Lake Spokane Water Quality Project

Project Background

Site Description

From its source at Lake Coeur d'Alene, the Spokane River flows west across the Idaho / Washington state line to the city of Spokane. From Spokane, the river flows northwesterly through the Lake Spokane reservoir, over Long Lake Dam, and through the Spokane Tribe of Indian's reservation to its confluence with the Franklin D. Roosevelt Lake impoundment of the Columbia River (Figure 1).

The river, including the Lake Coeur d'Alene catchment, drains an area of about 6,640 square miles in two states. Approximately 2,295 square miles are within eastern Washington with the remainder of the watershed in Idaho. Most residents in the watershed live in the Spokane metropolitan area. However, the incorporated area of Liberty Lake, east of Spokane, and the cities of Coeur d'Alene and Post Falls in Idaho are experiencing rapid growth.

There are seven wastewater discharges to the mainstem of the Spokane River between Lake Spokane and Lake Coeur d'Alene. These discharge a summer average of approximately
75 million gallons of treated wastewater per day. In Washington, beginning at Spokane and moving upstream, these discharges include the Spokane Wastewater Treatment Plant, Inland Empire Paper, Kaiser Aluminum, and Liberty Lake Sewer and Water District. Discharges in Idaho include the Post Falls Wastewater Treatment Plant, Hayden Sewer District, and the city of Coeur d'Alene Advanced Wastewater Treatment Plant.

Each discharger has a National Pollutant Discharge Elimination System (NPDES) permit which sets limits on the amount of pollutants that can be discharged to the river. NPDES permits set limits at levels protective of water quality. In Washington State, Ecology issues NPDES permits; in Idaho, EPA issues these permits.

There are seven hydroelectric dams downstream from the outlet of Lake Coeur d'Alene which significantly influence the dynamics of the Spokane River. The six Washington dams are
run-of-the river (flow-through) types except for Long Lake Dam, which creates Lake Spokane.

Lake Spokane (also known as Long Lake) is the 24 mile section of the Spokane River between Nine Mile Dam and Long Lake Dam. The lake is part of the Spokane River Water Resource Inventory Area (WRIA) 54. Dissolved oxygen levels in Lake Spokane are seasonally impaired because of excessive nutrient loading; particularly total phosphorus, which facilitates aquatic growth and decay.

There is particular interest in Lake Spokane because as dischargers are spending considerable amounts of money to reduce phosphorus loading to the Spokane River, the question arises "What are Lake Spokane residential areas contributing to the river system?" The Spokane River Watershed Nonpoint Phosphorus Reduction Plan specifically mentions the Suncrest area of Stevens County. The plan advocates aggressive actions to be taken in the areas nearest Lake Spokane. It states that "Connections should be established between specific sources and stakeholders that have the ability to take action". Of particular interest is the need to evaluate the phosphorus load from septic tanks within Suncrest and other densely developed areas.

Water Quality Concerns

While there is historical literature that suggests that septic systems and subsequent treatment in the unsaturated zone provides phosphorus removal from effluent, recent evidence that this may not be the case in all locations. Data indicate that septic systems release significant phosphorus loads into groundwater. Phosphorus loads can increase with time as the wetting front moves through the soil profile. The soils and geology of the Lake Spokane area have relatively little phosphorus removal capacity. The Suncrest area has been targeted as an area where septic system removal and establishment of a sewer system should be seriously considered.

Optical brighteners are primarily added to laundry soaps, detergents, and cleaning agents for the purpose of brightening fabrics. Optical brighteners are dyes that are added to essentially all laundry detergents. These brighteners are absorbed by fabric and brighten clothes.

Laundry wastewater is the largest contributor of optical brighteners to wastewater systems because it retains a large portion of dissolved brighteners. Laundry effluent is predominantly associated with sanitary wastewater. Toilet paper contains fluorescent whitening agents. As toilet paper breaks down, fluorescent whitening agents are released into the water column. Since optical brighteners decompose relatively slowly except through photo degradation, they serve as ideal indicators of discharges from septic systems.

The goal of the project was to use optical brightener presence as a means of determining the leaching of effluent from septic systems to Lake Spokane from the Suncrest area downstream to Tum Tum. To achieve this goal, the Stevens County Conservation District developed a water quality monitoring program that established 20 sampling sites, 16 sites on the Stevens County side of the lake and 4 sites on the Spokane County side, to provide a means of identifying possible septic system influence on Lake Spokane. Optical brighteners were measured using a Turner Designs Cyclops-7 Submersible Sensor connected to a DataBank handheld data logger. Fecal coliform bacteria monitoring was conducted during and Secchi depths were recorded during each sampling period at each sampling site.

Lake Spokane Water Quality Project

Figure 1: Spokane River Watershed in Washington

Lake Spokane Water Quality Project

Summary of Activities

January 2012

- District staff researched prices for a GPS unit for fluorometer. A Garmin unit was purchased, but it did not have the right adapters to be linked with the fluorometer.
- District staff met with science teacher Teri Sardinia of Lakeside High School to discuss working with her advanced science class on the water quality monitoring project. Students will possibly participate in the monitoring effort and will be given data to analyze. A tour of the Tshimakain Creek laboratory is also being planned.
- A brief overview of the project was provided to the Lake Spokane Association at their regularly scheduled meeting held January 11th.

February 2012

- District staff worked with the Garmin GPS unit to become familiar with it. Staff also worked with the fluorometer to become acquainted with the proper use of this unit.
- District staff made two trips to Lake Spokane to help identify potential sampling sites. One trip involved representatives from Ecology, Avista, and Spokane Conservation District and was a combination of potential site identification and landowner education. The group met with 5 different landowners to look at bank conditions and to discuss an Ecology project that would help landowners to develop vegetative buffers along the shoreline instead of well manicured lawns running right to the water's edge. The second trip involved going out in a boat with Eric Staggs, Lake Spokane Association (LSA) vice president, Ken Carmichael, LSA treasurer, and Tom Wimpy, aquatic weed consultant. The trip provided a look at the lake while the lake level was still down due to Long Lake Dam operations. Potential sampling sites were marked with the GPS and several pictures were taken. One highlight of the trip was the emergence of a very large beaver from a car body that had been exposed during the lake draw down. LSA has provided excellent support for District activities along the lake.

March 2012

- District staff contacted Northeast Tri County Health District about gaining access to their septic system records for the Suncrest area. Angela Klock, District intern, will be able to work with those records some time in April.
- Angela Klock is gathering GIS data for the Stevens County side of Lake Spokane as a part of the characterization portion of the project.
- District staff, Spokane County Water Resources staff and Meghan Lunney of Avista agreed on dates for 2011 satellite data. The data for July 8, and September 11, 2011 was provided by Blue Water Satellite. The data are being analyzed for total phosphorus concentrations. Cloud cover plays a role in the satellite data and so there are some gaps and at times the reflection from the land appears as water on the images. Angela has made detailed photos of the

Ecology / Avista water quality monitoring sites so that the satellite data can be compared with the actual samples taken on or near that date.

April 2012

- District staff attended a Spokane River DO TMDL Admin Working Group: Tracking/Monitoring meeting on April 3rd. The District's monitoring project was discussed. During the discussion of future needs, it became obvious that there is a need for more information on the contribution of the southern portion of the county to Lake Spokane. District staff will try to exploit this need in the next round of water quality grant applications. Working with this group will provide good regional support for District efforts along Lake Spokane. After the meeting, SCCD staff toured the Spokane River from Spokane downstream to the Long Lake Dam in order to gain a better understanding of the Spokane River system as it feeds into Lake Spokane.
- Sampling for optical brighteners and fecal coliform bacteria was held on April 11th, 17th, and 26th. Eric Staggs of the Lake Spokane Association has provided the boat for all the sampling excursions. There has been a great deal of water flowing through the lake presenting a significant dilution factor. The best time to conduct such sampling will be in the summer months so the District will be seeking funding to extend the sampling window to include July through September or October in the sampling scheme.

May 2012

- Sampling was conducted 3 times in May. Several dates were lost because Avista lowered the water level in the lake to make room for runoff from the heavy spring rains. Once the lake level was up enough to get to all the 20 sampling sites, sampling activities resumed.

June 2012

- Sampling was conducted twice in June. On the 5th of June, fecal coliform levels were higher than at any other time during the sampling with readings over 100 in an undisturbed control area and 700 at a site in Spokane County. The site with the 700 reading was adjacent to a property that was reported to be having trouble with their septic system.

Task 2 of the project was to identify the potential sources of nutrient inputs to the lake using Geographical Information System (GIS) Data. Figure 2 shows the location of the study area in relation to the rest of Stevens County. This are is unique in the county in that is the most densely populated portion of the county with over 1500 people per square mile. While much of the county is rural residential, this area is definitely suburban with the majority of the people relating more to Spokane than to the towns in Stevens County.

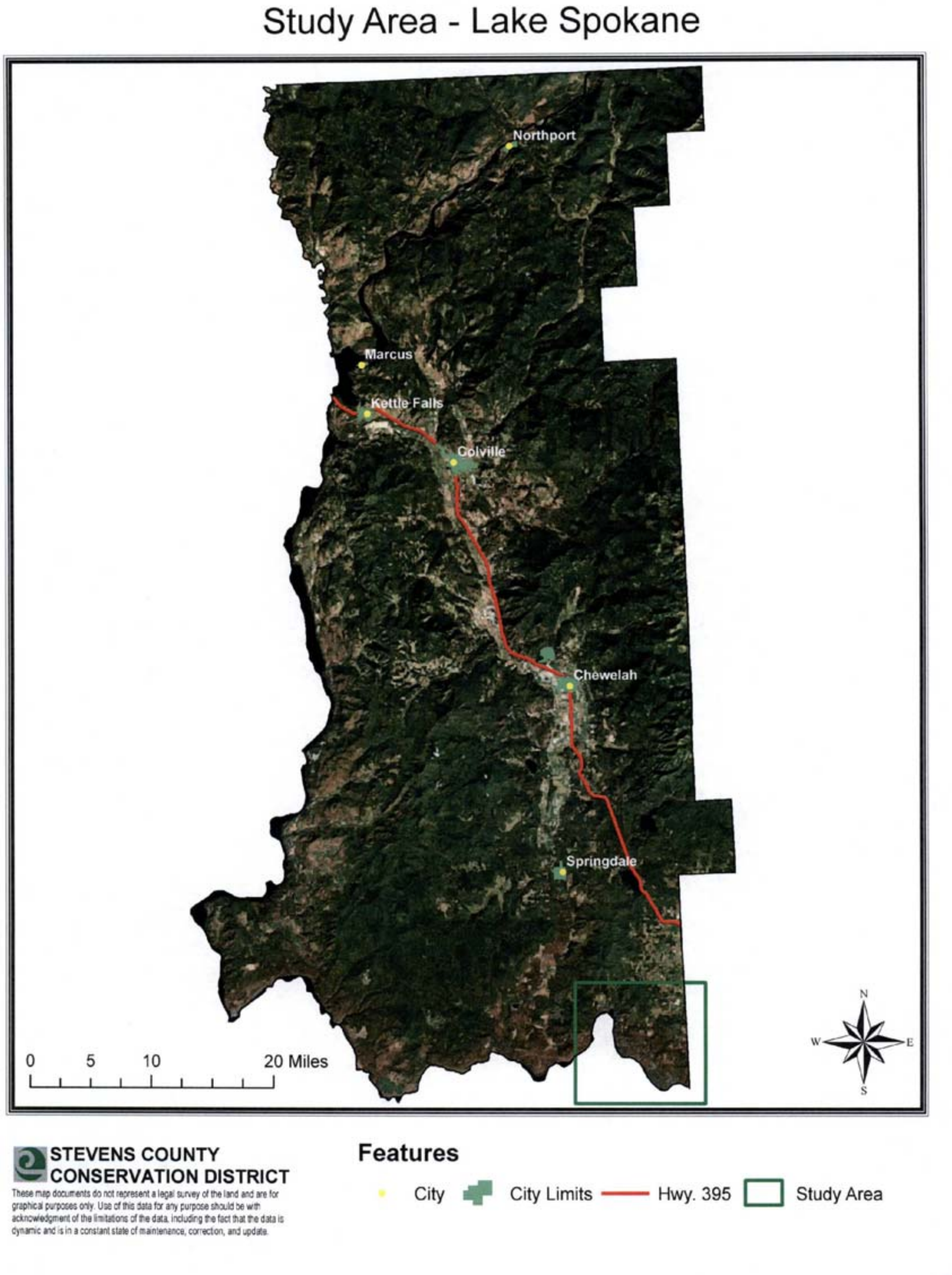


Figure 2: Study area in relation to the rest of Stevens County

Lake Spokane is generally considered the area between Nine Mile Falls Dam and Long Lake Dam. The lake is the reservoir behind Long Lake Dam and is therefore operated to produce power as well as serving as a recreation area. Avista Utilities operates both dams. Avista draws the water level down in the winter months to prepare for high runoff periods and to allow the cold winter temperatures to kill aquatic weeds that are prevalent in the lake.

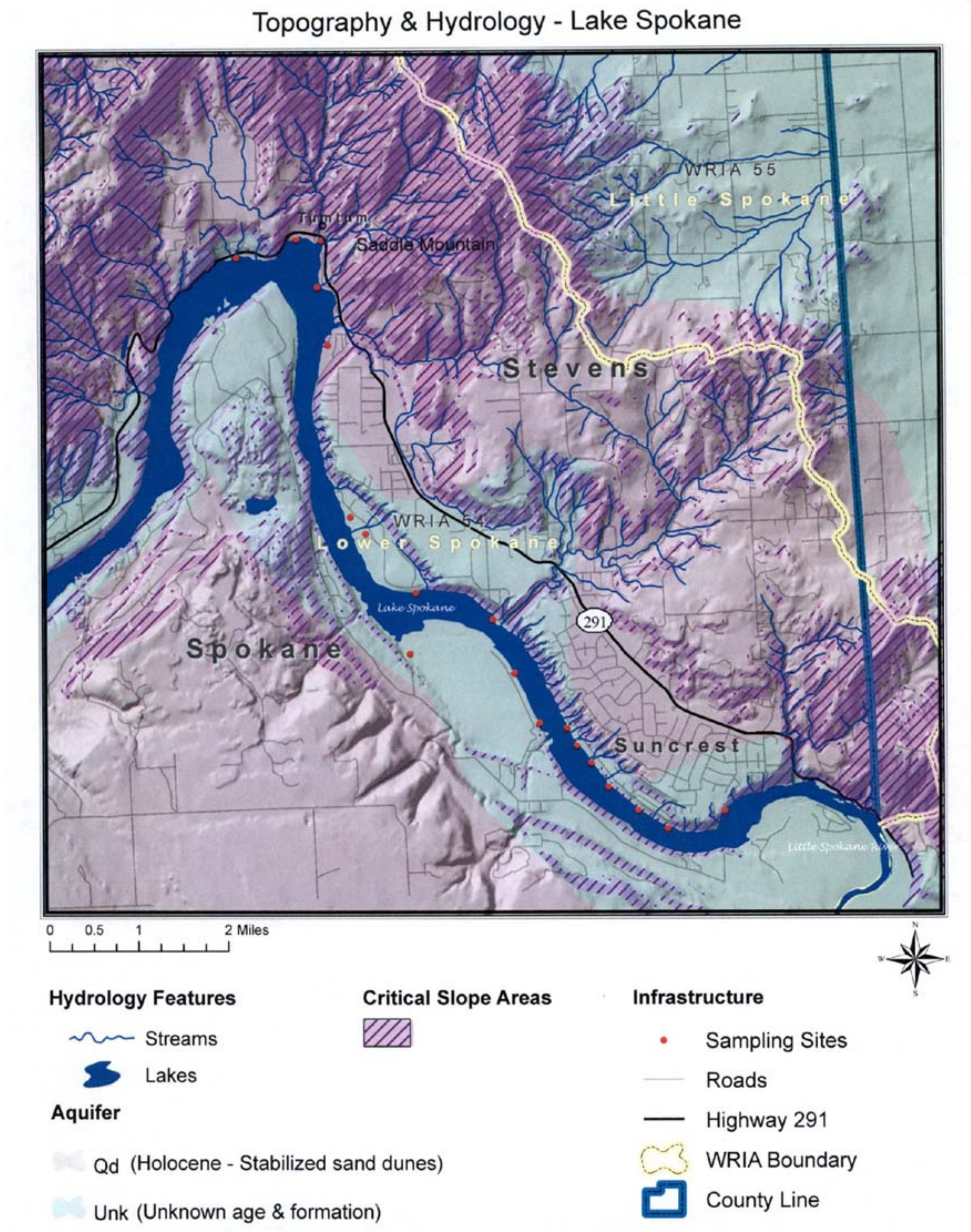


Figure 3: Lake Spokane from the Stevens County line to downstream of Tum Tum

As can be seen in Figure 3, much of the area near the lake is above the lake on a bench. Most of Suncrest sits above the lake on soils that are generally coarse so the movement of nutrients through the soil profile is a very real concern.

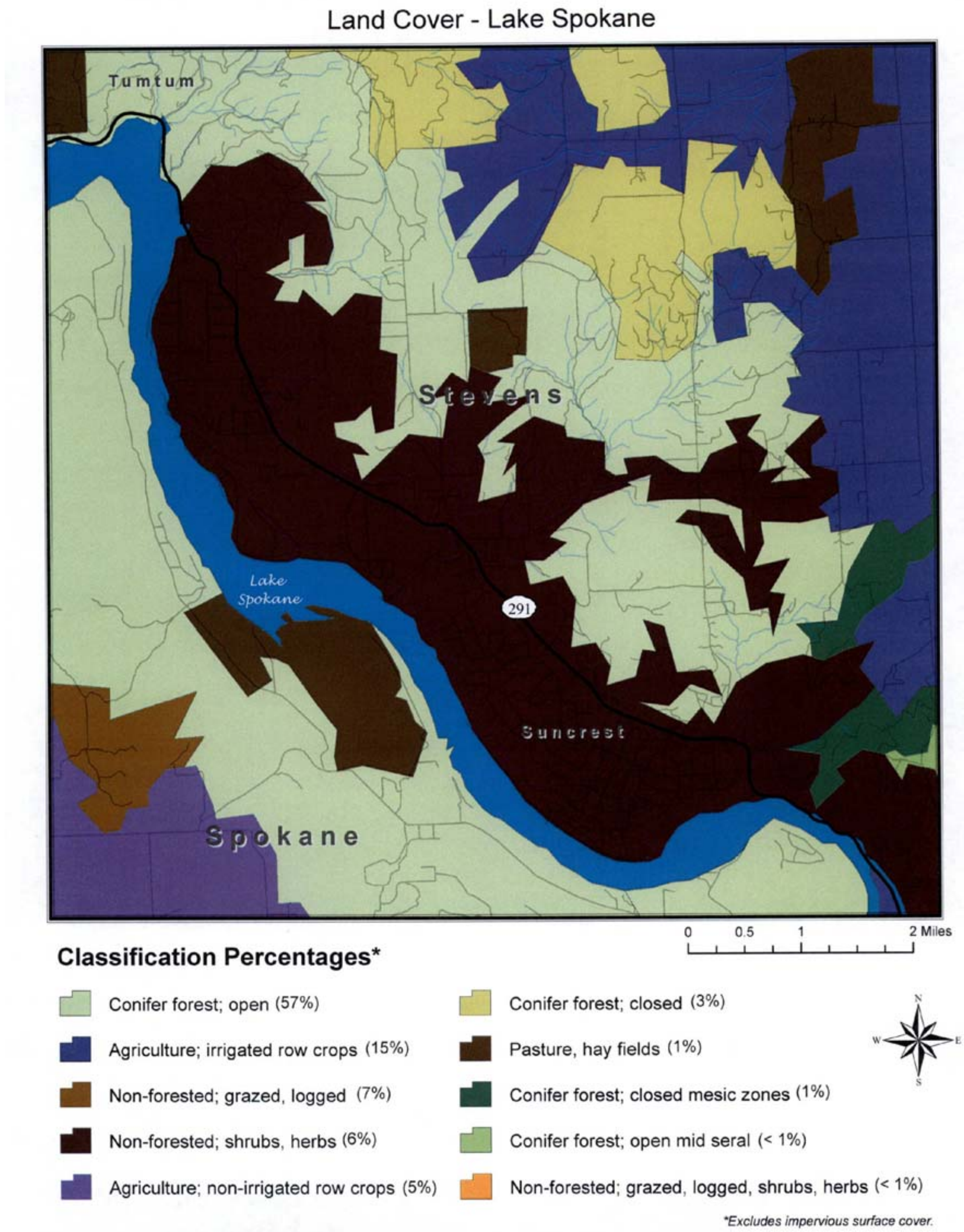


Figure 4: Land cover for the study area

As with much of the rest of Stevens County, forested ground makes up the majority of this area. Stevens County overall is 85% forest ground with a mix of pine, fir, and larch being the predominant coniferous species.

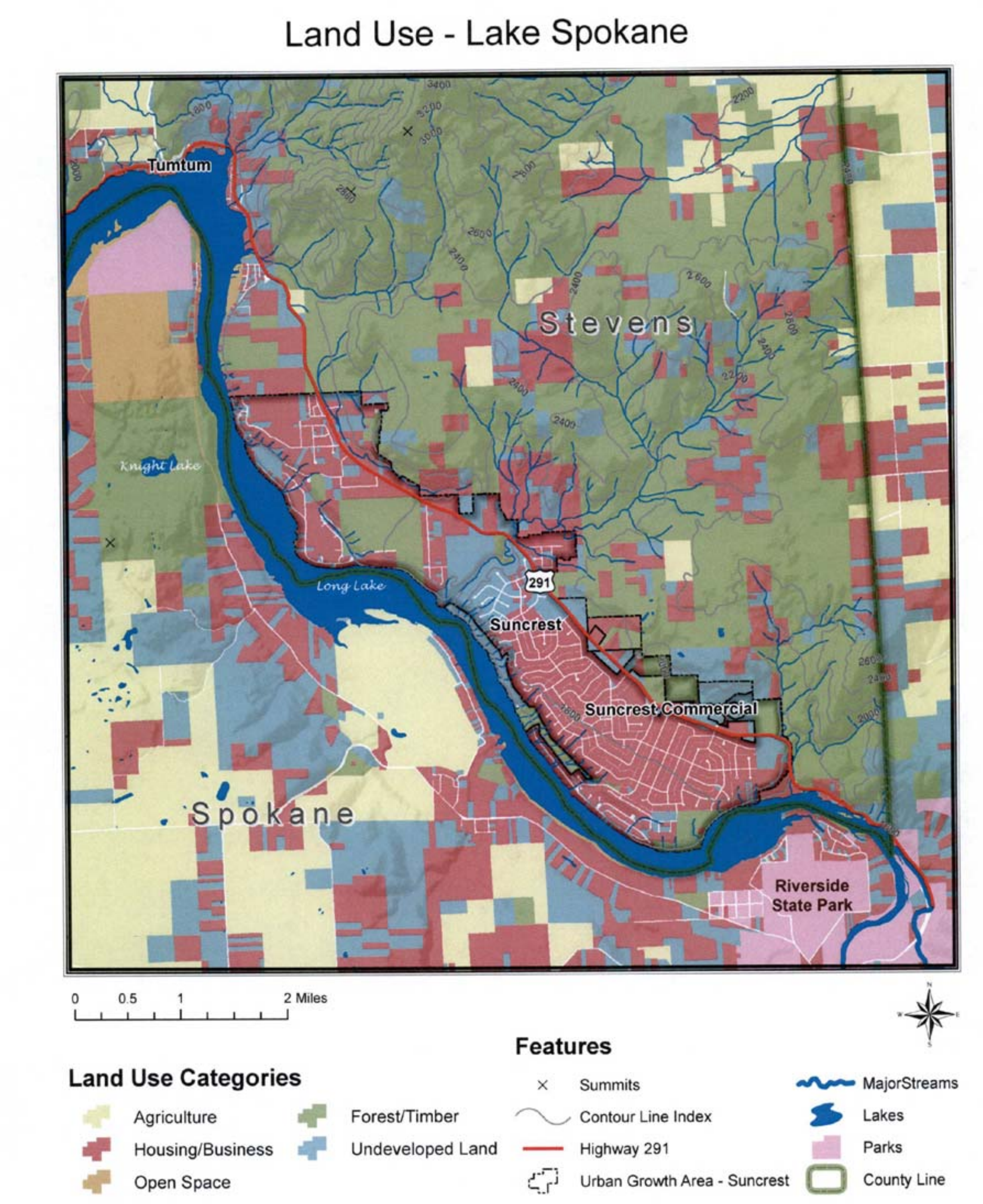


Figure 5: Land use in the study

Suncrest has a small business district with a grocery, fast food restaurant, gas station, fitness center, and various other businesses. Parcels are generally 1 acre in size with some larger parcels as one travels between Suncrest and Tum Tum. On the Spokane County side of the lake, it is strictly residential with several large tracts of homes that often unite as a homeowners' association for a specific area. All the homes in this area, on both sides of the lake are on on-site septic systems. Stevens Public Utility District has purchased land on the Stevens County side in hopes of one day constructing a municipal sewer system and a wastewater treatment facility.

Northeast Tri-County Health District was asked to supply septic system data for the Suncrest and Tum Tum areas. The Health District could not supply this information prior to the end of this project. The data that were provided could not be readily converted to GIS-friendly datasets. The HDR *Suncrest Septic System Phosphorus Loading Analysis* (December 2011) is therefore the best information currently available for the potential impact of on-site septic systems in this area.

Appendix A contains pictures of the area while the lake is drawn down and at normal water level. There are also pictures of the general area included in this appendix.

The Stevens County Conservation District, Spokane County Water Resources Section, and Avista collaborated on using satellite imagery and algorithms developed by Blue Water Satellite, Inc (BWSI). to get a picture of total phosphorus concentrations throughout the lake. The satellite passes over Lake Spokane approximately once every 8 days. The local collaborators selected dates that they deemed appropriate from 2011 and BWSI reviewed the dates to see if the cloud cover was too great to provide adequate coverage of the area. July 8, 2011 and September 11, 2011 were selected as two dates that would provide adequate coverage of the lake. The BWSI report is included in Appendix B. The project hoped to get 3 more dates in 2012 that coincided with water quality sampling, but the cloud cover in this region for the dates of the satellite passes made that impossible. After discussion among the Conservation District, Spokane County, and Avista, it was determined that 3 dates will be selected in the summer of 2012 with hopes of getting good information. The 2 sets of data mentioned in this report were paid for under this grant agreement. The additional 3 passes in the summer of 2012 will be paid for by Avista under a previously developed agreement.

Figures 6-9 present the results of these satellite passes with emphasis being given to the lake between Suncrest and Tum Tum.

Total Phosphorus - July 2011

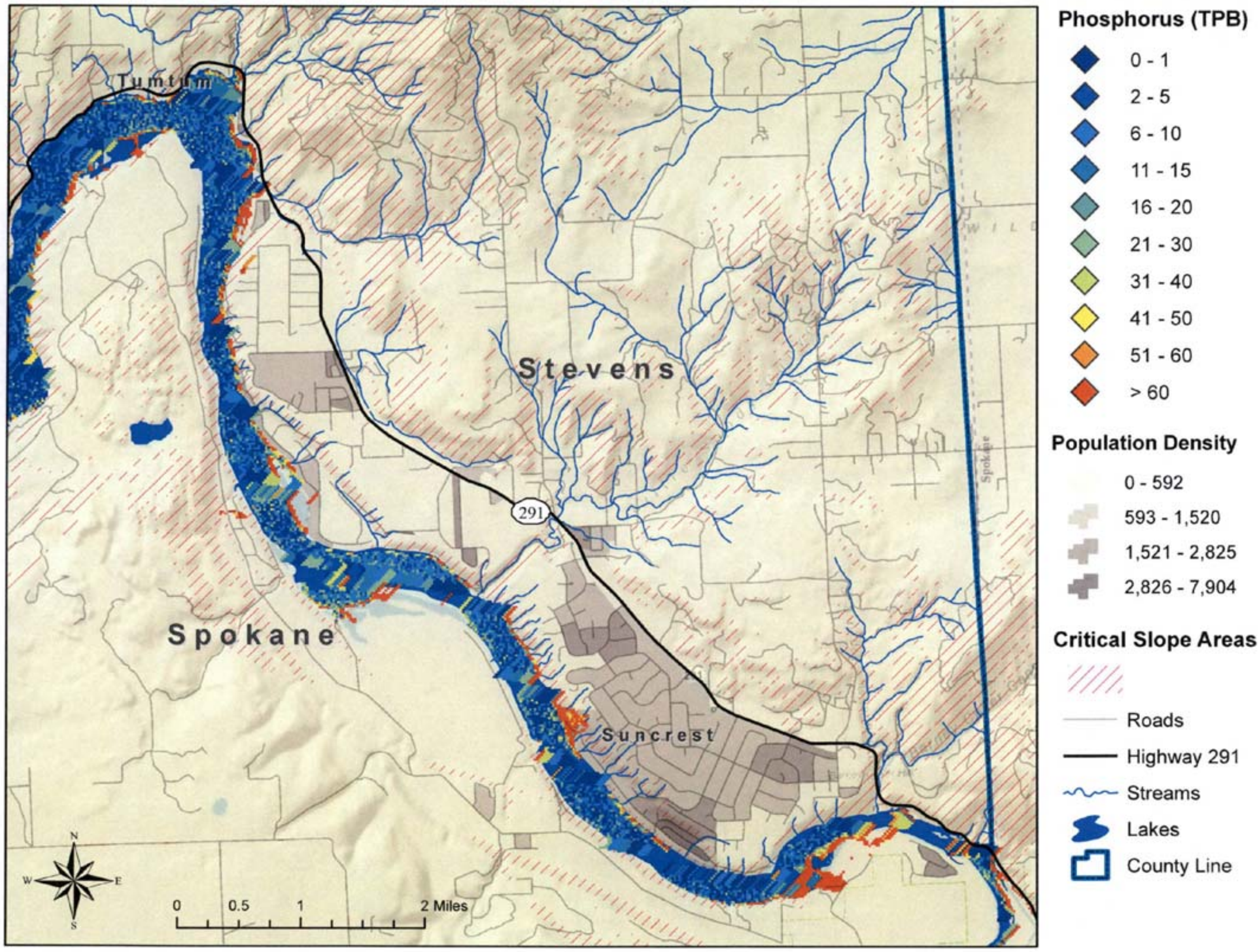


Figure 6: July 8, 2011 total phosphorus measurements by satellite and BWSI algorithm

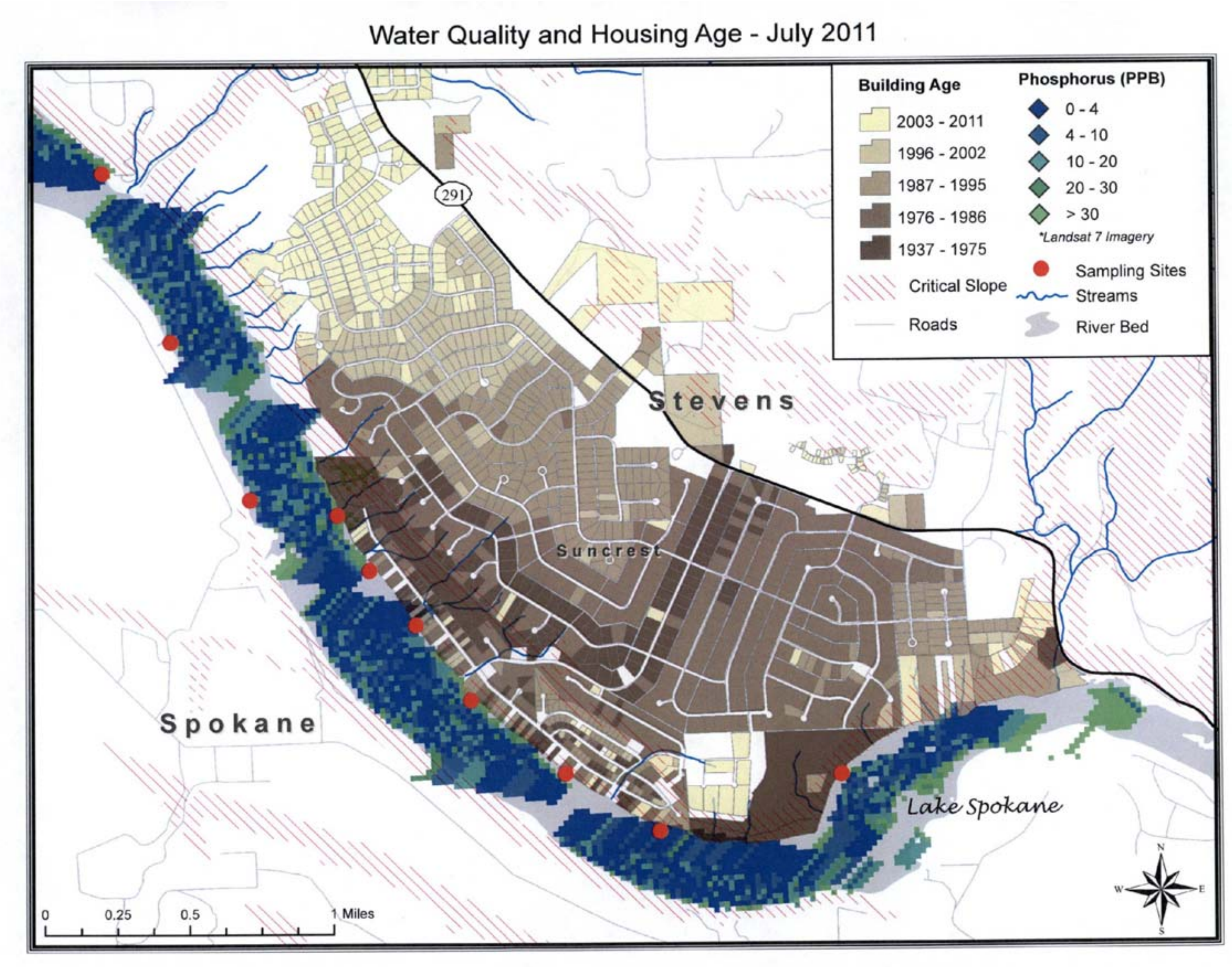


Figure 7: July 8, 2011 total phosphorus data for Suncrest area

Lake Spokane Water Quality Project

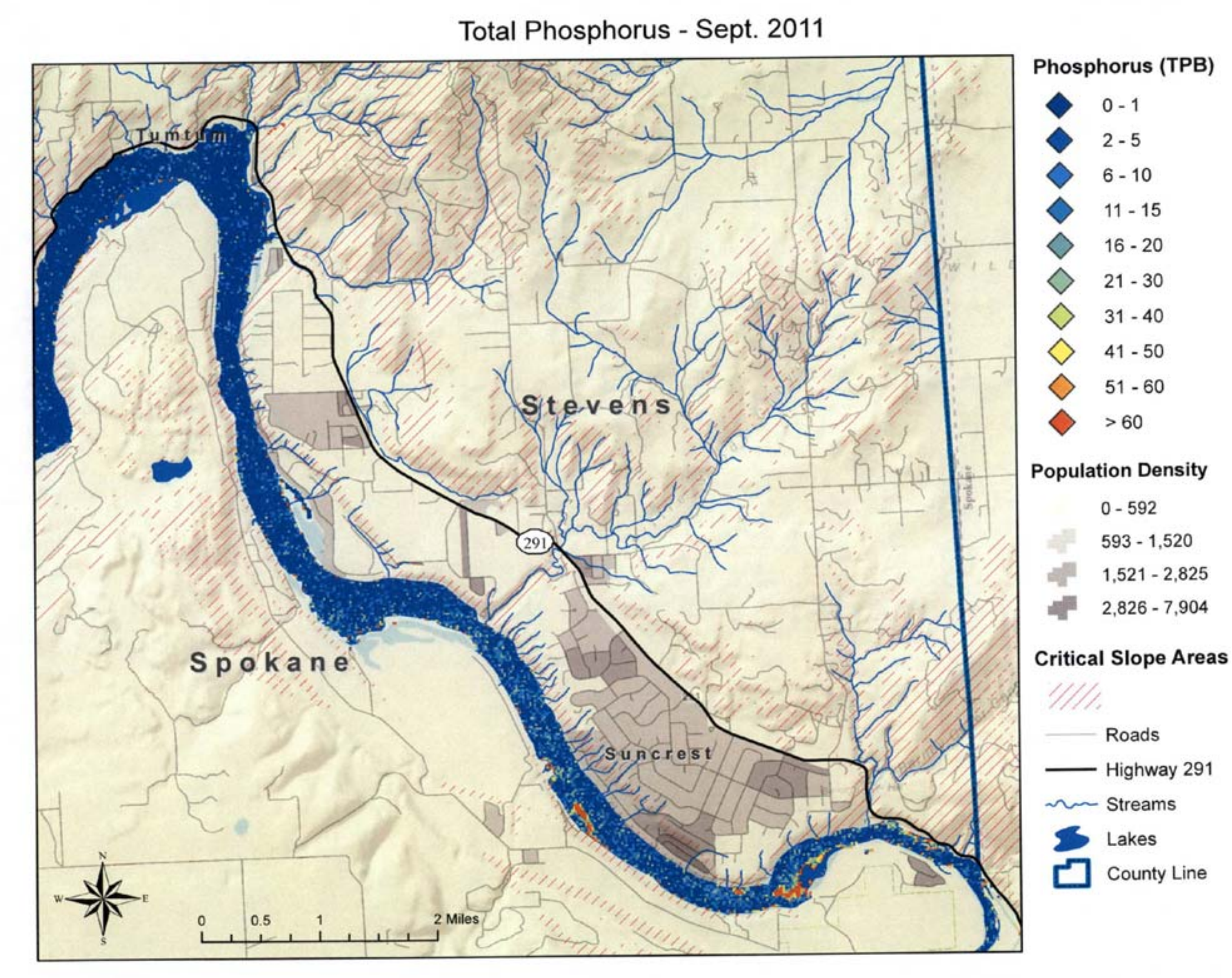


Figure 8: Total phosphorus for Lake Spokane on September 11, 2011

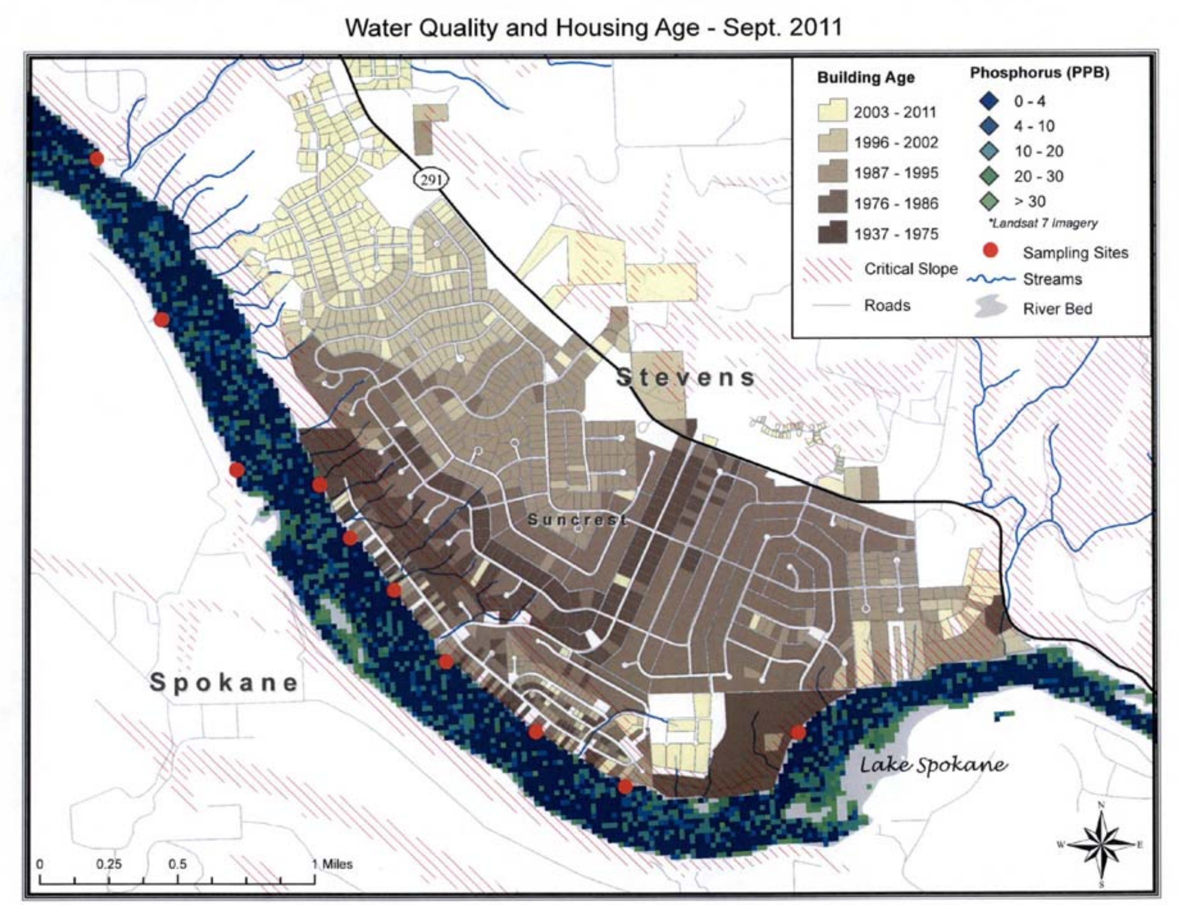


Figure 9: September 11, 2011 total phosphorus for the Suncrest area

Task 3 of the project involved water quality monitoring in an attempt to identify both surface water and shallow groundwater sources of onsite septic effluent input to Lake Spokane. The Conservation District hoped to identify these sources by conducting nearshore monitoring for optical brighteners used in most laundry detergents using a fluorometer (DataBank handheld datalogger equipped with a Cyclops-7 submersible sensor) and taking fecal coliform bacteria samples that will be analyzed by the Tshimakain Creek Laboratory operated by the Spokane Tribe. Eric Staggs, vice-president of the Lake Spokane Association (LSA) provided the boat needed to collect the samples. Twenty (20) sampling points were selected based upon density of housing and proximity of the houses to the lake. Sampling sites were marked wit a GPS unit so that they were replicated during multiple sampling events. Some samples were taken from unpopulated areas to provide a means of comparison with samples taken from the high density areas. Sampling dates were affected by drawdown conditions and extreme flow conditions through the lake. Sampling could not commence until April and had to be suspended due the level being dropped in order to protect houses upstream and to provide storage for snowmelt runoff from watersheds in Idaho that form the headwaters of the Spokane River Watershed.

Sampling Station	Latitude	Longitude
LSOPBR 1	N 47.79941	W 117.57126
LSOPBR 2	N 47.79693	W 117.58504
LSOPBR 3	N 47.80007	W 117.59183
LSOPBR 4	N 47.804	W 117.59865
LSOPBR 5	N 47.80793	W 117.60249
LSOPBR 6	N 47.8108	W 117.60576
LSOPBR 7	N 47.81369	W 117.60798
LSOPBR 8	N 47.83152	W 117.62444
LSOPBR 9	N 47.83629	W 117.64246
LSOPBR 10	N 47.84615	W 117.65377
LSOPBR 11	N 47.84894	W 117.65726
LSOPBR 12	N 47.87659	W 117.66069
LSOPBR 13	N 47.88582	W 117.66258
LSOPBR 14	N 47.89339	W 117.66115
LSOPBR 15	N 47.8937	W 117.66705
LSOPBR 16	N 47.89114	W 117.68147
LSOPBR 17	N 47.82668	W 117.64449
LSOPBR 18	N 47.82282	W 117.61984
LSOPBR 19	N 47.81465	W 117.61442
LSOPBR 20	N 47.7967	W 117.55814

Table 1: Location of Lake Spokane optical brightener sampling points

Eight sampling events were conducted. Fecal coliform bacteria samples were collected following Washington Department of Ecology lake monitoring guidelines. Samples were placed on ice and transported to the Tshimakain Creek Laboratory shortly after collection.

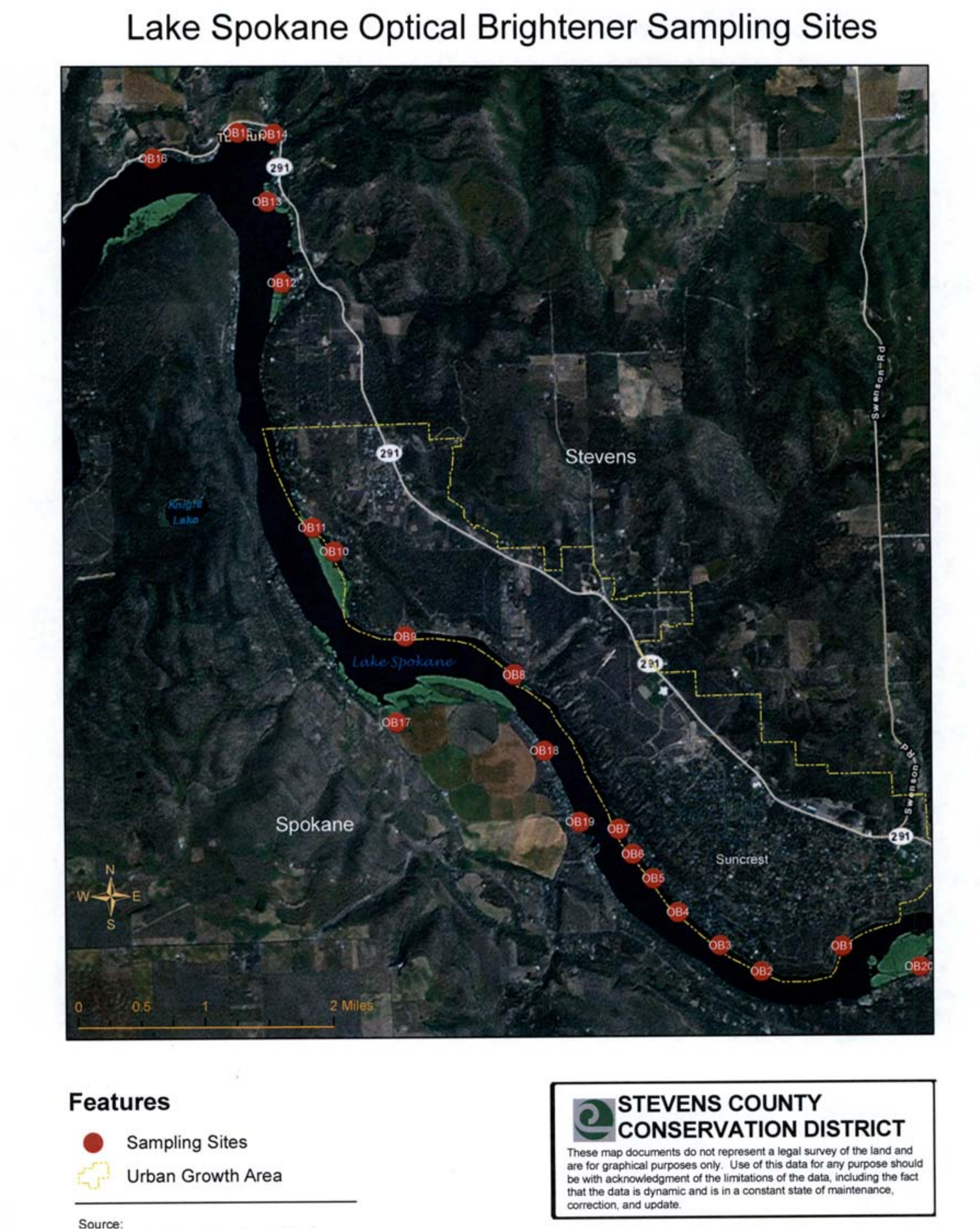


Figure 10: Sampling sites within the study area

The Quality Assurance Project Plan (QAPP) developed for this monitoring and the result of the monitoring can be found in Appendix C of this report.

The results of the sampling were affected by the flows through the lake during the sampling this spring. Flows during the sampling ranged from 12, 560 cfs to 30,178 cfs with an average of 20, 468 cfs. Normal summer time flows are between 1,000 cfs and 5,000 cfs. The Stevens County Conservation District therefore recommends continuing the sampling through the summer months.

During the early, higher flow periods, optical brighteners were not detected. As flows came down, they were detected by there was not a significant difference between sampling sites. Fecal coliform bacteria remained low until the last 2 sampling periods. There was a significant increase in bacteria during the June 5th sampling period after there had been a considerable amount of rain in the entire watershed. Again, the Conservation District recommends monitoring throughout the summer months when lake use is at its peak, summer residents are present, and flows through the lake are less in order to get a better picture of what is actually happening in the lake.

Lake Spokane

Naturally vegetated slope near Suncrest

Unstable slope between house and dock, dock failure

Lake Spokane

Sampling site 9 when reservoir is full

Sampling site 14, Dirty Shame Tavern and highway 291

Lake Spokane

Sampling site 14 and highway 291

Concrete bulkheads reflect the waves back across the lake

Lake Spokane

Avista bulkhead removal site at Tum Tum

Fairly typical house placement close to lake

Lake Spokane

Wild shoreline on Spokane County side of lake

Wild shorelines are still susceptible to wave action and wind throw

Lake Spokane

House close to the lake on Spokane County side

Wild shoreline with yellow flag iris

Lake Spokane

Wild shoreline with rock outcrops

Sampling site 9 from across the lake

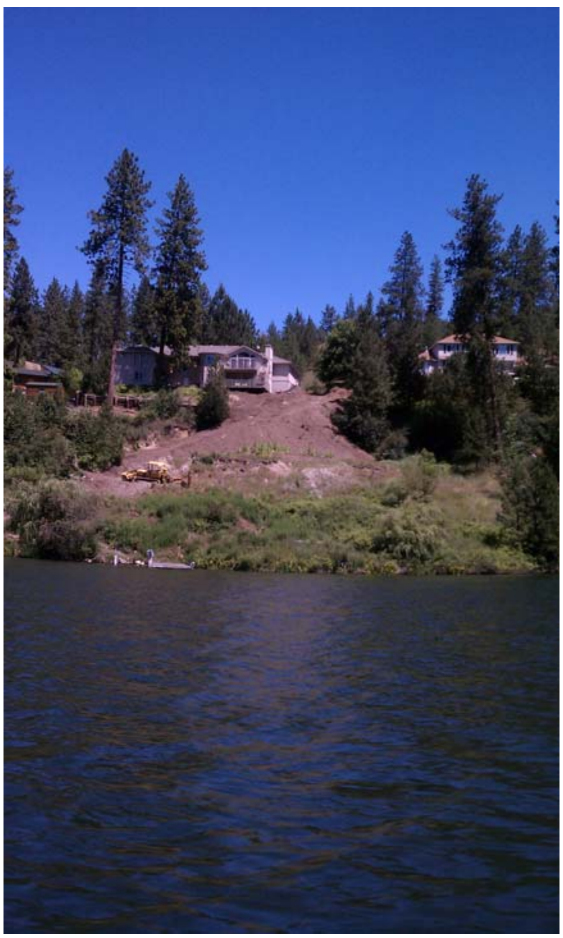
Lake Spokane

Unstable slopes between Suncrest and Tum Tum

Vegetative buffer between lawn and lake

Lake Spokane

Lawn and beach with no buffer along lake



Equipment working above lake, significant exposed soil

Lake Spokane

Yellow flag iris near an association's beach / recreation area

Bare slope along highway 291

Lake Spokane

A slough off the main part of the lake in Spokane County

Yellow flag iris providing bank protection

Lake Spokane

Highway 291 runs along the lake as you enter Stevens County

Large house and beach between highway 291 and lake

Lake Spokane

Animal keeping area adjacent to large house

LSA vice president Eric Staggs and water quality monitoring crew 6-25-12

Lake Spokane

Horse paddock between highway 291 and lake

Lake Spokane

Warning posted during one of the frequent algae blooms

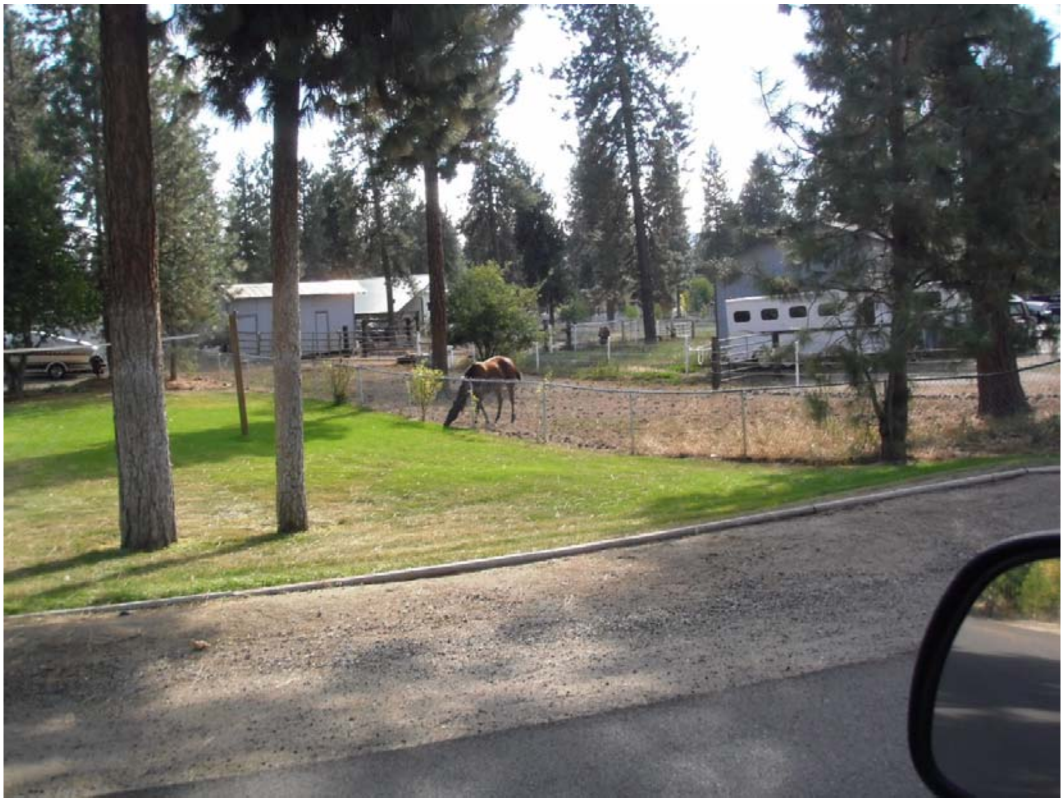
Horse paddock in Suncrest

Lake Spokane

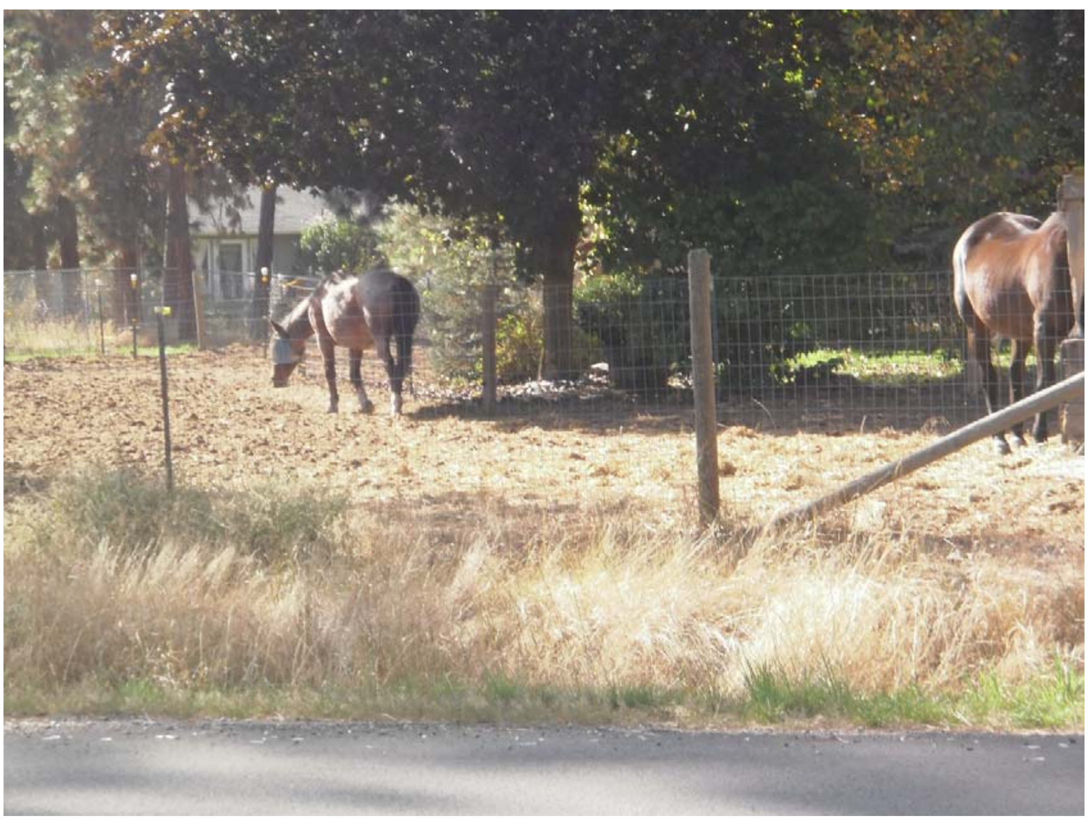
Backyard horse operation in Suncrest

Suncrest horse keeping

Lake Spokane



Horse in Suncrest neighborhood



Horses in Suncrest, note the heavy manure build-up

Lake Spokane Low Water Pictures

Poorly installed bottom barriers

Bottom barriers showing framework and rocks to hold them in place

Lake Spokane Low Water Pictures

Extensive use of well placed bottom barriers

Note the turbidity of the water in February 2012

Lake Spokane Low Water Pictures

Holes in the bottom showing the varied types of deposition found in the lake

Unstable side slopes between Suncrest and Tum Tum

Lake Spokane Low Water Pictures

Avista bulkhead removal site in Tum Tum

Bottom material just upstream of Avista bulkhead removal site

Lake Spokane Low Water Pictures

Creating bass habitat under a dock

A low water seep

Lake Spokane Low Water Pictures

Use of hardened landscaping between house and lake

Optical brightener sampling point 9 showing nearshore sampling area

Lake Spokane Low Water Pictures

Low water exposes a car body being used by a beaver

The beaver and the car

Report to Hach Hydromet

Lake Spokane, Washington

On behalf of Avista Corporation
and the Stevens County Conservation District

March 21, 2012

Blue Water Satellite, Inc.
440 East Poe Road
Suite 201
Bowling Green, Ohio 43402
(419) 728-0060
www.BlueWaterSatellite.com

History of Project

On March 21, 2012, Blue Water Satellite, Inc. received an order through Hach Hydromet (rep TJ Sisson) to produce five (5) Total Phosphorus data scans for Lake Spokane, Stevens and Spokane Counties, Washington.

Scope of Project

The *Statement of Work, Attachment to WA #1* provided to BWSI by Avista, client requested Total Phosphorus scans for the following dates:

- July 8, 2011
- September 11, 2011
- March 20, 2012
- April 21, 2012
- May 23, 2012

Blue Water Satellite has produced, and delivers this report and accompanying datasets to Hach Hydromet, the following:

- Scans for Total Phosphorus in Lake Spokane for July 8 and September 11, 2011.

The Landsat 7 overpass of March 20, 2012 was obscured by cloud cover. BWSI is waiting for direction from client on an alternate date for that data, having notified the client that the next available Landsat 7 overpass is scheduled for April 5, 2012.

The April and May 2012 scans and datasets will be produced and delivered as the raw Landsat data becomes available.

Methodology

Blue Water Satellite will acquire raw data from satellites Landsat 5 and Landsat 7, operated by the United States Geological Service. The raw data will be processed using BWSI's patented & proprietary algorithms.

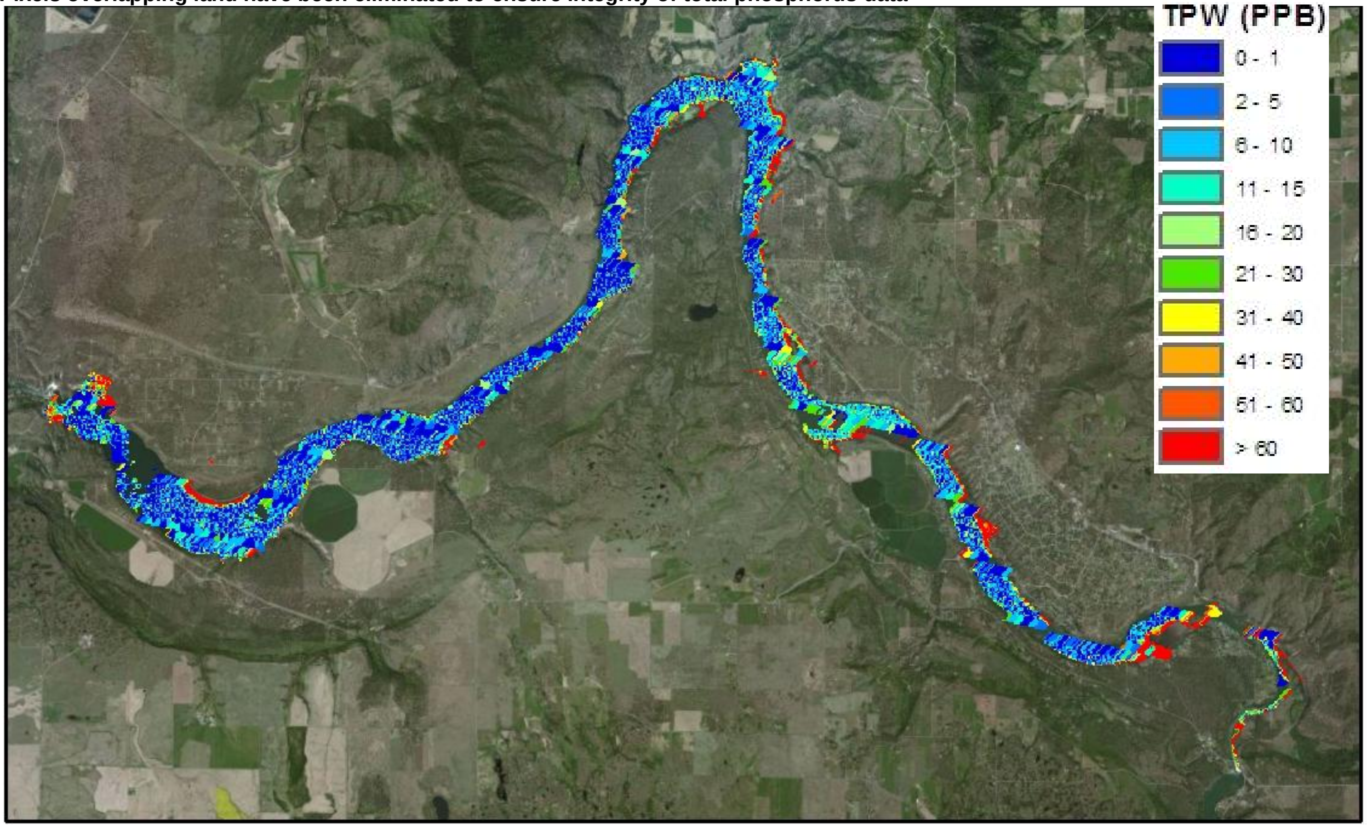
For the detection and measurement of Cyanobacteria, Blue Water Satellite detects and measures Phycocyanin, the pigment unique to Cyanobacteria.

Blue Water Satellite, Inc. detects the locations and concentrations of Cyanobacteria, Total Phosphorous, and Chlorophyll-a in rivers, lakes, reservoirs, streams, ponds, and other water bodies around the world. Our patented & proprietary technology allows us to measure these constituents in parts per billion (PPB). Each individual sample measures 30-meters by 30-meters.

Contents

Blue Water Satellite Results

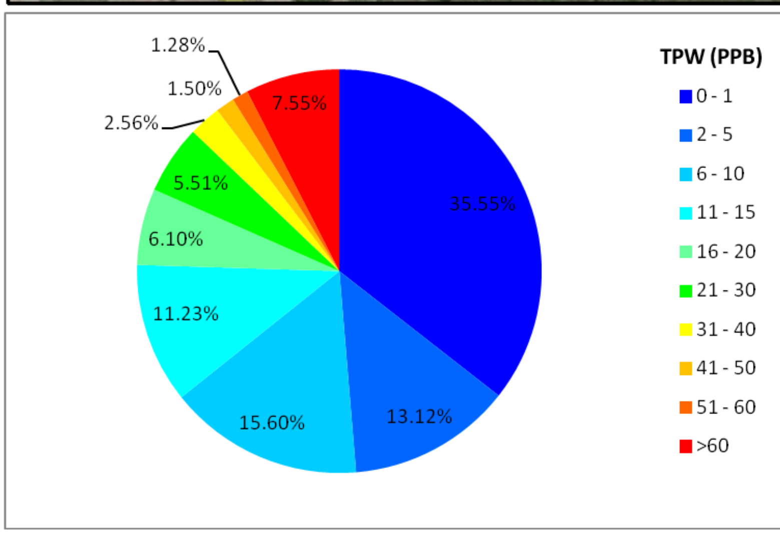
Total Phosphorus
Lake Spokane, July 8, 2011, Landsat 7
Overlay on natural color image of surrounding landscape
Pixels overlapping land have been eliminated to ensure integrity of total phosphorus data



Color scale (overlaid on image) indicates ranges of concentration of total phosphorus in parts per billion as represented in scan image (left).

Pie chart histogram (lower left) indicates percentage of water within view delineated by concentration ranges.

Table (lower center) indicates actual acreage falling within each range of concentration of total phosphorus.

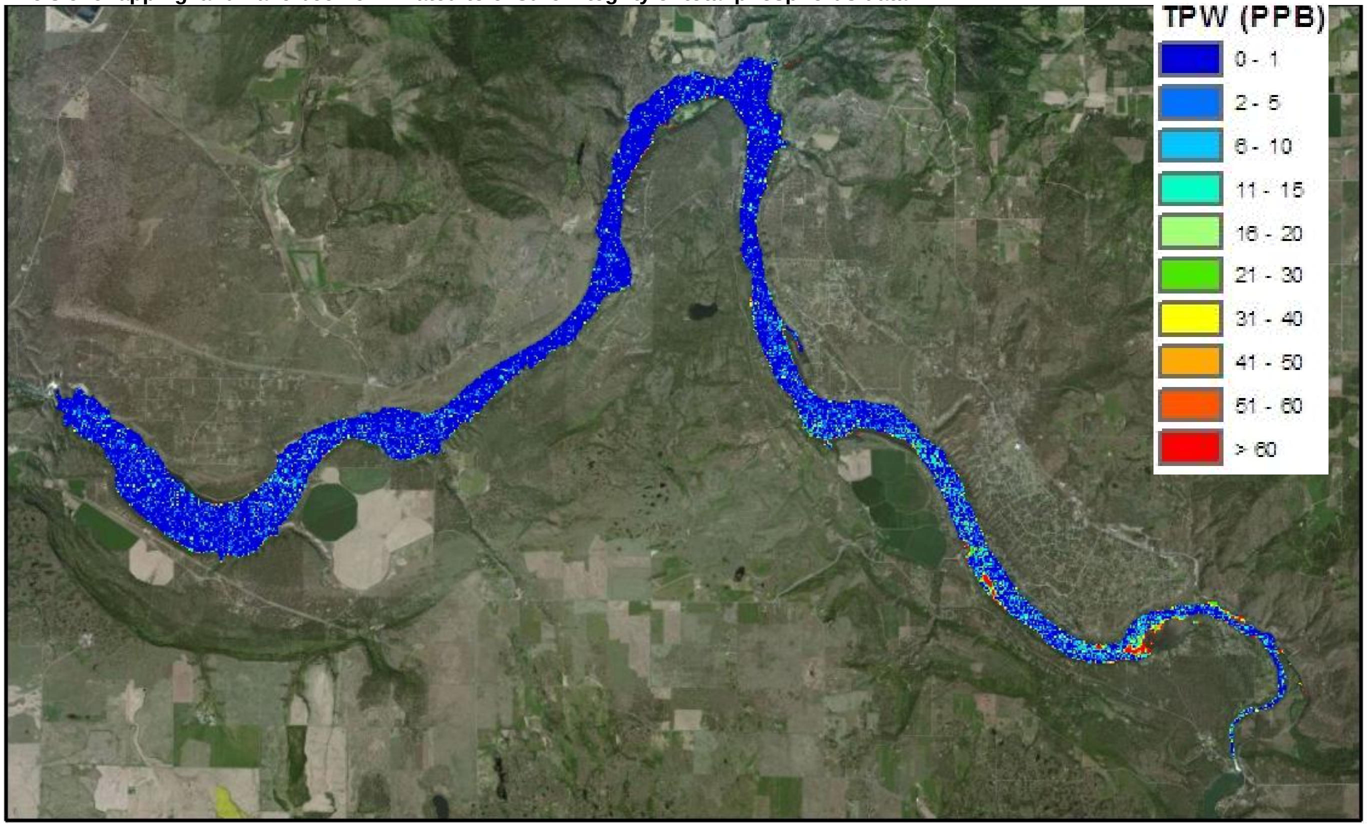


TPW (PPB)	Area (Acres)	Percent of Lake
0 - 1	1639.72	35.55
2 - 5	605.14	13.12
6 - 10	719.45	15.60
11 - 15	517.74	11.23
16 - 20	281.55	6.10
21 - 30	254.20	5.51
31 - 40	117.87	2.56
41 - 50	69.16	1.50
51 - 60	59.16	1.28
>60	348.05	7.55

NOTE: This scan was produced from data obtained by Landsat 7. Due to a malfunction on the spacecraft dating to May 30, 2003, called the "scan line corrector anomaly", the satellite provides no data for some small areas of Lake Spokane. In those areas, BWSI has extrapolated the concentration levels of the surrounding sample points, providing a scientifically modeled projection for those small areas.

Blue Water Satellite Results

Total Phosphorus
Lake Spokane, September 11, 2011, Landsat 5
Overlay on natural color image of surrounding landscape
Pixels overlapping land have been eliminated to ensure integrity of total phosphorus data



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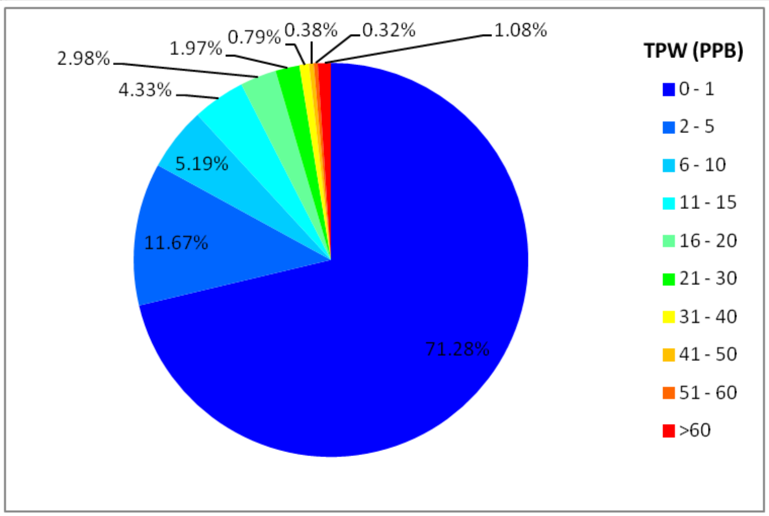

TPW (PPB)	Area (Acres)	Percent of Lake
0 - 1	3229.17	71.28
2 - 5	528.85	11.67
6 - 10	235.29	5.19
11 - 15	196.15	4.33
16 - 20	134.99	2.98
21 - 30	89.18	1.97
31 - 40	35.58	0.79
41 - 50	17.35	0.38
51 - 60	14.68	0.32
>60	48.70	1.08

Use of BWSI TIF files in your GIS software

As a client of Blue Water Satellite, Inc., you are also being provided with TIF files for each individual constituent scanned, a natural color image of the surrounding landscape, text files with the color values for the natural color image background, and instruction manuals for use of Blue Water Satellite GeoTIFs in ArcGIS and QGIS. Once properly installed in your GIS software you will be able to

- Isolate small areas for closer inspection,
- Identify specific concentrations (vs. ranges) of each constituent in each 30m x 30m sample area, and
- Overlay the scan on other digital maps/charts used in your profession.

Questions or need help?

Email

Louis Sanderson, Senior Project Scientist
lsanderson@bluewatersatellite.com

Jim Harpen, Manager of Business Development & Collaboration
jharpen@bluewatersatellite.com

Or call 001 (419) 728-0060

Lake Spokane Optical Brightener Monitoring Spring 2012

LSOPBR1		N 47.79941		W 117.57126		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	9:22	0		1		21,134
04/17/12	9:37	0	<	1	6.5	21,755
04/26/12	9:41	1	<	1	4.0	30,178
05/15/12	9:39	0		6	5.5	21,594
05/21/12	9:26	10	<	1	5.5	20,786
05/29/12	9:37	11		10	10.0	17,191
06/05/12	9:52	5		160	10.0	18,549
06/25/12	9:34	7		49	12.0	12,560
Maximum		11		160	12	30,178
Minimum		0		1	4	12,560
Average		4.3			7.6	20,468
Median		3			6.5	20,960
Geo.Mean				5		
St. Dev		4.4		51.9	2.8	4,673
LSOPBR2		**N 47.79693**		**W 117.58504**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	9:28	0		3		21,134
04/17/12	9:43	0	<	1	6.0	21,755
04/26/12	9:52	0.3		3	3.5	30,178
05/15/12	9:45	0		12	4.5	21,594
05/21/12	9:30	10	<	1	4.5	20,786
05/29/12	9:42	12		4	7.0	17,191
06/05/12	9:57	5		160	6.5	18,549
06/25/12	9:41	7		38	8.0	12,560
Maximum		12		160	8	30,178
Minimum		0		1	3.5	12,560
Average		4.3			5.7	20,468
Median		2.65			6	20,960
Geo.Mean				6		
St. Dev		4.6		51.3	1.5	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						

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LSOPBR3		N 47.80007		W 117.59183		
Date	Time	Optical Brightener		Fecal Coliform	Secchi Depth	Lake Inflow
		ppb		colonies / 100mL	ft	cfs
04/11/12	9:32	0	<	1		21,134
04/17/12	9:48	0		5	5.5	21,755
04/26/12	9:57	0		4	3.5	30,178
05/15/12	9:48	0		3	4.5	21,594
05/21/12	9:34	10	<	1	4.5	20,786
05/29/12	9:45	11		6	6.5	17,191
06/05/12	9:59	5		210	6.0	18,549
06/25/12	9:46	8		47	7.5	12,560
Maximum		11		210	7.5	30,178
Minimum		0		1	3.5	12,560
Average		4.3			5.4	20,468
Median		2.5			5.5	20,960
Geo.Mean				7		
St. Dev		4.5		67.8	1.3	4,673
LSOPBR4		**N 47.80400**		**W 117.59865**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	9:35	0		5		21,134
04/17/12	9:54	0		7	6.0	21,755
04/26/12	10:00	0		8	3.0	30,178
05/15/12	9:52	0		3	4.5	21,594
05/21/12	9:37	10		4	5.0	20,786
05/29/12	9:49	11		6	6.0	17,191
06/05/12	10:02	5		170	5.5	18,549
06/25/12	9:49	8		61	8.5	12,560
Maximum		11		170	8.5	30,178
Minimum		0		3	3	12,560
Average		4.3			5.5	20,468
Median		2.5			5.5	20,960
Geo.Mean				11		
St. Dev		4.5		54.9	1.6	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						

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LSOPBR 5		**N 47.80793**	**W 117.60249**		
Date	**Time**	**Optical Brightener ppb**	**Fecal Coliform colonies / 100mL**	**Secchi Depth ft**	**Lake Inflow cfs**
04/11/12	9:40	0	5		21,134
04/17/12	9:56	0	3	6.0	21,755
04/26/12	10:04	0	10	3.0	30,178
05/15/12	9:55	0	6	3.0	21,594
05/21/12	9:40	9	5	5.0	20,786
05/29/12	9:52	11	9	6.5	17,191
06/05/12	10:05	5	90	6.0	18,549
06/25/12	9:52	8	56	8.0	
Maximum		11	90	8	30,178
Minimum		0	3	3	17,191
Average		4.1		5.4	21,598
Median		2.5		6	21,134
Geo.Mean			11		12,560
St. Dev		4.4	30.2	1.7	3,840
LSOPBR 6		N 47.8108	W 117.60576		
Date	**Time**	**Optical Brightener ppb**	**Fecal Coliform colonies / 100mL**	**Secchi Depth ft**	**Lake Inflow cfs**
04/11/12	9:44	0	2		21,134
04/17/12	9:58	0	3	5.5	21,755
04/26/12	10:08	0	15	3.5	30,178
05/15/12	9:57	0	2	5.0	21,594
05/21/12	9:44	9	6	5.0	20,786
05/29/12	9:55	11	7	7.0	17,191
06/05/12	10:08	4	90	6.5	18,549
06/25/12	9:56	8	54	8.5	12,560
Maximum		11	90	8.5	30,178
Minimum		0	2	3.5	12,560
Average		4.0		5.9	20,468
Median		2		5.5	20,960
Geo.Mean			9		
St. Dev		4.4	30.3	1.5	4,673
Note: Secchi Disk values in italics denotes disk on the bottom					

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LSOPBR 7		**N 47.81369**		**W 117.60798**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	9:47	0		2		21,134
04/17/12	10:01	0		4	*4.0*	21,755
04/26/12	10:12	0		8	3.0	30,178
05/15/12	10:01	0		4	4.5	21,594
05/21/12	9:47	9		7	*3.5*	20,786
05/29/12	9:57	11		4	*4.5*	17,191
06/05/12	10:10	4		41	*4.5*	18,549
06/25/12	9:59	8		38	*4.5*	12,560
Maximum		11		41	4.5	30,178
Minimum		0		2	3	12,560
Average		4.0			4.1	20,468
Median		2			4.5	20,960
Geo.Mean				8		
St. Dev		4.4		15.1	0.6	4,673
LSOPBR 8		**N 47.83152**		**W 117.62444**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	9:56	0		1		21,134
04/17/12	10:07	0	<	1	5.0	21,755
04/26/12	10:22	0.2	<	1	3.0	30,178
05/15/12	10:10	0		4	4.0	21,594
05/21/12	10:06	9	<	1	5.5	20,786
05/29/12	10:19	10		5	7.0	17,191
06/05/12	10:15	4		26	5.5	18,549
06/25/12	10:07	8		56	7.0	12,560
Maximum		10		56	7	30,178
Minimum		0		1	3	12,560
Average		3.9			5.3	20,468
Median		2.1			5.5	20,960
Geo.Mean				4		
St. Dev		4.2		18.5	1.4	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						

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LSOPBR 9		**N 47.83629**		**W 117.64246**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:04	0		3		21,134
04/17/12	10:16	0		2	6.0	21,755
04/26/12	10:27	0.2	<	1	3.0	30,178
05/15/12	10:15	0		12	5.0	21,594
05/21/12	10:10	10	<	1	6.0	20,786
05/29/12	10:22	11		5	6.0	17,191
06/05/12	10:20	4		21	6.5	18,549
06/25/12	10:16	7		68	7.0	12,560
Maximum		11		68	7	30,178
Minimum		0		1	3	12,560
Average		4.0			5.6	20,468
Median		2.1			6	20,960
Geo.Mean				5		
St. Dev		4.4		21.4	1.2	4,673
LSOPBR 10		**N 47.84615**		**W 117.65377**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:11	0		1		21,134
04/17/12	10:22	0	<	1	6.0	21,755
04/26/12	10:34	2	<	1	3.5	30,178
05/15/12	10:22	0		5	5.0	21,594
05/21/12	10:15	10	<	1	6.0	20,786
05/29/12	10:29	11		3	5.5	17,191
06/05/12	10:24	4		17	6.0	18,549
06/25/12	10:25	7		27	5.5	12,560
Maximum		11		27	6	30,178
Minimum		0		1	3.5	12,560
Average		4.3			5.4	20,468
Median		3			5.54	20,960
Geo.Mean				3		
St. Dev		4.3		9.1	0.8	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						

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LSOPBR 11		**N 47.84894**		**W 117.65726**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:16	0		2		21,134
04/17/12	10:25	0		1	5.5	21,755
04/26/12	10:39	0.4		2	3.0	30,178
05/15/12	10:26	0		3	4.5	21,594
05/21/12	10:33	9		2	6.0	20,786
05/29/12	10:31	11		2	5.5	17,191
06/05/12	10:27	3		15	6.5	18,549
06/25/12	10:28	7		18	7.0	12,560
Maximum		11		18	7	30,178
Minimum		0		1	3	12,560
Average		3.8			5.4	20,468
Median		1.7			5.5	20,960
Geo.Mean				3		
St. Dev		4.3		6.3	1.2	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						
LSOPBR 12		**N 47.87659**		**W 117.66069**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:26	0	<	1		21,134
04/17/12	10:32	0		1	*4.5*	21,755
04/26/12	10:46	0		10	*4.0*	30,178
05/15/12	10:37	0		3	*4.0*	21,594
05/21/12	10:40	10		12	*3.5*	20,786
05/29/12	10:42	9		4	*4.0*	17,191
06/05/12	10:34	3		15	*4.0*	18,549
06/25/12	10:37	8		90	*4.0*	12,560
				6/25 sample hits		
				lake bottom		
Maximum		10		90	4.5	30,178
Minimum		0		1	3.5	12,560
Average		3.8			4.0	20,468
Median		1.5			4	20,960
Geo.Mean				6		
St. Dev		4.2		28.0	0.3	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						

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LSOPBR 13		**N 47.88582**	**W 117.66258**		
Date	**Time**	**Optical Brightener**	**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb	**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:35	0	1		21,134
04/17/12	10:37	0	2	6.0	21,755
04/26/12	10:51	0	7	3.5	30,178
05/15/12	10:42	0	1	3.5	21,594
05/21/12	10:45	9	5	*5.5*	20,786
05/29/12	10:45	10	2	5.5	17,191
06/05/12	10:40	3	3	6.5	18,549
06/25/12	10:43	7	19	5.5	12,560
Maximum		10	19	6.5	30,178
Minimum		0	1	3.5	12,560
Average		3.6		5.1	20,468
Median		1.5		5.5	20,960
Geo.Mean			3		
St. Dev		4.1	5.6	1.1	4,673
LSOPBR 14		**N 47.89339**	**W 117.66115**		
Date	**Time**	**Optical Brightener**	**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb	**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:40	27	3		21,134
04/17/12	10:43	10	1	5.0	21,755
04/26/12	10:55	25	9	3.5	30,178
05/15/12	11:12	0	14	4.5	21,594
05/21/12	10:48	10	6	5.0	20,786
05/29/12	10:59	10	27	6.0	17,191
06/05/12	10:42	3	29	6.0	18,549
06/25/12	10:50	7	16	6.0	12,560
Maximum		27	29	6	30,178
Minimum		0	1	3.5	12,560
Average		11.5		5.1	20,468
Median		10		5	20,960
Geo.Mean			9		
St. Dev		9.0	9.8	0.9	4,673
Note: Secchi Disk values in italics denotes disk on the bottom					

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LSOPBR 15		N 47.8937		W 117.66705		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:48	0	<	1		21,134
04/17/12	10:48	0	<	1	6.0	21,755
04/26/12	11:00	0		13	3.5	30,178
05/15/12	11:16	0		3	5.5	21,594
05/21/12	10:53	9		2	6.0	20,786
05/29/12	11:05	11		2	6.0	17,191
06/05/12	10:45	3		23	6.5	18,549
06/25/12	10:56	6		16	8.0	12,560
Maximum		11		23	8	30,178
Minimum		0		1	3.5	12,560
Average		3.6			5.9	20,468
Median		1.5			6	20,960
Geo.Mean				4		
St. Dev		4.2		8.0	1.2	4,673
LSOPBR 16		**N 47.89114**		**W 117.68147**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	10:53	0	<	1		21,134
04/17/12	10:51	0	<	1	5.5	21,755
04/26/12	11:05	0	<	1	3.5	30,178
05/15/12	11:20	0		3	*5.0*	21,594
05/21/12	10:57	7	<	1	5.5	20,786
05/29/12	11:10	10		3	5.5	17,191
06/05/12	10:48	3		31	6.0	18,549
06/25/12	11:01	6		6	*6.0*	12,560
Maximum		10		31	6	30,178
Minimum		0		1	3.5	12,560
Average		3.3			5.3	20,468
Median		1.5			5.5	20,960
Geo.Mean				3		
St. Dev		3.7		9.6	0.8	4,673

Note: Secchi Disk values in italics denotes disk on the bottom

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LSOPBR 17		N 47.82668		W 117.64449		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	11:18	0	<	1		21,134
04/17/12	11:12	0		2	4.0	21,755
04/26/12	11:21	13	<	1	3.0	30,178
05/15/12	11:40	0		12	*4.0*	21,594
05/21/12	11:14	11	<	1	*4.5*	20,786
05/29/12	11:29	11		2	*4.5*	17,191
06/05/12	11:05	4		26	*5.0*	18,549
06/25/12	11:48	9		32	2.0	12,560
Maximum		13		32	5	30,178
Minimum		0		1	2	12,560
Average		6.0			3.9	20,468
Median		6.5			4	20,960
Geo.Mean				4		
St. Dev		5.2		11.8	1.0	4,673
LSOPBR 18		**N 47.82282**		**W 117.61984**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	11:28	0	<	1		21,134
04/17/12	11:22	0		1	6.0	21,755
04/26/12	11:31	0	<	1	3.5	30,178
05/15/12	11:49	0		5	5.0	21,594
05/21/12	11:21	9	<	1	4.5	20,786
05/29/12	11:37	11		6	6.0	17,191
06/05/12	11:12	4		27	5.0	18,549
06/25/12	12:02	7		26	8.0	12,560
Note: Secchi Disk values in italics denotes disk on the bottom						
Maximum		11		27	8	30,178
Minimum		0		1	3.5	12,560
Average		3.9			5.4	20,468
Median		2			5	20,960
Geo.Mean				3		
St. Dev		4.3		10.6	1.3	4,673

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LSOPBR 19		**N 47.81465**		**W 117.61442**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	11:31	0	<	1		21,134
04/17/12	11:26	0		1	6.5	21,755
04/26/12	11:36	0	<	1	3.5	30,178
05/15/12	11:53	0		4	5.0	21,594
05/21/12	11:25	10	<	1	5.5	20,786
05/29/12	12:07	10		5	5.5	17,191
06/05/12	11:15	3		20	6.0	18,549
06/25/12	12:12	6		30	8.5	12,560
Maximum		10		30	8.5	30,178
Minimum		0		1	3.5	12,560
Average		3.6			5.8	20,468
Median		1.5			5.5	20,960
Geo.Mean				3		
St. Dev		4.2		10.3	1.4	4,673
LSOPBR 20		**N 47.7967**		**W 117.55814**		
Date	**Time**	**Optical Brightener**		**Fecal Coliform**	**Secchi Depth**	**Lake Inflow**
		ppb		**colonies / 100mL**	**ft**	**cfs**
04/11/12	12:09	0	<	1		21,134
04/17/12	11:41	0	<	1	*4.0*	21,755
04/26/12	11:47	0.5		2	2.0	30,178
05/15/12	12:08	0		7	*4.0*	21,594
05/21/12	11:39	10		7	*4.0*	20,786
05/29/12	12:19	11		13	*4.5*	17,191
06/05/12	11:29	6		770	*3.5*	18,549
06/25/12	13:25	6		26	*4.5*	12,560
Maximum		11		770	4.5	30,178
Minimum		0		1	2	12,560
Average		4.2			3.8	20,468
Median		3.25			4	20,960
Geo.Mean				8		
St. Dev		4.4		252.1	0.8	4,673
Note: Secchi Disk values in italics denotes disk on the bottom						