's license, it required Avista to discharge at least 600 cubic feet per second (cfs) of water from the Post Falls Dam from June 7 until the Tuesday after Labor Day. The only exception is if Lake Coeur d'Alene drops below a certain level during the summer, at which time Avista can reduce their discharge to no less than 500 cfs. At the corporation's Monroe Street and Upper Falls dams, they are required to pass 850 cfs of water from June 16 to September 30. These FERC requirements will prevent the Spokane River from flowing as low as it did during the 2001 critical year established by the TMDL.

- In September 2014, Ecology initiated a rule-making process to establish a minimum instream flow for the Spokane River. The rule allocates flows to protect fish habitat and other uses

(Table 9). The instream flow rule goes into effect at the end of February 2015, and is essentially a water right for fish habitat. Any water rights issued *after* the adoption date of the instream flow rule will be curtailed if flows fall below the instream flow. So, this rule may also help keep flows higher than they were in the summer of 2001.

Table 9. Spokane River Instream Flows

Location	Time	Flow (cfs)
Spokane River at Barker Road (Greenacres)	June 16 - September 30	500
Spokane River	October 1 - March 31	1700
	April 1 – June 15	6500
	June 16 – September 30	850

Avista calculated the inflows of all incoming water by using midnight to midnight lake elevation and day average outflow at midnight as recorded at Long Lake Dam (Figure 14). Maximum inflows in Lake Spokane typically occur during March, April, and May due to spring runoff. Peak flows in 2014 were significantly smaller than peak flows observed in 2011 and 2012, but were slightly greater than peak flows in 2013, and much greater than peak flows in 2010 (Figure 14).

Ecology's analysis of flow conditions from 1975 through 2014 shows that the inflow conditions for 2010 through 2014 were near or above average. Trends in annual minimum flows are declining in the Spokane River, and although this is likely to be somewhat offset by the minimum flows set for the Spokane River below Post Falls, it may also be affected by long-term trends in climate and aquifer withdrawals.

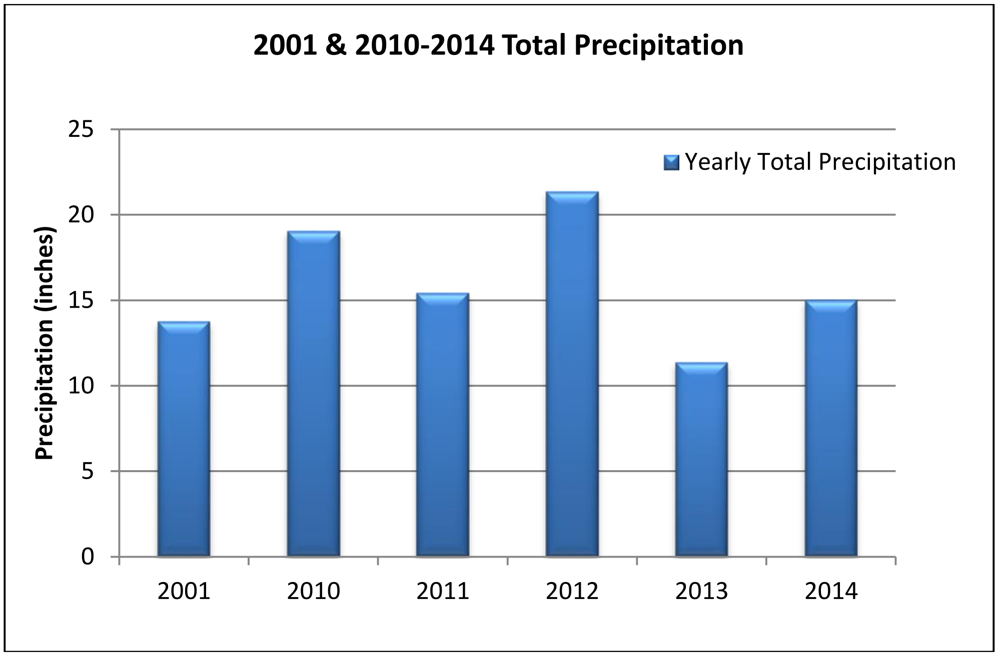


Figure 13. Precipitation data from the Spokane Airport for the TMDL critical year and 2010-2014

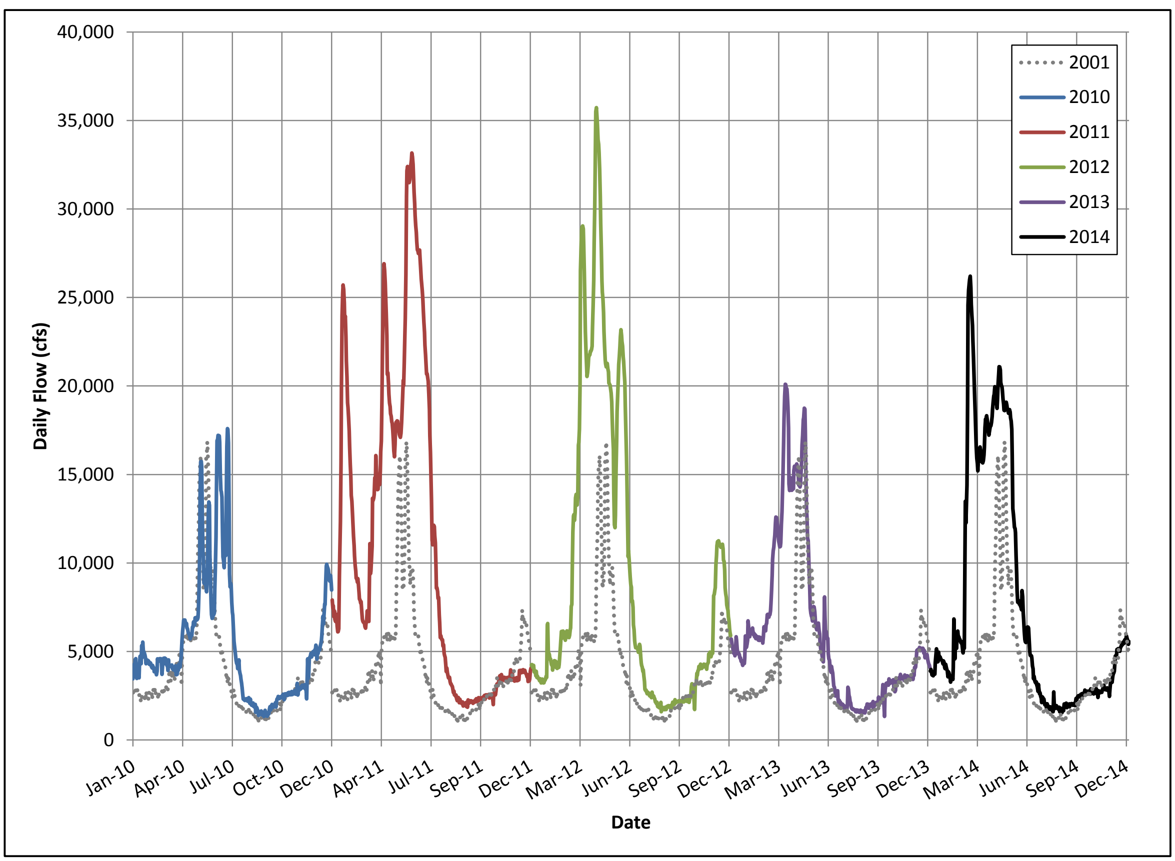


Figure 14: Total inflows into Lake Spokane 2010-2014 (Avista 2015)

Data Observations

Lake Coeur d'Alene
In Lake Coeur d'Alene, total phosphorus, soluble reactive phosphorus, and total nitrogen levels are variable, but the highest concentrations occur in spring during run-off, then decline through the rest of the year (Cooper 2014).

Spokane River

Idaho
The United States Geological Survey (USGS) used the LOADEST model to determine loads and flow-weighted concentrations as a way to reduce bias from "variation in the sampling frequency and timing of sampling over the stream hydrograph." (Clark and Mebane 2014). The river flow during water year 2010 was less than the mean, while most of water years 2011 and 2012 were greater than the historic 25-year mean. Water years 2009 and 2013 had flows right around the historic mean.

The mean flow-weighted total phosphorus concentration for all five years at the outlet of Coeur d'Alene was 0.008 mg/L, and near Post Falls the mean concentration was 0.009 mg/L. The authors attributed the 0.001 mg/L increase in total phosphorus between the sites to the wastewater treatment plants' discharge. Mean total nitrogen concentration at the Lake Coeur d'Alene outlet was 0.095 mg/L and near Post Falls mean total nitrogen increased by 0.035 mg/L to 0.130 mg/L. The water year 2009 to 2013 mean total phosphorus loading from Lake Coeur d'Alene into the Spokane River was 52.9 tons/year, and the mean total nitrogen load was 628 tons/year.

Washington
Figure 15 shows the variation in flow in relation to total and dissolved phosphorus (called ortho phosphorus) concentrations in the Spokane River at Riverside State Park. The flow data represent the median of monthly average flows between1990 and 2014 from the US Geological Survey (USGS), while the phosphorus data are the median of monthly observations from Ecology's 2004 to 2013 monitoring results. These are typical patterns observed since 2004 to 2013. The main sources of phosphorus to the Spokane River at the Riverside monitoring station are derived from point sources such as the City's Riverside Park Water Reclamation Facility, which provide a fairly constant phosphorus load to the river. As flow increases in the spring (March through May), phosphorus concentrations decline significantly due to dilution. When the lowest flows occur in late summer (August and September), total phosphorus concentrations increase from their May low (10 ug/L) to about 25 ug/L in August.

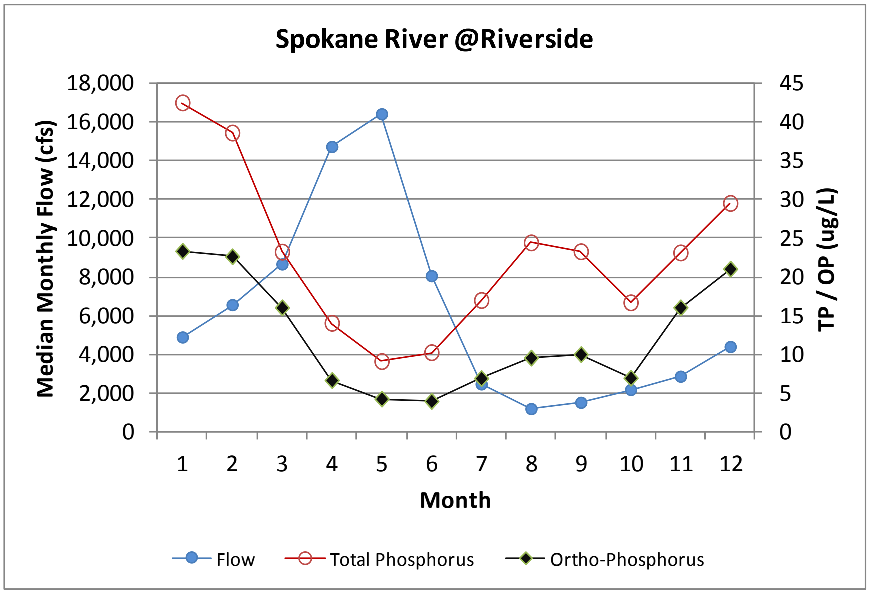


Figure 15. Typical seasonal variation in 1990-2014 flows and 2004 -2013 phosphorus concentrations observed at Ecology's Spokane River at Riverside State Park monitoring location

These seasonal phosphorus patterns changed in recent years (2012-2014) (Figure 16). Over the past few summer periods, phosphorus concentrations have remained low. Total phosphorus concentrations observed in 2014 at Ecology's Riverside State Park monitoring location during the most critical months for both algal growth and dissolved oxygen concentrations (June through September) ranged between 8.2 µg/L in June and 16 µg/L in August (0.0082 – 0.016 mg/L).

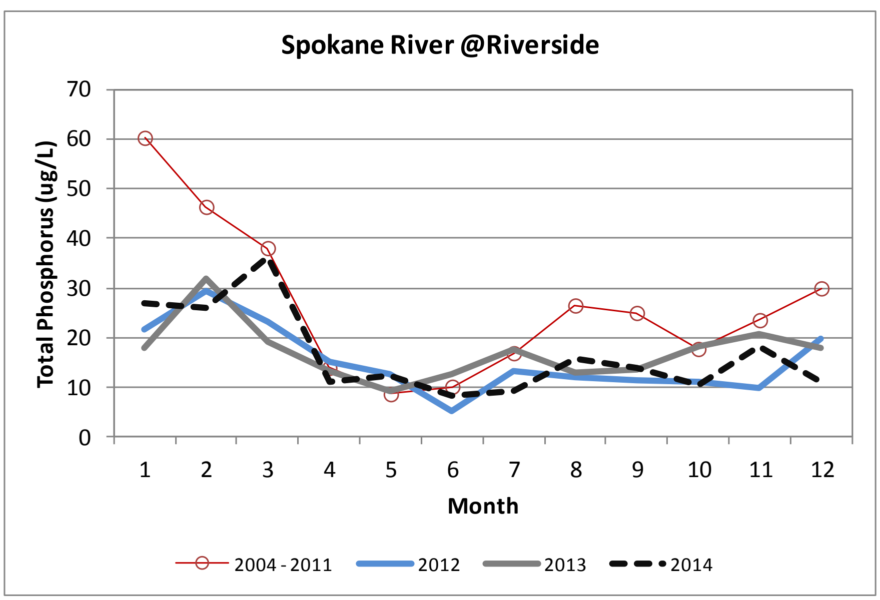


Figure 16. Median 2004-2011 total phosphorus concentrations in relation to those observed 2012 and 2013 at Ecology's Riverside monitoring location.

Looking at long-term patterns in total phosphorus (Figure 17) and ortho-phosphorus (Figure 18) it is evident that activities implemented to control phosphorus since 2012 are having a significant effect on reducing concentrations.

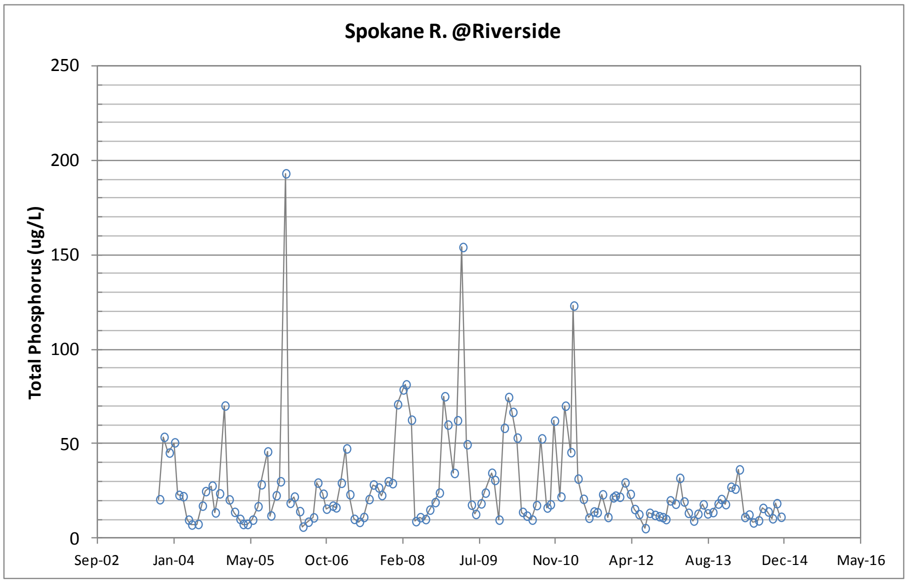


Figure 17. Variation in monthly total phosphorus concentrations at the Riverside monitoring location

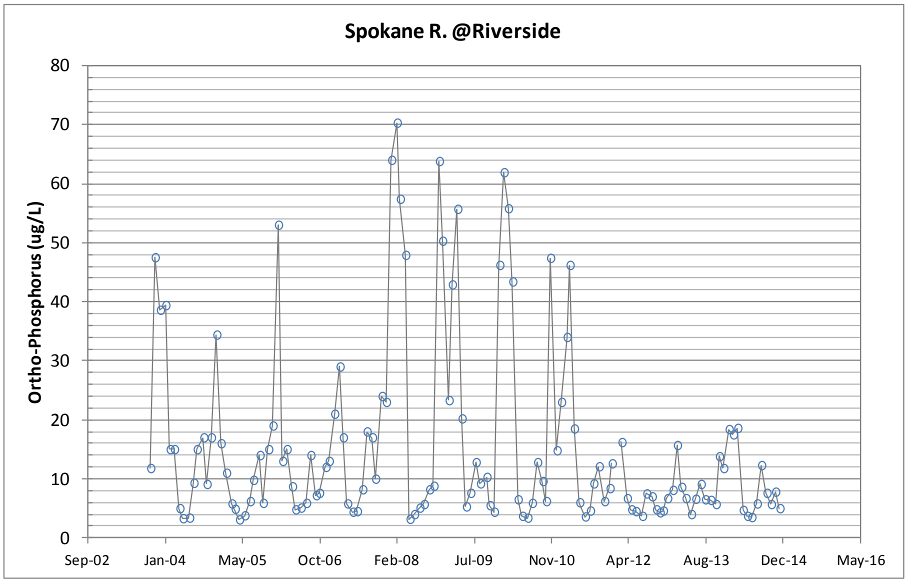


Figure 18. Variation in monthly ortho-phosphorus concentrations at the Riverside monitoring location

The last series of figures (Figures 19 and 20) display monthly phosphorus variation since the 1970s to the most recently reported data. For most months, phosphorus concentrations observed over the past three years are at historic low concentrations.

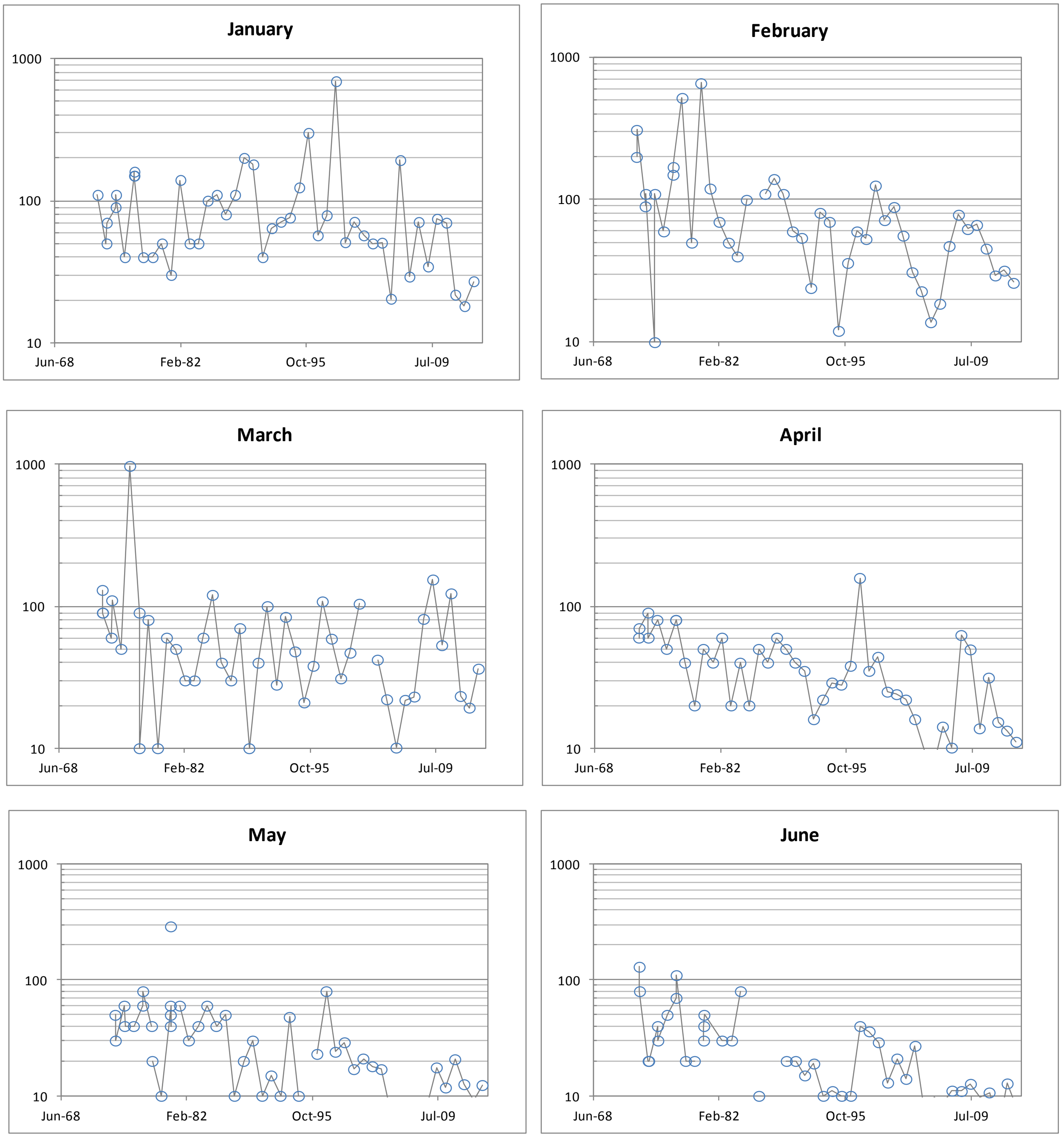


Figure 19. Variation in Spokane River total phosphorus concentrations (ug/L) (verticle axes), January to June, Riverside State Park monitoring location

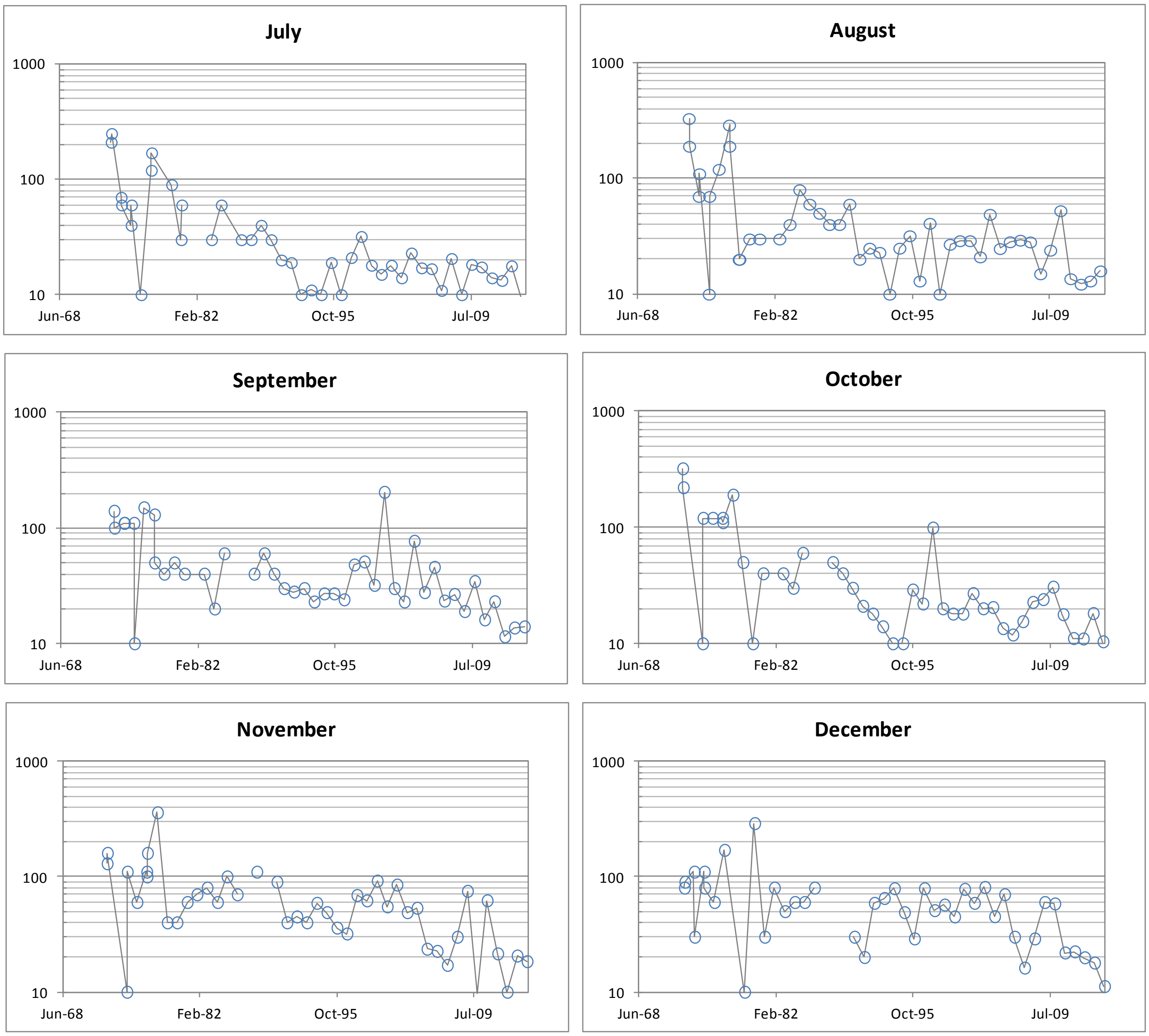


Figure 20. Variation in Spokane River total phosphorus concentrations (ug/L) (vertical axes), July to December, Riverside State Park monitoring location

Spokane River longitudinal data assessment

In August and September 2000, Ecology conducted sampling along the Spokane River from the Washington-Idaho state line to downstream of Nine Mile Dam to determine phosphorus concentration in the river as part of the Dissolved Oxygen TMDL investigation (Cusimano 2004, Ecology Publication 2004-03-006). More recent data, collected at several of the same locations, in August and September 2013 and 2014 indicate there has been a decrease in TP concentrations (Figure 21). The data used in Figure 21 are presented in Table 10, which provides the measured values, averages, and percent reductions from 2000 to 2013-14. All four sites shown in Table 10 had at least a 40 percent reduction in the average August and September total phosphorus concentration between 2000 and 2013-14.

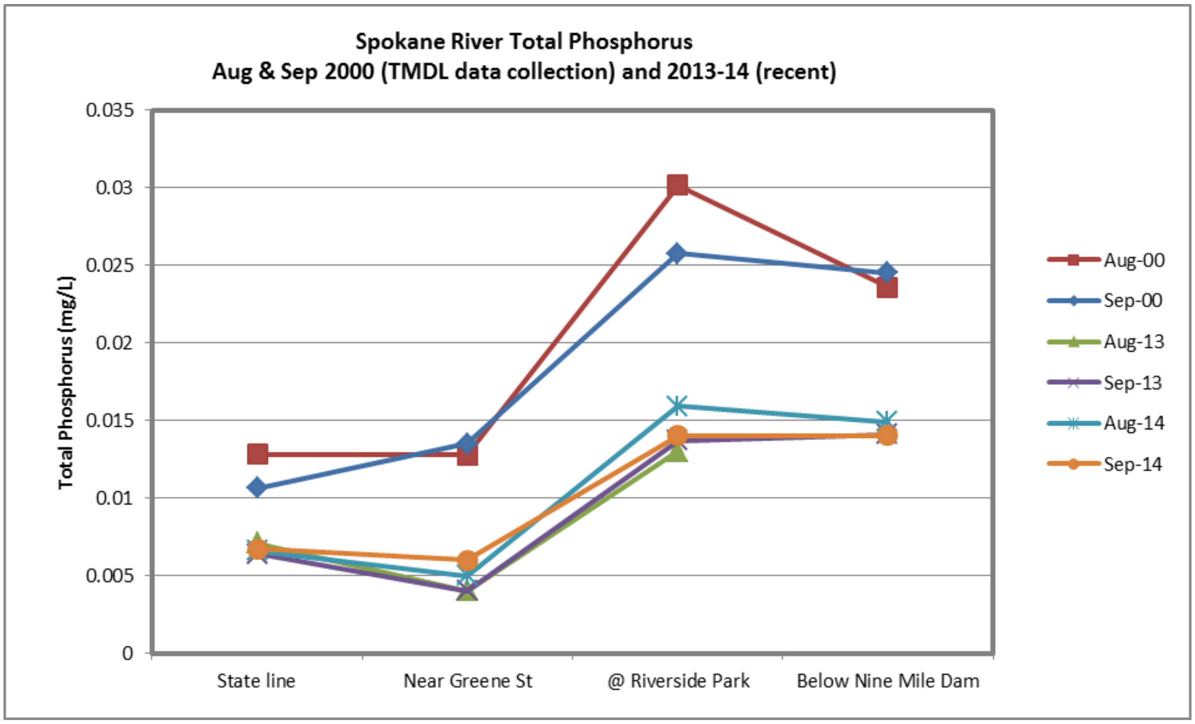


Figure 21: Spokane River total phosphorus concentrations from August and September data collected in 2000 and 2013-14 *(Ecology collected all of the data except 2013-14 data at Greene Street which were collected by Spokane County. Ecology data from 2013 and 2014 are preliminary. Samples collected in 2000 are averages of two grab samples per day collected over two consecutive days.)*

Table 10: Spokane River total phosphorus concentrations (mg/L)*

Sample Site	Stateline	Greene St	@ Riverside State Park	Below Nine Mile Dam
Aug 2000	0.013	0.013	0.030	0.024
Sep 2000	0.011	0.014	0.026	0.025
Average (2000)	0.012	0.013	0.028	0.024
Aug 2013	0.007	0.004	0.013	No sample
Sep 2013	0.006	0.004	0.014	0.014
Aug 2014	0.007	0.005	0.016	0.015
Sep 2014	0.007	0.006	0.014	0.014
Average (2013-14)	0.007	0.005	0.014	0.014
Percent change (of average), 2000 to 2013-14	-43%	-64%	-49%	-40%

* All data were collected by Ecology, except 2013-14 data at Greene Street which were collected by Spokane County. Ecology data from 2013 and 2014 are preliminary. Samples collected in 2000 are averages of two grab samples per day collected over two consecutive days.

Tributaries

Hangman Creek
The data indicate that the March to May timeframe is when phosphorus levels are highest at the mouth of Hangman Creek (Figure 22). Hangman Creek concentration data indicate high turbidity during February, April, and December 2012, as well as February, March, and April 2013. Fecal coliform bacteria was extremely high (estimated 1500 cfu/100 mL) during the December 2012 sampling event. Nitrates were high in February and December 2012 and January through March 2013. The pH levels regularly exceeded state water quality criteria, and exceeded nine pH units in May of 2013. Overall, the trend indicates generally decreasing phosphorus concentrations (Figure 23), except during the July-October timeframe for the most current data.

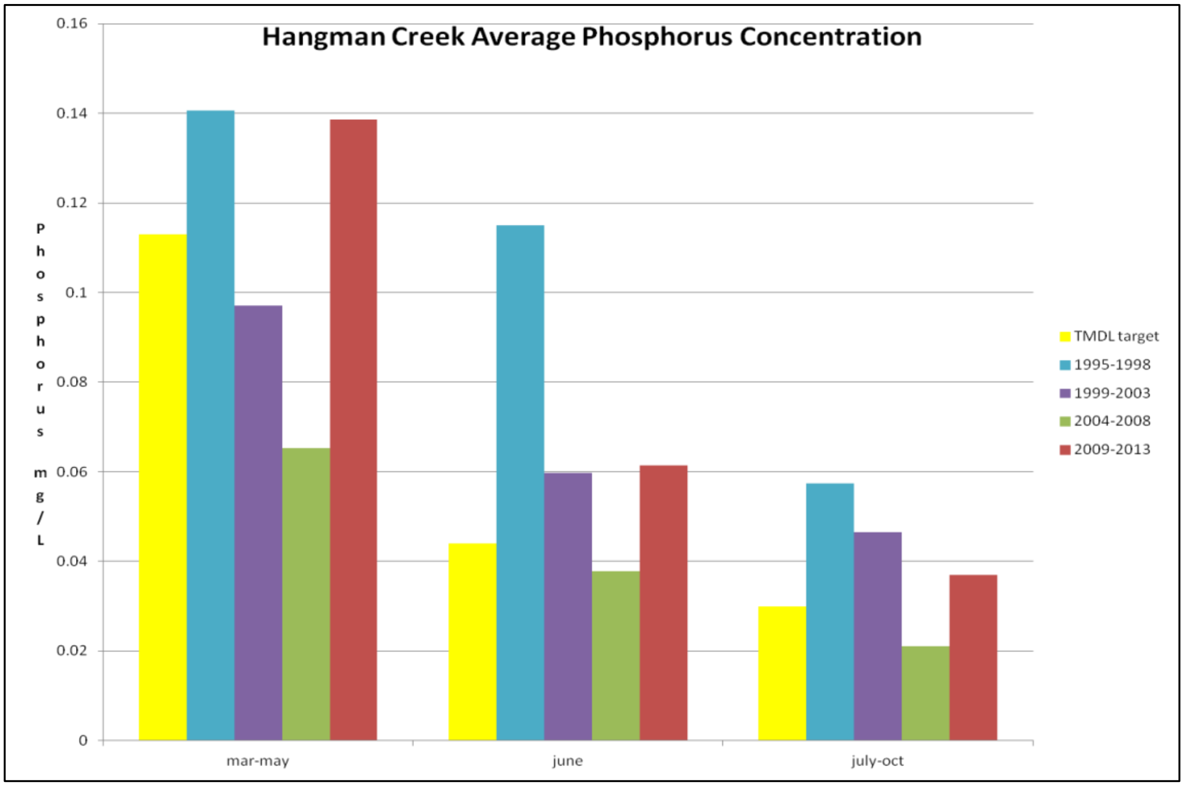


Figure 22. Hangman Creek historic average phosphorus concentrations

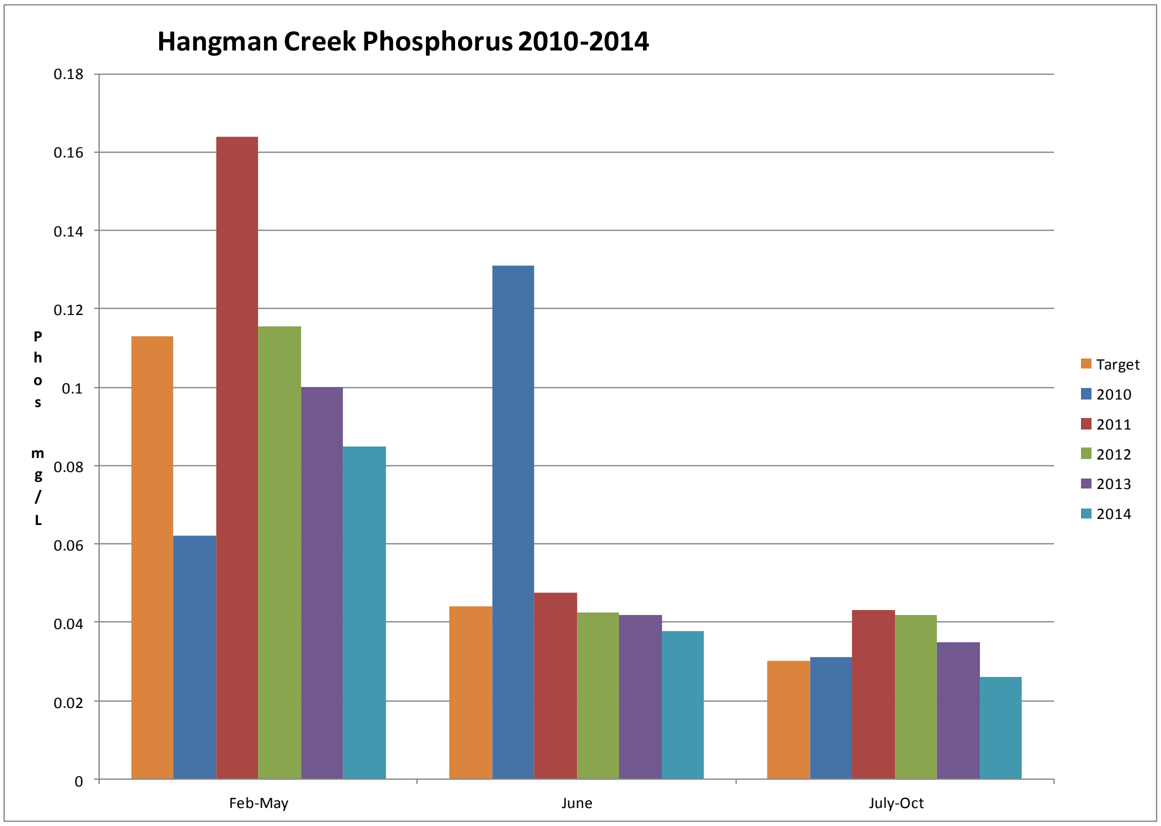


Figure 23. Hangman Creek current phosphorus concentrations

Little Spokane River

Similar to Hangman Creek, the data indicates that the March to May timeframe is when phosphorus levels are highest at the mouth of the Little Spokane River (Figures 24 and 25). The data suggest that phosphorus concentrations are higher during high flow years. As with Hangman Creek, the trend indicates generally decreasing phosphorus concentrations, except during the July-October timeframe for the most current data.

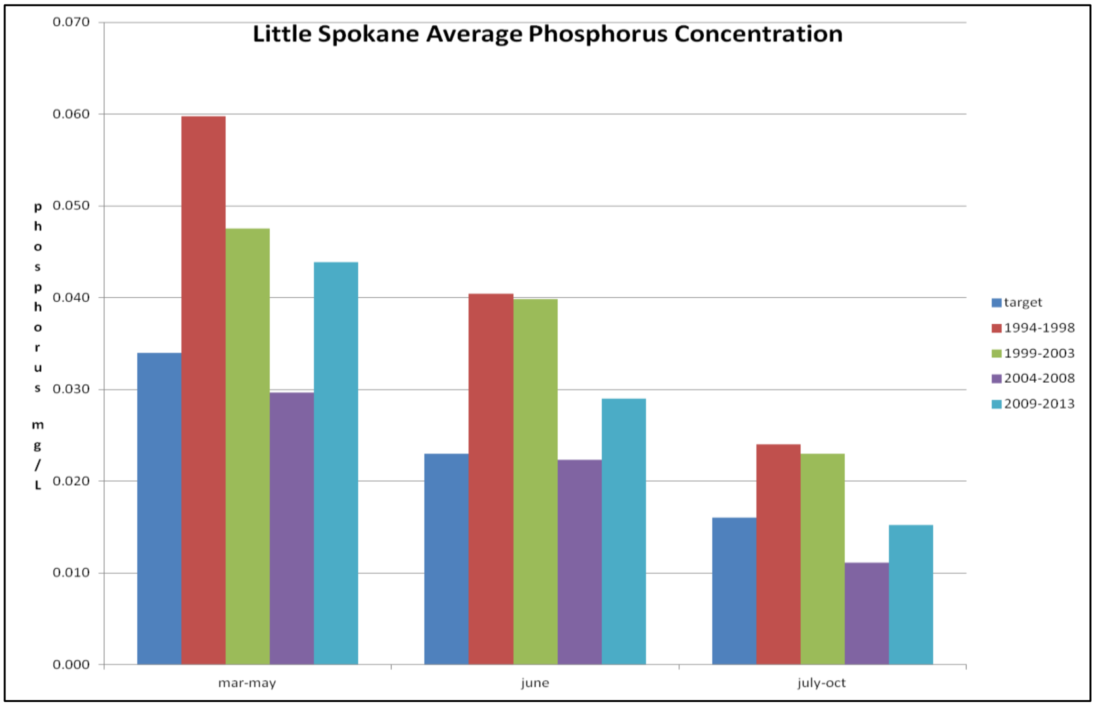


Figure 24. Little Spokane River historic average phosphorus concentrations

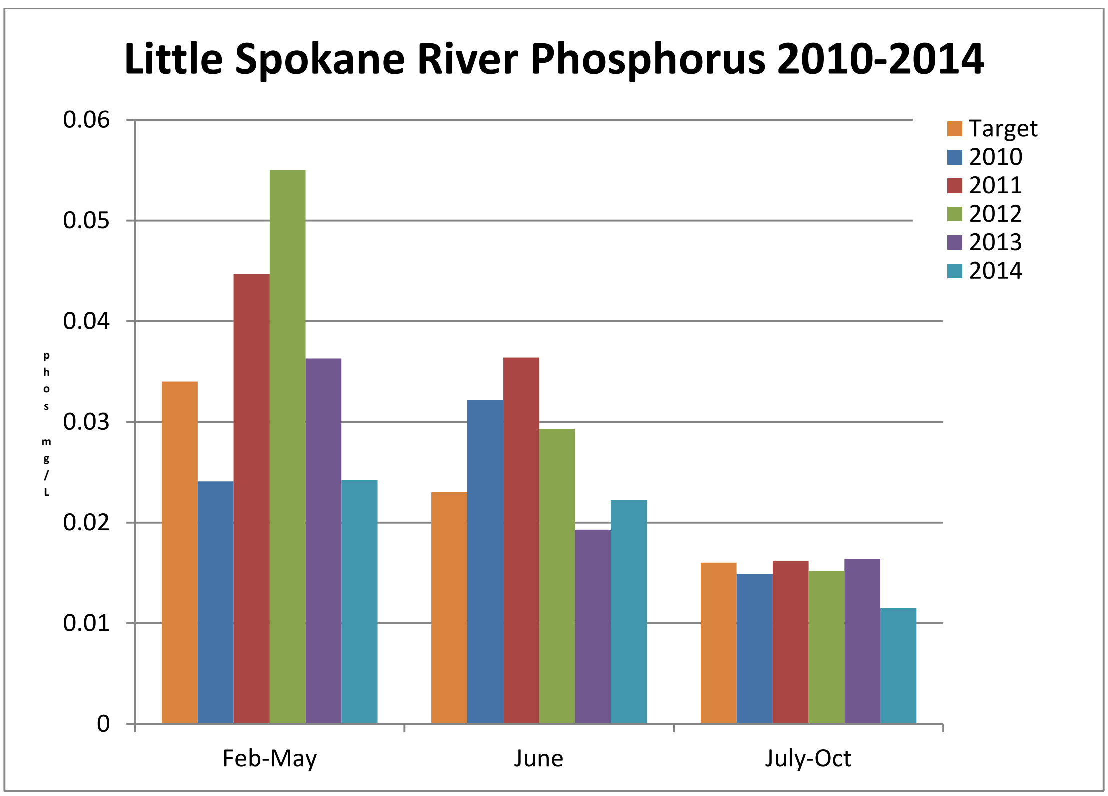


Figure 25. Little Spokane River current phosphorus concentrations

Coulee & Deep Creeks
Ecology's new sampling locations on Deep and Coulee creeks will help to refine the TMDL model. When the Spokane River model was constructed, Ecology made an assumption that the water from Deep and Coulee Creeks was similar to that from Hangman Creek. Preliminary data from sampling the Deep and Coulee Creek basin stations indicate this assumption was incorrect. The surface water concentrations appear to be lower than Hangman Creek in the spring, and higher during other times of the year. However, these surface water flows dry up several miles upstream from the confluence with the Spokane River, so it is unknown what nutrient concentrations enter the system.

Riverine Assessment Point
A key element of the TMDL was the inclusion of a riverine assessment point that would in theory parse out the contributions of upstream effects to the Spokane River from impacts due to hydrological modifications due to Long Lake Dam. To determine the phosphorus concentrations at the riverine assessment point, Ecology established a monitoring station immediately below Nine Mile dam (54A090). Flow weighted average of phosphorus at this station and that at the mouth of Little Spokane River (55B070) will determine progress towards this target. Figure 26 compares data collected for the riverine assessment during 2010 and 2014.

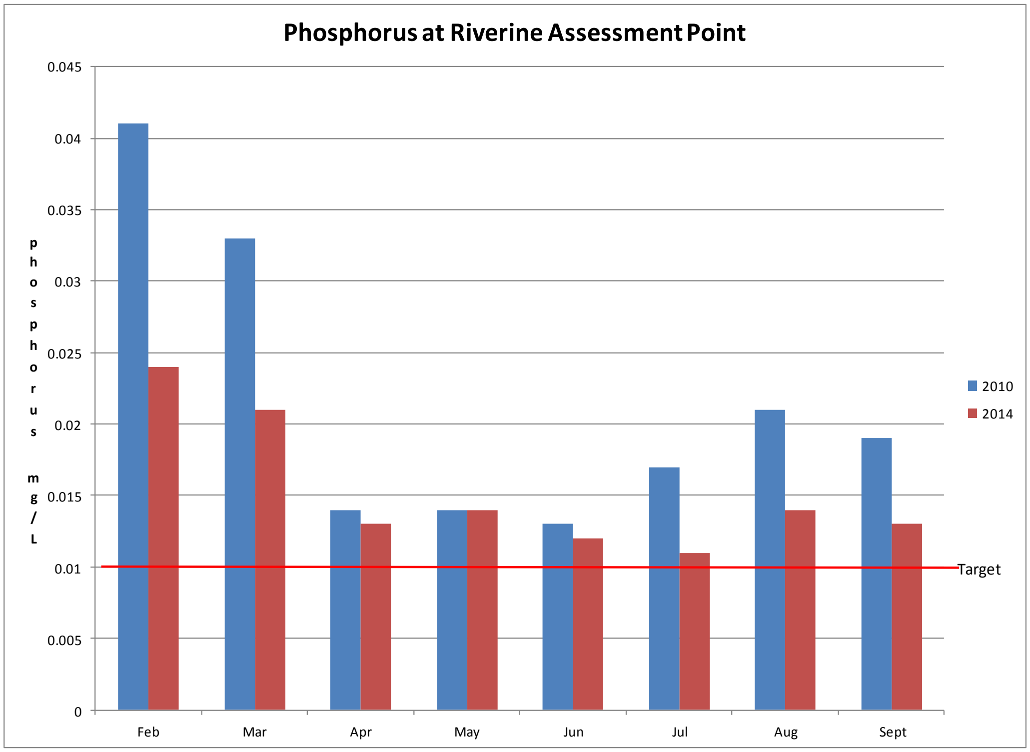


Figure 26. 2010 and 2014 average phosphorus concentrations at the riverine assessment point

Lake Spokane
The following discussion provides key highlights of select parameters from the Lake Spokane nutrient monitoring results from 2010 through 2014 (Avista 2015).

With regard to dissolved oxygen, average water column dissolved oxygen in 2014 ranged from 8.3 to 10.3 milligrams per liter (mg/L). Maximum dissolved oxygen concentrations ranged from 12.0 to 14.1 mg/L at the six stations, with the higher values occurring in the lacustrine zone during 2014. Over the five-year period of 2010 – 2014, maximum dissolved oxygen concentrations ranged from 10.7 to 14.5 mg/L in 2010, 11.9 to 12.4 mg/L in 2011, 11.4 to 12.5 mg/L in 2012, and 11.6 to 13.4 mg/L in 2013.

Minimum dissolved oxygen concentrations of 0.0 mg/L occurred near the bottom at the two deepest stations, LLO (~154 ft) and LL1 (~108 ft) in 2014. Minimum dissolved oxygen concentrations in 2010 – 2013 also occurred at the two deepest stations (LL0 and LL1), with minimum concentrations in 2011 being significantly higher (3.2, 6.9 mg/L).

The minimum dissolved oxygen concentrations near the bottom of LL0 and LL1 are associated with a small fraction of the water column, and may not reflect the average dissolved oxygen concentration throughout the entire hypolimnion. Volume weighting the dissolved oxygen concentrations is a method that provides an average concentration throughout the hypolimnion, and is calculated by the following technique:

> At each station, for each sampling day, measured dissolved oxygen concentrations from the hypolimnion (15 m and deeper) are multiplied by their associated volume of water, summed, and then divided by the total volume of water at each station from 15 m and deeper. The volumes of water were obtained from the CE-QUAL-W2 model segment volumes identified in the dissolved oxygen TMDL.

Figure 27 displays the results of the minimum volume weighted dissolved oxygen concentrations for each lacustrine station (LL0-LL2) for 2010-2014, and LL3 for 2012-2014. (Station LL3 has only a very small hypolimnion deeper than 15 m.)

With regard to total phosphorus, there are several ways to analyze data collected within a lake, including presenting the range of concentrations measured at all stations, at all depths, throughout the whole monitoring season. From this perspective, total phosphorus concentrations ranged from 4 to 70 micrograms per liter (µg/L) during 2014, with total phosphorus usually highest at stations LL0, LL1, and LL2 in the hypolimnion (49 ft and deeper) and higher levels usually occurred in July.

Total phosphorus concentrations can also be analyzed by isolating and averaging the concentrations measured in the epilimnion layer of the lake. Table 11 summarizes 2014 mean epilimnetic total phosphorus concentrations for the six Lake Spokane stations for various times during the year. Table 12 summarizes the mean epilimnion total phosphorus concentrations for Lake Spokane from 2010-2014 during these same times. Figure 28 shows the summer (June to September) epilimnetic mean total phosphorus concentrations. Summer mean epilimnetic total phosphorus levels in 2012 to 2014 were calculated using concentrations at 0.5 m and 5 m for stations LL0 to LL2, and concentrations at 0.5 m for stations LL3 to LL5. Summer means for 2010 and 2011 are based on averages from euphotic zone composite samples. Summer (June to September) mean eplimnetic total phosphorus concentrations in 2014 were lower than in 2010, 2012, and 2013, but similar to those in 2011.

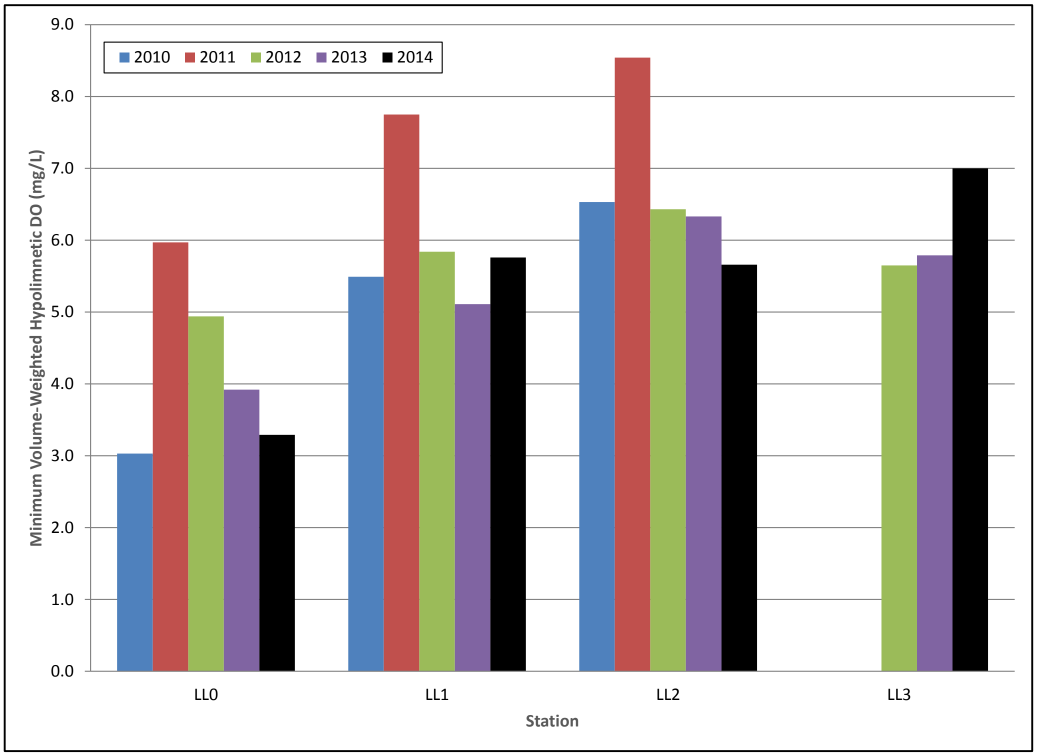


Figure 27. Minimum volume-weighted hypolimnetic DO in Lake Spokane at stations LL0, LL1, LL2 and LL3

Table 11. Mean epilimnetic TP concentrations for Lake Spokane in 2014

Mean Epilimnetic TP (µg/L)	Lake Station					
	LL5	LL4	LL3	LL2	LL1	LL0
May	15.8	16.3	16.7	11.4	10.5	11.1
June	8.4	7.7	7.7	12.0	7.9	8.5
July – Sept.	14.1	18.5	10.4	9.9	8.5	6.4
Oct.	8.2	18.9	9.1	9.9	14.3	6.0

Table 12. Mean epilimnetic TP concentrations for Lake Spokane for 2010-2014

Mean Epilimnetic TP (µg/L)	Lake Station					
	LL5	LL4	LL3	LL2	LL1	LL0
May	16.4	16.4	18.6	15.0	14.9	14.5
June	12.0	11.8	13.0	11.9	10.8	11.1
July – Sept.	16.5	17.9	10.5	10.4	9.5	8.6
Oct.	11.8	14.8	12.7	8.7	10.1	7.1

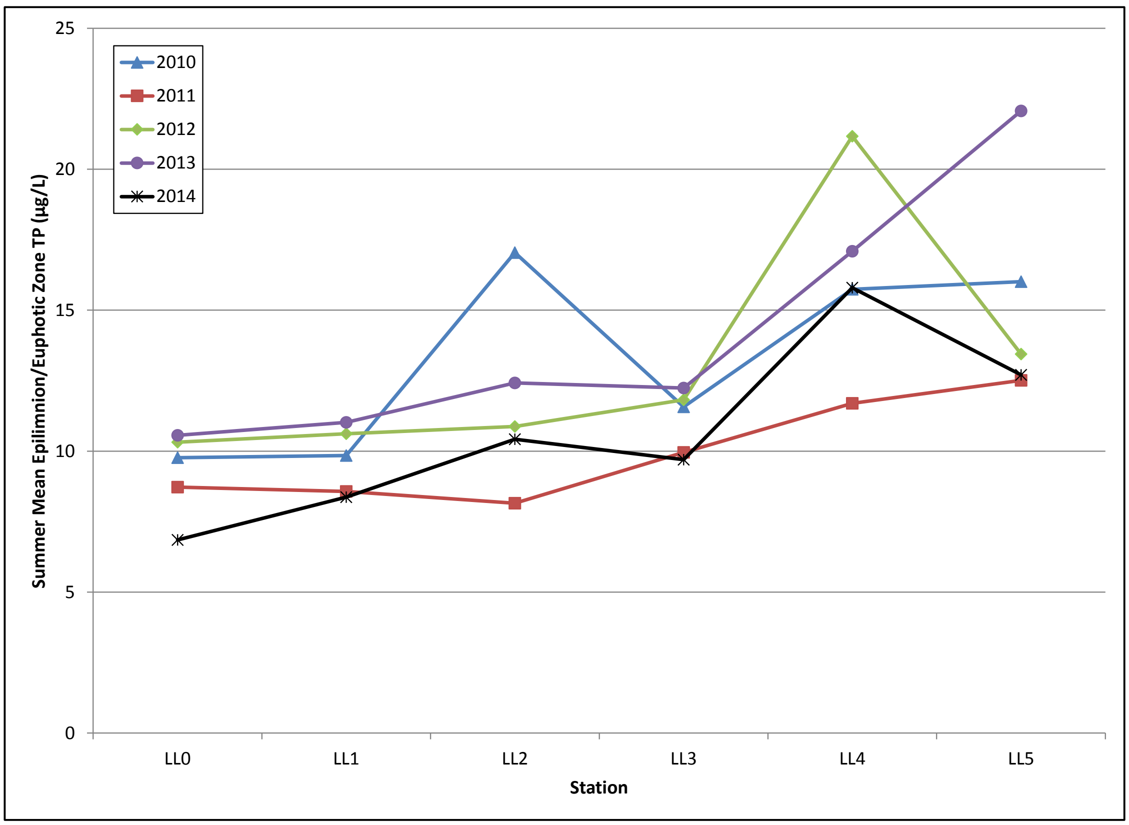


Figure 28. Summer mean epilimnion Total Phosphorus (TP) concentrations, 2010-2014
(Data is presented from down reservoir to up reservoir left to right.)

By applying volume weighting, which calculates the concentration relative to the volume of water it correlates with, total phosphorus concentrations for all stations during 2014 were 35 µg/L or below. As shown in Figure 28, summer mean total phosphorus decreased slightly through the reservoir in all five years with total phosphorus at station LL0 being the lowest (Tables 11 and 12).

Chlorophyll-a is a pigment that is present in all types of algae and is an indicator of the amount of photosynthetic activity occurring in the reservoir's surface waters. Similar to total phosphorus, summer mean epilimnetic chlorophyll-a concentrations in 2012-2014 were calculated using concentrations at 0.5 and 5 m for stations LL0 to LL2, and concentrations at 0.5

m for stations LL3 to LL5. Summer means for 2010 and 2011 are based on averages from euphotic zone composite samples. Chlorophyll-a concentrations at the six lake stations during 2014 ranged from 0.5 to 25.4 µg/L. Transparency (secchi disc depth) ranged from 5 to 25 ft throughout the reservoir. As shown in Figure 29, results from 2010 - 2014 indicate chlorophyll-a concentrations were highest in the lacustrine and transition zones of the reservoir during all five years.

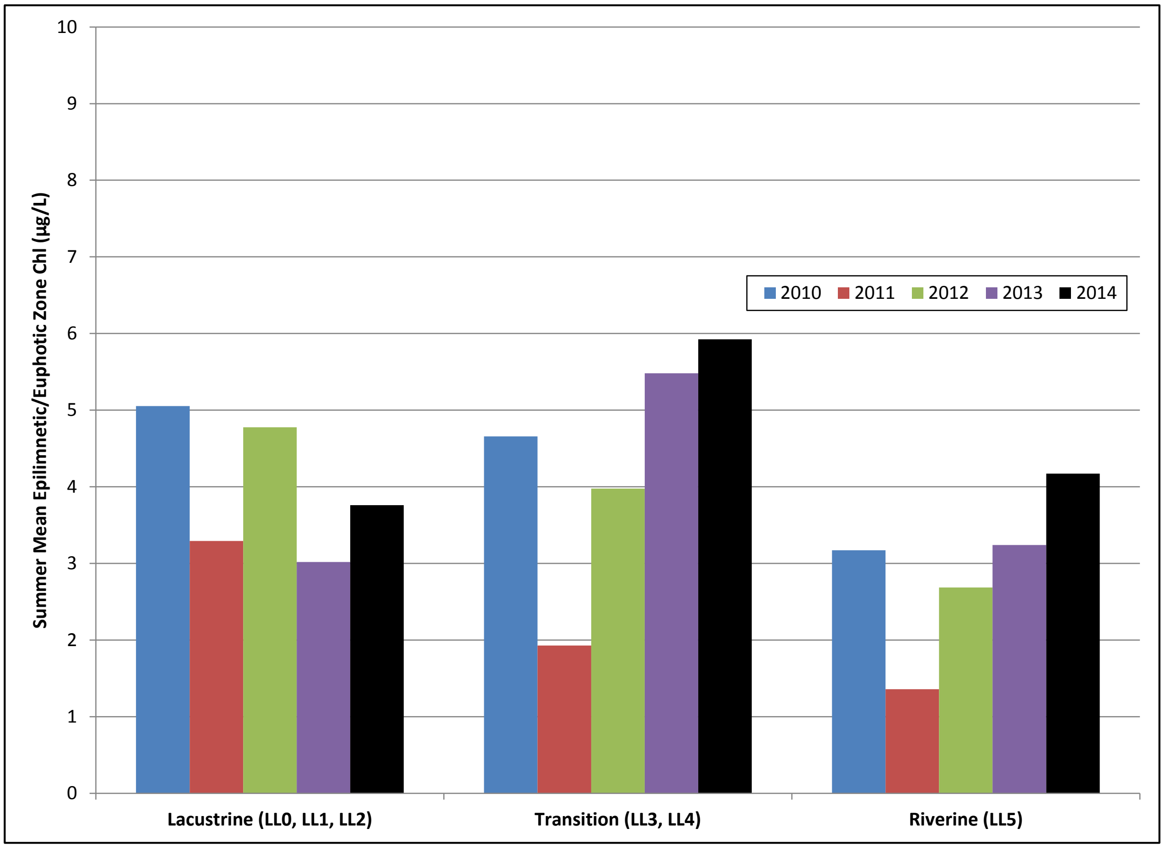


Figure 29. Summer mean epilimnion/euphotic zone chlorophyll-a concentrations, 2010-2014 (Data is presented from down reservoir to up reservoir left to right.)

Table 13 summarizes the summer (June-September) epilimnetic means for total phosphorus, chlorophyll-a, and transparency (Secchi disk depth) for each reservoir zone. Summer epilimnetic means provide a way to compare a significant amount of data across a number of years and is a method used to assess lake water quality and trophic state.

Phytoplankton samples have been collected in Lake Spokane at 0.5 m depth since 2011. Sample collection occurred once a month in 2011, and twice per month in 2012 to 2014. Mean summer (June-September) phytoplankton biovolume are shown in Figure 30. Overall phytoplankton biovolume was greater at all stations in 2013 and 2014.

The pattern of phytoplankton distribution showing maximum chlorophyll-a, cell density, and biovolume at LL4, usually indicates an in-reservoir source of phosphorus and algal-generated organic matter that provides dissolved oxygen demand to the lacustrine zone's meta and hypolimnia.

Table 13. 2012-2014 Summer (June to September) epilimnetic means compared to 2010 and 2011 Summer euphotic zone means in lacustrine, transition, and riverine zones in Lake Spokane

Year	Lacustrine (0.5, 5 m)			Transition (0.5 m)			Riverine Zone (0.5 m)		
	TP* (µg/L)	Chl** (µg/L)	Secchi (m)	TP* (µg/L)	Chl** (µg/L)	Secchi (m)	TP* (µg/L)	Chl** (µg/L)	Secchi (m)
2010	9.8	5.1	5.1	13.7	4.7	3.7	16.0	3.2	3.6
2011	9.1	3.3	5.8	10.8	1.9	4.7	12.5	1.4	4.8
2012	10.6	4.8	4.4	16.5	4.0	3.9	13.4	2.7	4.7
2013	11.3	3.0	5.7	14.7	5.5	3.9	22.1	3.2	4.1
2014	8.5	3.8	5.0	12.7	5.9	3.6	12.7	4.2	4.0
Average	9.9	4.0	5.2	13.7	4.4	4.0	15.3	2.9	4.2

* Total Phosphorus
** Chlorophyll-a

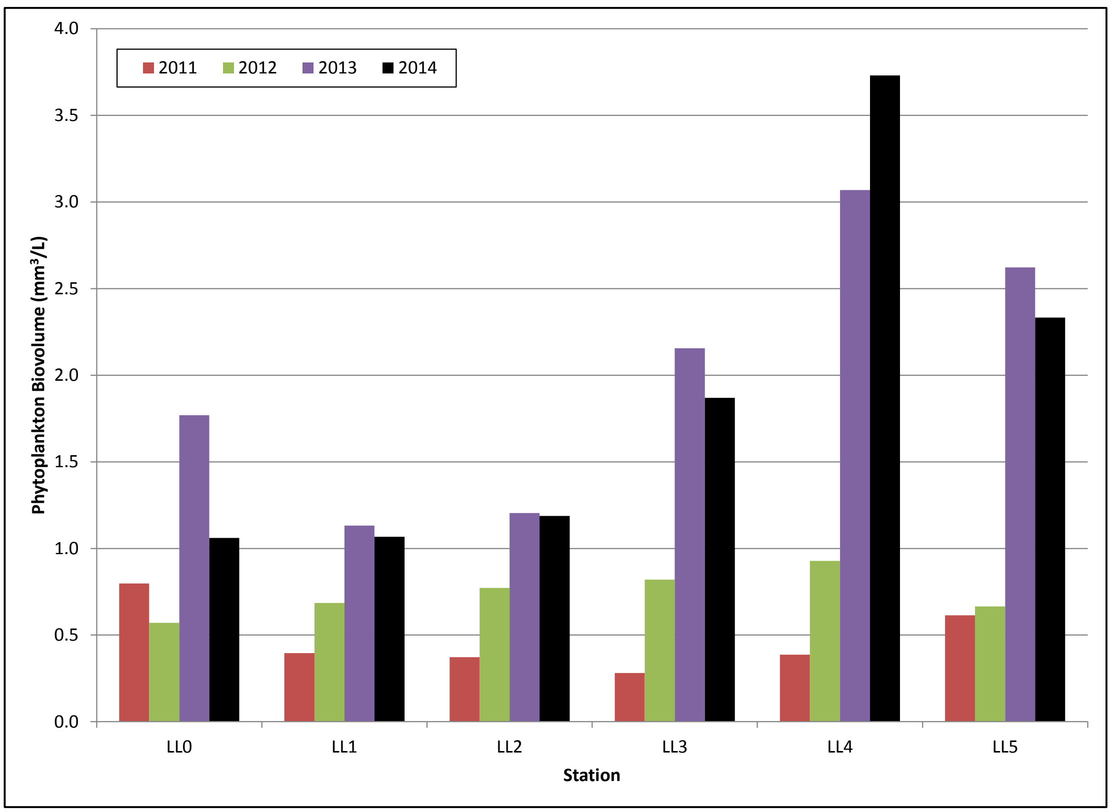


Figure 30. Summer (June-September) mean phytoplankton biovolume in Lake Spokane

Avista's 2013 Annual Summary Report includes an examination of all the water quality data since 1977, which can be accessed by visiting:

http://www.avistautilities.com/environment/spokaneriver/resources/Documents/Lake%20Spokane%20DOWQAP_2013%20Annuary%20Summary%20Rpt_1-31-14.pdf.

Groundwater
According to Greenlund (2015), Ray Street has the highest concentrations for both nitrate and phosphorus. Table 14 shows the highest yearly total phosphorus and nitrate concentration. The 2010-2014 average high phosphorus concentration at this location is 0.027 mg/L. The 2014 average total phosphorus concentration among the six wells other than Ray Street, is 0.004 mg/L, which is a slight increase 2013's average of 0.002 mg/L.

Of the locations sampled by Spokane County Water Resources Program in 2014 (Figure 31), 14 had concentrations above 0.010 mg/L, which is the TMDL target set at the riverine assessment point downstream of Nine Mile Dam. However, 14 wells is a decrease from 19 wells exceeding 0.010 mg/L in 2011. The highest phosphorus concentrations in groundwater appear to be decreasing as well (bolded numbers in Table 15). Except for a couple sites, the majority of wells with high phosphorus concentrations are located along the edge of the aquifer. Greenlund (2011-2014) asserts the higher concentrations are a result of runoff from the higher elevations at the edge of the aquifer.

Table 14. Ray Street well highest yearly total phosphorus and nitrate concentrations

Year	Total Phosphorus (mg/L)	Nitrate (mg/L)
2010	0.032	3.53
2011	0.024	3.33
2012	0.028	3.68
2013	0.026	3.59
2014	0.025	3.23

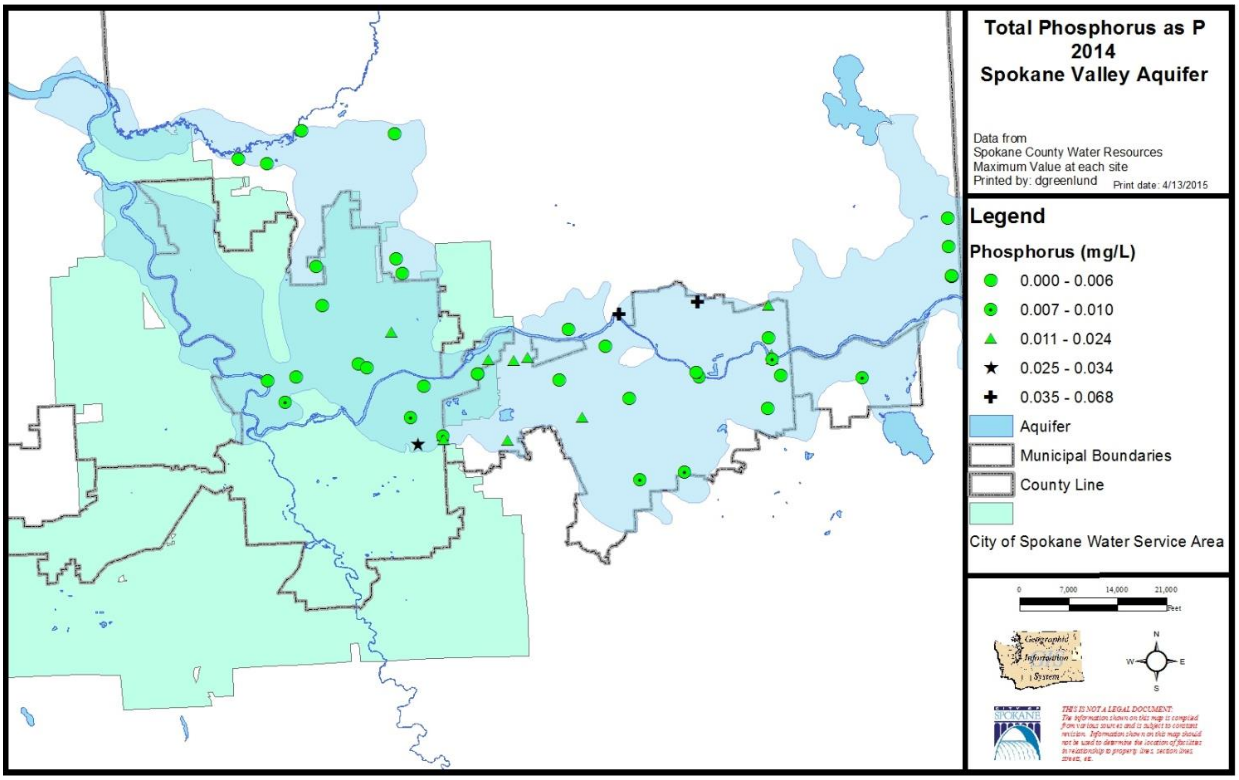


Figure 31. Total phosphorus concentrations in groundwater (Greenlund 2015).

Table 15. Spokane County highest well phosphorus concentrations

Year	2010	2011	2012	2013	2014
Range of highest Total Phosphorus concentrations (mg/L)	0.101**- 0.352**	0.101 **- 0.282**	0.101 – **0.150**	0.035 – **0.076**	0.035 – **0.068**
# of sampling sites above 0.010 mg/L	12	19	15	15	14

Monitoring Recommendations

Over nine different entities monitor some part of the basin, so the primary recommendation is to hold monitoring coordination meetings to discuss:

- How to enhance current monitoring efforts, such as coordinating sample collection on one day to get a synoptic data set of the entire basin.
- Verify who is collecting what data.
- Identify anything else the entities should collect or do while monitoring.
- Identify data gaps.

- Determine if resources should be refocused.

Another recommendation is to sample for phosphorus and other nutrients in the tributaries and river during springtime high flows. Nutrients carried by the high flows can linger in Lake Spokane and become trapped when the lake stratifies. Understanding where high nutrient concentrations come from in the spring can pinpoint where implementation efforts should occur.

Monitoring groundwater along Lake Spokane shorelines with housing developments, such as the Nine Mile community is recommended. If groundwater is found to contain low levels of nutrients, the monitoring results can be used to update future model runs. On the other hand, if groundwater contains higher nutrient levels, then working with the communities to reduce the nutrients will lead to water quality improvements in the lake.

Funding

The amount of money groups have spent toward reducing phosphorus is significant, and the amount will greatly increase within the next several years. Understanding the amount of money various groups spend on activities indicates the dedication, or level of effort toward improving water quality.

Between 2010 and 2014, Ecology provided more than 131 million dollars toward water quality improvement in the entire Spokane basin (the Spokane River, Hangman Creek watershed, Little Spokane River watershed, and Lake Spokane). Ecology's funding includes grants, loans, and forgivable principle among five general categories to improve water quality (Figure 32):

- Reducing combined sewer overflows
- Upgrading wastewater treatment plants
- Treating and reducing stormwater
- Replacing or removing septic systems
- Installing nonpoint source best management practices

Comparing the amount of money spent on each category is not an indicator of how much work was accomplished due to the large disparity of project cost. For example, a wastewater treatment plant upgrade is much more expensive than installing nonpoint source best management practices such as erecting fences and planting trees and shrubs. A list of Ecology funded projects is provided in Table 16. Stormwater projects are the most common with 18 projects, followed by 11 nonpoint source projects and 10 wastewater treatment projects. It is unknown how much of the available funding recipients have spent.

Ecology supplies only some of the money used to improve water quality in the basin. Many other sources also contribute such as funding recipients, businesses (which do not qualify for Ecology funding), the Washington State Conservation Commission, landowners and rate payers, Washington State Department of Commerce, the State of Idaho, etc. For example, grant amounts shown in Table 16 do not include the 25 percent match that recipients are required to contribute toward the project. For the 11 non-point source projects, the recipients must collectively add over $363,000 as either cash match or in-kind contributions. In addition, loan recipients must pay back the loan. Table 17 provides a list of non-Ecology funding that some entities within the Spokane basin have contributed toward water quality improvement. Not accounted for in Table 17 are the hours volunteers have spent on some projects such as the annual Willow Warrior event, or working on behalf of The Lands Council.

Finally, as indicated above, efforts to reduce nutrients in the Spokane basin began before 2010, so the amount of money spent toward water quality improvement is much higher than indicated here. The following list is a small example of the funding spent between 2001 and 2009:

- The City of Spokane spent over $107 million on upgrades to the Riverside Park Water Reclamation Facility to improve effluent water quality; $6 million to reduce combined sewer overflows; $1.7 million to reduce stormwater flows; and $4.3 million on sanitary sewer aquifer protection projects.

- The City of Spokane and Spokane County contributed $55 million toward their Septic Tank Elimination Program.
- Collectively, the City of Post Falls, Hayden Area Regional Sewer Board, and Liberty Lake Sewer and Water District funded $15.6 million in wastewater treatment upgrades.

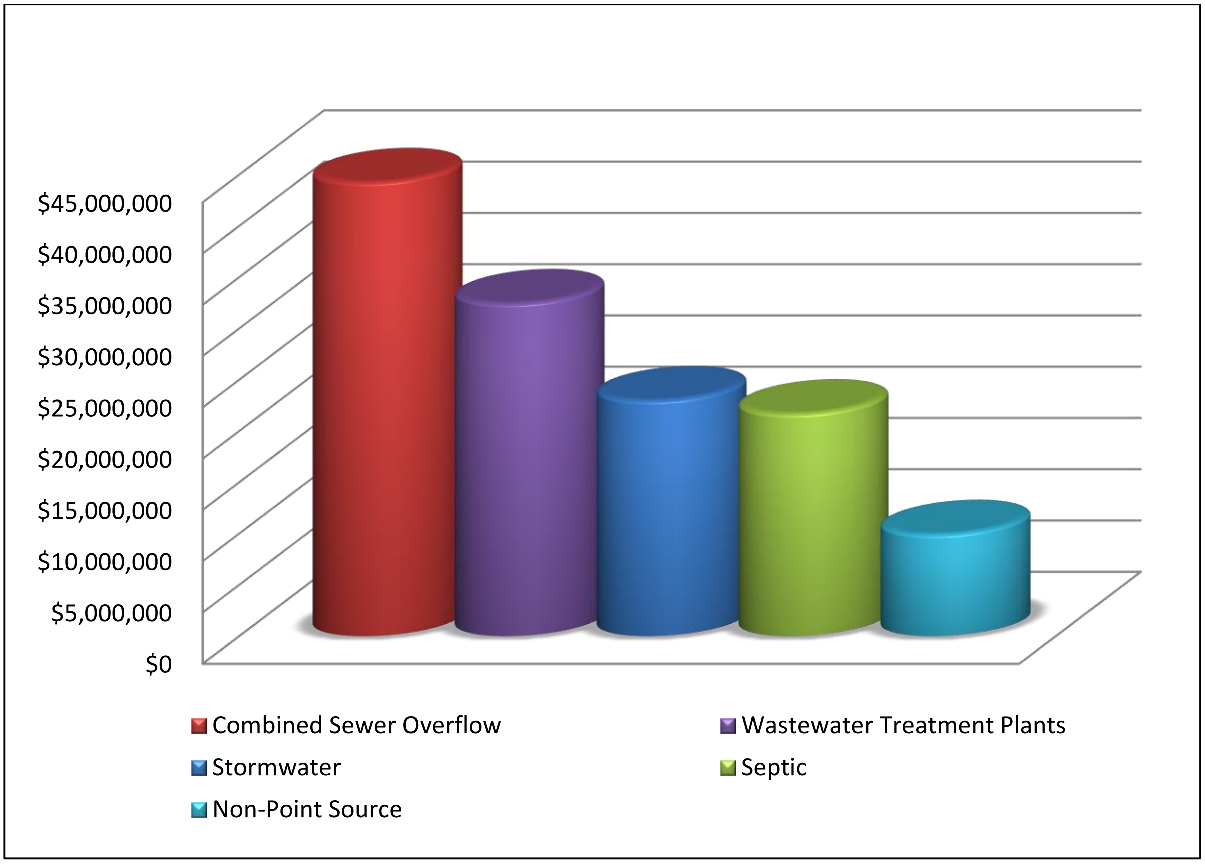


Figure 32. Ecology funding in the Spokane watershed by project category.

Table 16. Ecology Funded projects in the Spokane Watersheds

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
Non-Point Source	Pend Oreille Conservation District	Little Spokane River Watershed Restoration	$213,747		$213,747	
	Spokane Conservation District, Stevens Co Conservation District, Lake Spokane Landowners Association, Ecology	Lake Spokane Shoreline Implementation and Education Project	$41,892		$41,892	
	Spokane Conservation District	Spokane County Livestock and Land Program	$250,000	$100,000	$350,000	
	Spokane County Conservation District	Bear Creek Livestock BMP Continuation	$168,750		$168,750	
	Spokane County Conservation District	Conservation Tillage Sediment Reduction Program		$43,375	$43,375	
	Spokane County Conservation District	Direct Seed Loan Program	$73,765	$8,333,398	$8,407,163	
	Spokane County Conservation District	Hangman Creek Phosphorus Reduction	$128,000		$128,000	
	Spokane County Conservation District	Hangman Creek TMDL Implementation Project	$250,000		$250,000	
	Spokane, City of	Garden Springs Creek Restoration	$154,345		$154,345	
	The Lands Council	Riparian Restoration in Hangman Creek	$75,000		$75,000	11 projects
	Stevens County Conservation District	South Stevens Education & Monitoring	$99,625		$99,625	$9,931,897
Septic	Airway Heights, City of	The Septic Tank Elimination Project	$133,316	$757,684	$891,000	
	Spokane Conservation District	Spokane County Septic Tank Replacement Loan Program	$350,000	$450,000	$800,000	3 projects
	Spokane County & City of Spokane	Spokane-Rathdrum Prairie Aquifer Protection Project	$20,000,000		$20,000,000	$21,691,000
Combined Sewer Overflow	Spokane, City of	CSO 34-1 Project		$3,478,000	$3,478,000	
	Spokane, City of	CSO 41 Control Facility		$4,968,000	$4,968,000	
	Spokane, City of	CSO Basin 10 Abatement Project		$957,519	$957,519	
	Spokane, City of	CSO Basin 20		$4,521,400	$4,521,400	
	Spokane, City of	CSO Basin 26 Control Facility		$1,195,000	$1,195,000	

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
	Spokane, City of	CSO Basin 33-2 Control Facility		$4,270,800	$4,270,800	
	Spokane, City of	CSO Basin 34-2 and 34-3 Control Facilities		$20,719,000	$20,719,000	8 projects
	Spokane, City of	CSO Basins 38-39-40 Control Facilities		$4,135,238	$4,135,238	$44,244,957
Stormwater	Spokane County	2013-15 Municipal Stormwater Capacity Grant Program	$170,000		$170,000	
	Spokane County	Country Homes Boulevard Restoration Project	$1,750,000		$1,750,000	
	Spokane County	Municipal Stormwater Capacity Grant Program	$484,027		$484,027	
	Spokane County	Spokane County Regional Decant Facility	$684,000		$684,000	
	Spokane County	Spokane County UIC/Water Quality Retrofit Project	$206,250		$206,250	
	Spokane Valley, City of	2013-15 Municipal Stormwater Capacity Grant Program	$170,000		$170,000	
	Spokane Valley, City of	Spokane Valley Regional Decant Facility	$735,000		$735,000	
	Spokane Valley, City of	Sprague Avenue UIC Elimination	$666,622		$666,622	
	Spokane Valley, City of	Sullivan Bridge Drain Retrofit	$237,375		$237,375	
	Spokane Valley, City of	Phase II Stormwater Pass-through Grant Program	$50,000		$50,000	
	Spokane, City of	Cannon Hill Pond Retrofit		$277,000	$277,000	
	Spokane, City of	Hazel's Creek Downstream Conveyance LID Demonstration Project	$183,710	$1,428,960	$1,612,670	
	Spokane, City of	River Runoff Reduction Phases 1 and 2		$1,372,800	$1,372,800	
	Spokane, City of	Summit Low-Impact Urban Retrofit Project		$1,848,985	$1,848,985	
	Spokane, City of	Summit-Nettleton (formerly Bridge Avenue) LID project	$342,000		$342,000	
	Spokane, City of	Wet Weather Integrated Strategic Planning		$5,220,000	$5,220,000	

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
	Spokane, City of	Cochran Basin River Runoff Reduction & stormwater conveyance	$2,000,000	$5,100,000	$7,100,000	18 projects
	Spokane, City of	Phase II Stormwater Pass-through Grant Program	$50,000		$50,000	$22,976,729
Wastewater Treatment Plants	Airway Heights, City of	Water Reclamation and Recharge Project	$2,923,104	$9,026,454	$11,949,558	
	Airway Heights, City of	City of Airway Heights WasteWater Treatment Reclamation and Recharge Project (Phase 1B)		$13,646,092	$13,646,092	
	Deer Park, City of	Deer Park Aerated Lagoon Screening and Aeration Project	$1,126,540	$593,952	$1,720,492	
	Deer Park, City of	Effluent Reuse Feasibility Study/Sewer Plan Update	$30,000	$30,000	$60,000	
	Deer Park, City of	Wastewater Storage Lagoon #1 and #2 Upgrade		$300,375	$300,375	
	Liberty Lake Sewer and Water District	Engineering Report		$82,073	$82,073	
	Liberty Lake Sewer and Water District	Water Reclamation Plant Upgrades – Phase II		$900,000	$900,000	
	Rockford, Town of	Rockford Wastewater Treatment Facility Improvements Project	$1,805,343	$1,093,911	$2,899,254	
	Tekoa, City of	Infiltration and Inflow Reduction Improvements	$824,102		$824,102	10 projects
	Tekoa, City of	Tekoa Infiltration and Inflow Reduction Design Project	$53,199		$53,199	$32,435,145
					Total:	**$131,279,729**

* Includes grants and loans with forgivable principle but amounts do not include recipient's required match

** Loans are repaid by recipients

Table 17. Non-Ecology funding spent by category.

Type	Entity	Activity or Project Name	Expenses 2010-2014	Funding Source	2010 - 2014 Category Totals
Nonpoint Source	Spokane Conservation District	Spokane County Livestock and Land Program	$30,000	landowners & SCD	
	Spokane Conservation District	Bear Creek Livestock BMP Continuation	$42,000	landowners & SCD	
	Spokane Conservation District	Hangman Creek Phosphorus Reduction	$32,000	landowners & SCD	
	Spokane Conservation District	Hangman Creek TMDL Implementation Project	$62,500	landowners & SCD	$ 166,500
Septic	City of Spokane	Haven Street Septic Removal	$96,000	Utility Rates	$96,000
Combined Sewer Overflow	City of Spokane	CSO Basins 38-39-40 Control Facilities	$2,000,000 $1,836,500	PWTF Utility Rates	
	City of Spokane	CSO Basin 10 Control Facility	$653,200	Utility Rates	
	City of Spokane	CSO Basin 34-2 and 34-3 Control Facilities	$627,300	Utility Rates	
	City of Spokane	CSO Weir Modifications	$1,349,800	Utility Rates	$ 6,466,800
Stormwater	City of Spokane	Lincoln SURGE	$1,131,500	Utility Rates	
	City of Spokane	Broadway SURGE	$362,200	Utility Rates	
	City of Spokane	14th and Lindeke Stormwater Improvements	$236,200	Utility Rates	
	City of Spokane	16th Ave from Chestnut to Inland Empire Way	$147,200	Utility Rates	
	City of Spokane	SVI Stormwater Improvements	$61,200	Utility Rates	
	City of Spokane	Kendall Yards Stormwater Tank	$128,600	Utility Rates	
	City of Spokane	Summit-Nettleton (formerly Bridge Avenue) LID project	$197,200	Utility Rates	
	City of Spokane	Hazel's Creek LID Demonstration Project and Third Detention Pond	$693,600	Utility Rates	
	City of Spokane	Street Tree Inventory	$250,000	Utility Rates	
	City of Spokane	Vactor Waste Decant Facility	$769,900	Utility Rates	$3,977,600
Municipal and Industrial Wastewater Treatment Plants	Kaiser	Conversion to air cooling - discharge reduction	$733,000 [1]	Industry	
	HARSB	PHASE IIIC -Oxidation Ditch/Clarifier	$ 66,489	Cap Fees	
	HARSB	Long Range Facility Plan	$ 254,047	User/Cap Fees	
	HARSB[2]	Biological Nutrient Removal Phase I Facility Upgrade	$ 8,426,552	Entity DEQ Loans/Cap Fees/ User Fees	
	City of Post Falls	2011 Facility Plan	$ 214,000	Ratepayers	
	City of Post Falls	2011 AlgEvolve Pilot Test	$ 56,000	Ratepayers	
	City of Post Falls	2014 Phase I Design	$ 720,000	Ratepayers	
	City of Spokane[3]	Riverside Park Water Reclamation Facility Upgrades	$42,030,600	Utility Rates	$ 222,500,688

Type	Entity	Activity or Project Name	Expenses 2010-2014	Funding Source	2010 - 2014 Category Totals
	Spokane County[3]	Spokane County Regional Water Reclamation Facility project	$170,000,000	Ratepayers	

[1] Cost does not include third party costs for modifications to an on-site leased facility
[2] HARSB Construction Costs are through 2/2015, with estimated phase 1 total $15,756,914.37; Due to being a Joint Resolution Non Taxing Entity HARSB cannot Bond or take out Loans
[3] Capital costs only. Does not include operations and maintenance or finance charges.

Progress Report

There is a high level of energy among the groups working to reduce phosphorus in the watershed. Multiple activities underway, described in the preceding pages, provide evidence of the energy and money groups are investing in the TMDL's goals. The following section discusses progress in relation to water quality, the allocations, TMDL goals, and the Nonpoint Source Phosphorus Reduction Plan.

Water Quality of the Spokane River and Lake Spokane

As discussed in the monitoring section above, during the summer total phosphorus concentrations in the river are trending downward at the Idaho-Washington state line, Greene Street, Riverside State Park, and the riverine assessment point below Nine Mile Dam (Table 10). The average total phosphorus concentration for the months of August and September in 2013 and 2014 at the state line are 0.005 mg/L less and 0.008 mg/L less at Green Street than they were in 2000. Since 2012, total phosphorus levels are consistently less than 0.020 mg/L for much of the critical season (March through October) at Ecology's Riverside State Park monitoring location. In contrast, during November 2010 at that same location, the total phosphorus concentration was over 0.045 mg/L. At the riverine assessment point downstream of the Nine Mile Dam, the average total phosphorus concentration for August and September is 0.010 mg/L less than the 2000 average concentration for the same time period. Total phosphorus concentrations at this assessment point have not yet met the 0.01 mg/L (10 μg/L) target established by the TMDL, but the level is within 0.005 mg/L of attaining the goal.

The two deepest and furthest downstream Lake Spokane monitoring sites (LL1 and LL0) continue to experience the lowest dissolved oxygen levels in the hypolimnion. Years with higher flows, such as 2011, help keep dissolved oxygen levels in this bottom layer higher. In the past five years, minimum volume-weighted dissolved oxygen in the hypolimnion at LLO ranged from 3 to almost 6 mg/L (Figure 27), with 2010 levels being the lowest. Mean summer total phosphorus concentrations in the epilimnion show a slight downward trend through the reservoir, meaning LL5 near Nine Mile typically has higher concentrations and LLO has the lowest concentration.

TMDL Allocations

Wasteload Allocations

Entities discharging into the Spokane River in Washington have wasteload allocations (Table 1). Ecology issued permits with interim limits and a ten-year compliance schedule allowing the dischargers to make gradual progress toward achieving the allocations. Data from the dischargers is included in Appendix C. Kaiser Aluminum and Spokane County are meeting their allocation. The remaining dischargers have demonstrated reductions in total phosphorus, ammonia, and carbonaceous biochemical demand (CBOD) in recent years and are meeting their interim permit limits.

The TMDL also assigned stormwater and combined sewer overflow wasteload allocations. The available data (Appendix A) for these sources is limited, so it is not possible to identify if nutrient concentrations have changed.

The Idaho dischargers' permits with interim limits and a compliance schedule to meet Lake Spokane water quality standards became effective on Dec. 1, 2014. Data from the Idaho Dischargers is also available in Appendix C and show some declines as well.

Load Allocations

In TMDLs, nonpoint sources of pollution receive load allocations. The load allocations for the Spokane TMDL were assigned to the three tributaries, groundwater upstream of Lake Spokane, and the Lake Spokane watershed combined with groundwater, each of which is discussed below.

Hangman Creek is demonstrating a downward trend in total phosphorus concentrations during the critical season. March and May continue to have the highest concentrations during the critical period. The good news is that three of the last five years experienced lower total phosphorus concentrations than the TMDL target for these months (Figure 23). During June, three years out of the previous five have also had lower amounts of total phosphorus than the target. July through October concentrations do not follow this same trend; 2014 was the only year since 2010 to have a total phosphorus concentration lower than the TMDL target.

The Little Spokane River met the TMDL target for total phosphorus in two of the previous five years during both the February through May and June time periods. In July and October, four of the last five years achieved or fell below the total phosphorus target. The data suggests that high flows carry higher total phosphorus concentrations.

Ecology is gathering data from Coulee and Deep Creek. Preliminary data suggests that the assumptions about this system during TMDL development are incorrect. Total phosphorus concentrations appear to be lower in the spring and higher during the other times of the year. Comparing the data to the TMDL target is complicated by the fact that Coulee Creek surface flows occur infrequently, so it is difficult to determine the contribution to the Spokane River. Ecology anticipates collecting more data to understand the impact of this tributary on the system.

Groundwater quality appears to be experiencing a downward trend in total phosphorus, but the levels are higher than the allocation. The allocation ranges from 0.0081 to 0.0076 mg/l depending on the season. The City of Spokane's groundwater monitoring data show that their Ray Street well in 2010 had a total phosphorus concentration of 0.032 mg/L, and in 2014 the level decreased to 0.025 mg/L. However, the 2011 to 2014 data do not show a consistent downward trend; 2011 had the lowest concentration and 2012 had the highest concentration within the four year period. Spokane County's well monitoring data revealed that in 2010, the highest total phosphorus concentration was 0.352 mg/L. The highest concentrations steadily declined since 2010 to 0.068 mg/L of total phosphorus in 2014.

No total phosphorus concentration data exist from surface water runoff from the watershed around Lake Spokane. The USGS began collecting groundwater data from the Suncrest area (along the northeastern part of the lake) in early 2015. Therefore, no information is available to compare with the allocation.

TMDL Goals and Objectives

The Introduction section of this report listed the five-, ten-, and fifteen-year TMDL goals. Comparing the first four years of implementation with the five-year goals shows that implementation is generally on target:

- NPDES permittees are operating within limits, including submitting best management or annual plans. The need for the dischargers to start, continue, or complete target pursuit actions is uncertain, since the allocations may be met by installing tertiary treatment.

- Avista sent their Ecology-approved Dissolved Oxygen Water Quality Attainment Plan to FERC in the beginning of October 2012.

- Approximately 100 nonpoint source reduction projects were installed between 2010 and 2011. This accounts for about half of the projects in Ecology’s nonpoint source implementation tracking database for the Spokane basin. The earliest projects in the database date back to 2000. If the database is accurate and contains a majority of the projects, then in the last 4 years, the number of nonpoint source implementation projects has doubled from what occurred from 2000 to 2010.

- As described above, many groups are collecting monitoring data in the basin.

- Ecology’s development of the dissolved oxygen and pH TMDLs for the Little Spokane River and Hangman Creek are delayed beyond 2015. Ecology needed to collect additional water quality data so the Little Spokane River TMDL would be more accurate. Data collection is expected to be complete in 2015, so a draft TMDL should be available sometime in 2016. Ecology needs extra time to be thoughtful about resolving complex natural condition issues for the Hangman Creek TMDL, so it may take a few more years to produce a draft TMDL.

Nonpoint Source Phosphorus Reduction Plan

The Spokane River Watershed Nonpoint Source Phosphorus Reduction Plan (NPS Plan) (Geoengineers, et al 2011) recommended several best management practices (BMPs) and nonpoint source reduction activities within each subbasin. The plan took a comprehensive look at land uses and applicable BMPs. The plan prioritized working along Hangman Creek, the Little Spokane River, and upper Spokane River in Washington. Establishing buffers and stabilizing stream banks are the top recommended BMPs in each sub-basin because of the low cost and effectiveness in reducing nutrients.

From protecting riparian areas, to direct seeding, infiltrating stormwater, and rehabilitating forest roads, the actions taken during the 2010 to 2014 timeframe are consistent with the NPS Plan recommendations. As demonstrated above, various groups have completed several projects that planted and protected riparian buffers; the Natural Resources Conservation Service (NRCS) and

Spokane Conservation District have awarded funding to advance direct seeding; entities with stormwater permits are working to treat stormwater; and Inland Empire Paper is actively working to improve their forest roads.

The NPS Plan also identified a need to evaluate phosphorus loads from septic systems within Suncrest and other densely populated areas. Although there is an effort to sample groundwater along Suncrest, several other densely populated areas along Lake Spokane should be studied. Recognizing this need, the Stevens County Conservation District submitted a grant proposal to study other areas along the lake in Stevens County. Should this proposal receive funding, additional studies will be underway in 2016.

Summary of Progress

All of the activities to address point and nonpoint sources appear to have the desired effect of lowering nutrient levels in the river, lake, and groundwater. The steps outlined in existing compliance schedules and plans seem on target to achieve the TMDL targets. The focus for the years to come is to continue working on activities described in the plans or permits.

Future Outlook

Nonpoint sources

Ecology plans to continue tracking nonpoint source BMP implementation activities that groups in Washington and Idaho complete each year. Implementation partners will continue to provide a spreadsheet with their completed activities to Ecology. Ecology will combine all the information into a master spreadsheet. In late 2015 or 2016, the Spokane River Forum will use the database to create an interactive map showing the locations of the BMPs. The map will be available online so the public can see what work has been accomplished and where. Ecology will also use the map to help identify where to focus future education or BMP installation activities.

Ecology is working with the Spokane Dissolved Oxygen Nonpoint Source Workgroup (NPS Workgroup), which is a subset of the advisory group. The NPS Workgroup is meeting to establish interim targets or milestones that indicate measurable progress toward achieving the TMDL allocations. Ecology expects the milestones to be in place by 2016.

For projects installed in 2015, the NPS Workgroup decided to use a simple spreadsheet model, STEPL, to estimate the phosphorus reductions from implementation projects. STEPL stands for Spreadsheet Tool for the Estimation of Pollutant Load. The purpose for using this model is to have a consistent methodology for tracking progress that everyone working to install best management practices (BMPs) can use. The phosphorus reduction tool helps us by:

- Recording how much phosphorus is being prevented from entering surface water due to the BMPs.
- Identifying effective BMPs.
- Demonstrating the level of effort to control nonpoint source pollutants.
- Being consistent so we can compare different parts of the watershed.

STEPL will not gauge compliance with the TMDL; only monitoring data gathered from established monitoring sites at the mouth of the tributaries will be used to determine compliance.

Another activity expected to help with TMDL compliance is that Stevens County is in the process of updating their Shoreline Master Program (SMP). The SMP plans for development while providing protections for shorelines so they are able to resist erosive forces of water as well as retain vegetation to filter and take up nutrients. This SMP update will apply to the northern shoreline of Lake Spokane, which will help control nutrients from new or expanding developments.

Ecology anticipates work to reduce nonpoint sources of phosphorus will gain momentum in the coming years. As more people become aware of the BMPs that both reduce nutrient pollution and provide benefits to them, the amount of implementation activities will increase. Outreach activities and data from monitoring projects are essential to increasing the public's awareness, and should be a focus for groups working to reduce nonpoint sources of phosphorus.

Point Sources

Washington State point source dischargers (Liberty Lake Sewer and Water District, Kaiser Aluminum, Inland Empire Paper, and the City of Spokane) will continue following their compliance schedules to meet TMDL reductions for phosphorus, ammonia, and carbonaceous biochemical oxygen demand. Next steps in the compliance schedules include developing engineering reports, and plans and specifications for new tertiary treatment. Timelines for installing treatment technology varies slightly among the dischargers, but the target to meet the final water quality-based effluent limits in 2021 is consistent among the dischargers. Ecology's role in the compliance schedules is to approve reports and plans submitted, as well as reissue the permits in 2016 with interim limits.

Ecology will reissue stormwater permits in 2019 to the City of Spokane, City of Spokane Valley, Spokane County, and Washington State Department of Transportation (WSDOT). Although the permit for WSDOT is different from the three municipalities, all the permits require monitoring for nutrients and applying stormwater best management practices (BMPs) to reduce nutrients if needed.

According to the Idaho permits, construction of tertiary treatment facilities must be completed by November 30, 2022.   Compliance date is 2024.

Adaptive Management

Ecology uses adaptive management in TMDLs to assess whether the identified actions to solve the documented pollution problems are the correct ones and whether they are working. Adaptive management allows fine-tuning actions to make them more effective, and to try new strategies if scientific evidence suggests they could help achieve compliance. The TMDL states that biennial reports such as this document, should lead to "course correction actions" such as dropping unproductive efforts and adding or enhancing productive ones. At this time, Ecology does not detect any necessary alterations in implementation activities.

Potential adaptive management decisions such as modification of required phosphorus reductions, target pursuit actions, or water quality standards will not occur until after the ten-year assessment process (Moore and Ross, 2010). Decisions about any adjustments to the implementation strategy will be based upon an evaluation of the data collected for the target pursuit actions, the biennial reports, and ten-year assessment. Ecology will collaborate with the Spokane River TMDL Advisory Committee when deciding upon any modifications or appropriate actions for the second ten-year implementation period.

Ten Year Assessment

The concept of a ten-year assessment was developed while working with the Spokane River dissolved oxygen TMDL advisory group. As such, Ecology does not have an established protocol for a ten-year assessment. The TMDL (Moore and Ross 2010) characterizes the ten-year assessment as a data-based, objective review conducted on the data summaries collected to date, monitoring information, and the CE-QUAL-W2 model or its successor. The TMDL also states that the assessment will give particular attention to Lake Spokane's hypolimnion (lowest) layer. The ten-year assessment will consider factors such as how long the treatment technology has been in operation, and whether sufficient data are available to determine river conditions and dissolved oxygen response. This assessment for the TMDL should occur in 2121 through 2022. Ecology anticipates discussing what the ten-year assessment will entail during advisory group or recommended monitoring meetings.

2020 TMDL Goals

The TMDL stated the ten-year goals would be accomplished by 2020. Achieving the 10 μg/L total phosphorus concentration at the riverine assessment point (downstream of Nine Mile Dam) by 2020 appears achievable. However, two goals below may be slightly altered now that four years have passed:

- The Washington Dischargers will likely have their new technology installed, but due to the need for time to get the plant running properly (called optimization), the dischargers have until 2021 to meet their TMDL allocations. This date is within the permitted ten-year compliance schedule because Ecology did not issue the NPDES permits until October 2011. Ecology will re-issue the permits in 2021 with the TMDL allocations. Although in 2020 the new technology will lack optimization, phosphorus, ammonia, and CBOD levels are expected to be much lower once it is operating.

- Avista's water quality attainment plan extends until 2022, so a final evaluation of their activities to improve dissolved oxygen will come after 2020. However, Avista's attainment plan includes annual monitoring to detect nutrient reductions from their activities, so they will have some information available by 2020.

The fifteen-year goal of applying 75 to 100 percent of necessary BMPs in the Hangman Creek watershed by 2025 is lofty, but it is too early to assess whether the target will be met. As described above, nutrient concentrations in the watershed appear to be decreasing, and ten years remain to implement best management practices (BMPs). Several groups are expending a lot of effort to expand the BMPs within the watershed so the target is not impossible to achieve.

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Appendices

Appendix A. Monitoring Data

Ecology Ambient Monitoring Data 2010-2014

The definitions below apply to all of the following tables:

J = estimated value

U = not detected at the reported level

57A240 Spokane River @ Lake Coeur d'Alene

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	8:45	60		4		0.01	U	0.023		0.004		11.5		7.99		1				0.005	U	0.12		0.5	
2/8/2010	8:15	58		1	J	0.01	U	0.03		0.005		11.4				2		4		0.007		0.12		1.8	
3/8/2010	8:20	62		1		0.01	U	0.026		0.003	U	11.5		7.87		4		6.8		0.008		0.12		2.5	
4/12/2010	8:30	64		1	U	0.01	U	0.016		0.004		11.4		7.88		1	U			0.005	U	0.09		0.6	
5/10/2010	8:20	58.9		5		0.01	U	0.01	U	0.003		11.2		7.92		2		8.7		0.007		0.05		0.8	
6/14/2010	8:00	56		1	U	0.01	U	0.01	U	0.003	U	10.2		8.19		1	U	14		0.005		0.09		0.7	
7/13/2010	8:45	62		2		0.01	U	0.01	U	0.003		8.5		7.92		2		19		0.009		0.11		0.8	
8/16/2010	8:40	56	J	3		0.01	U	0.01	U	0.004		8.19		7.87		1	U	22		0.007		0.13		0.6	
9/20/2010	9:10			23		0.01	U	0.01	U	0.003	U	8.5		7.44		1	U	17		0.006		0.14		0.6	

57A150 Spokane River @ State Line

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	10:15	56		2		0.024		0.06		0.006		12.4		7.58		2				0.01		0.19		0.7	
2/8/2010	9:00	56		1	J	0.013		0.051		0.006		12				2		4.2		0.009		0.15		0.7	
3/8/2010	9:05	58		1	U	0.01	U	0.048		0.003	U	11.8		7.73		2		6.9		0.01		0.19		0.8	
4/12/2010	9:15	58		2	J	0.015		0.044		0.003		11.5		7.66		2				0.007		0.14		1.8	
5/10/2010	9:00	59.8		2		0.015		0.019		0.003	U	11.1		7.75		2		8.9		0.007		0.11		0.9	
6/14/2010	8:50	52		10		0.01	U	0.012		0.003	U	9.89		7.71		2		15		0.007		0.1		1	
7/13/2010	9:30	50		7		0.01	U	0.038		0.004		7.9		7.87		2		21		0.012		0.11		1.1	
8/16/2010	10:00	60	J	5		0.01	U	0.178		0.01		7.8		7.7		1	U	22		0.018		0.26		0.5	U
9/20/2010	10:00			36		0.01	UJ	0.091		0.004		9.5		7.06		2	U	17		0.009		0.18		0.7	
10/12/2010	10:15	66		1		0.017		0.072		0.006		9.1		8.01		1		15		0.011		0.22		0.6	
11/8/2010	11:45	60		1		0.022		0.062				10.3		8.08		1		11		0.02		0.21		1.4	
12/20/2010	12:10	66		2		0.025		0.045		0.006		11.91		7.21		2		4.6		0.009		0.12		1	
1/18/2011	8:45	54		4		0.02		0.04		0.004		12.9		7.92		8		3.8		0.012		0.12		3.1	
2/23/2011	10:20	56		17		0.034		0.088		0.007		12.6		7.74		2		2.2		0.015		0.19		2.7	
3/14/2011	12:00	74		1		0.03		0.097		0.006		12.1		8.43		2		3.4		0.015		0.2		3.5	
4/11/2011	9:55	54		1	U	0.043		0.1		0.01		13.63		7.96		2		4.1		0.014		0.28		3.6	
5/16/2011	10:10	50		3		0.018		0.023		0.004		12.02		7.49				9.2		0.016		0.12		3.3	
6/21/2011	8:05	44		1		0.013		0.01	U	0.009		11.8		7.6		2		13		0.015		0.14		1.3	
7/24/2011	10:30																								
8/15/2011	9:50																								
9/19/2011	10:00	48		10		0.01		0.083		0.005		8.5		7.33		1		19		0.009		0.18		0.6	
10/26/2011	7:30																								
11/30/2011	7:35	58.1		1		0.035		0.067		0.007		10.72		7.92	J	2		6.5		0.013		0.16		1.2	
12/13/2011	7:45	50		1	U	0.033		0.046		0.007		11.25		7.21		2		4.9		0.01		0.13		0.8	
1/10/2012	8:00	45		2	J	0.026		0.055						7.67		2		4.3		0.009		0.1		0.7	
2/14/2012	8:15			1	U	0.061		0.042		0.005		12.52				1	U	3.4		0.01		0.14		0.5	U
3/20/2012	7:15	51		1	U	0.019		0.022		0.003		12.62		7.4		5		3.3		0.012		0.09		1.4	
4/17/2012	7:30	55		1	J	0.015		0.015		0.003		13.13		7.56		3		4.6		0.011		0.07		1.4	
5/14/2012	11:15	46		1	U	0.01	U	0.01	U	0.003		11.71		7.6		3		11		0.012		0.11		2.2	
6/25/2012	11:40	43		5		0.014		0.018		0.004		9.9		7.61		2		15		0.007		0.05		0.9	
7/23/2012	11:15	43		9		0.02		0.061		0.003		7.63		7.63		1		24		0.01		0.13		0.8	
8/27/2012	11:10	49		6		0.014		0.152		0.003	U	8.18		7.77		1	U	22		0.008		0.23		0.6	
9/24/2012	11:15	49		3		0.01	U	0.086		0.004		8.88		7.78		1		18		0.007		0.16		0.7	
10/17/2012	13:15	50		8		0.014		0.09		0.004		10		7.59		1	U	13		0.009		0.15		0.6	
11/7/2012	13:15	47		1	U	0.01		0.038		0.004		10.28		7.79		2		11		0.01		0.1		0.5	U
12/5/2012	12:35	47		1	U	0.017		0.029		0.003		12.121		7.56		3		8.2		0.01		0.09		0.7	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/9/2013	14:41	51		7		0.044		0.068		0.004		12.1		7.42		2		4.9		0.008		0.15		0.7	
2/6/2013	12:50	49		1	U	0.026		0.055		0.003		12.56		7.73		2		4.1		0.009		0.14		0.7	
3/6/2013	12:31	51		1	U	0.025		0.05		0.003		12.22		7.68		2		3.7		0.009		0.14		1.1	
4/3/2013	12:28	53		1	U	0.013		0.014		0.003		12.6		7.63		2		5.4		0.007		0.09		0.7	
5/8/2013	13:08	50		1	U	0.01	U	0.01	U	0.003		11.5	J	7.78		2		10		0.008		0.06		1.2	
6/5/2013	13:45	47		2		0.01	U	0.03		0.004		9.7		7.97		1		16		0.008		0.11		0.6	
7/10/2013	13:10	49		4		0.017		0.066		0.003				7.72		1	U	24		0.006		0.14		0.7	
8/7/2013	13:50	51		4		0.01	U	0.067		0.003	U	8.8		7.78		1	U	24		0.007		0.14		0.6	
9/11/2013	13:15	52		7		0.01	U	0.093		0.003	U	8.8		7.94		1	U	23		0.006		0.18		0.6	
10/15/2013	13:20	53		4		0.01	U	0.102		0.003	U	9.6		8.04		1		14		0.008		0.17		0.6	
11/5/2013	12:05	54		11		0.013		0.066		0.003	U	10.4		7.5		1	U	8.5		0.008		0.14		0.6	
12/3/2013	13:10	53		2		0.026		0.055		0.004		11.2		7.55		1	U	5.5		0.01		0.13		0.5	U
1/7/2014	11:55	54		6		0.03		0.045		0.003	U	11.9		7.5		2		2.9		0.007		0.12		0.8	
2/4/2014	12:35	55		1	U	0.028		0.06		0.004		12.4		7.52				1.9		0.008		0.15		0.7	
3/4/2014	12:10	58		1	U	0.047		0.039		0.004		12.3		7.47		2		2.1	J	0.01		0.14		1	
4/8/2014	13:00	57		1	U	0.01	U	0.013		0.003	U	12.4		7.43		2		6.2	J	0.009		0.09		1.7	
5/6/2014	12:15	49		13		0.017		0.734		0.02		11.6		7.43		14		8		0.035		0.84		5.1	
6/3/2014	12:40	44		3		0.01	U	0.01		0.003		9.5		7.62		2		16		0.009		0.08		0.7	
7/8/2014	12:10			2		0.015				0.003		8		7.59		2		22		0.008		0.12		0.7	
8/5/2014	13:05	50		6		0.011		0.107		0.003	U	7.5		7.8		1	U			0.007		0.19		0.6	
9/9/2014	12:40	50		5		0.01	U	0.091		0.003		8.7		8.03		1		20		0.007		0.16		0.5	U
10/7/2014	12:40	51		3		0.021		0.095		0.004		9.1		7.8		2		17		0.009		0.19		0.5	U
11/4/2014	11:35	52		8		0.012		0.094		0.005		9.7		7.5		1		11		0.011		0.17		0.5	U
12/2/2014	12:20	52		1	U	0.018		0.064		0.003		10.7		7.46		2		5.1		0.006		0.13		0.5	U

57A146 Spokane River @ Sullivan Road

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	10:45	68		1	U	0.029		0.137		0.006		12.3		7.59		2				0.011		0.26		0.7	
2/8/2010	9:40	64		1	J	0.015		0.109		0.005		11.8				1		4.8		0.008		0.22		0.7	
3/8/2010	9:40	62		1	U	0.01	U	0.077		0.003	U	11.4		7.73		2	J	6.8		0.009		0.18		0.9	
4/12/2010	10:30	58		1	J	0.01	U	0.048		0.003		11.6		7.66		3	J			0.007		0.14		1.1	
5/10/2010	9:40	60		1		0.01	U	0.018		0.003	U	10.8		7.66		2		9.1		0.007		0.09		1.1	
6/14/2010	10:15	54		5		0.01	U	0.017		0.003		9.49		7.58		3	J	15		0.007		0.1		1.4	
7/13/2010	10:10	58		8		0.01	U	0.078		0.004		7.9		7.77		2		20		0.012		0.17		0.9	
8/16/2010	10:40	102	J	10		0.01	U	0.324		0.008		8		7.68		1	U	19		0.013		0.41		0.7	
9/20/2010	10:50			170		0.01	U	0.213		0.005		9		7.77		1		16		0.009		0.32		0.8	

57A140 Spokane River @ Plantes Ferry Park

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	11:30	106		4		0.028		0.306		0.006		11.4		7.72		6				0.01		0.42		0.9	
2/8/2010	10:15	98		1	J	0.017		0.26		0.005		11.2				2		4.7		0.01		0.37		0.7	
3/8/2010	10:10	90		1	U	0.01	U	0.216		0.003	U	10.9		7.74		2		7.1		0.009		0.3		1.3	
4/12/2010	11:00	74		1	U	0.01	U	0.12		0.004		11.2		7.67		2				0.007		0.21		0.9	
5/10/2010	10:20	68		1	UJ	0.01	U	0.058		0.003	U	10.7		7.58		2		9.3		0.007		0.13		1	
6/14/2010	11:00	62		3		0.01	U	0.058		0.003	U	9.39		7.59		2		15		0.006		0.16		1	
7/13/2010	10:45	82		6		0.011		0.249		0.004		8		7.86		2		19		0.013		0.36		1	
8/16/2010	11:30	192	J	3		0.01	U	0.752		0.006		8.4		8.01		1	U	15		0.008		0.81		0.5	U
9/20/2010	11:10			19		0.01	U	0.506		0.005		8.8		7.79		2		14		0.008		0.67		0.6	

57A123 Spokane River @ Sandifer Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	12:20	132		220	J	0.01	U	0.401		0.006		11.9		8.05		2				0.008		0.46		0.8	
2/8/2010	12:30	124		150		0.01	U	0.344		0.005		11.6				2		5.7		0.009		0.43		0.9	
3/8/2010	11:15	112		3	U	0.01	U	0.336		0.003	U	11.1		7.94		2		8.8		0.008		0.39		0.7	
4/12/2010	11:55	88		1		0.01	U	0.184		0.003		12.3		7.77		2				0.007		0.25		0.9	
5/10/2010	11:15	75.8		230	J	0.01	U	0.102		0.003	U	12.1		7.87		2		9.5		0.009		0.2		1.7	
6/14/2010	11:50	72		14		0.01	U	0.106		0.003	U	10.8		7.74		2		15		0.007		0.19		1.2	
7/13/2010	11:50	104		18		0.01	U	0.345		0.003		8.5		8.03		1		18		0.011		0.41		0.6	
8/16/2010	12:30	206	J	8		0.01	U	0.783		0.005		8.8		8.23		1	U	16		0.008		0.87		0.6	
9/20/2010	12:30			500	G	0.01	U	0.613		0.004		9.69		8.18		1	U	14		0.008		0.69		0.5	

56A070 Hangman Creek @ Mouth

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	13:00	212		43		0.098		3.08		0.109		12.8		7.92		14				0.22		3.2		85	
2/8/2010	13:00	258		27	J	0.01	U	3.86		0.068		11.6				11		4.4		0.117		4.5		22	
3/8/2010	11:40	270		1		0.01	U	1.95		0.025		11.2		8.23		5	J	8.6		0.054		3.41		8.6	
4/12/2010	12:15	238		10		0.01	U	1.15		0.036		11		8.17		5				0.067		1.34		12	
5/10/2010	11:45	161		4		0.011		0.597		0.044		10		8.03		9		13		0.105		0.81		21	
6/14/2010	12:15	206		59		0.017		0.595		0.068		8.28		7.97		15		19		0.131		0.95		25	
7/13/2010	12:20	266		26		0.01	U	0.224		0.008		11.8		8.73		4		19		0.033		0.48		2.2	
8/16/2010	13:00	435		22		0.01	U	0.84		0.019		11.2		8.44		3		18		0.035		1.06		1.6	
9/20/2010	13:30			130		0.01	U	0.812		0.015		11.9		8.51		4		15		0.028		1.13		2.7	
10/12/2010	11:30	384		24		0.01	U	0.71		0.018		12.2		8.4		1		9.9		0.028		0.98		0.8	
11/8/2010	12:30	356		14		0.01	U	0.564		0.016		12		8.37		1		7.2		0.024		0.64		1.2	
12/20/2010	13:45	214		51		0.054		4.26		0.09		12.81		7.71		5		0.5		0.147		4.94		27	
1/18/2011	10:00	112		340		0.044		3.64		0.085		11.4		8.11	J	172	J	4.8		0.372		4.18		190	
2/23/2011	12:30	220		15		0.01	U	4.77		0.063		12.4		7.81		10	J	1		0.116		5.11		27	
3/14/2011	13:00	152		200		0.025		5.25		0.082		12.3		7.67		203	J	5.2		0.33		5.27		150	
4/11/2011	11:30	180		3	U	0.02		2.99		0.064		14.84		7.53		18		8.6		0.118		3.19		25	
5/16/2011	11:20	192		140		0.027		1.5		0.043		9.49		7.97		13		13		0.093		1.79		13	
6/21/2011	9:15	288		31		0.03		1.44		0.028		8.69		8.41		4		17		0.048		1.83		2.9	
7/24/2011	11:10	313		23		0.019		0.674		0.021		11.7		8.45		9	J	18		0.064		0.97		2.9	
8/15/2011	11:00			16		0.018		0.824		0.033		13.3		8.56		3		17		0.043		1.06		1.7	
9/19/2011	12:00	396		14		0.015		0.862		0.029		10.8		8.32		2		16		0.036		1.09		1	
10/24/2011	14:45	444		5		0.022		0.922		0.02		13		8.63		4	J	10		0.029		1.21		1	
11/28/2011	16:05	353		6		0.01	U	2		0.019						2		4.1		0.029		2.26		1.1	
12/12/2011	16:15	417		1		0.01	U	2.32		0.026		13.79		8.45		3		1.8		0.031		2.54		1.4	
1/25/2012	13:30			12		0.032		3.13				13.05				7		1.8				3.46		9.5	
2/22/2012	14:20	240	J	7		0.023		5.11		0.063		12.3	J	8.16	J	10		3.1	J	0.159		5.24		50	
4/16/2012	16:00	182		16		0.011		2.46		0.057		10.5		8.02		11		9.9		0.107		2.66		17	
5/14/2012	16:20	247		11		0.013		1.77		0.046		9.39		8.42	J	7		19		0.081		1.87		9.9	
6/25/2012	17:15	262		54		0.01	U	0.635		0.022		10.7		8.99		4		21		0.043		0.55		2.3	
7/23/2012	16:15	333		110		0.022		0.755		0.055		10.15		8.73		4		22		0.075		0.97		1.7	
8/27/2012	16:50	389		15		0.015		0.901		0.034		11.31		8.69		5	J	20		0.041		1.06		1.5	
9/24/2012	16:10	384		19		0.016		0.805		0.02		13.88		8.82		2		16		0.027		0.87		1.1	
10/17/2012	16:10	375		22		0.012		0.73		0.02		12.3		8.73		1		12		0.026		0.91		1.2	
11/7/2012	16:00	358		6		0.01	U	0.905		0.023		12.19		8.72		1		9.6		0.029		1.1		0.8	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
12/5/2012	15:20	172		####	J	0.039		5.1		0.079		12.63		7.82		86		5.5		0.349		4.76		210	
1/9/2013	17:20	265		16		0.012		3.97		0.052		12.8		8.01		4		1.5		0.072		4.1		7.2	
2/6/2013	15:58	186		26		0.019		8.46		0.085		12.46		7.81		29		3.3		0.161		8.45		45	
3/6/2013	15:54	155		11		0.013		3.37		0.056		11.667		7.9		36		4.3		0.142		3.63		37	
4/3/2013	15:48	177		2		0.01	U	1.69		0.03		10.9		8.22		7		13		0.059		1.9		13	
5/8/2013	16:28	250		7		0.012		0.816		0.02		11.1		9.07		5		21		0.038		1.1		3.4	
6/5/2013	15:16	311		23		0.029		0.593		0.021		10.2		8.15		5		22		0.042		0.88		2.1	
7/10/2013	17:22	372		27		0.022		0.623		0.04		11.36		8.79		5		23		0.056		0.95		1.9	
8/7/2013	17:46	383		68		0.026		0.674		0.029		11.9		8.8		4		24		0.035		0.94		1.2	
9/11/2013	16:25	396		30		0.017		0.751		0.02		12.8		8.72		1		20		0.029		1.01		0.7	
10/15/2013	16:35	361		13		0.01	U	0.568		0.014		13.3		8.8		2		11		0.021		0.73		0.8	
11/5/2013	15:20	408		100		0.067		0.653		0.018		12.4		8.46		4		4.6		0.036		0.88		4.4	
12/3/2013	16:05	328		6		0.01	U	1.15		0.016		13.9		8.47		3		0.2		0.026		1.31		1.5	
1/7/2014	15:10	266		5		0.032		1.87		0.055		12.7		8.05		5		0.5		0.1		2.12		30	
2/4/2014	16:25			1	U	0.019		2.11		0.066		12.9		8.12		4		0		0.091		2.2		9.4	
3/4/2014	15:10	270		25		0.031		2.39		0.068		12.3		7.92		13		1.6	J	0.116		2.66		23	
4/8/2014	16:47	180		2		0.01	U	1.43		0.035		9.6		8.15		7		14	J	0.076		1.62		16	
5/6/2014	15:15	189		12		0.013		0.388		0.022		9.9		8.75		6		16		0.058		0.63		9.2	
6/3/2014	16:10	312		48		0.019		0.344		0.012		9.6		8.71		6		23		0.038		0.68		2.6	
7/8/2014	15:25	371		52		0.018		0.46		0.017		11.4		8.78		4				0.03		0.75		1.7	
8/5/2014	16:15	424		26		0.019		0.725		0.013		12.2		8.68		5		23		0.02		0.95		2.2	
9/9/2014	15:30	433		17		0.014		0.816		0.011		13		8.67		4		17		0.037		0.99		0.8	
10/7/2014	15:40	425		16		0.014		0.745		0.011		12.3		8.59		1		14		0.018		0.9		0.9	
11/4/2014	14:40	374		110		0.014		0.57		0.025		11.1		8.38		2		9.1		0.033		0.72		2.8	

54A130 Spokane River @ Fort Wright Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	13:30	140		150	J	0.01	U	0.534		0.011		12.1		8.07		3				0.019		0.61		4.4	
2/8/2010	14:10	136		100		0.01	U	0.561		0.009		11.7				3		6.1		0.014		0.66		2.2	
3/8/2010	12:30	122		1	U	0.01	U	0.392		0.003	U	11.3		8.3		2	J	9		0.011		0.44		1.2	
4/12/2010	12:50	94		1	U	0.01	U	0.219		0.004		12.1		7.86		3				0.008		0.29		1.7	
5/10/2010	12:10	77.8		120		0.01	U	0.111		0.003	U	12		7.95		2		9.8		0.009		0.18		1.5	
6/14/2010	12:45	76		7		0.01	U	0.121		0.003		10.8		8.02		3		15		0.008		0.2		1.5	
7/13/2010	12:45	108		8		0.01	U	0.352		0.004		8.69		8.27		1		19		0.01		0.45		0.6	
8/16/2010	14:15	194		2		0.01	U	0.83		0.005		9		8.34		1		17		0.009		0.9		0.7	
9/20/2010	14:05			420	J	0.01	U	0.636		0.004		10.4		8.29		2		14		0.008		0.78		0.6	

54A120 Spokane River @ Riverside State Park

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	13:55	156		120	J	0.015		1.15		0.062		11.9		8.07		3				0.075		1.25		4.4	
2/8/2010	15:40	146		110		0.019		1.05		0.056		11.8				3		6		0.067		1.2		1.9	
3/8/2010	13:10	132		1	U	0.01	U	0.915		0.043		11.3		8.17		2		9.1		0.053		0.96		1.1	
4/12/2010	13:30	100		1	U	0.01	U	0.524		0.007		12		7.81		3	J			0.014		0.6		2.4	
5/10/2010	13:00	84		75		0.01	U	0.29		0.004		11.6		7.66		2		10		0.012		0.34		1.3	
6/14/2010	13:30	82		20		0.01	U	0.277		0.003		11.11		7.8		2		15		0.01		0.38		1.6	
7/13/2010	13:15	140		11		0.01	U	0.809		0.006		8.8		8.19		1		19		0.017		0.85		0.7	
8/16/2010	14:45	214		3		0.01	U	2.23		0.013		9.9		8.29		8		17		0.053		2.94		1	
9/20/2010	14:40			400	G	0.01	U	1.57		0.01		10.3		7.27		3		14		0.016		1.75		1.6	
10/12/2010	12:20	174		20		0.01	U	1.16		0.006		10.5		8.31		1		13		0.018		1.32		0.6	
11/8/2010	13:00	158		14		0.01	U	1.08		0.047		10.5		8.08		2		10		0.062		1.13		0.9	
12/20/2010	14:40	92		220	J	0.018		0.438		0.015		12.61		7.61		4		5.6		0.022		0.58		1.9	
1/18/2011	10:50	72		51		0.021		0.615		0.023		14.1		8.35	J	30		4.3		0.07		0.71		22	
2/23/2011	13:20	110		1400	J	0.026		0.707		0.034		12.8		7.75		7	J	3.5		0.045		0.81		3.6	
3/14/2011	13:40	106		23		0.02		1.58		0.046		12.1		7.74		56	J	4		0.123		1.73		35	
4/11/2011	12:20	68		1		0.016		0.336		0.019		15.05		7.26		4		5.1		0.031		0.46		4.8	
5/16/2011	12:00	58		64		0.01	U	0.204		0.006		12.72		7.44		7	J	9.7		0.021		0.27		3.9	
6/21/2011	10:10	66		3	U	0.01	U	0.218		0.004		12.9		7.71		2		13		0.011		0.3		1.5	
7/24/2011	12:00	122		19		0.01	U	0.76		0.005		10.8		7.93		1		16		0.014		0.75		0.6	
8/15/2011	11:45			10		0.01		1.7		0.009		10		8.23		1		16		0.014		1.8		0.5	U
9/19/2011	12:45	227		57		0.01	U	1.64		0.012		9.8		8.34		1		14		0.023		1.75		0.6	
10/24/2011	14:00	188		160		0.01	U	1.19		0.006		9.9		7.96		1		11		0.011		1.23		0.5	
11/28/2011	15:35	155		1300	J	0.01	U	1.05		0.008						1		7.7		0.022		1.07		0.6	
12/12/2011	15:30	139		26		0.015		0.771		0.013		12.11		8.06		2		5.8		0.022		0.87		0.6	
1/9/2012	16:30	136		82	J	0.011		0.922						8.06		2		6.1		0.022		1		1.7	
2/13/2012	17:10	133	J	500	J	0.013		1.25		0.016		12.32				4		5.9		0.029		1.34		4.2	
3/19/2012	16:40	69		5		0.019		0.339		0.007		13.73		7.6		11		4.1		0.023		0.42		5.5	
4/16/2012	14:45	70		8		0.011		0.219		0.005		14.64		7.67		6	J	6.1		0.015		0.28		2.2	
5/14/2012	15:35	68		2		0.01	U	0.181		0.005		12.52		7.75	J	6		12		0.013		0.28		2.3	
6/25/2012	16:30	82		3		0.01	U	0.319		0.004		11		7.88		2		16		0.005		0.36		1	
7/23/2012	15:30	142		22	J	0.01	U	0.899		0.008		8.74		8.32		1		20		0.013		0.96		0.6	
8/27/2012	16:05	241		5		0.01	U	1.85		0.007		10		8.42		1	U	16		0.012		1.8		0.5	U
9/24/2012	15:15	200		15		0.022		1.4		0.005		10		8.45		1		15		0.012		1.44		0.6	
10/17/2012	15:35	201		31		0.016		1.43		0.004				8.47		2		12		0.011		1.55		0.5	U
11/7/2012	15:25	121		13		0.013		0.691		0.005		11.083		8.2		1		11		0.01		0.76		0.5	U
12/5/2012	14:35	72		32		0.017		0.413		0.007		12.32		7.79		5		8.3		0.02		0.47		5.8	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/9/2013	16:25	132		31		0.021		0.79		0.008		12.1		7.81		2		5.9		0.018		0.82		1.7	
2/6/2013	15:25	112		4		0.013		1.65		0.016		12.56		7.94		5		5.3		0.032		1.8		6.3	
3/6/2013	15:10	101		7		0.011		0.771		0.009		12.53		7.97		3		5.1		0.019		0.89		3.3	
4/3/2013	14:57	76		4	J	0.01	U	0.281		0.007		13.3		7.8		3		6.9		0.013		0.35		1.5	
5/8/2013	15:45	70		1	U	0.01	U	0.209		0.004		12.2	J	7.84		3		11		0.009		0.26		1.2	
6/5/2013	16:31	106		2		0.01	U	0.511		0.007		10.51		8.14		1		16		0.013		0.59		0.6	
7/10/2013	15:57	189				0.01	U	1.26		0.009		10.15		8.35		1	U	19		0.018		1.32		0.6	
8/7/2013	16:58	199		15		0.01	U	1.46		0.007		10		8.36		1		19		0.013		1.53		0.6	
9/11/2013	15:45	220		31		0.01	U	1.7		0.006		10.4		8.4		2		18		0.014		1.74		0.5	U
10/15/2013	15:20	236		50		0.016		1.45		0.011		9.6		8.13		4		12		0.021		1.46		1.5	
11/5/2013	13:50	155		9		0.01	U	0.902		0.011		10.7		7.95		1		8.4		0.016		0.93		0.5	U
12/3/2013	14:50	146		14		0.013		0.802		0.011		11.5		7.94		2		6.2		0.015		0.86		0.6	
1/7/2014	13:45	156		10		0.029		0.933		0.018		11.8		7.82		2		4.8		0.025		1.03		1.1	
2/4/2014	15:00	155		14		0.029		0.919		0.017		12		7.83		4		3.7		0.024		1		1	
3/4/2014	13:50	133		56		0.031		0.652		0.01		12.4		7.74		7		3.7	J	0.021		0.73		3.1	
4/8/2014	14:55	78		56		0.01	U	0.239		0.005		12.5		7.52		4		7.4	J	0.012		0.31		2.7	
5/6/2014	13:53	66		16		0.02		0.169		0.004		12.3		7.6		5		8.7		0.014		0.23		2	
6/3/2014	14:45	81		22		0.012		0.284		0.004		9.8		7.88		3		17		0.012	J	0.35		0.8	
7/8/2014	13:50	148		5				0.793		0.006		8.6		7.98		2		19		0.01		0.85		0.7	
8/5/2014	14:50	254		7				1.57		0.008		9.1		8.42				18		0.015		1.73			
9/9/2014	14:15	237		8		0.012		1.74		0.008		9.5		8.4		3		15		0.014		1.77		0.8	
10/7/2014	14:20	189		14		0.015		1.15		0.007		9.8		8.16		3				0.012		1.19		0.9	
11/4/2014	13:15	190		48		0.011		1.12		0.01		9.7		8		2		11		0.014		1.18		0.8	
12/2/2014	14:05	140		7		0.041		0.698		0.007		11.2		7.91		3		5.3		0.011		0.79		0.8	

54B100 Deep Creek @ Garfield Road Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
10/14/2013	15:05	382		12		0.01	U	3.61		0.051		11.4		8.38		2		7		0.052		3.66		1.3	
11/4/2013	16:15	454		1	U			2.62		0.012		13.1		8.87		3		5.3		0.014		2.53		0.5	U
12/2/2013	15:15	463		2		0.01	U	2.99		0.026		12.7		8.75		1	U	3.8		0.026		2.97		0.5	U
1/6/2014	15:20	459		1	U	0.01	U	2.96		0.027		14.8		8.72		1		0.3		0.025		3.15		0.5	U
2/3/2014	15:19	456		1	U	0.01	U	2.87		0.028		13.8		8.94		1		3.5		0.026		2.91		0.5	U
3/3/2014	16:25	474		2		0.01	U	3.66		0.06		11.2		8.34		2		4.5	J	0.056		3.8		1.1	
4/7/2014	15:25	458		1	U	0.014		2.77		0.017		11.7		8.88		3		14	J	0.028		3.01		1	
5/5/2014	15:22	446		7		0.01	U	2.41		0.007		13.2		9.01		2		12		0.012		3.24		0.6	
6/2/2014	15:10	433		16	J	0.01	U	2.38		0.007		12.3		8.88		3		17		0.011		2.55		0.5	U
7/7/2014	16:05	455		150	J	0.018		2.39		0.009		10		8.65		7		17		0.018		2.57		0.8	
8/4/2014	15:05	453		49		0.02		2.18		0.009		12		8.7		11		16		0.012		2.39		1.5	
9/8/2014	14:40	474		14		0.011		0.77		0.011		12.4		8.64		5		11		0.015		2.41		0.6	
10/6/2014	14:25	481		29		0.01	U	2.28		0.013		11.8		8.44		1		12		0.013		2.56		0.5	U

54C050 Coulee Creek @ N Brooks Road

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
10/14/2013	15:50	511		12		0.01	U	3.12		0.04		7.6		7.74		1	U	10		0.039		2.75		0.5	U
11/4/2013	15:20	418		5				4.12		0.053		12.2		8.4		1	U	3.5		0.055		3.78		0.5	U
12/2/2013	14:35																								
1/6/2014	14:50																								
2/3/2014	14:50																								
3/3/2014	15:45	419		3		0.016		4.37		0.076		12.1		8.07		4		0	J	0.083		4.49		2.3	
4/7/2014	14:35	393		3		0.01	U	3.01		0.03		12.1		8.59		3		12	J	0.037		3.17		1.5	
5/5/2014	14:45	372		13		0.021		2.31		0.026		12.2		8.67		2		12		0.032		2.84		1	
6/2/2014	14:30	345		34		0.032		1.63		0.045		9.7		8.45		4		17		0.054		1.86		1.3	
7/7/2014	15:25	334		140		0.022		1.15		0.073		6.9		8		12		19		0.081		1.33		2.3	
8/4/2014	14:20	328		180		0.048		0.488		0.085				7.6		1		19		0.08		0.68		0.7	J

54A090 Spokane River @ Nine Mile Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	14:45	166		65	J	0.016		1.12		0.057		11.6		7.99		6				0.071		1.25		6.7	
2/8/2010	16:20	154		140		0.014		0.897		0.034		11.8				6		5.6		0.043		1.03		2.8	
3/8/2010	14:00	140		3	U	0.01	U	0.75		0.023		10		8.01		4	J	8.3		0.034		0.79		1.7	
4/12/2010	14:30	106		1	U	0.01	U	0.441		0.007		11.7		7.89		4				0.013		0.52		1.6	
5/10/2010	13:30	85.4		120		0.01	U	0.234		0.004		11.3		7.84		3		10		0.014		0.29		1.5	
6/14/2010	14:20	84		6		0.01	U	0.262		0.004		10.5		7.88		3		15		0.012		0.36		1.7	
7/13/2010	14:15	124		8		0.01	U	0.651		0.006		9.5		8.16		2		18		0.017		0.69		0.7	
8/16/2010	15:30	217		11		0.01	U	1.46		0.012		9.69		8.26		3		18		0.023		1.57		0.9	
9/20/2010	15:40			400		0.01	U	1.18		0.012		10.3		7.99		3		14		0.021		1.24		1.1	
10/15/2013	15:20	236		50		0.016		1.45		0.011		9.6		8.13		4		12		0.021		1.46		1.5	
11/5/2013	13:50	155		9		0.01	U	0.902		0.011		10.7		7.95		1		8.4		0.016		0.93		0.5	U
12/3/2013	14:50	146		14		0.013		0.802		0.011		11.5		7.94		2		6.2		0.015		0.86		0.6	
1/7/2014	13:45	156		10		0.029		0.933		0.018		11.8		7.82		2		4.8		0.025		1.03		1.1	
2/4/2014	15:00	155		14		0.029		0.919		0.017		12		7.83		4		3.7		0.024		1		1	
3/4/2014	13:50	133		56		0.031		0.652		0.01		12.4		7.74		7		3.7	J	0.021		0.73		3.1	
4/8/2014	14:55	78		56		0.01	U	0.239		0.005		12.5		7.52		4		7.4	J	0.012		0.31		2.7	
5/6/2014	13:53	66		16		0.02		0.169		0.004		12.3		7.6		5		8.7		0.014		0.23		2	
6/3/2014	14:45	81		22		0.012		0.284		0.004		9.8		7.88		3		17		0.012	J	0.35		0.8	
7/8/2014	13:50	148		5				0.793		0.006		8.6		7.98		2		19		0.01		0.85		0.7	
8/5/2014	14:50	254		7				1.57		0.008		9.1		8.42				18		0.015		1.73			
9/9/2014	14:15	237		8		0.012		1.74		0.008		9.5		8.4		3		15		0.014		1.77		0.8	
10/7/2014	14:20	189		14		0.015		1.15		0.007		9.8		8.16		3				0.012		1.19		0.9	
11/4/2014	13:15	190		48		0.011		1.12		0.01		9.7		8		2		11		0.014		1.18		0.8	
12/2/2014	14:05	140		7		0.041		0.698		0.007		11.2		7.91		3		5.3		0.011		0.79		0.8	

55B070 Little Spokane River near Mouth

date	time	COND (umhos/cm)	FC (#/100ml)	NH3_N (mg/L)	NO2_NO3 (mg/L)	OP_DIS (mg/L)	OXYGEN (mg/L)	PH (pH)	SUSSOL (mg/L)	TEMP (deg C)	TP_P (mg/L)	TPN (mg/L)	TURB (NTU)
1/11/2010	15:15	288	26	0.01 U	1.3	0.02	10.3	8.2	7		0.026	1.42	2.7
2/8/2010	16:45	280	19	0.01 U	1.15	0.02	10.19		7	7.1	0.029	1.29	2.6
3/8/2010	14:25	274	1	0.01 U	1.19	0.011	11	8.2	8 J	10	0.023	1.23	2.9
4/12/2010	15:00	244	5	0.01 U	0.94	0.014	10	8.14	8 J		0.023	1.03	4
5/10/2010	14:20	251	3	0.01 U	0.934	0.011	9.69	8.23	6	12	0.022	1.05	1.8
6/14/2010	15:00	228	47	0.01 U	0.749	0.018	9.09	8.08	9 J	16	0.032	0.94	4.4
7/13/2010	14:45	258	21	0.01 U	0.909	0.009	10.1	8.46	2	16	0.02	0.97	1.1
8/16/2010	16:30	243	14	0.01 U	1.13	0.011	9.9	8.43	2	16	0.016	1.2	0.9
9/20/2010	16:30		26 G	0.01 U	1.17	0.008	9.9	8.25	3	13	0.01	1.28	0.9
10/12/2010	13:45	275	17	0.01 U	1.14	0.012	10.3	8.35	2*	11	0.015	1.27	1.1
11/8/2010	13:55	275	17	0.01 U	1.19	0.012	9.8	8.15	3	8.9	0.015	1.29	0.8
12/20/2010	15:55	248	17	0.02	1.06	0.018	10.81	7.98	7	4.2	0.034	1.2	4.2
1/18/2011	11:40	174	100	0.023	0.819	0.061	11.1	7.97	20 J	1.8	0.111	0.9	21
2/23/2011	14:45	246	6	0.01 U	1.02	0.017	10.5	8.09	7	5.1	0.03	1.09	4.1
3/14/2011	14:30	206	14	0.015	0.768	0.031	10.3	7.77	15 J	6.9	0.069	0.93	13
4/11/2011	13:15	180	10	0.01	0.421	0.014	11.51	7.96	8 J	9.9	0.03	0.6	4.2
5/16/2011	13:10	170	82	0.018	0.446	0.029	8.88	7.58	7 J	12	0.051	0.6	4.1
6/21/2011	11:10	230	6	0.018	0.787	0.021	10.3	8.04	10	15	0.036	0.92	4.8
7/24/2011	12:45	175	18	0.013	1.03	0.012	10.1	7.71	4	15	0.021	1.1	1.6
8/15/2011	12:40		34	0.013	1.2	0.016	9.8	8.29	3	15	0.017	1.23	0.9
9/19/2011	13:15	282	28	0.01 U	1.23	0.012	9.4	8.14	3	13	0.013	1.34	0.8
10/24/2011	13:10	287	10	0.01 U	1.22	0.012	10.3	8.21	3	10	0.015	1.31	0.8
11/28/2011	15:00	266	9	0.01 U	1.21	0.013			4 J	6.9	0.019	1.3	1.6
12/12/2011	15:05	292	4	0.01 U	1.38	0.014	10.74	8.19	6	5.8	0.019	1.44	1.9
1/9/2012	15:45	261	3	0.014	1.32			8.26	6	6.6	0.021	1.38	1.9
2/13/2012	16:30	233 J	91	0.036	1.05	0.048	10.7		22	6.3	0.084	1.22	8.9
3/19/2012	16:00	193	9	0.023	0.67	0.034	9.79	7.83	30 J	6.2	0.06	0.85	11
4/16/2012	14:00	172	14	0.01 U	0.41	0.016	10.3	7.89	11 J	9.4	0.034	0.53	4.2
5/14/2012	14:50	219	13			0.024	9.19	8.1	17	14	0.042		4.6
6/25/2012	15:35	216	43	0.01 U	0.771	0.019	9.4	8.26	9	16	0.029	0.84	3.4
7/23/2012	14:40	243	87	0.01 U	0.954	0.012	9.44	8.39	7	17	0.024	1.04	1.9
8/27/2012	15:20	262	28	0.01 U	1.13	0.011	9.49	8.34	4	15	0.013	1.19	1.2
9/24/2012	14:35	275	28	0.01 U	1.17	0.008	9.49	8.33	5	13	0.013	1.16	1.5
10/17/2012	14:45	278	26	0.01 U	0.126	0.007	9.9	8.3	3	11	0.011	1.3	1.3
11/7/2012	14:45	265	14	0.01 U	1.19	0.013	9.87	8.26	4	9.9	0.019	1.26	1.4

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
12/5/2012	13:55	236		16		0.016		1		0.019		10.2	J	8.15		7		7.6		0.032		1.13		3.2	
1/9/2013	15:50	246		15		0.014		1.13		0.016		10.7		8.05		7		5.9		0.023		1.23		2.5	
2/6/2013	14:25	230		28		0.012		1.08		0.017		11.06		8.16		10		6.6		0.032		1.14		5.7	
3/6/2013	14:30	207		13		0.013		0.862		0.019		10.71		8.09		14		6.1		0.039		1.01		8	
4/3/2013	13:50	191		12		0.01	J	0.594	J	0.018		9.5		7.99		16		11		0.043		0.67	J	7.1	
5/8/2013	14:29	224		15		0.014		0.804		0.019		9		8.15		13		16		0.031		0.9		5.1	
6/5/2013	15:10	251		8		0.01	U	0.936		0.012		10		7.99		6		16		0.019		1.09		2	
7/10/2013	14:30	259		28		0.01	U	0.986		0.014		9.95		8.35		4				0.017		1.07		1.3	
8/7/2013	15:30	274		58		0.01	U	1.11		0.013		10		8.33		2		16		0.017		1.25		0.6	
9/11/2013	14:31	283		36		0.01	U	1.12		0.009		10.3		8.25		4	J	15		0.016		1.23		0.9	
10/15/2013	14:41	280		33		0.01	U	1.55		0.009		9.7		8.23		3		11		0.015		1.26		1	
11/5/2013	13:13	278		1	U	0.01	U	1.13		0.008		10		8.21		3		7.9		0.012		1.27		0.9	
12/3/2013	14:25	271		12		0.01	U	1.25		0.013		10.6		8.22		4		5.3		0.021		1.35		1.5	
1/7/2014	13:05	276		17		0.012		1.42		0.014		10.5		8.21		6		5.4		0.018		1.44		1.4	
2/4/2014	14:30	276		8		0.014		1.39		0.016		10.7		8.23		8		4.5		0.024		1.4		2.8	
3/4/2014	13:20	271		12		0.014		1.31		0.015		10.8		8.12		10		6.3	J	0.025		1.36		3.4	
4/8/2014	14:25	210		3		0.01	U	0.733		0.017		9.2		7.98		16		12	J	0.036		0.87		5.7	
5/6/2014	13:25	211		1	U	0.013		0.016		0.004		8.8		8.03		2		12		0.012		0.08		1.7	
6/3/2014	14:20	253		25		0.017		0.95		0.011		9		8.36		6		17		0.022		1.08		1.9	
7/8/2014	13:20	274		33		0.011		1.04		0.011				8.25		5		17		0.016		1.15		1.6	
8/5/2014	14:25	286		35		0.01	U	1.1		0.009		9		8.29		3		16		0.01		1.21		0.9	
9/9/2014	13:45	288		27		0.01	U	1.18		0.007		9.5		8.33		2		13		0.011		1.21		0.7	
10/7/2014	13:55	287		10		0.01	U	1.17		0.008		9.3		8.17				12		0.014		1.22		0.9	
11/4/2014	12:45	292		31				1.18		0.011		9.3		8.15				9.5		0.013		1.4		1.1	
12/2/2014	13:35	283		13		0.015		1.19		0.012		10.6		8.28		4		5.2		0.015		1.31		1.4	

54A070 Spokane River @ Long Lake

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	16:20	174		1		0.024		0.971		0.043		11.3		8.06		2				0.055		1.1		3.8	
2/8/2010	18:00	168		3		0.023		1		0.044		10.6				5		5.6		0.062		1.1		7.1	
3/8/2010	15:25	172		1	U	0.01	U	1.05		0.03		11.4		8.07		4	J	8.2		0.043		1.1		2.5	
4/12/2010	16:05	150		1	U	0.01	U	0.655		0.008		11.7		8.28		6	J			0.019		0.74		2.5	
5/10/2010	15:45	98.1		1		0.01		0.297		0.003		11.5		8.12		4		10		0.016		0.42		2.7	
6/14/2010	16:00	80		2		0.014		0.176		0.004		10.6		7.93		3		15		0.012		0.33		1.9	
7/13/2010	15:50	90		1	U	0.021		0.327		0.005		8.9		7.93		1		18		0.02		0.46		1.1	
8/16/2010	17:30	164		1	U	0.01	U	0.849		0.013		6.7		7.77		1	U	19		0.02		0.9		0.7	

City of Spokane Combined Sewer Overflow Data*

Discharge Location	Sample Date	BOD (mg/L)	CBOD (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	NO3+NO2 as N (mg/L)	NH3-N (mg/L)	notes
CSO 6	11/7/2013	62	55	151	1.81	0.679	4.519	
CSO 6	1/8/2014	37		159	1.21	0.039	3.830	
CSO 6	2/12/2014			277	4.55	0.703	3.678	
CSO 6	4/24/2014	53	56	200	1.94	0.405	7.223	
CSO 6	6/17/2014			155	1.233	0.118	2.727	
CSO 34	5/21/2013	104	124	246	1.5		8.023	
CSO 34	6/20/2013	73	64	113	2.27		9.429	grab
CSO 34	6/20/2013	103	51	123	1.26		3.469	composite
CSO 34	8/1/2013	74	64	328	2.03		4.812	
CSO 34	9/4/2013	112	106	466	2.57		3.396	
CSO 6 AVG:		50.7	55.5	188.4	2.149	0.389	4.395	
CSO 34 AVG:		93.2	81.8	255.2	1.926		5.826	
CSO Combined AVG:		77.3	74.3	221.8	2.037	0.389	5.111	

* From the City of Spokane RPWRF Lab.

City of Spokane Stormwater Data*

Discharge Location	Sample Date	BOD (mg/L)	CBOD (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	NO3+NO2 as N (mg/L)	NH3-N (mg/L)	notes
Cochran Basin	10/15/2012	18		140	0.732		0.3843	
Cochran Basin	10/25/2012	15		75	0.445		0.035	
Cochran Basin	11/3/2012	8		55	0.337		0.007	
Cochran Basin	11/8/2012	11		48	0.296		0.007	
Cochran Basin	11/12/2012	17		260	0.625		0.3676	
Cochran Basin	11/19/2012	8		40			0.007	
Cochran Basin	12/4/2012	9		100	0.367		0.0052	
Cochran Basin	12/24/2012	16		508	1.39		0.6926	
Cochran Basin	1/8/2013	21		269	0.867		0.7677	
Cochran Basin	1/25/2013	34		668	1.97		0.897	
Cochran Basin	2/22/2013	21	17.91	608	1.69		0.2381	
Cochran Basin	3/6/2013			1388	2.92		0.3778	
Cochran Basin	3/20/2013	15	11	566	1.39		0.3277	
Cochran Basin	5/13/2013			187	0.937		1.2764	
Cochran Basin	5/21/2013	27	27	263	0.557		0.1964	
Cochran Basin	6/19/2013	12	9	120	0.436		0.1199	
Cochran Basin	11/7/2013	15	14	80	0.409	0.3928	0.0189	
Cochran Basin	1/8/2014	24	20	195	0.643	0.3682	0.9049	
Cochran Basin	2/11/2014	22	20	189	0.769	0.491	0.97	
Cochran Basin	4/17/2014	10	8	76	0.343	0.5178	0.3213	
Cochran Basin	6/3/2014	32	26	782	1.84			
Cochran Basin	6/17/2014			79	0.428	0.1129	0.1318	
Washington Basin	2/22/2013	17	13.91	500	1.42		0.3561	
Washington Basin	3/6/2013			1766	4.18		0.4444	
Washington Basin	5/13/2013			207	1.02		0.2879	
Washington Basin	5/21/2013	33	32	229	0.735		0.5573	

Discharge Location	Sample Date	BOD (mg/L)	CBOD (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	NO3+NO2 as N (mg/L)	NH3-N (mg/L)	notes
Washington Basin	6/19/2013	10	8	61	0.286		0.0526	
Cochran Basin AVG:		17.6	16.99	304.4	0.923	0.377	0.384	
Washington Basin AVG:		20.0	17.97	552.6	1.528		0.340	
Stormwater AVG:		18.0	17.235	350.3	1.040	0.377	0.375	

*From the City of Spokane RPWRF Lab.

Appendix B. Nonpoint Source Success Stories

The following pages highlight activities that have helped reduce nonpoint sources of phosphorus in the Spokane River and Lake Spokane basin. Ecology writes up the information about the projects as success stories in order to share them with the public. For other success stories throughout the state, visit: http://www.ecy.wa.gov/programs/wq/wqstories/index.html.

A Focused Assistance Program in Hangman Creek Watershed

Motivated producers make strides toward cleaner water


Hangman Creek delivering sediment to the Spokane River during spring runoff.

Introduction

The Hangman Creek Watershed has been involved in a long process to develop a water quality improvement plan (also known as a total maximum daily load or TMDL). The Hangman Creek watershed consists of 689 square miles in Washington, Idaho and the Coeur d'Alene Tribal Reservation. About 70 percent of the watershed is devoted to agriculture. The conservation districts in both Washington and Idaho have been actively working with agricultural landowners to increase the acreage utilizing direct seed tillage to reduce runoff and erosion. These districts also worked with producers to limit livestock access to streams. However, funding to support these efforts has always been a limiting factor. In the spring of 2010, Ecology and the Spokane County Conservation District (SCCD), with the support of several Washington and Idaho agencies and organizations, partnered to submit a funding application to the Natural Resources Conservation Service (NRCS).

Problem

Hangman Creek and its tributaries generally have an excess of fecal coliform bacteria and sediment in the water during the high flow winter and spring months. During the summer months, water temperature is too warm to protect cold-water fish. People in the Spokane area are very familiar with the way the creek runs a chocolate-milk color during spring run-off. These issues are outlined in the TMDL developed by Ecology in partnership with the SCCD. Now, that partnership has turned to implementing the activities called for in the TMDL. In the past, lack of coordination between jurisdictions has been a barrier to achieving our goal of better water quality. However, this project is different in that it brought together four conservation districts, two state agencies, a federal agency, and a Tribe to work on shared water quality problems.


Example of agricultural erosion in the Hangman Creek watershed.

Upland agricultural runoff and riparian degradation are the focus of this project. In the Hangman Creek watershed, about 260,000 acres are devoted to dryland farming practices on highly erodible soils. Under conventional farming methods, average losses of these soils amounts to over 12 tons per acre per year. Using direct seed tillage, soil losses can be cut to less than five tons per acre, for a total annual soil savings of nearly two million pounds. Because most of the eroded soil eventually winds up in the Spokane River, the benefits extend well past the Hangman Creek watershed.

DEPARTMENT OF ECOLOGY
State of Washington

Water quality modeling for the watershed showed that to protect the streams, significant agricultural acreage needs to be converted to conservation cropping systems such as direct seed or mulch-till. Direct seed cropping is a low soil disturbance planting practice where the new season's crop is planted directly into the stubble of the previous crop. Mulch-till, like direct seed, results in a large amount of residue left on the soil and does not involve fully tilling (inverting) the soil. These methods result in very little runoff and erosion. In addition, streams need to have their banks stabilized and planted with native vegetative buffers, and livestock need to be managed so as to avoid water quality impacts.

Project details

The SCCD and Ecology recognized that to better manage the watershed, a funding source was necessary to help landowners and producers employ these practices. This funding needed to be available throughout the entire watershed, not just in Washington. Together, we submitted a proposal to NRCS for their Agricultural Watershed Enhancement Program (AWEP). The proposal asked for $1.2 million over three years to fund direct seed technology adoption, livestock exclusion fencing and off-stream watering systems, and stream bank stabilization projects. Our application asked that funds be made available in both Washington and Idaho so sources throughout the entire watershed could be addressed. Our application package included letters of support from the city of Spokane, Spokane County, Idaho Department of Environmental Quality, the Coeur d'Alene Tribe, and the Benewah Soil and Water Conservation District.

Milestones and outcomes


Example of a direct seed drill planting into the last crop's stubble.

The application was awarded a little more than $757,000 for the three-year program. During this time, 5720 acres of conventional tillage were converted to conservation tillage. Approximately 3000 acres were put into direct seed while the remaining acreage was converted to mulch-till. Additionally, a five-acre grassed waterway was implemented to reduce runoff and capture sediment and over 4600 feet of fence was installed to keep livestock out of a stream. A nutrient management plan was developed for 521 acres. There is also a water and sediment control structure planned. These practices were implemented in both states with 14 contracts in Washington and 2 in Idaho. The conversion of conventional tillage to conservation practices alone could reduce erosion by approximately 40,000 tons per year.

Project highlights

This project brought together a team of people dedicated to seeing water quality protection implemented in the Hangman Creek Watershed. Both Idaho and Washington are at the table and actively working on this project without letting the state line create a barrier to success.

A challenge during the first year of the program was a very short timeframe in which to advertise and enroll producers. The award was announced during the first week of July 2010, and all funds had to be under contract with the landowners/producers by August 31, 2010. This meant the enrollment period had to be limited to little over two weeks. Once the producers submitted applications, NRCS and the conservation districts had less than a month to develop plans and contracts outlining what practices would take place. In spite of the short timeframe, enough producers enrolled for eligible practices to exhaust all of the first year's funding allotment emphasizing the need for additional funding for the following two years.

The response to the request for applications surprised everyone involved. It demonstrated that there are a lot of producers interested in implementing these practices. Past experience suggests that one of the barriers to implementing direct seed technology is the fear that it will fail. One of the eligible practices funded through this program allows the producer to work with an experienced direct-seed farmer. The mentor helps plan and manage their direct-seed system to get them started on the right track. This watershed is the only location where NRCS will currently fund the addition of a mentor to the direct seed practice. This project's success may help expand this to other areas.

Funding

The funding for this project comes from NRCS's Agricultural Watershed Enhancement Program (AWEP). Part of the Environmental Quality Incentives Program (EQIP), AWEP provides contracts with producers to implement conservation practices in the project area. In addition, each partner organization devoted many hours and resources to this project.

Partners

The AWEP team is made of staff from several organizations and agencies:

Washington Department of Ecology
Jon Jones (now retired) & Elaine Snouwaert

Spokane County Conservation District
Rich Baden, Walt Edelen, Ty Meyer, & Rick Noll

Natural Resources Conservation Service
Gary Mitchell, Rich Edlund, Mark Cottrell, Mark Addy, Colleen Winchester, Steve Sprecher, and Colfax NRCS staff

Benewah Soil & Water Conservation District
Sherry Klaus

Pine Creek Conservation District
Raymond Brown

Kootenai Soil & Water Conservation District
Erica Waterman

We believe much of the success in receiving the award from NRCS came from the diverse support that accompanied our application. Letters of support were provided by:

- Coeur d'Alene Tribe Water Resources
- Idaho Department of Environmental Quality
- City of Spokane
- Spokane County

We also must recognize the landowners and producers who are taking the steps to ensure their operations are protecting water quality.

For more information
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To ask about the availability of this document in a format for the visually impaired, call the Water Quality Program at 360-407-6404. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Lake Spokane Shoreline Goes Au Naturel

What happens when you return to the basics?

The Staggs's shoreline before the start of the project

Introduction

Why would anyone strip away a concrete bulkhead and expose their property to erosive forces? Well, one answer would be that a brave Lake Spokane (also known as Long Lake) couple recognized that their existing bulkhead was failing. It did not provide habitat for fish and wildlife, and could not filter pollutants from runoff before it entered the water. They also understood that bulkheads can cause problems for neighbors by increasing erosion further down the shoreline. For these reasons, Eric and Alycia Staggs agreed to install a naturalized shoreline as a demonstration project to other Lake Spokane homeowners.

Problem

Lake Spokane is known for low dissolved oxygen levels and algae blooms. In 2010, the Department of Ecology (Ecology) completed a water quality improvement plan for the lake. The plan identified run-off and other non-point source pollution from homes as contributors to the water quality problems. In order to help address these impacts, Ecology began working with local partners in the spring of 2012 to identify potential property owners interested in naturalizing their shoreline on Lake Spokane. The project team pursued developing a demonstration project so landowners could see how a naturalized shoreline can protect their property from erosion and provide other benefits. Those benefits include increased safety by providing a gradual slope rather than a drop-off at the water, increased aesthetic value of the property, privacy, and compliance with water quality regulations.

Project or Event Goals

The Staggs decided their property, located on the southeast side of Lake Spokane, was the perfect guinea pig for the project. Their bulkhead was breaking down and they were excited about making the change to a naturalized shoreline.

The failing bulkhead prior to removal

The Spokane Conservation District (District) was key to success of the project. Their staff provided technical assistance by working with the project engineer on the design, providing additional funding, applying for permits, and supervising construction contractors. After obtaining all the required permits, the project began in February 2013 following reservoir drawdown. The District spent four days on-site overseeing bulkhead demolition and re-grading of the shoreline, returning in the spring to plant shoreline vegetation, and later repairing erosion caused by high lake levels and rain. The homeowners used time-lapse video to show the project transformation from start to finish, which is available to view at:http://www.youtube.com/watch?v=luT0RZShJoY&feature=youtube_gdata.

Milestones and Outcomes

One of the biggest challenges to this project was timing. The project had to occur when Avista lowered lake levels to make room for spring flows. The contractor, project designs, and permits had to be ready when the lake was ready. This time period is not the same every year and the amount of drawdown can vary. For some time the project team was not sure a drawdown would occur at all. Fortunately, it did and the project proceeded.

The permitting required a high level of coordination because four different agencies had five authorizations or exemptions to issue. Each agency had different concerns about, and requirements for, the project, such as the placement of rock and plants to dissipate wave energy and shoreline slope. The project engineer ended up creating two designs before all the agencies could agree to the project. In addition, three of the agencies needed to complete a cultural resources consultation with the Spokane Tribe, but because this was unknown at the time, two separate consultations occurred. Despite a short timeline, the agencies issued all the permits so construction and planting occurred as planned.

Since completing the project, the Staggs have discussed their project and answered questions from neighbors who live along the lake. Their next door neighbor also had the Spokane Conservation District plant native vegetation along their shoreline to help filter runoff and reduce erosion. The Staggs reported an abundance of small fish just off their shoreline. One year later, the Staggs need to replace some sedges that died and finish other minor maintenance, but they report the shoreline is doing great.

The Staggs' shoreline after completed construction

Partners

Ecology would like to thank the Staggs family for providing a time-lapse video of their project to share. Thanks also to the Lake Spokane Association, Spokane Conservation District, Stevens County Conservation District, Governor's Office for Regulatory Innovation and Assistance, Washington Department of Fish and Wildlife, US Army Corps of Engineers, Spokane County, and Avista Corporation for helping make this project possible.

One year later

Funding

Funding for this project came from Ecology's Water Quality Program's Direct Implementation Fund. This fund is a subset of federal grant funds dedicated specifically to addressing nonpoint sources of pollution such as residential runoff and erosion. The Spokane Conservation District supplied engineering and design grant funds, and the Staggs family purchased the plant material.

For more information

For more information on this particular project, Lake Spokane, bulkhead removal, and green shorelines visit:

- Lake Spokane Association - http://www.lakespokaneassociation.org/
- Spokane Conservation District - http://sccd.org/
- WA State Department of Ecology - http://www.ecy.wa.gov/programs/sea/greenshorelines/index.html
- Stevens County Conservation District - http://www.co.stevens.wa.us/cons_district/Partners/partners.htm

- Avista Utilities - https://www.avistautilities.com/environment/spokaneriver/Pages/default.aspx

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Ecology joins partners in educational mission

Regional experts help students understand complex watershed issues

Introduction


Students of Lakeside High

High school students are deciding what they want to be when they grow up, what matters to them, and how they will make a difference in their world. For those of us working to protect our natural resources, we must recognize that the future of our watersheds depend on our youth. What we teach students and the values we instill in them affect the health of our ecosystems and how those systems provide for future generations. This is why a group of natural resource professionals is taking part in the South Stevens Education Project sponsored by Stevens County Conservation District and funded by Washington Department of Ecology.

The Project

The South Stevens Education Project has the following goals:

- Increase awareness that each watershed resident has the ability to greatly impact water quantity and quality within their watershed by making them aware of activities that degrade or enhance, maintain, and/or protect water resources;
- Attempt to create a sense of natural resource stewardship for all watershed residents, and
- Use press releases, workshops, youth events, and displays to present information to school children as well as adults in the watershed.

Mrs. Teri Sardinia's Investigative Microbiology class at Lakeside High School is part of the South Stevens Education Project. Her students learn about natural resource processes by focusing investigative study on the area around Lake Spokane. The students are divided into three groups, each with a different topic to study so that they can prepare presentations for adults and school students of various ages. One group is looking into managing runoff, one is studying water conservation practices, and the third is doing research on vegetative buffers. To help the students understand the complexity of the environmental issues concerning a lake of this size, the Conservation District has brought many presenters to the classroom.

Milestones and Outcomes

Martyn Quinn, an Ecology TMDL Lead, has talked to the students about the concept of a watershed and how agencies and different levels of government work together to help local residents improve or maintain water quality. Martyn also spent time answering student questions and reviewing student projects. "Martyn's input in this educational effort has been invaluable," said Charlie Kessler, Conservation District Water Quality Coordinator. "He has a way of explaining things that the students enjoy and can easily understand."

Martyn Quinn talks to students at Lakeside High

Other presenters have included Tom Wimpy of Inland Water Pest Control and Consulting and Avista Utilities representatives. Tom spoke of the aquatic weed problem the lake is facing and how different people are tackling the problem. Many lake property owners use bottom barriers to cover the lake bottom like a blanket, compressing aquatic plants and blocking the light needed for them to grow.

Pat Maher and Mac Mikkelsen from Avista Utilities pointed out that Lake Spokane is the reservoir behind Long Lake Dam. This means the lake level may vary during times of the year as the reservoir is drawn down to prepare for the snowmelt runoff period. Also, draw down during the winter months helps to kill some of the aquatic weeds as the weather gets colder. They demonstrated a model which shows how electricity is generated by the weight of the water going through the turbines in the dam. Mr. Mikkelsen was a special presenter as he is a graduate of Lakeside High School and is currently on the Nine Mile School District Board.

Project highlights

"The support our educational efforts have received from these regional experts has been tremendous" stated Mr. Kessler. "I have also been impressed by the enthusiasm demonstrated by the students so far. Mrs. Sardinia has done a very good job getting the students prepared, and they have made good efforts since the first classroom visit on February 1st. One never knows what they will find when they enter the classroom, but this looks like it will be a positive experience for all involved."

Lake Spokane watershed

Partners

Ecology staff worked closely with the Stevens county Conservation District, who in-turn collaborated input from Inland Water Pest Control and Consulting, Tri-Counties Health Department and from Avista Utilities representatives.

Funding

The South Stevens Education Project was funded with $15,000 from a Watershed Planning grant to Stevens County Conservation District.

For more information

To learn more about this project, contact Charlie Kessler of Steven's County Conservation District at 509-685-0937, extension 111.

Acknowledgements

Special thanks to the Outpost Weekly Newspaper (www.lakespokaneoutpost.com) for permission to use content from their April 11, 2012 story.

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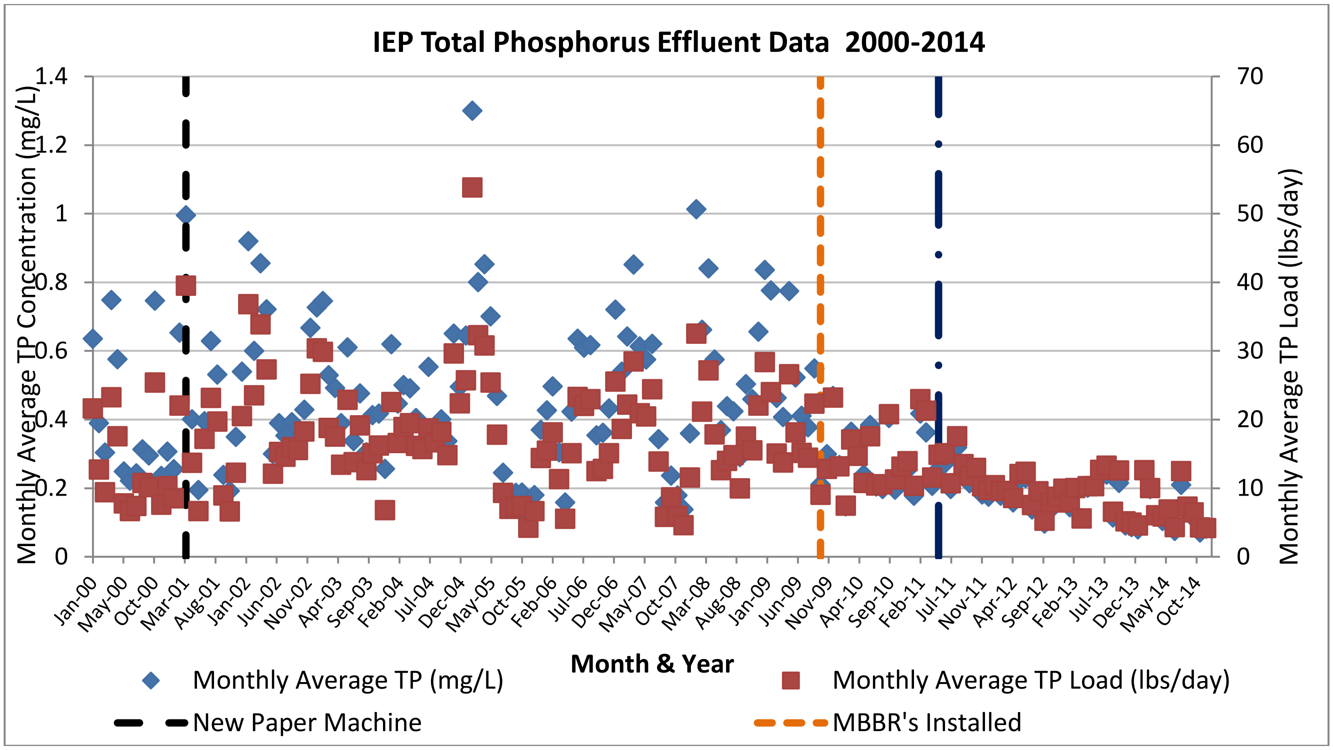
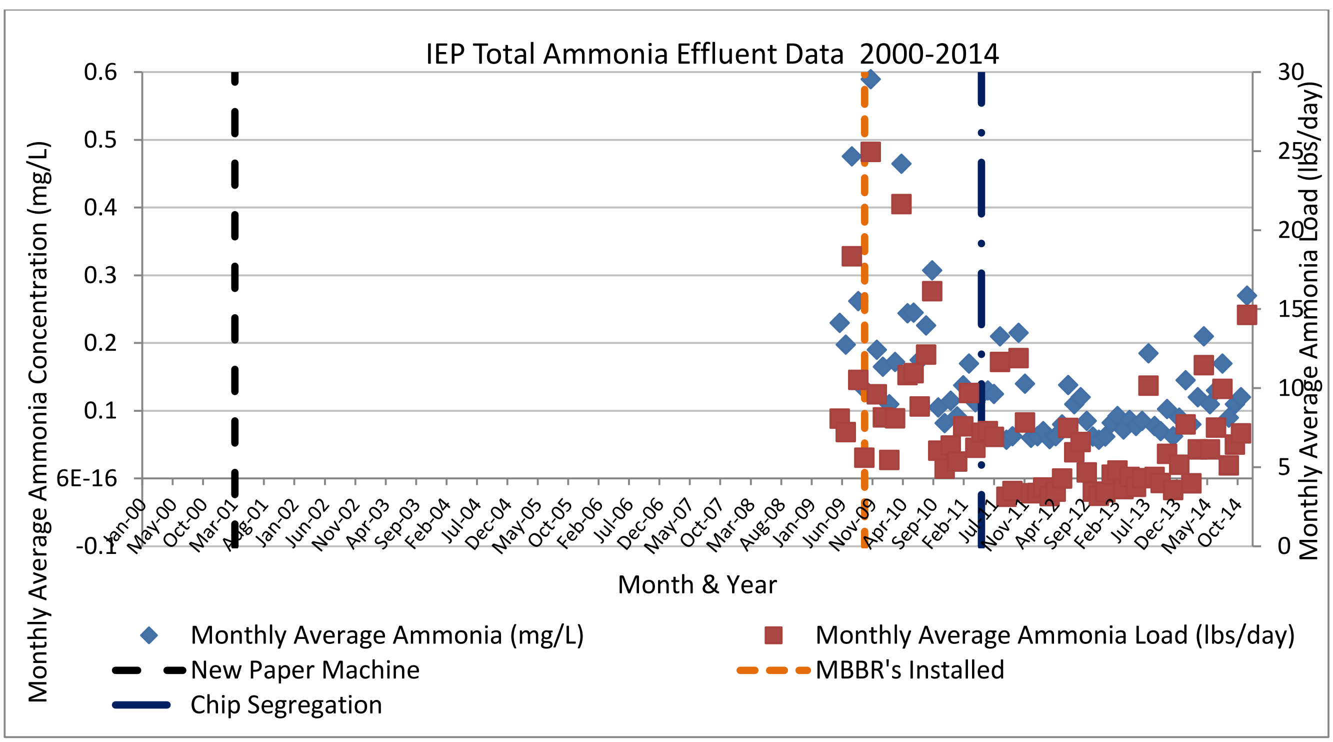
Appendix C. Discharger Monitoring Graphs

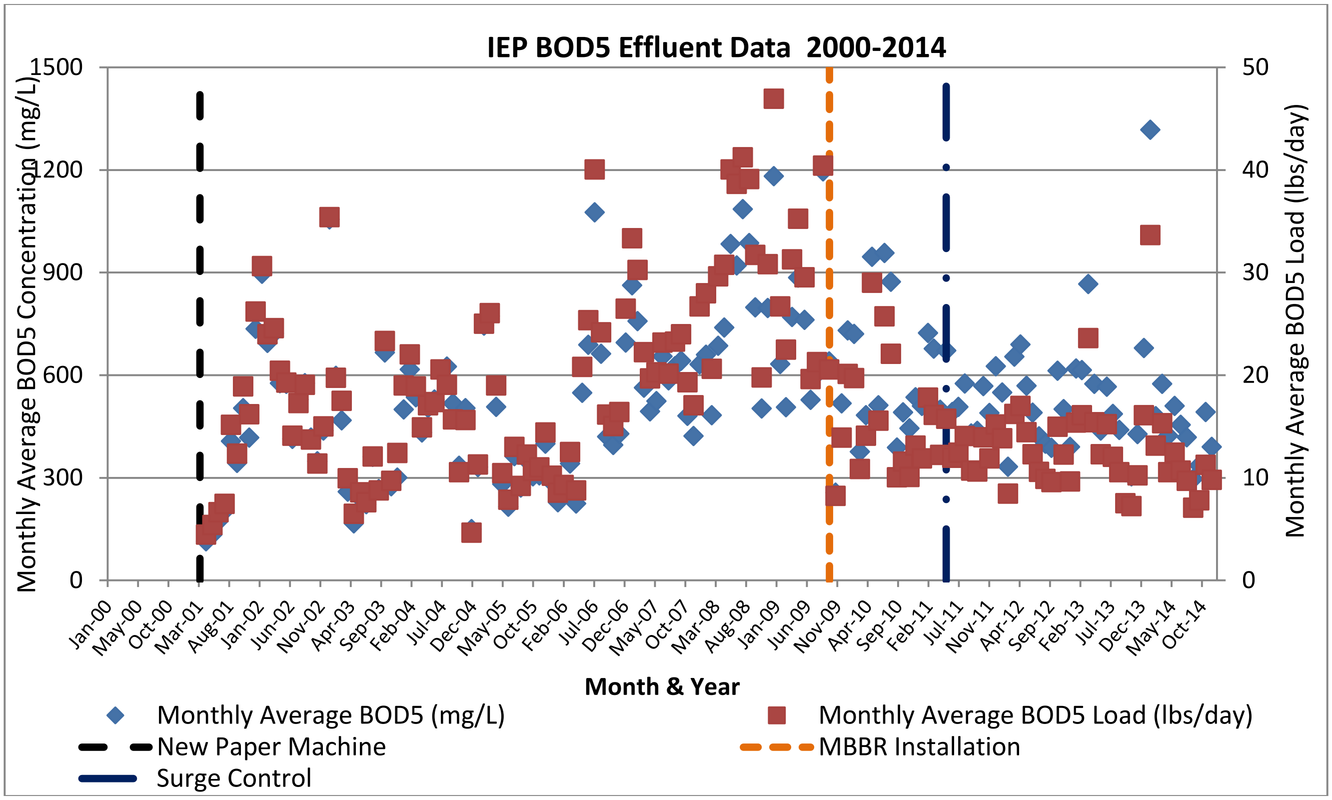
Data presented herein are presented as monthly averages for purposes of clearly illustrating trends in concentrations over time; permit compliance limits vary seasonally and have changed over the duration of the dataset. Monthly averages should not be compared to TMDL allocations or permit limits since those are based on seasonal averages.

Washington State Dischargers

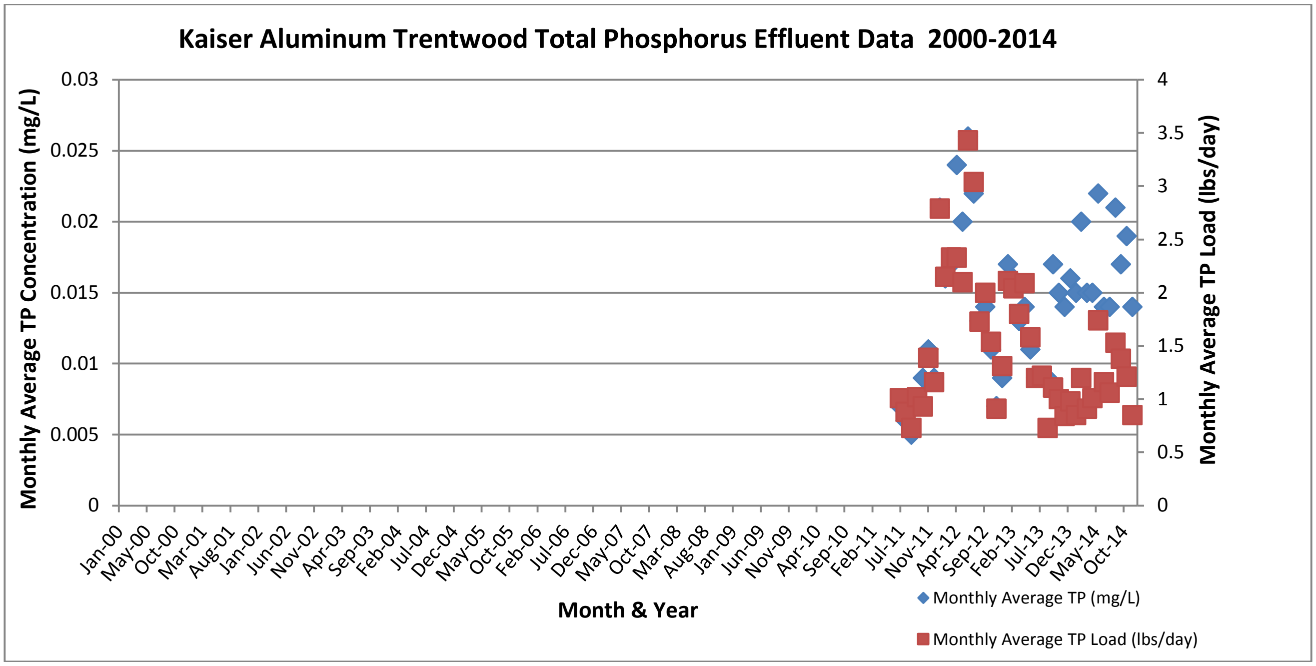
Inland Empire Paper Company

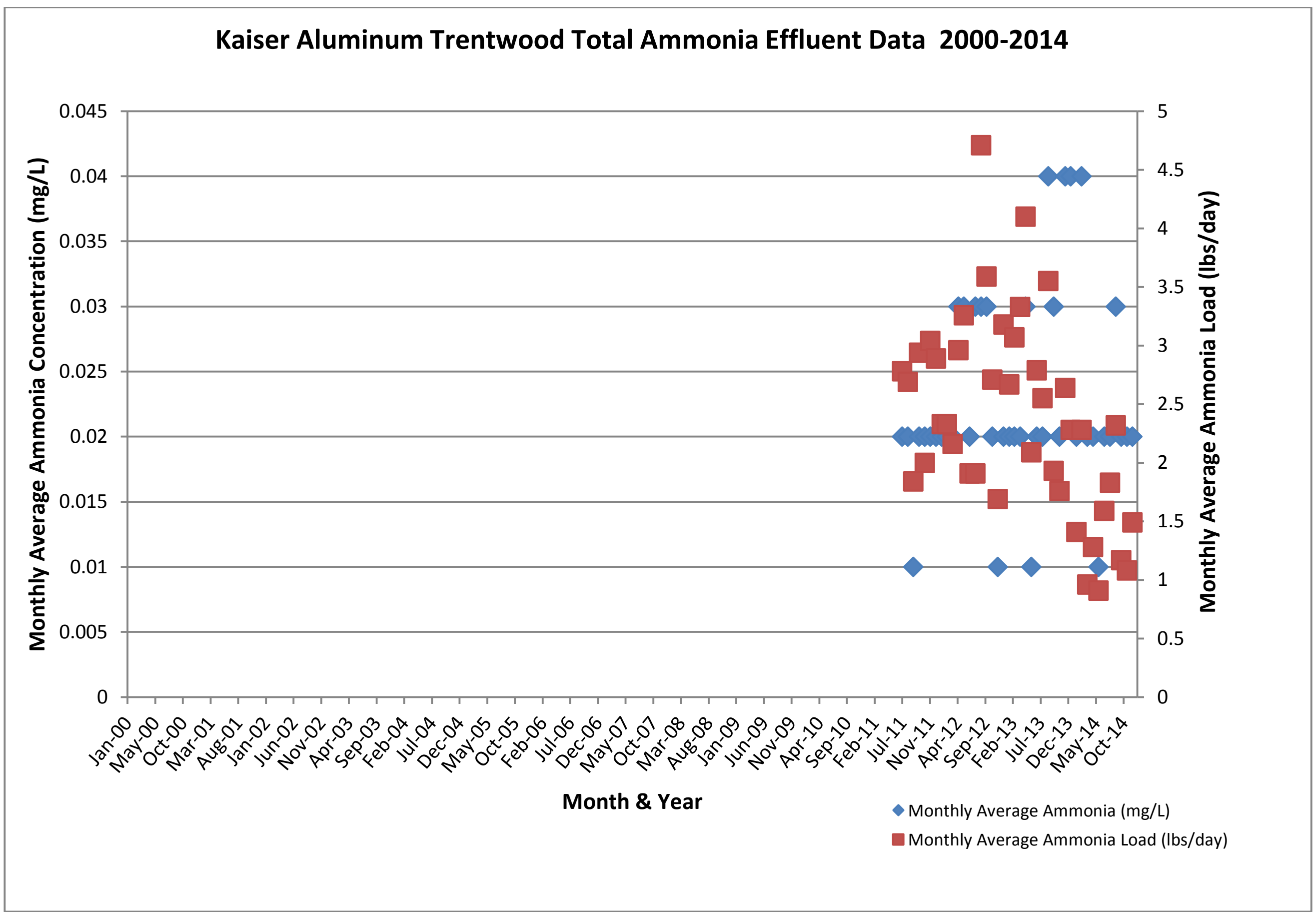


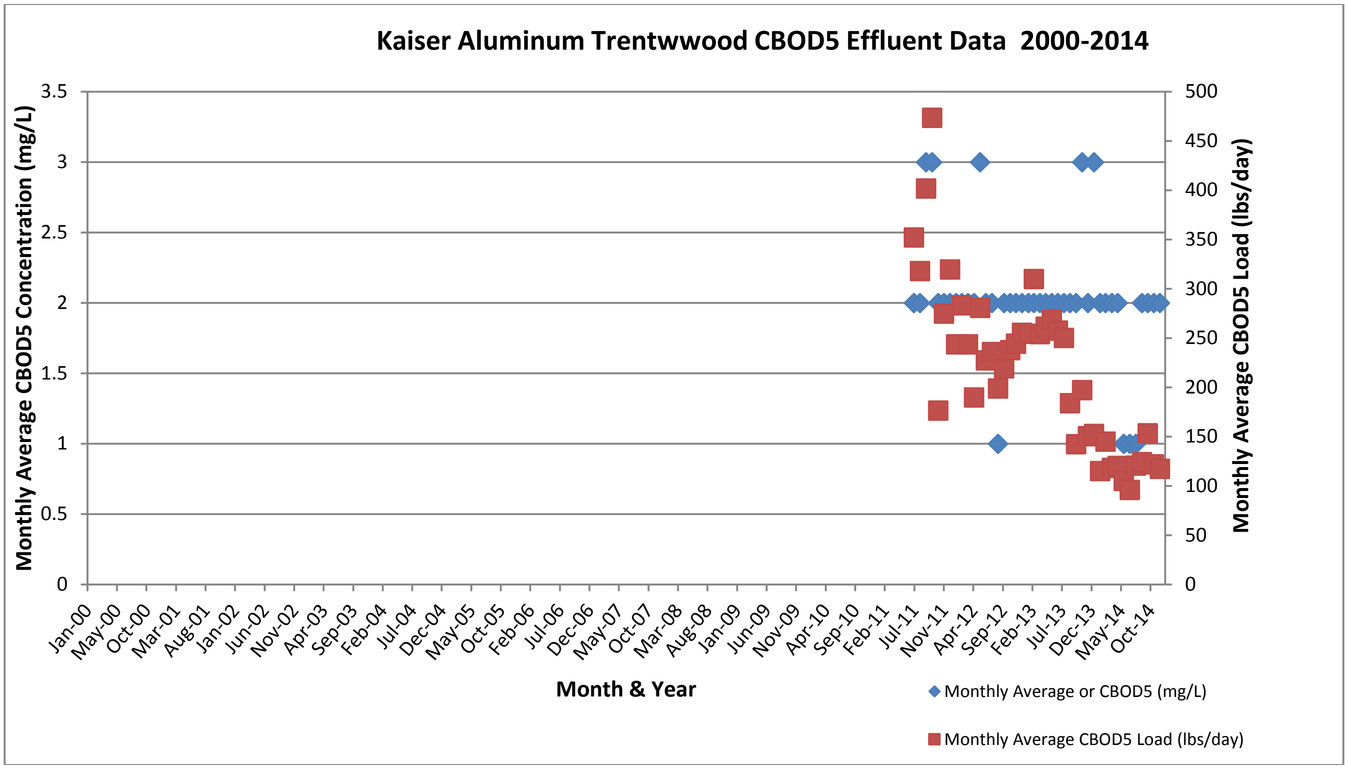



IEP BOD5 Effluent Data 2000-2014
Monthly Average BOD5 Concentration (mg/L)
Monthly Average BOD5 Load (lbs/day)
1500
1200
900
600
300
0
50
40
30
20
10
0
Jan-00
May-00
Oct-00
Mar-01
Aug-01
Jan-02
Jun-02
Nov-02
Apr-03
Sep-03
Feb-04
Jul-04
Dec-04
May-05
Oct-05
Feb-06
Jul-06
Dec-06
May-07
Oct-07
Mar-08
Aug-08
Jan-09
Jun-09
Nov-09
Apr-10
Sep-10
Feb-11
Jul-11
Nov-11
Apr-12
Sep-12
Feb-13
Jul-13
Dec-13
May-14
Oct-14
Month & Year
Monthly Average BOD5 (mg/L)
Monthly Average BOD5 Load (lbs/day)
New Paper Machine
MBBR Installation
Surge Control

Kaiser Aluminum, Inc.

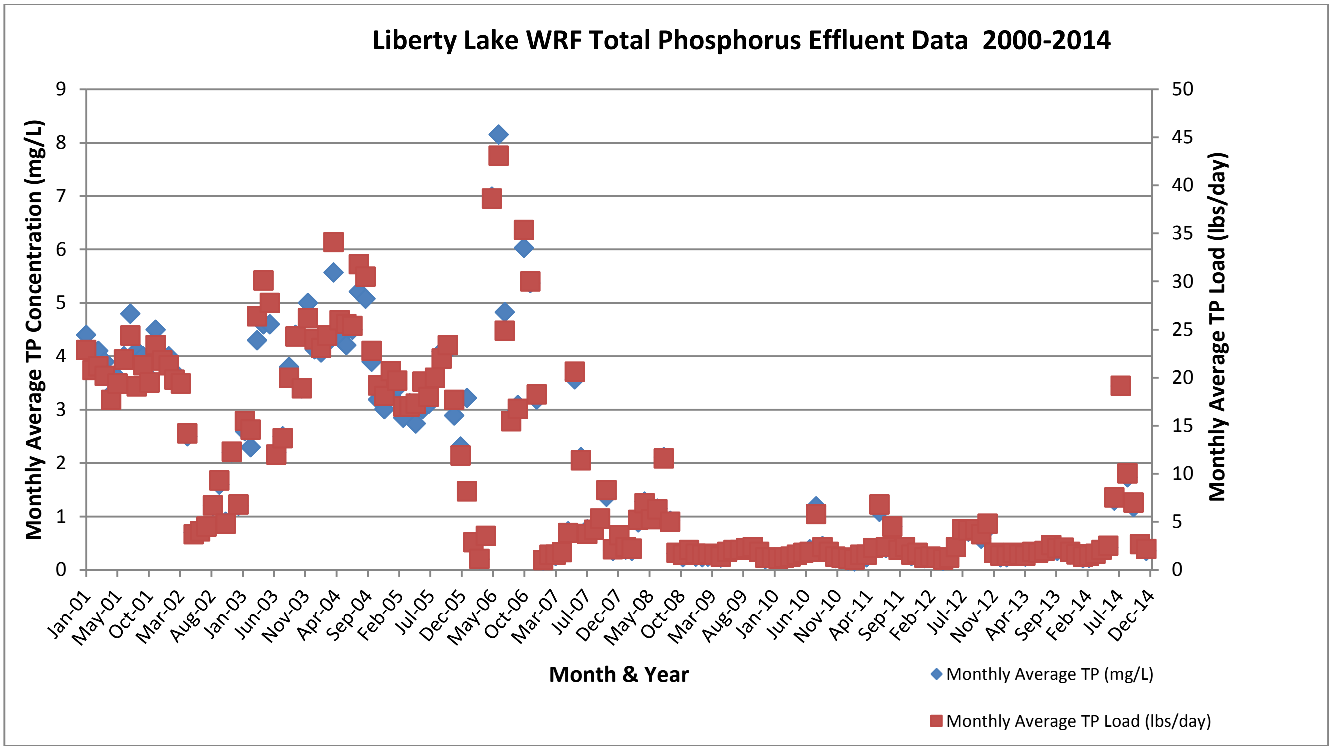


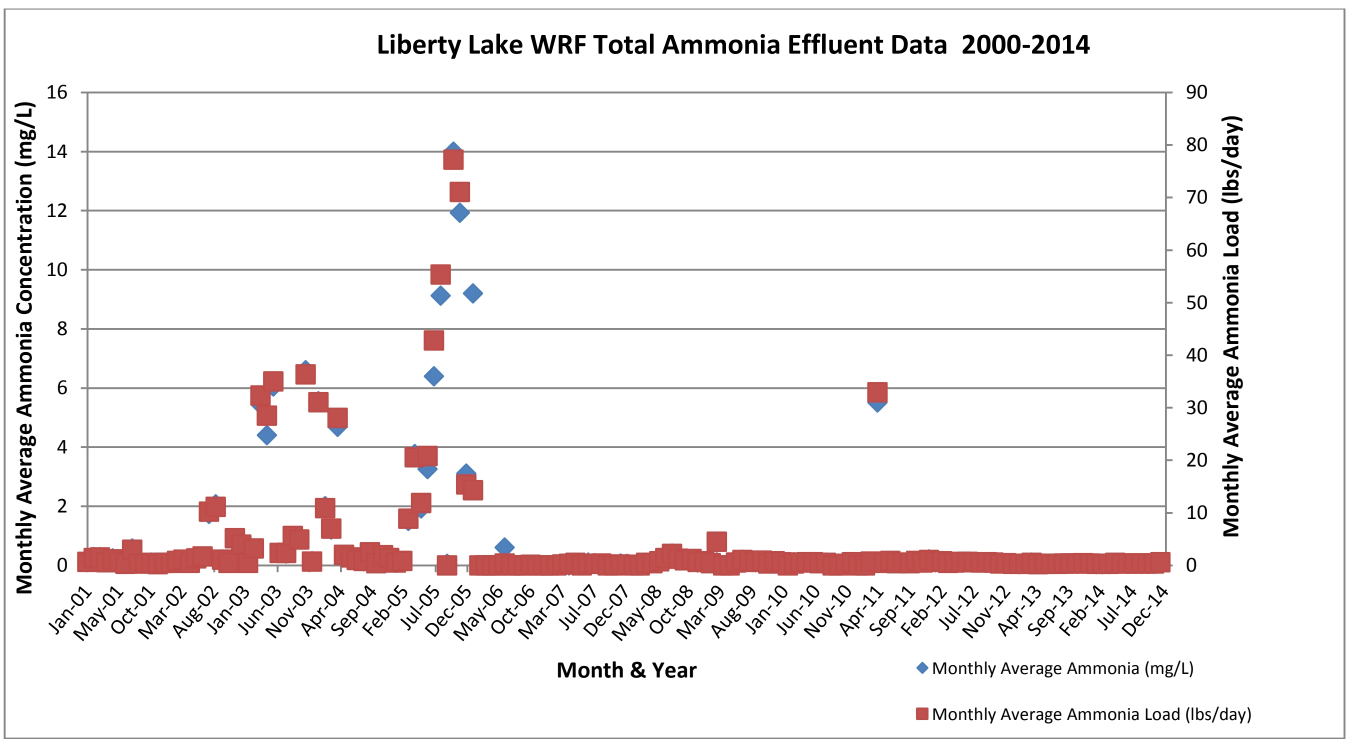


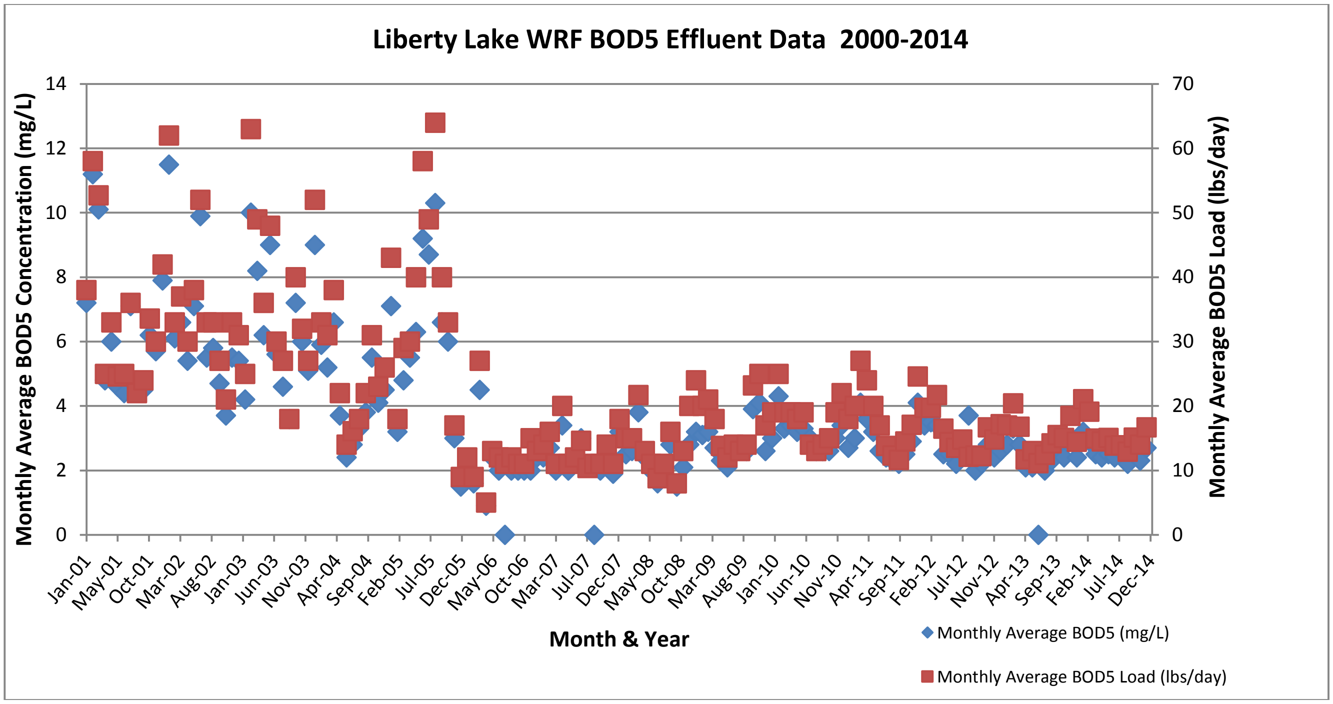


Kaiser Aluminum Trentwwood CBOD5 Effluent Data 2000-2014
Monthly Average CBOD5 Concentration (mg/L)
Monthly Average CBOD5 Load (lbs/day)
Month & Year
Monthly Average or CBOD5 (mg/L)
Monthly Average CBOD5 Load (lbs/day)

Liberty Lake Sewer & Water District

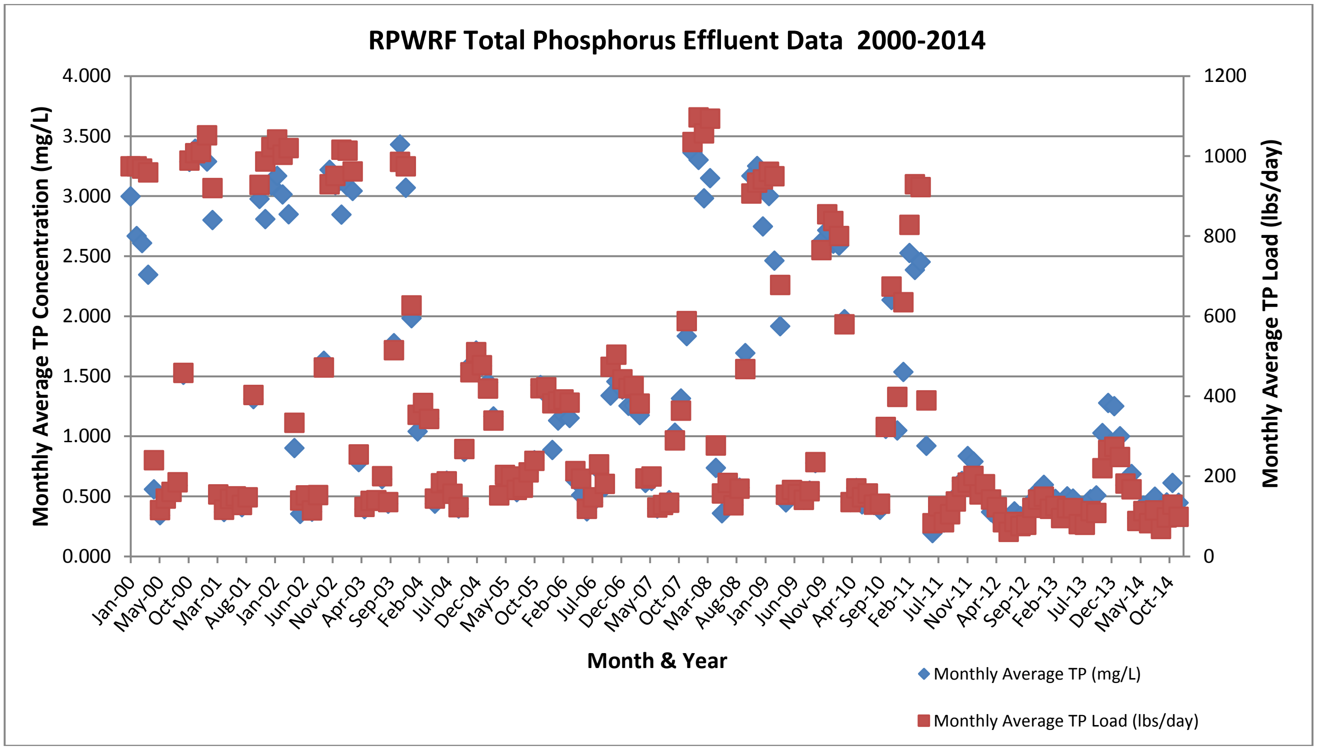




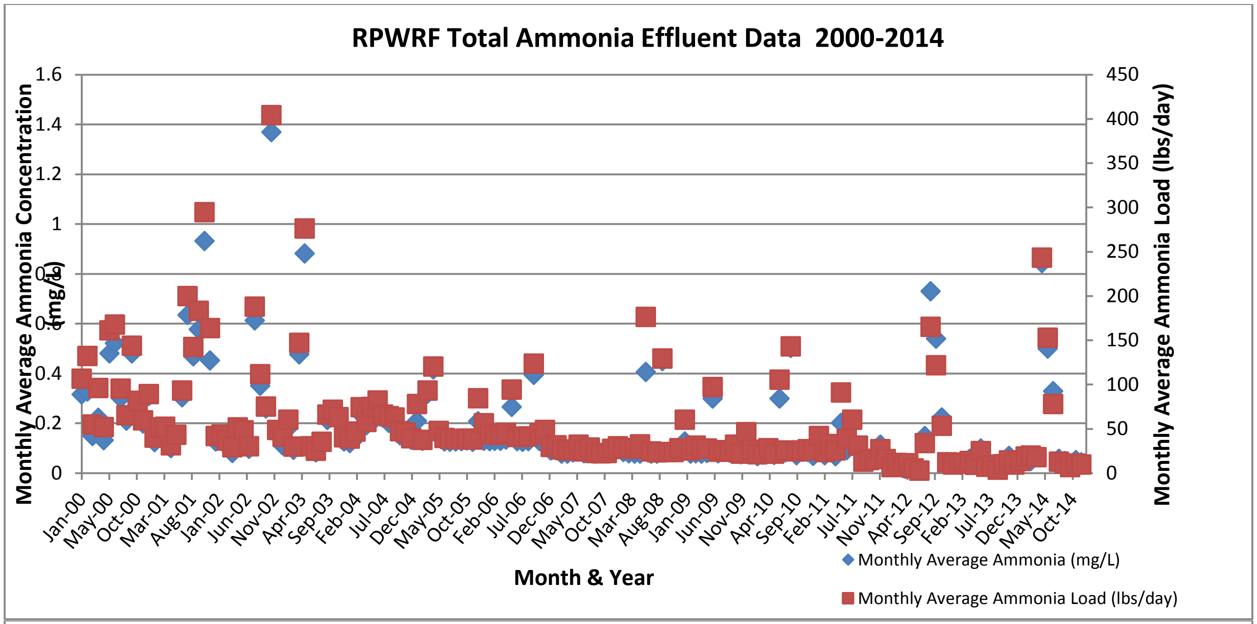


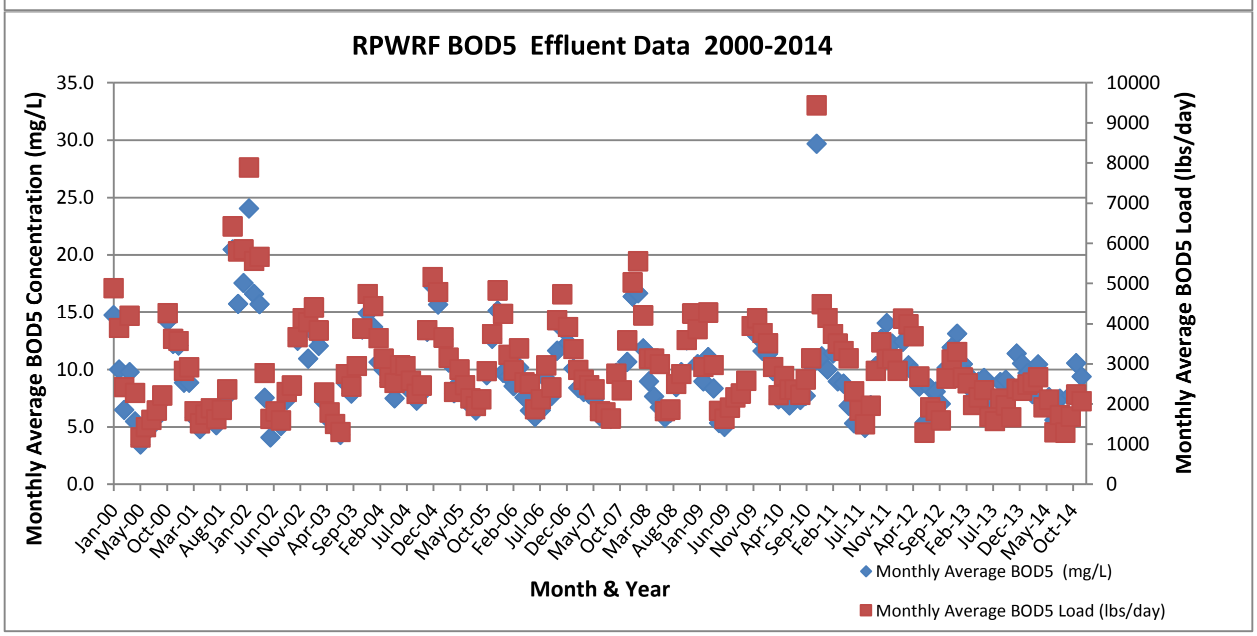
Liberty Lake WRF BOD5 Effluent Data 2000-2014
Monthly Average BOD5 Concentration (mg/L)
Monthly Average BOD5 Load (lbs/day)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
Jan-01
May-01
Oct-01
Mar-02
Aug-02
Jan-03
Jun-03
Nov-03
Apr-04
Sep-04
Feb-05
Jul-05
Dec-05
May-06
Oct-06
Mar-07
Jul-07
Dec-07
May-08
Oct-08
Mar-09
Aug-09
Jan-10
Jun-10
Nov-10
Apr-11
Sep-11
Feb-12
Jul-12
Nov-12
Apr-13
Sep-13
Feb-14
Jul-14
Dec-14
Month & Year
Monthly Average BOD5 (mg/L)
Monthly Average BOD5 Load (lbs/day)

Riverside Park Water Reclamation Facility (City of Spokane)



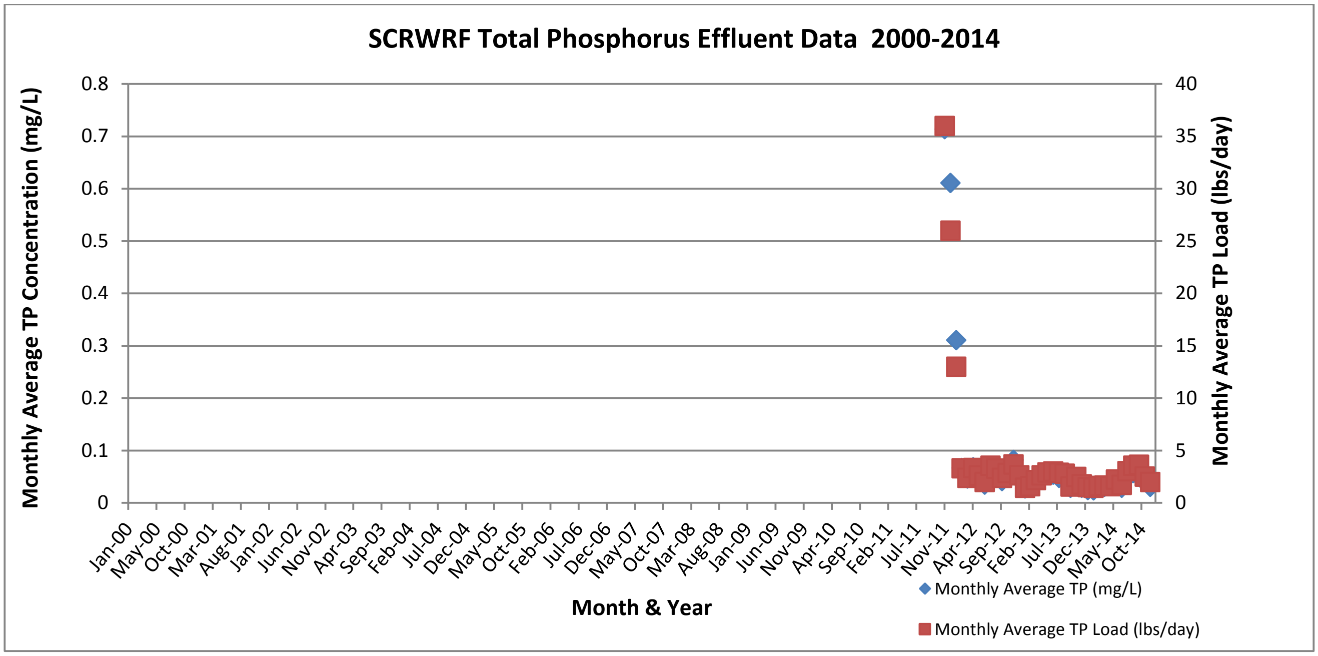
Beginning in June 2011, RPWRF began using chemically enhanced primary treatment (CEPT). With CEPT, the City adds alum as well anionic polymer ahead of the primary clarifiers to aid in solids and phosphorus removal (before, alum was only used in the secondary process for phosphorus removal). The use of CEPT has allowed the City to increase its treatment capacity while reducing phosphorus in its effluent. Initially, CEPT was implemented as a short-term pilot project, but with its success in reducing phosphorus levels, the City will likely continue to use CEPT up through the startup of the next-level treatment process.

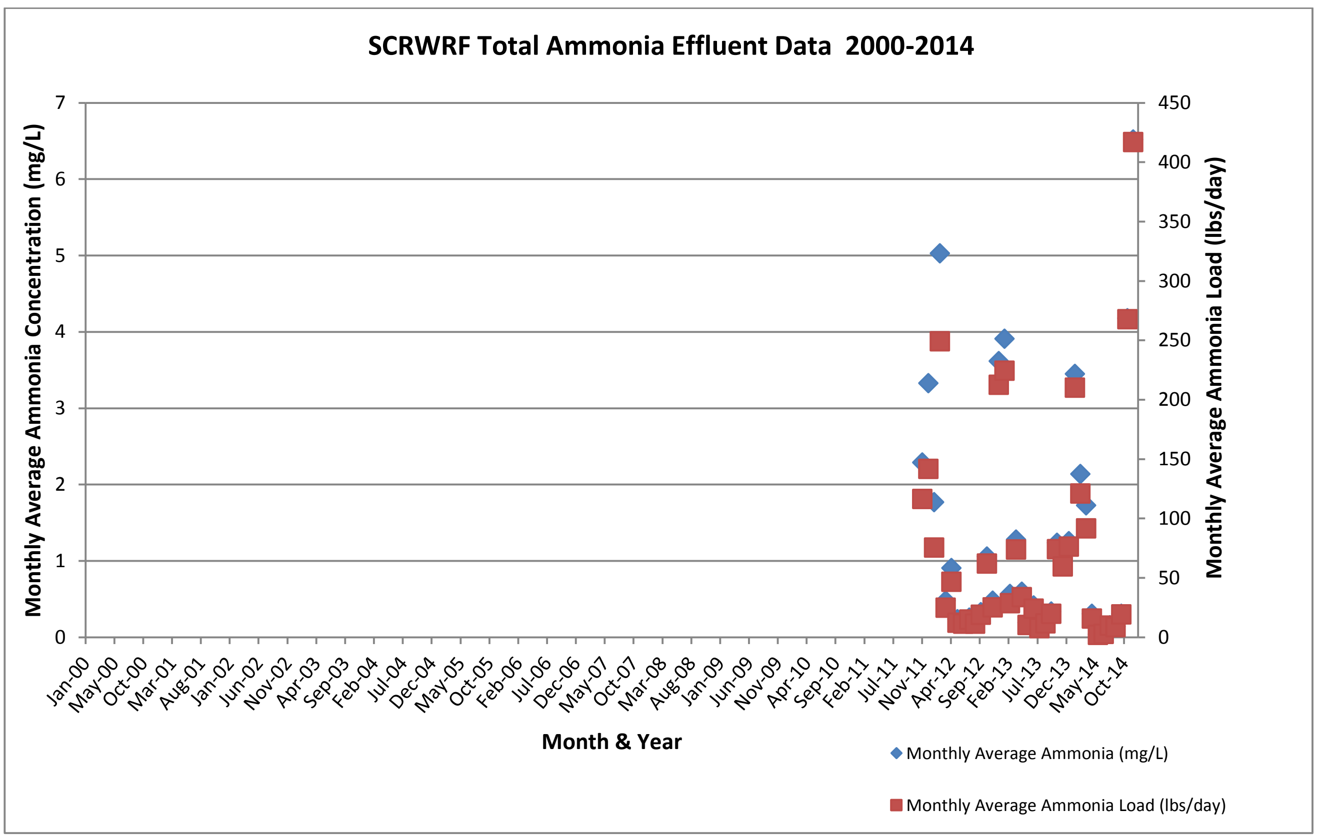


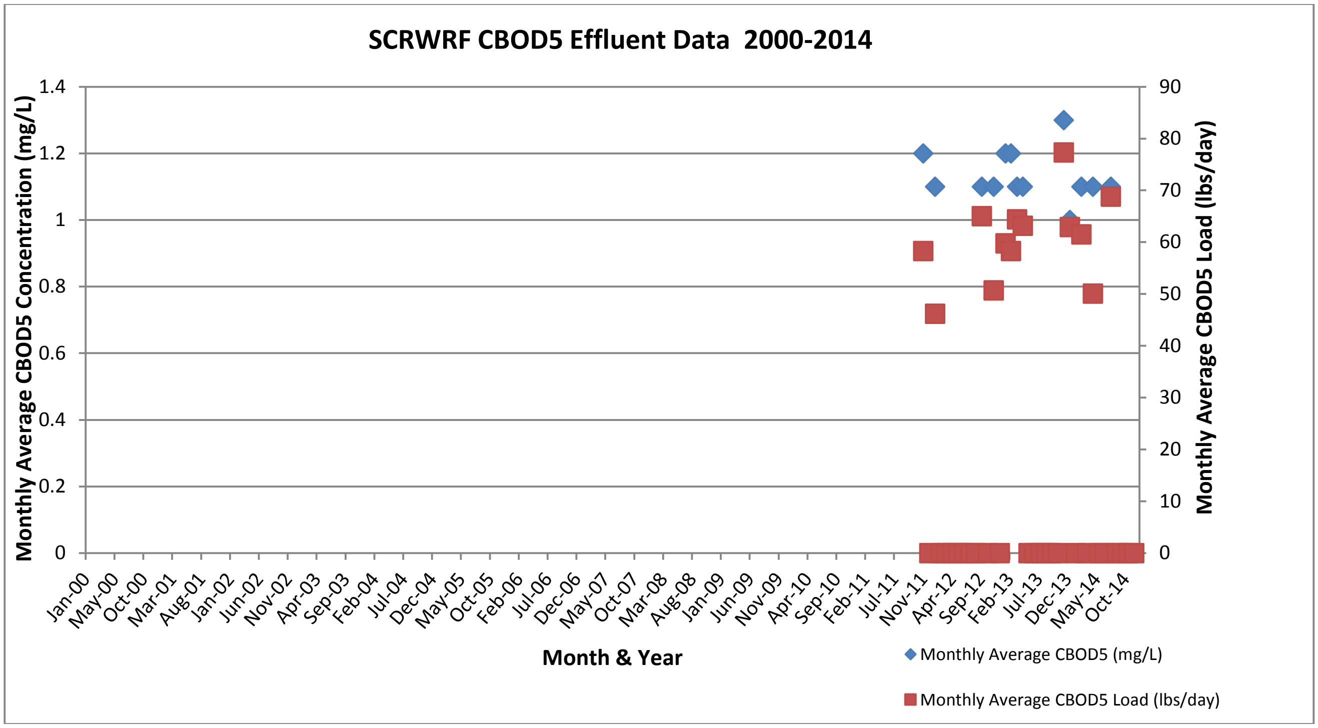


Note: RPWRF has historically monitored for BOD5, but has a final effluent limit for CBOD5. RPWRF began monitoring both BOD5 and CBOD5 in July 2014 to determine a BOD/CBOD relationship and will eventually transition to monitoring just CBOD5.

Spokane County Regional Water Reclamation Facility

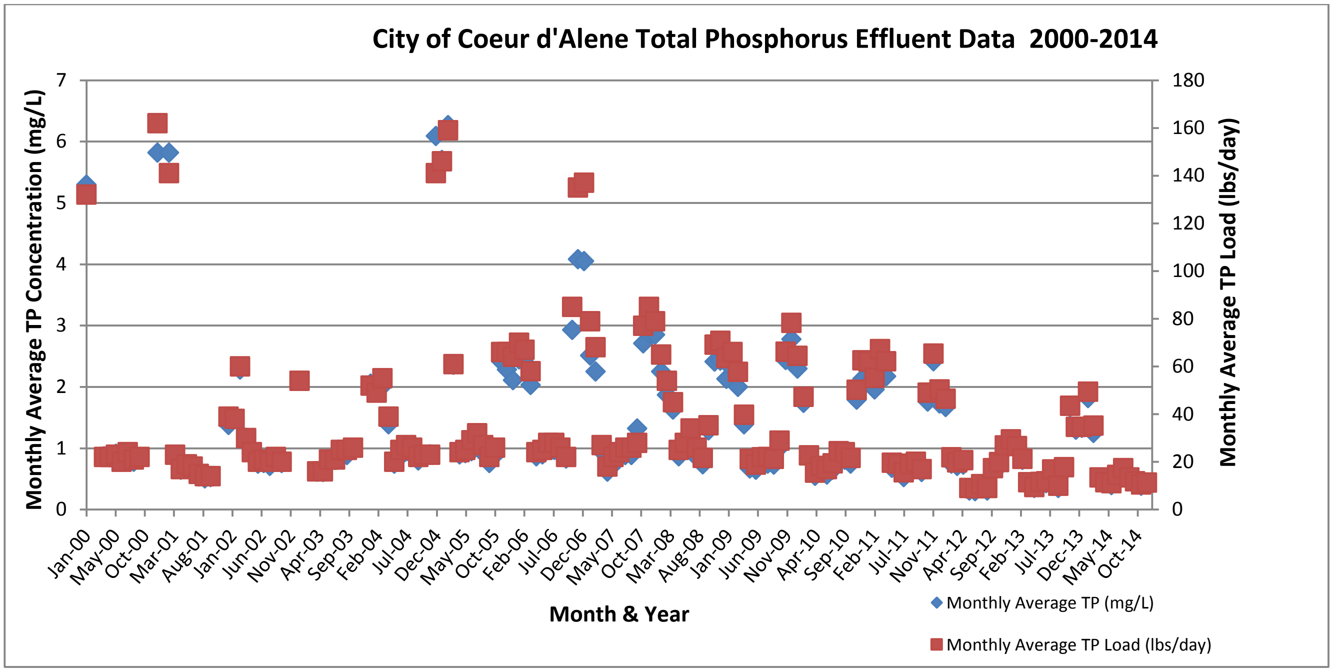


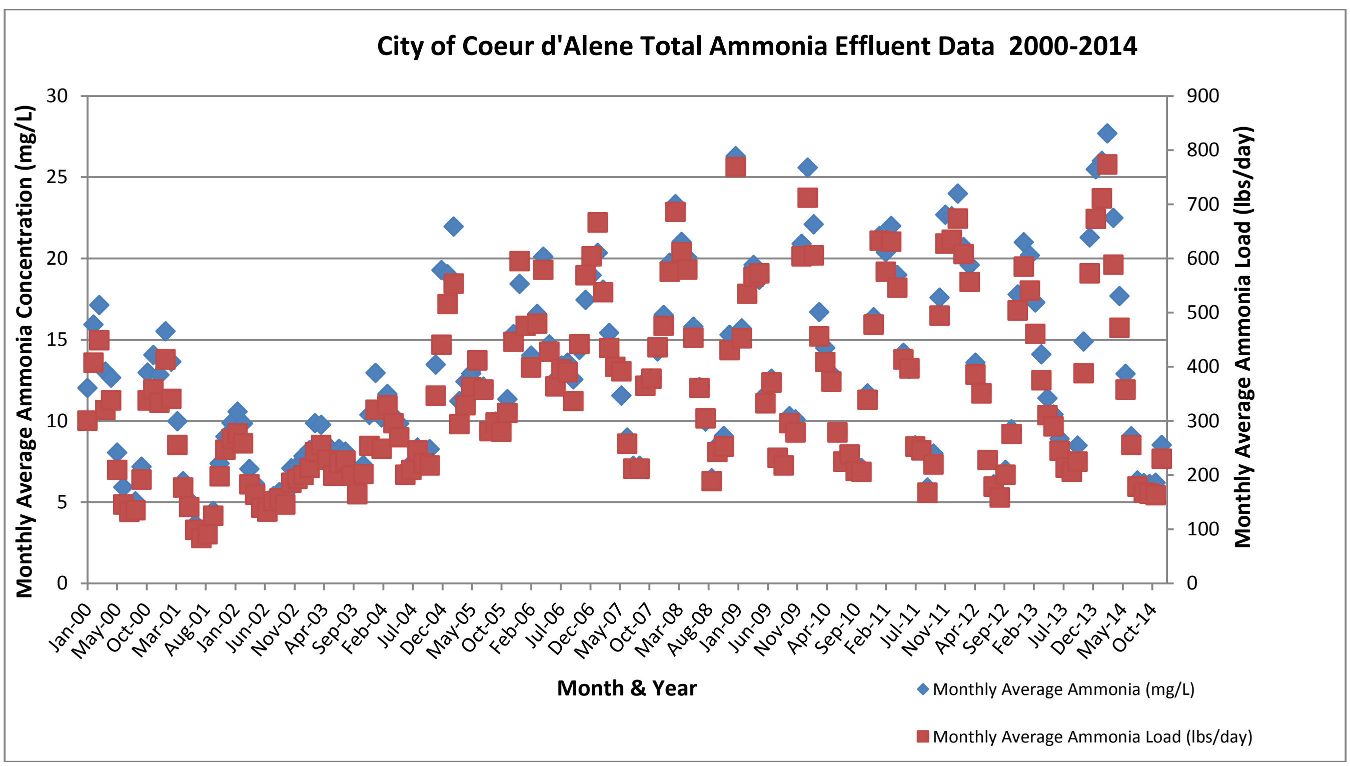


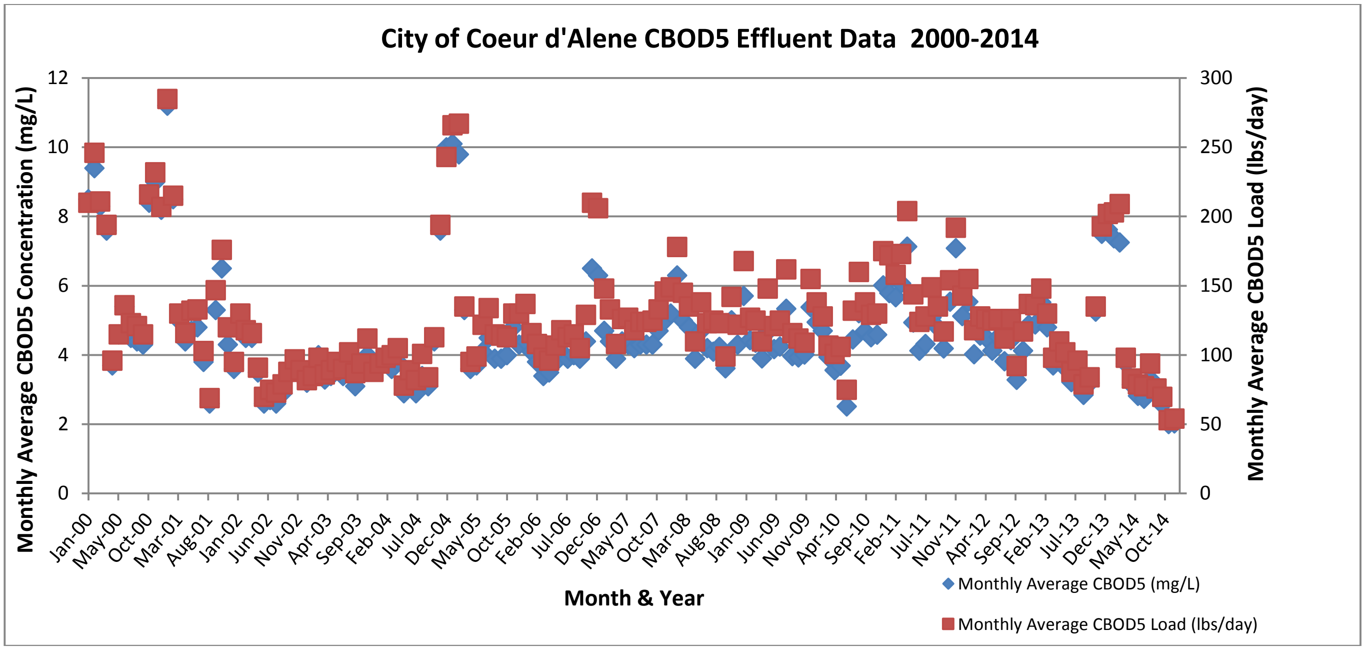

SCRWRF CBOD5 Effluent Data 2000-2014
Monthly Average CBOD5 Concentration (mg/L)
Monthly Average CBOD5 Load (lbs/day)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
90
80
70
60
50
40
30
20
10
0
Jan-00
May-00
Oct-00
Mar-01
Aug-01
Jan-02
Jun-02
Nov-02
Apr-03
Sep-03
Feb-04
Jul-04
Dec-04
May-05
Oct-05
Feb-06
Jul-06
Dec-06
May-07
Oct-07
Mar-08
Aug-08
Jan-09
Jun-09
Nov-09
Apr-10
Sep-10
Feb-11
Jul-11
Nov-11
Apr-12
Sep-12
Feb-13
Jul-13
Dec-13
May-14
Oct-14
Month & Year
Monthly Average CBOD5 (mg/L)
Monthly Average CBOD5 Load (lbs/day)

Idaho Dischargers

Coeur d'Alene

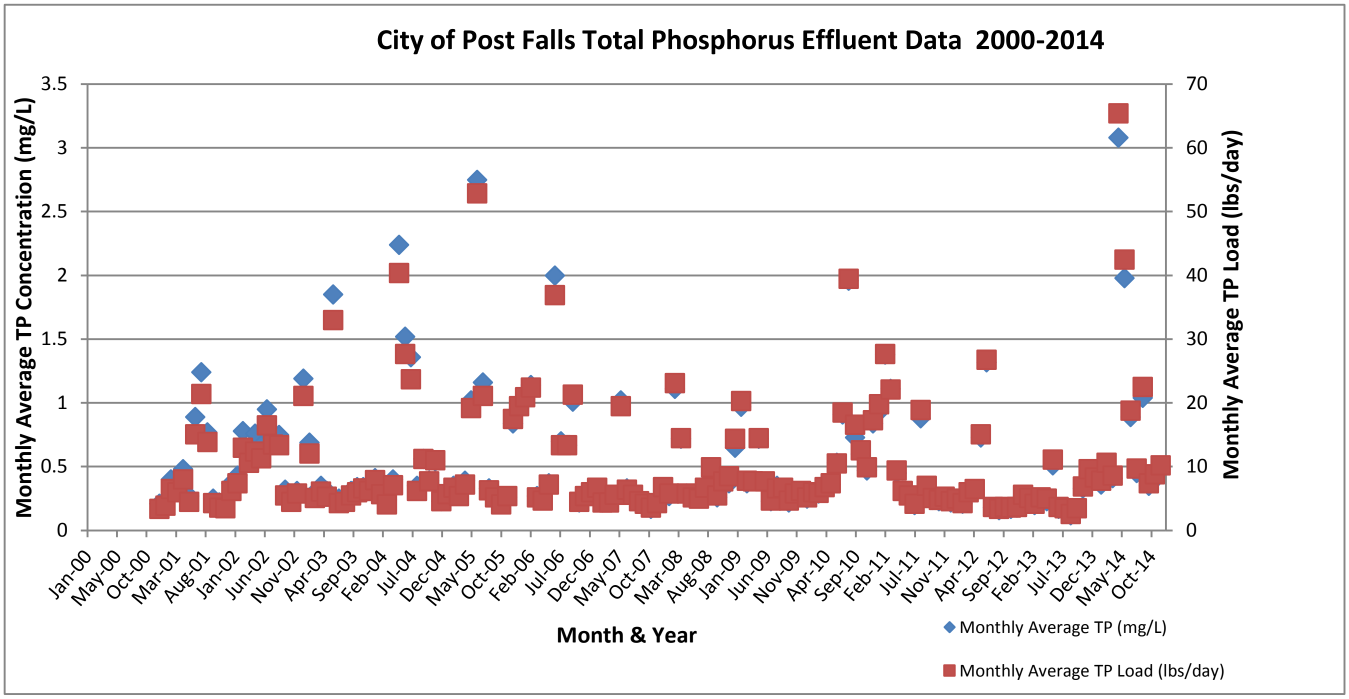


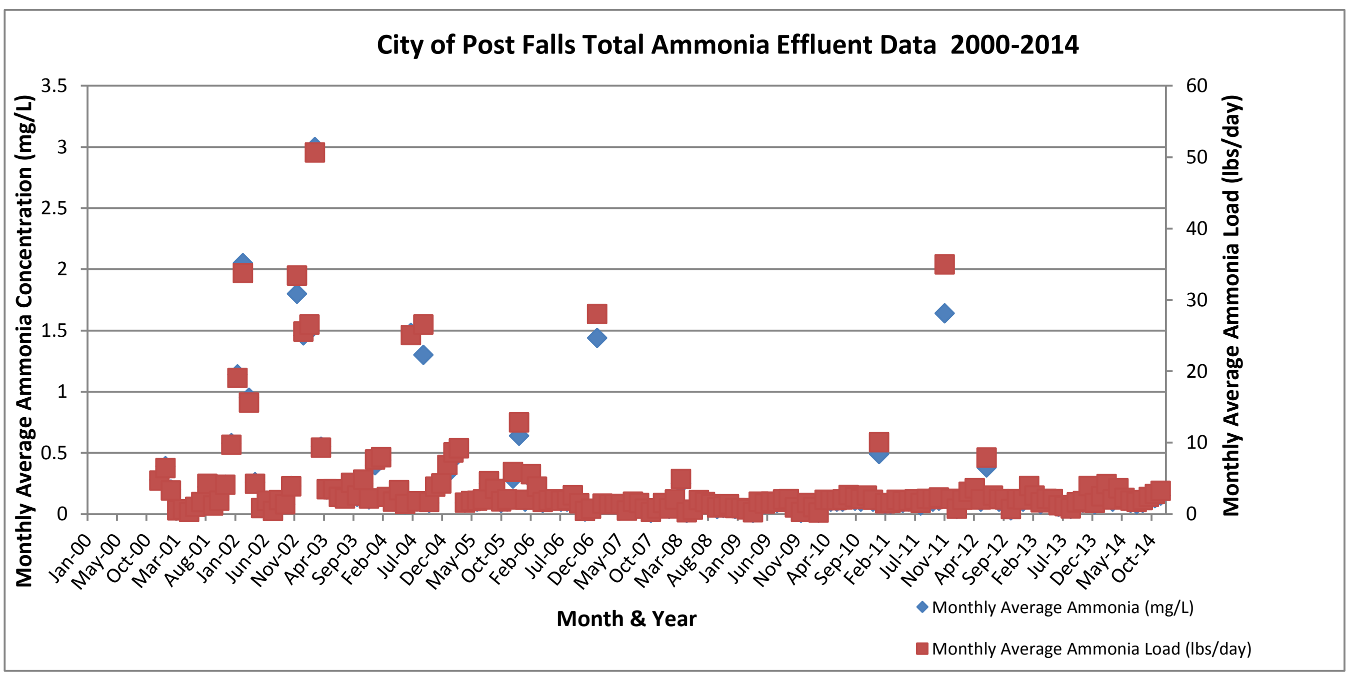


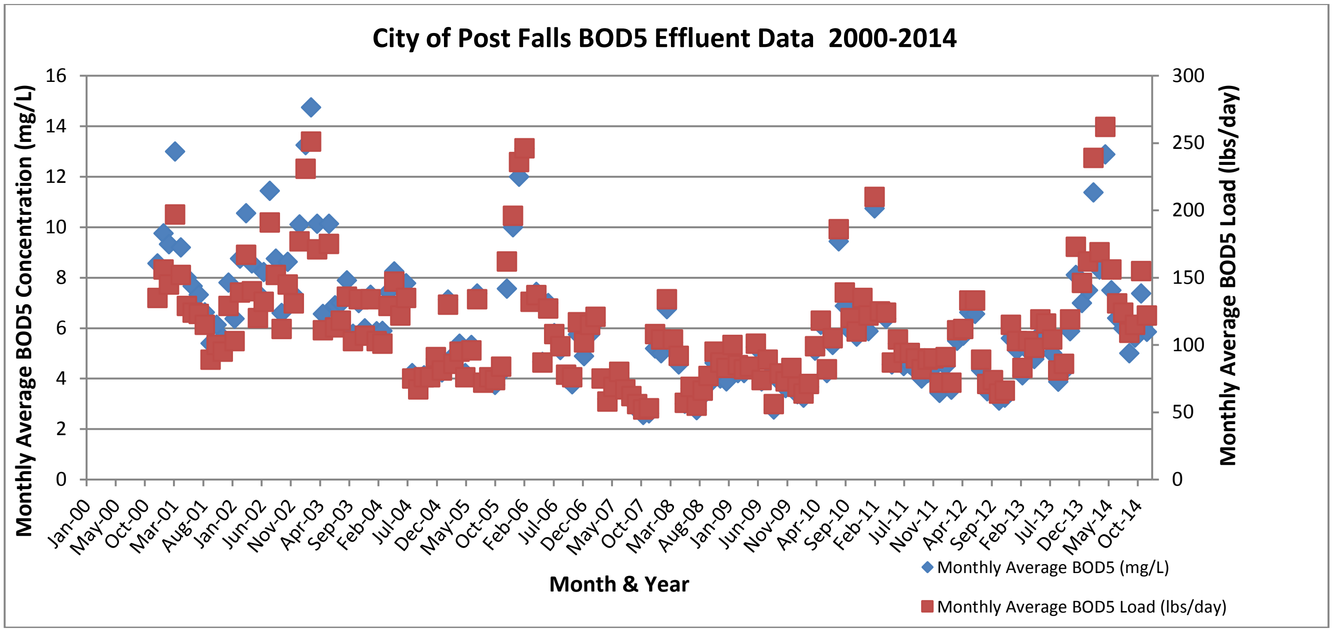


City of Coeur d'Alene CBOD5 Effluent Data 2000-2014
Monthly Average CBOD5 Concentration (mg/L)
Monthly Average CBOD5 Load (lbs/day)
0
2
4
6
8
10
12
0
50
100
150
200
250
300
Jan-00
May-00
Oct-00
Mar-01
Aug-01
Jan-02
Jun-02
Nov-02
Apr-03
Sep-03
Feb-04
Jul-04
Dec-04
May-05
Oct-05
Feb-06
Jul-06
Dec-06
May-07
Oct-07
Mar-08
Aug-08
Jan-09
Jun-09
Nov-09
Apr-10
Sep-10
Feb-11
Jul-11
Nov-11
Apr-12
Sep-12
Feb-13
Jul-13
Dec-13
May-14
Oct-14
Month & Year
Monthly Average CBOD5 (mg/L)
Monthly Average CBOD5 Load (lbs/day)

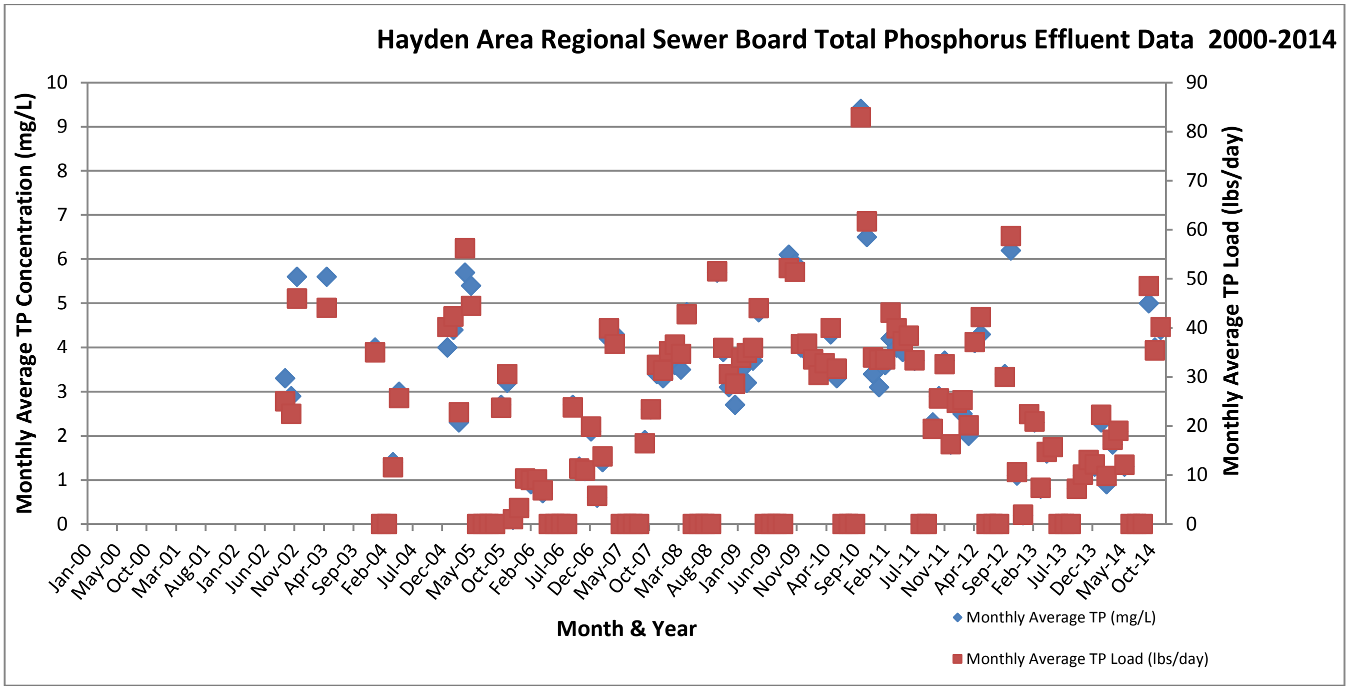
Post Falls

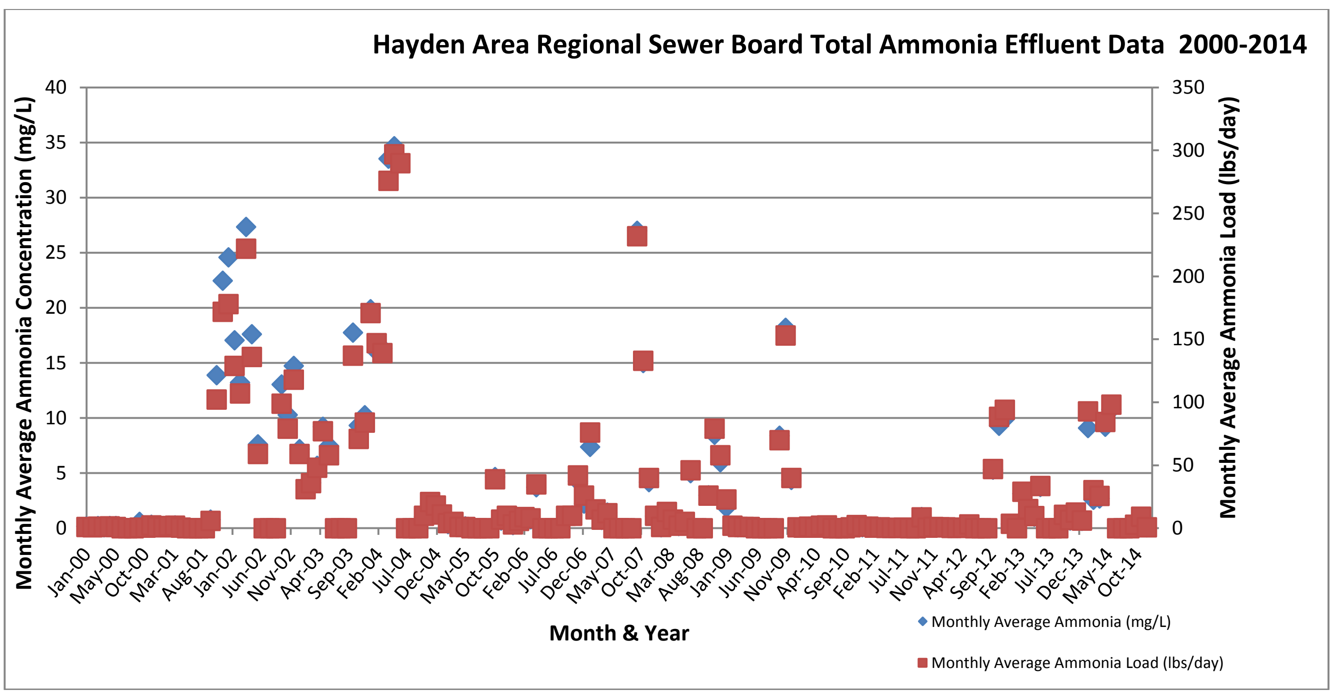

City of Post Falls Total Phosphorus Effluent Data 2000-2014
Monthly Average TP Concentration (mg/L)
Monthly Average TP Load (lbs/day)
Month & Year
Monthly Average TP (mg/L)
Monthly Average TP Load (lbs/day)
Jan-00 May-00 Oct-00 Mar-01 Aug-01 Jan-02 Jun-02 Nov-02 Apr-03 Sep-03 Feb-04 Jul-04 Dec-04 May-05 Oct-05 Feb-06 Jul-06 Dec-06 May-07 Oct-07 Mar-08 Aug-08 Jan-09 Jun-09 Nov-09 Apr-10 Sep-10 Feb-11 Jul-11 Nov-11 Apr-12 Sep-12 Feb-13 Jul-13 Dec-13 May-14 Oct-14

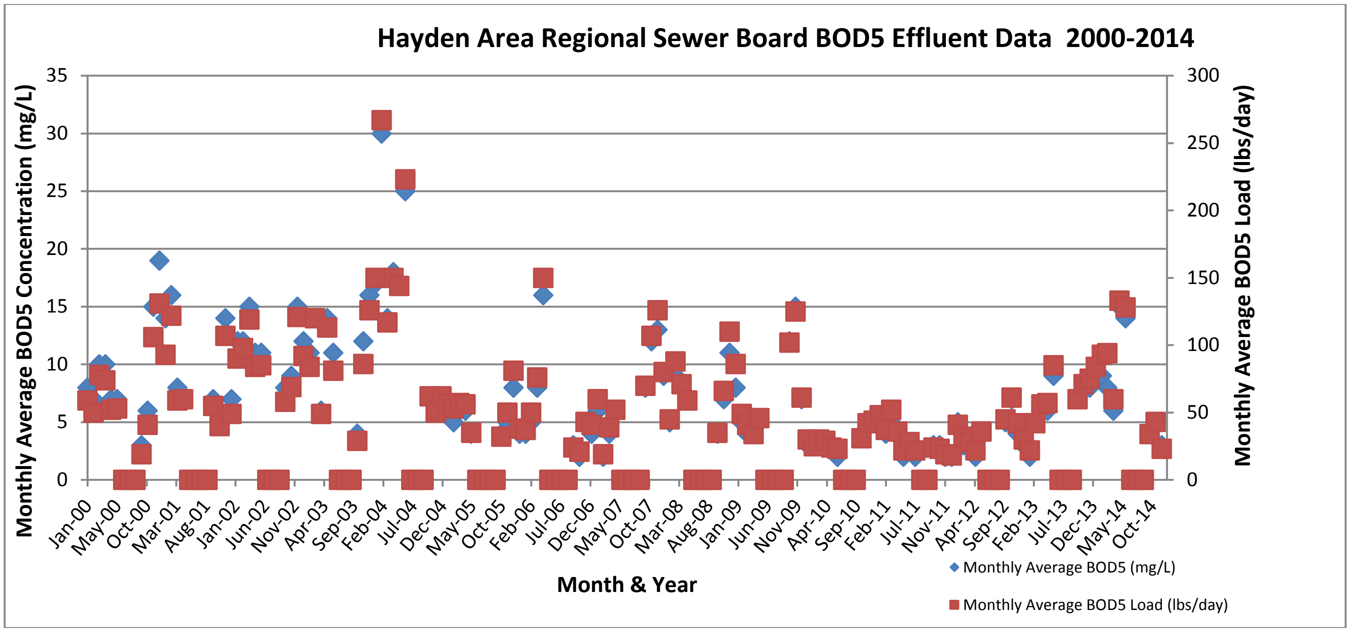

City of Post Falls Total Ammonia Effluent Data 2000-2014
Monthly Average Ammonia Concentration (mg/L)
Monthly Average Ammonia Load (lbs/day)
Month & Year
Monthly Average Ammonia (mg/L)
Monthly Average Ammonia Load (lbs/day)
Jan-00 May-00 Oct-00 Mar-01 Aug-01 Jan-02 Jun-02 Nov-02 Apr-03 Sep-03 Feb-04 Jul-04 Dec-04 May-05 Oct-05 Feb-06 Jul-06 Dec-06 May-07 Oct-07 Mar-08 Aug-08 Jan-09 Jun-09 Nov-09 Apr-10 Sep-10 Feb-11 Jul-11 Nov-11 Apr-12 Sep-12 Feb-13 Jul-13 Dec-13 May-14 Oct-14


City of Post Falls BOD5 Effluent Data 2000-2014
Monthly Average BOD5 Concentration (mg/L)
Monthly Average BOD5 Load (lbs/day)
Month & Year
16
14
12
10
8
6
4
2
0
300
250
200
150
100
50
0
Jan-00
May-00
Oct-00
Mar-01
Aug-01
Jan-02
Jun-02
Nov-02
Apr-03
Sep-03
Feb-04
Jul-04
Dec-04
May-05
Oct-05
Feb-06
Jul-06
Dec-06
May-07
Oct-07
Mar-08
Aug-08
Jan-09
Jun-09
Nov-09
Apr-10
Sep-10
Feb-11
Jul-11
Nov-11
Apr-12
Sep-12
Feb-13
Jul-13
Dec-13
May-14
Oct-14
Monthly Average BOD5 (mg/L)
Monthly Average BOD5 Load (lbs/day)

Hayden Area Regional Sewer Board






Hayden Area Regional Sewer Board BOD5 Effluent Data 2000-2014
Monthly Average BOD5 Concentration (mg/L)
Monthly Average BOD5 Load (lbs/day)
35
30
25
20
15
10
5
0
300
250
200
150
100
50
0
Jan-00
May-00
Oct-00
Mar-01
Aug-01
Jan-02
Jun-02
Nov-02
Apr-03
Sep-03
Feb-04
Jul-04
Dec-04
May-05
Oct-05
Feb-06
Jul-06
Dec-06
May-07
Oct-07
Mar-08
Aug-08
Jan-09
Jun-09
Nov-09
Apr-10
Sep-10
Feb-11
Jul-11
Nov-11
Apr-12
Sep-12
Feb-13
Jul-13
Dec-13
May-14
Oct-14
Month & Year
Monthly Average BOD5 (mg/L)
Monthly Average BOD5 Load (lbs/day)

Appendix D. Temperature and Precipitation Data

Temperature and Precipitation Data

http://www.wrh.noaa.gov/otx/climate/lcd/lcd.php

Spokane, WA Airport Weather Station

Shaded area = 2001 TMDL Critical Year

Black bold numbers = calendar year totals

Date	Average monthly temp (ºF)	High temp (ºF)	Low temp (ºF)	Total precip (inches)	Yearly average temp (ºF)	Yearly high temp (ºF)	Yearly average high temp (ºF)	Yearly low temp (ºF)	Yearly total precip (inches)
Jan-01	27.1	41	9	0.63					
Feb-01	26.8	40	7	0.66					
Mar-01	39.1	63	20	1.37					
Apr-01	43.6	77	23	1.71					
May-01	55.4	90	27	0.8					
Jun-01	58.7	89	38	1.1					
Jul-01	68.4	98	41	0.28					
Aug-01	71.1	99	44	0.26					
Sep-01	63.3	89	38	0.17					
Oct-01	45.9	78	29	2.1					
Nov-01	39.9	61	24	2.61					
Dec-01	28.1	44	10	2.03	**47.3**	**99**	**72.4**	**7**	**13.72**
Jan-10	35.1	51	16	1.54					
Feb-10	37.9	53	23	1.28					
Mar-10	41.2	64	22	1.2					
Apr-10	46.8	75	26	1.21					
May-10	51.3	81	29	2.15					
Jun-10	59.1	83	43	2.56					
Jul-10	68.9	95	45	0.36					
Aug-10	68.5	93	44	0.21					
Sep-10	59.8	85	41	0.69					
Oct-10	49.7	81	30	1.54					
Nov-10	33.1	60	-10	3.1					
Dec-10	29.4	46	-7	3.19	**48.4**	**95**	**72.25**	**-10**	**19.03**
Jan-11	29.2	51	-4	2.43					
Feb-11	28.9	52	-10	1.14					
Mar-11	39.3	59	26	3.25					
Apr-11	41.5	63	28	1.81					
May-11	52	79	32	1.83					
Jun-11	59	85	39	0.57					
Jul-11	66.7	91	46	0.53					
Aug-11	70.8	94	48	0.23					
Sep-11	65	93	40	0.14					
Oct-11	48.1	75	23	0.73					
Nov-11	35.1	56	18	1.73					
Dec-11	28.6	49	15	1.01	**47.0**	**94**	**70.58**	**-10**	**15.4**

Temperature and Precipitation Data

http://www.wrh.noaa.gov/otx/climate/lcd/lcd.php

Spokane, WA Airport Weather Station

Date	Average monthly temp (ºF)	High temp (ºF)	Low temp (ºF)	Total precip (inches)	Yearly average temp (ºF)	Yearly high temp (ºF)	Yearly average high temp (ºF)	Yearly low temp (ºF)	Yearly total precip (inches)
Jan-12	30	53	9	1.81					
Feb-12	32.7	48	6	1.68					
Mar-12	38.6	63	21	4.56					
Apr-12	48.3	81	26	1.39					
May-12	53.9	86	30	0.69					
Jun-12	59.6	85	38	2.86					
Jul-12	72.1	98	43	0.84					
Aug-12	71.6	97	47	0.13					
Sep-12	63.4	86	35	T					
Oct-12	48.5	76	30	1.54					
Nov-12	38.9	57	20	3.24					
Dec-12	31.2	49	9	2.58	**49.1**	**98**	**73.25**	**6**	**21.32**
Jan-13	24.7	43	4	1.63					
Feb-13	33.8	50	21	0.74					
Mar-13	41.2	68	22	0.82					
Apr-13	46	73	21	0.94					
May-13	56.9	86	30	0.8					
Jun-13	61.7	91	44	1.86					
Jul-13	73.9	99	51	T					
Aug-13	72.2	92	52	0.68					
Sep-13	63	92	42	1.56					
Oct-13	45.7	67	25	0.09					
Nov-13	34.8	52	15	1.56					
Dec-13	25.7	44	-2	0.68	**48.3**	**99**	**71.42**	**-2**	**11.36**
Jan-14	29.6	47	13	1.01					
Feb-14	26	46	-5	1.81					
Mar-14	39.6	56	11	2.88					
Apr-14	46.9	72	31	1.14					
May-14	57.7	80	37	0.56					
Jun-14	61.7	85	44	1.84					
Jul-14	75.7	100	48	0.18					
Aug-14	72.2	98	52	0.58					
Sep-14	63.1	88	39	0.26					
Oct-14	53.3	80	35	1.42					
Nov-14	34.6	59	10	1.34					
Dec-14	32.8	57	8	1.97	**49.4333**	**100**	**72.33**	**-5**	**14.99**