2015 Water Quality Report Card

Spokane
RIVERKEEPER®

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Executive Summary: The Spokane Riverkeeper is a non-profit organization working in the Spokane River watershed dedicated to maintaining the health of the area's surface waters. We began a water quality monitoring program in February 2015 dedicated to using the scientific process to advocate for a cleaner watershed. We began by focusing on Hangman Creek and using other rivers and creeks in the areas for comparison.

Our research and water quality data shows that Hangman Creek is heavily polluted. We documented high water temperatures, high nutrient levels, high levels of turbidity, and low dissolved oxygen. These pollution problems are human caused and preventable.

In our pollution monitoring program, we found and reported 11 pollution violations of the Water Pollution Control Act. We quickly learned that well documented violations often do not get fixed due to politics. In spite of this, several pollution problems were remedied because of our work.

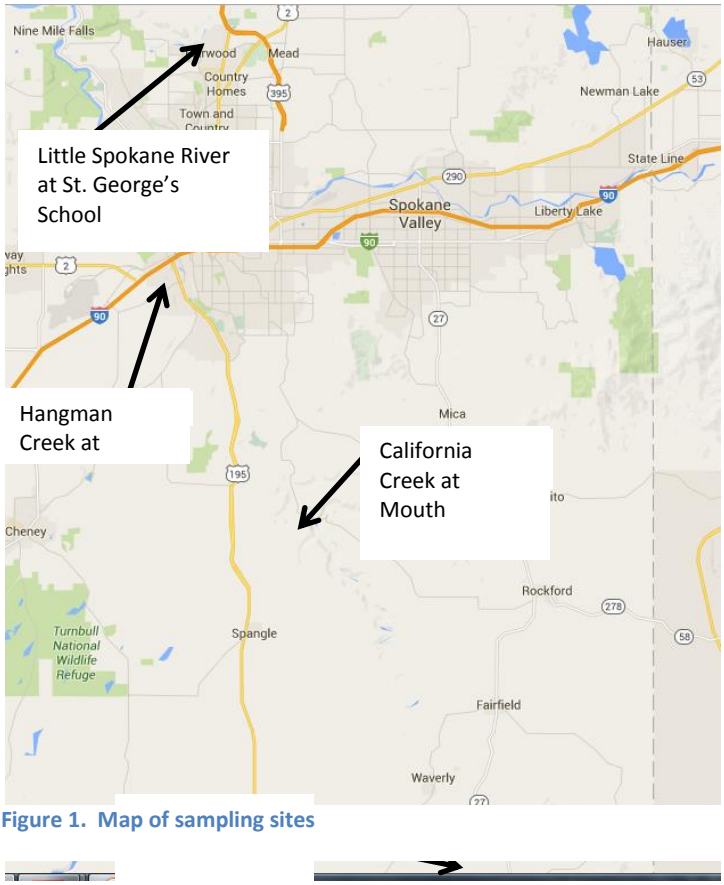


Figure 1. Map of sampling sites

Below, I highlight some of our data that we collected. This report is not meant to be an exhaustive summary. If you would like to see the raw data, check out our River Data page. All of these data were collected by Riverkeeper Technical Lead Jule Schultz, along with Dillon Wilke, a volunteer who helped develop our water quality program.

Methods: These data were collected both on monthly water quality trips that were pre-planned (ambient) and from samples that were taken during run-off events (event).

We collected dissolved oxygen, conductivity (DO), and pH data with our YSI ProPlus. We calibrated pH before every sampling run, DO quarterly, and conductivity yearly. These calibrations were based on advice from Brian Gallagher, an employee of the water quality division at the Washington State Department of Ecology. We collected water clarity data using a 60 cm tube with a Secchi disc at one end. We collected water samples in triple rinsed mason jars at each site for analysis of nitrates, phosphate, and turbidity in the lab using a YSI 9500 photometer. All data were checked against data taken at the same time as Ecology, in their "side by side" sampling program. All data excepting phosphate were similar to that of Ecology's.

We collected samples at the mouth of Hangman Creek at 11th Street Bridge, from Hangman Creek near Waverly off of the Roberts Road Bridge, at the mouth of California Creek, and from the Spokane River at River Run development and the Sandifur Bridge. Sample locations in Hangman Creek were chosen to determine water quality from the entire creek (mouth sample) and from a portion of the Palouse (Waverly sample). California Creek was added later as a creek to compare to Hangman Creek, as it contains much better water quality and is located in the Hangman Creek watershed. The stream corridor of California Creek contains much more streamside vegetation, providing an example of what water quality could look like in this region in an intact watershed. The Spokane River was monitored to determine the effect of Hangman Creek, if any, on the River. No clear difference in samples in the Spokane River from above and below the mouth of Hangman Creek was noticed.

Turbidity Summary: Hangman Creek contained extremely turbid water during portions of the months of January through June. Water clarity as low at 4 centimeters was recorded during pollution events.

Grade: F.

Turbidity is a measure of water clarity, in this case caused by sediment in the creek, and has important implications for aquatic life. Large amounts of sediment in the water clogs fish gills, creates habitat stress for fish, covers spawning habitat, and reduces aesthetic values. State standards state that less than a 5 NTU or 10% increase in turbidity from "background" is acceptable. In a thoroughly impaired and developed watershed such as Hangman a true background condition does not exist. Turbidities over 10 NTU can harm trout over long exposures. Given the lack of clear state water quality standards for turbidity, I set the standard of 10 NTU as turbidity maximum, as that is frequently used by states as a water quality guideline for cold water streams. Regardless of state standards, dirty water in Hangman Creek is pollution.

Table 1. Turbidity summaries and grades for monitored locations in Hangman Creek and the Little Spokane River.

Turbidity (Water Clarity) in Hangman Creek Watershed		
Location	**Percentage Turbidity under 10 FTU**	**Grade**
Hangman Mouth	50	F
Waverly	25	F
Spokane River	100	A
California Creek	100	A

Our water quality program measured turbidity of Hangman Creek both in the lab and the field. Field measurements showed that ***water clarity during pollution events decreases to 4-7 inches!*** These pollution events typically occur during periods of high stream flow, such as on 1/6/15, 2/10/15, and

3/17/15. However, pollution events occur during periods of low flow as well, shown in the photos below. These photos, from May 2015, occurred when rain washed fallow farmland into Hangman Creek, polluting it for weeks. Unfortunately, no data were taken from this event. A similar event occurred in June 2015 as well.

Figure 2. Sediment pollution clogs Hangman Creek (left) and pollutes the otherwise clear Spokane River (right) in May, 2015.

Figure 3. Water from the mouth of California Creek (left) and Hangman Creek (right) during a runoff event on 2/10/15. Located in the same watershed, California Creek has clear water while Hangman's water clarity is approximately 5 cm.

In addition to containing heavy loads of sediment that suffocates fish and benthic macroinvertebrates, sediment in Hangman Creek pollutes the Spokane River and Lake Spokane. These waterbodies still contain native Redband Trout, a federally designated "Species of Concern".

We sampled for turbidity at five locations: Waverly (Roberts Road), 11th Street Bridge in Spokane, the mouth of California Creek, and at Sandifur Bridge and River Run Development in the Spokane River. Other than in Hangman Creek, we found good water clarity (>60 inches visibility). We sampled every month, as well as during high flow events (11th Street location only). Based on our monthly and event sampling data

shown below, Hangman Creek contains very turbid water in January-March, especially during high flow and runoff events. Hangman Creek also contained highly turbid water in April-June not related to high flow events, although we did not sample the creek during these events.

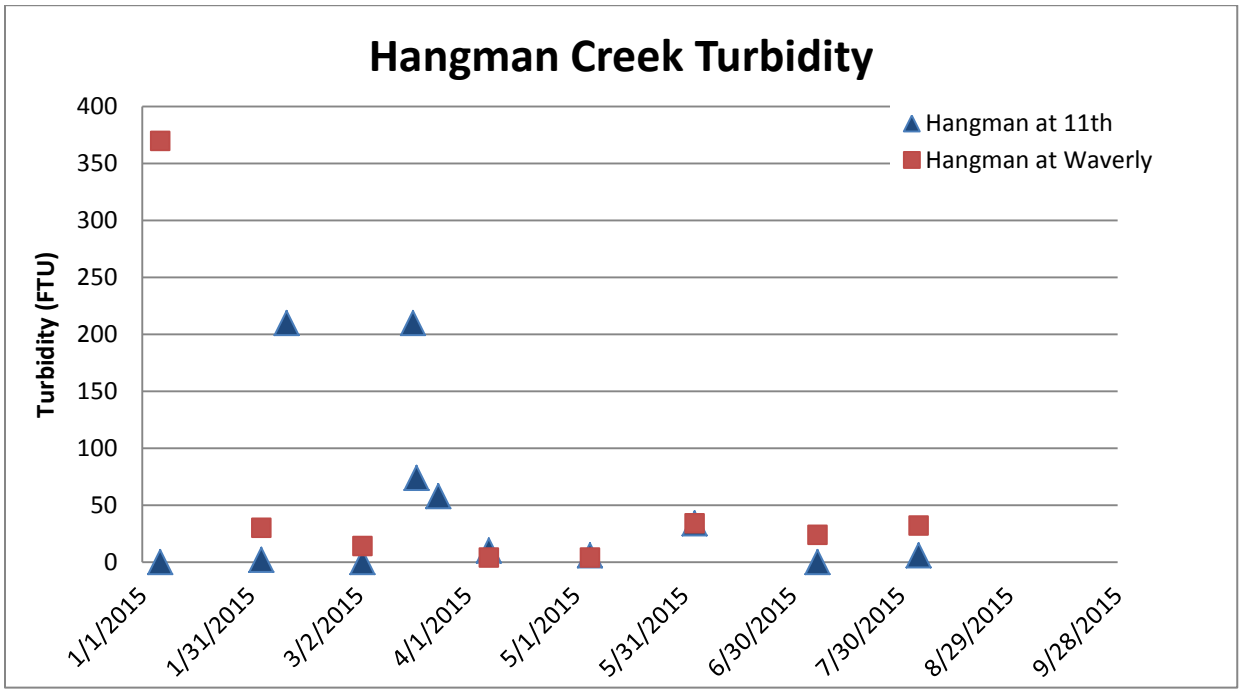


Figure 4. Turbidity (water clarity) in Hangman Creek. High levels of turbidity were caused by sediment in Hangman Creek, creating an environment deadly for trout and other species.

Temperature Summary: Hangman Creek contained water temperatures far above the water quality standard of 18 C for over a month at sites near Waverly and the mouth. Temperature in California Creek was lower than Hangman Creek. Grade: F

Table 2. Grades and standards for water temperatures at monitored locations in Hangman Creek and the Little Spokane River.

Location	Percent of days under 18 C (7DADMax)	Date Range	Grade
Waverly	0	7/7/15-9/21/15	F
Hangman Mouth	19	7/7/15-9/21/15	F
California Creek	27	7/7/15-9/21/15	D
LSR	100	7/15/15-9/21/15	A

Elevated summertime temperatures in Hangman Creek are a longstanding problem. Much of the mainstem of Hangman Creek and many tributaries continue to violate the water quality standard of 18C. Much of Hangman Creek does not contain the streamside vegetation needed to shade the creek. This

has led to increased solar heating. The high water temperatures of Hangman Creek make it impossible for trout to inhabit the creek during the hot summer months.

We placed "Hobo Tidbit" temperature loggers in the water at four locations: Hangman Creek at Waverly (Roberts Road), Hangman Creek at the 11th Street Bridge, California Creek at Mouth, and the Little Spokane River at Saint George's School. Loggers recorded water temperature every 30 minutes from 7/15/15 to 9/30/15. We calculated a Seven Day Average Daily Maxima (7DADMax) for each location by averaging the hottest temperature recorded each day for seven days.

Water temperatures, shown in the graph below, show that Hangman Creek at Waverly was the hottest location, followed by Hangman Creek at 11th Street Bridge, California Creek and the Little Spokane River. Temperature ranged from a high of 27.2 C (81 F) at Waverly on 7/19/15 to a low of 6.3 C (43 F) in California Creek on 9/30/15.

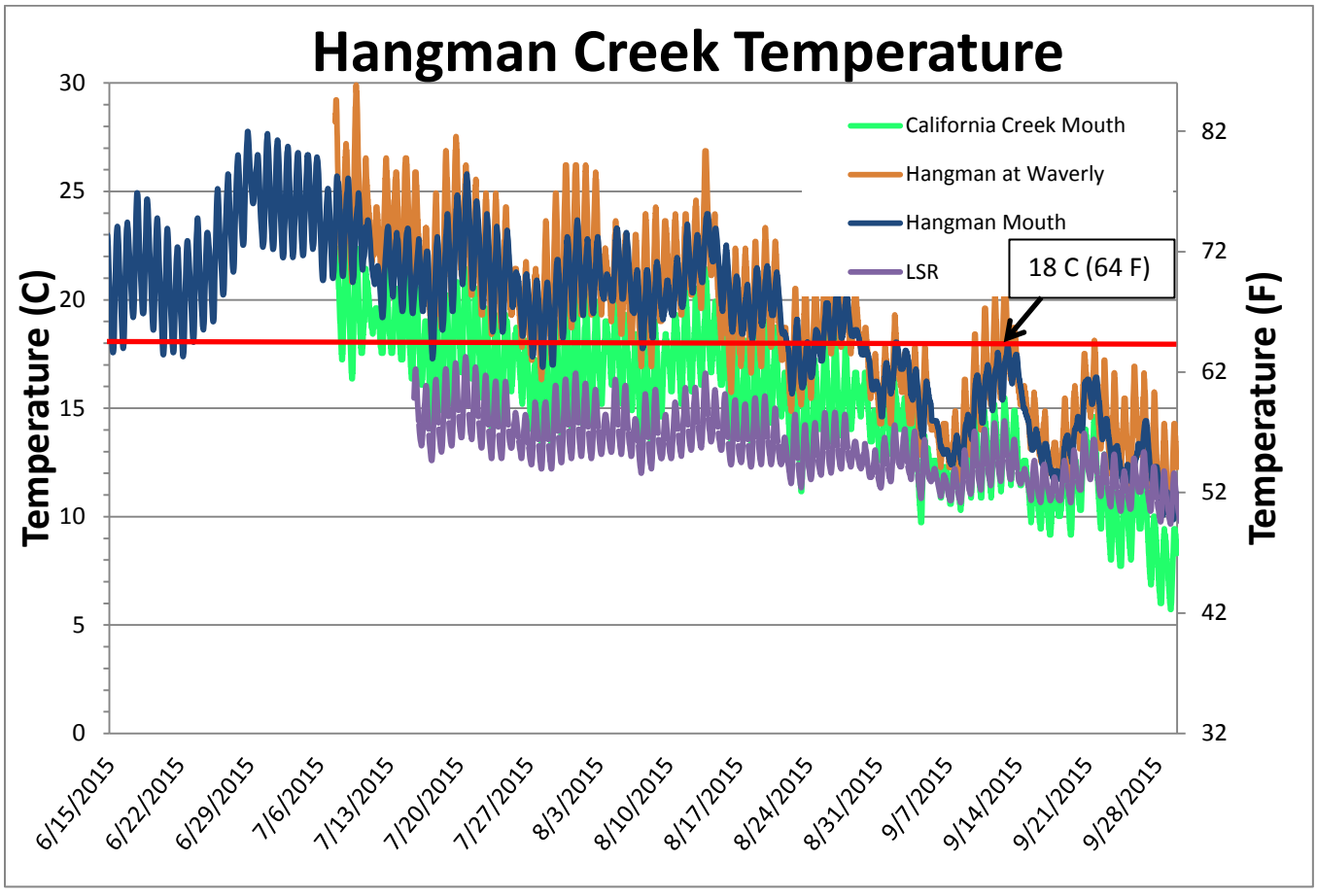


Figure 5. Continuous water temperature data from Hangman Creek, the Little Spokane River, and California Creek. Water temperature in Hangman Creek was over Washington State's temperature standard for most of the summer.

The mainstem of Hangman Creek had average daily temperatures above 18 C (64.4 F) for over 40 days at both the mouth and Waverly. Hangman at the mouth and at Waverly had seven day average daily

maximum (7DADMax) temperatures of 24.2 (75.5 F) and 25.8 C (78.4 F), respectively. California Creek was much cooler, with a 7DADMax of 20.2 C (68.4 F), with only 5 days over 18 C (64.4 F).

Table 3. Water temperature summaries for monitored locations.

Water temperature summaries for monitored locations in Spokane River tributaries.			
Location	**Days above 18 C**	**Days Below 18 C**	**Seven Day Average Daily Maximum (7DADMax)**
Waverly	43	4	25.8
11th Street	41	7	24.2
California Creek	5	43	20.2
Little Spokane River	0	47	16.2

Our data show that Hangman Creek was much too hot this year for trout to survive. It exceeds Washington State's water temperature standard for Class A water for over 40 days and exceeds the maximum temperature in which trout can survive. The high temperature in Hangman Creek is a direct reflection of the lack of streamside vegetation throughout the watershed. California Creek, which has streamside vegetation, was much cooler. The Little Spokane River's temperature reflected the influence of the aquifer that feeds the river cool water throughout the year.

Dissolved Oxygen Summary: Hangman Creek contained low dissolved oxygen (DO) levels at Waverly during the spring and summer, but other locations contained DO above the state standard. Grade: B.

Aquatic life requires dissolved oxygen (DO) to survive. Low dissolved oxygen can stress or kill trout and other sensitive invertebrates. Low DO levels are an indicator of an unhealthy stream and are caused by high nutrients feeding algal growth and temperatures. In Washington State, surface waters below 8 mg/L are considered impaired for dissolved oxygen.

Table 4. Grades of water dissolved oxygen content at monitored locations in Hangman Creek, California Creek, and Little Spokane River.

Dissolved Oxygen

Location	**DO >8mg/L (percent of measurement)**	**Grade**
Hangman Mouth	91	A
Waverly	63	B-
Spokane River	100	A
California Creek	83	A

Dissolved oxygen levels in the Spokane River and its tributaries show that many sites have healthy levels of dissolved oxygen. The exception is Hangman Creek at Waverly, which contained low levels of dissolved oxygen from June-August. This site is directly downstream of areas in which Hangman Creek pools and the low dissolved oxygen may be a result of algal growth in the semi-stagnant pools above the sample site. This site had the highest temperatures of our samples sites as well. Higher temperature water can hold less dissolved oxygen. However, the mouth of Hangman Creek contained adequate levels of dissolved oxygen throughout our sample period. Hangman Creek contains numerous minor rapids and riffles above the mouth, possibly aerating the water in this portion of the river.

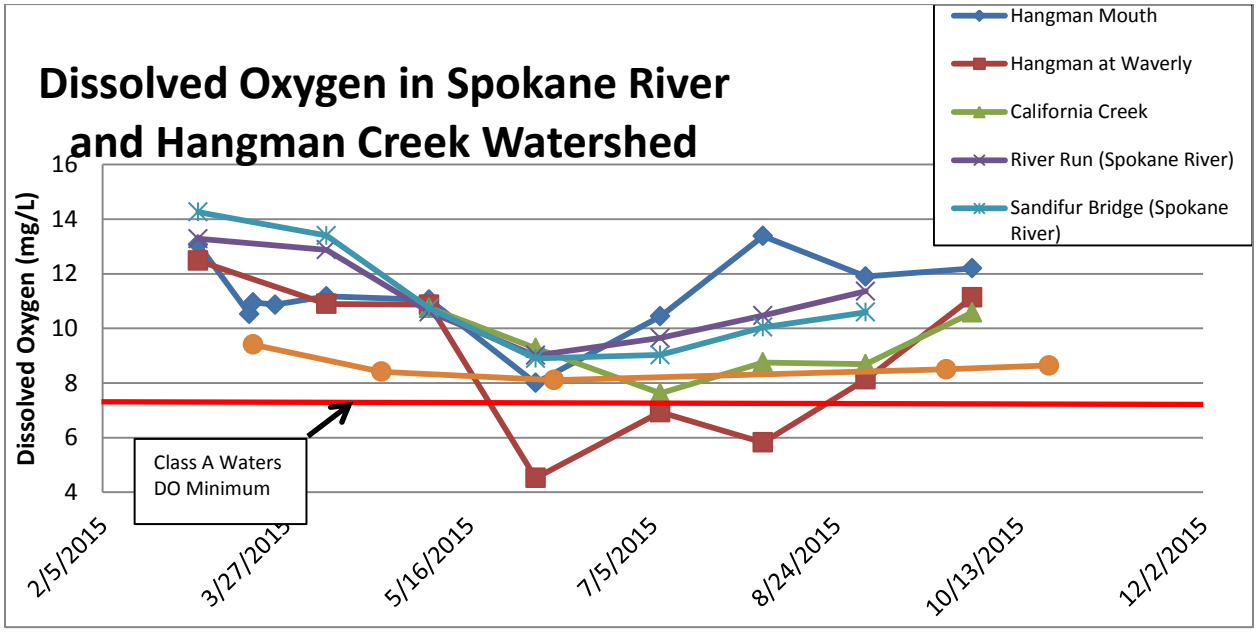


Figure 6. Dissolved oxygen content of water in Hangman Creek, California Creek, Little Spokane River (LSR) and the Spokane River. All locations meet standards except for Hangman Creek at Waverly, which had very low levels during the summer.

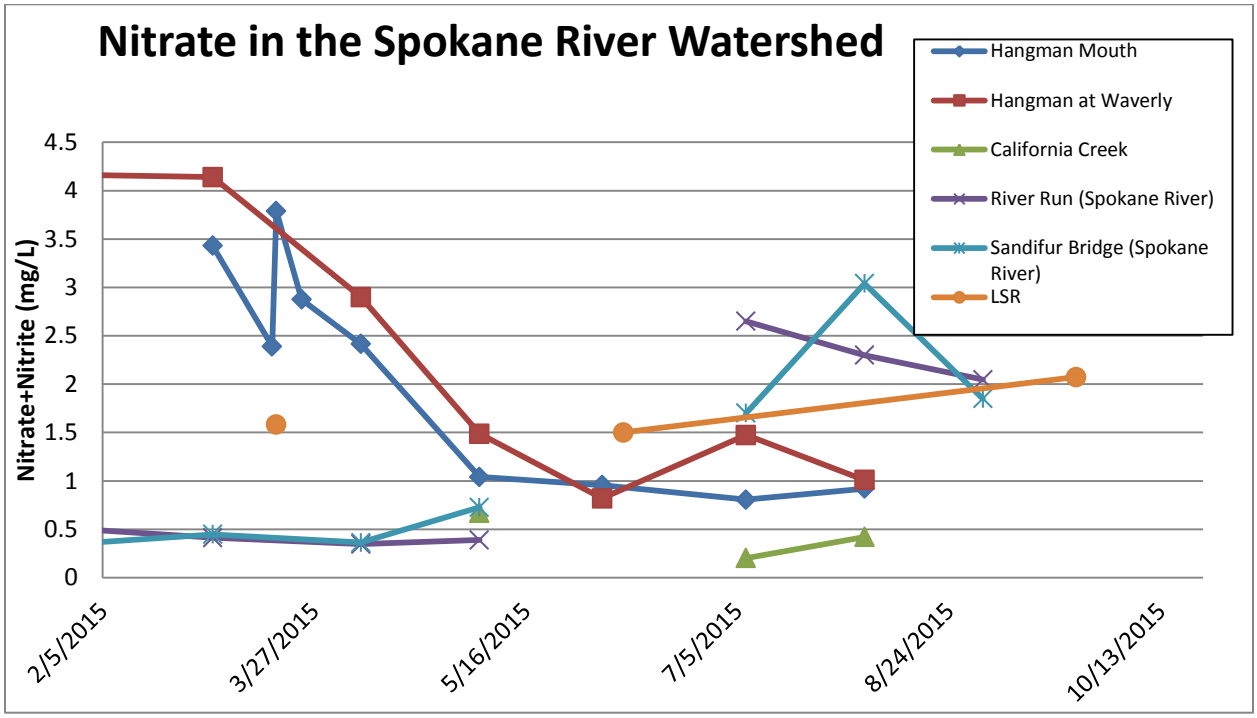
Sites in the Little Spokane River and the Spokane River contained healthy levels of dissolved oxygen as well. This is most likely a reflection of the cool aquifer water flowing into these water bodies. Although aquifer water does not contain high levels of dissolved oxygen, it is cool, allowing it to hold more oxygen. Any aeration, such as over rapids, could be absorbed by this cooler water.

Nutrients Summary: We found the highest levels of nitrate in Hangman Creek in the spring. Although no state standards exist, nitrate levels far above the dry weather condition were found during high flows. Hangman Creek contains some of the highest nitrate levels in the state based on data collected by Ecology. Grade: D.

Nutrients such as nitrate and phosphorous are important elements in fertilizer and allow for plant growth. However, these fertilizers become pollution when they enter our waterways and fuel algal growth or pollute drinking water. Washington State does not have standards for nitrate and phosphorous in surface waters. Levels of nitrate over 10 mg/L are generally considered unsafe in drinking water, although in some cases levels above 1 mg/L are thought to be over background

(http://www.pca.state.mn.us/index.php/view-document.html?gid=14949). Phosphate levels over .1 mg/L can cause eutrophication in creeks and rivers.

Table 5. Nitrate levels in the Hangman Creek, California Creek, Little Spokane River (LSR) and the Spokane River. Nitrate levels are highest in winter and spring, when water washes fertilizer off fields.



Our nitrate testing showed that levels in Hangman Creek peaked in the spring at over 4 mg/L. These levels correlate with large runoff events in Hangman Creek. During the late spring and summer nitrate levels dropped to near 1 mg/L. The elevated nitrate levels seen in Hangman Creek in late winter/early spring are most likely due to fertilizer running off farmland and into our surface waters.

Nitrate levels in the Spokane River, California Creek, and the Little Spokane River (LSR) were mostly below 1 mg/L in the spring, but showed higher levels in the summer. These higher levels correlate with lower flows in these waterways. Both the Spokane River and LSR are influenced fed by groundwater and during periods of low flows the percentage of groundwater in these waterways increases. Groundwater generally contains higher levels of nitrates in the Spokane area, and the higher levels seen in these streams during low flow probably reflects the higher proportions of high nitrate groundwater in these streams during summer.

Although phosphate data were taken during these sampling runs, our monitoring equipment does not appear to be sensitive enough to detect the amounts of phosphate in surface waters.

PCBs: Recent data contained in the "Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report" show that Hangman Creek contains high levels of PCBs. These high levels may be caused by runoff during local precipitation events.

PCBs are man-made chemicals that were invented for use in electrical equipment in the 1930s and made illegal in 1979. It was found that they cause neurological deficiencies, skin and skeletal abnormalities, problems with reproduction, weakened immune systems, and many forms of cancer. Despite this, they are still made as byproducts in many types of paints, papers, and pigments. The Spokane River has a major PCB problem. The limit set for PCBs in Spokane is 1.3 parts per quadrillion (ppq) and in Washington State is 170 ppq.

The **"Spokane River Regional Toxics Task Force Phase 2 Technical Activities Report"** contains PCB data collected from the Spokane watershed, including Hangman Creek. PCB levels violate the Washington State Standard of 170 ppq in Hangman Creek on two of the eight sampling days. In one case, on August 20th 2014, the sample of 2,444 ppq was over 10 times the state standard. The PCB concentration in this sample is approximately equivalent to samples taken from industrial discharges such as Inland Empire Paper and Kaiser Aluminum.

Weather and Hangman Creek flow data on 8/20/2014 show evidence of precipitation during the otherwise dry month of August. Hangman Creek increased in flow approximately 50% from 6:00PM to 8:00PM, suggesting a short localized rainfall in the area. Weather data from the Spokane Airport on 8/20/2014 shows 0.12" of rain and observed thunder. These data suggest that localized runoff occurred on 8/20/2014 and contributed to the high PCB levels in Hangman Creek on this day. And although no Combined Sewage Overflow's occurred into Hangman Creek on 8/20/2014, other runoff from roads and parking lots could have washed into the creek.

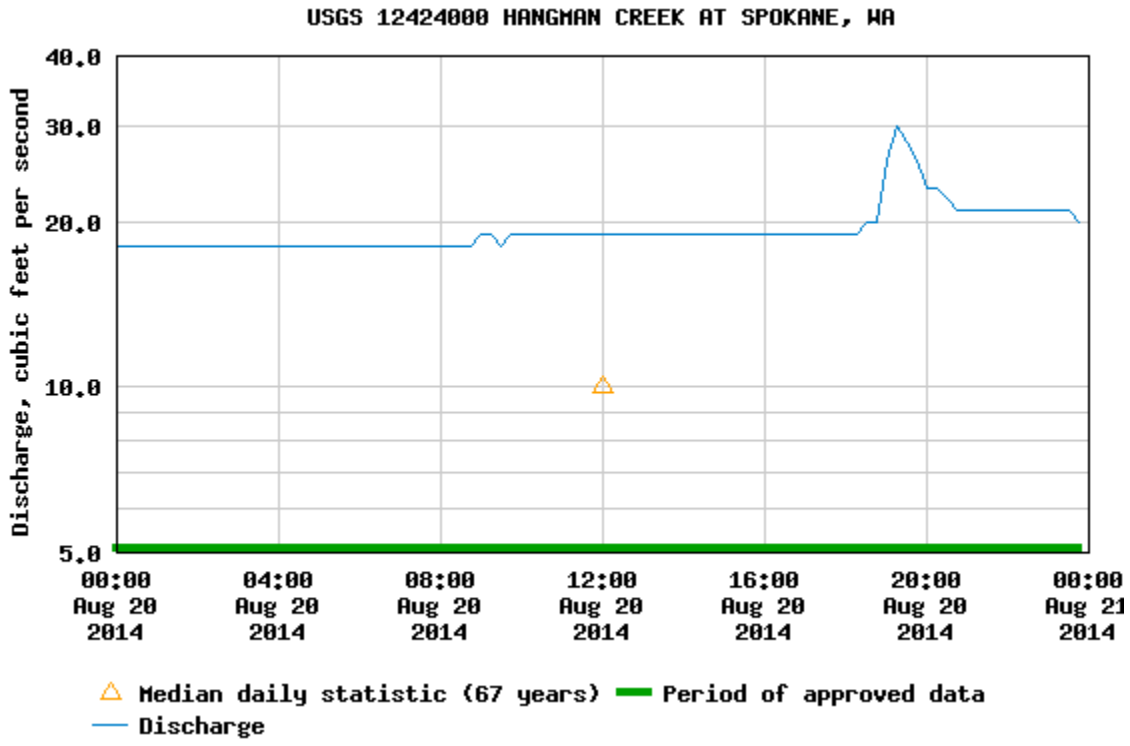


Figure 7. Hangman Creek flow on 8/20/2014 showing an approximately 50% increase in flow.

Flow Summary: Hangman Creek displayed its' extremely "flashy" nature, rising and falling of rates of over 1,000 cubic feet/second (cfs)/hour. Summertime flows ranked in the bottom 10% of historical observations. Grade: F

Although flow is not a regulated water quality parameter in Washington State, It is impossible to discuss water quality dynamics in the Hangman Creek watershed without understanding flow dynamics. This very flashy watershed tends to have rapid increases and decreases in water levels, usually during rain on snow events. Summertime flows are generally between 10-15 cfs and do not provide for the designated use of salmon and trout spawning and rearing. The flow regime of a watershed reflects local geology and land use practices. In the case of the Hangman watershed, the steep hills of the Palouse, combined with farming practices such as conventional tillage, field ditching, and lack of streamside (riparian) vegetation creates a watershed that sees flows fluctuate rapidly and returns very little water to the ground.

The graph compares average daily flows in Hangman Creek with the Little Spokane River (LSR). Hangman Creek **rose to over 1000 cubic feet/second (cfs) on five occasions** in WY 2015, while the Little Spokane River never did. After each rapid rise, the creek decreased to pre-rise flows in a matter of days. These rapid increases in creek levels bring quick moving water, which are associated with heavy sediment loading and nutrient levels (and are dangerous!). Although Hangman Creek did not flood in WY 2015 (It can reach almost 20,000 cfs), the rapid rise and associated pollution discolored the Spokane River for weeks.

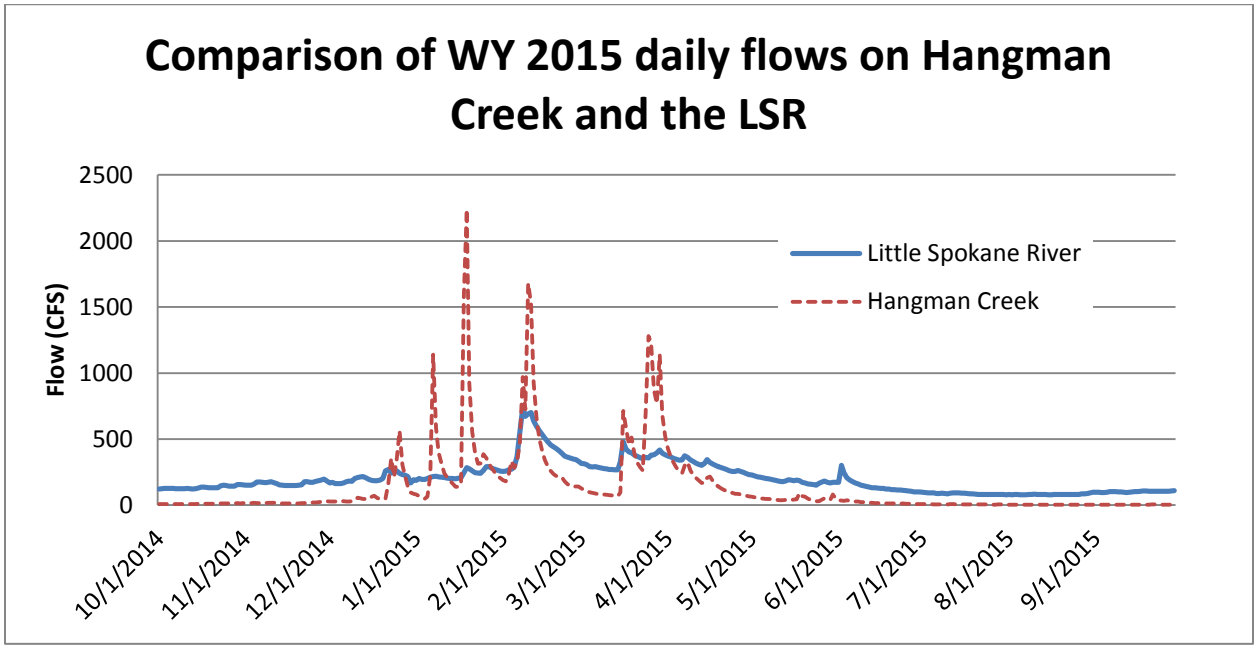


Figure 8. Comparison of flows between Hangman Creek and the Little Spokane River. The quick rise and fall of river flows in Hangman Creek causes many pollution problems in the watershed. Data taken from USGS gages at http://waterdata.usgs.gov/usa/nwis/uv?1242

The rate of this rise is sometimes dramatic. Graphing the instantaneous data (taken every 15 minutes) highlights the dramatic rises in Hangman Creek. Hangman Creek rose **over 1000 cfs/hour twice** in 2015, in both instances increasing its flow by over **20 times**.

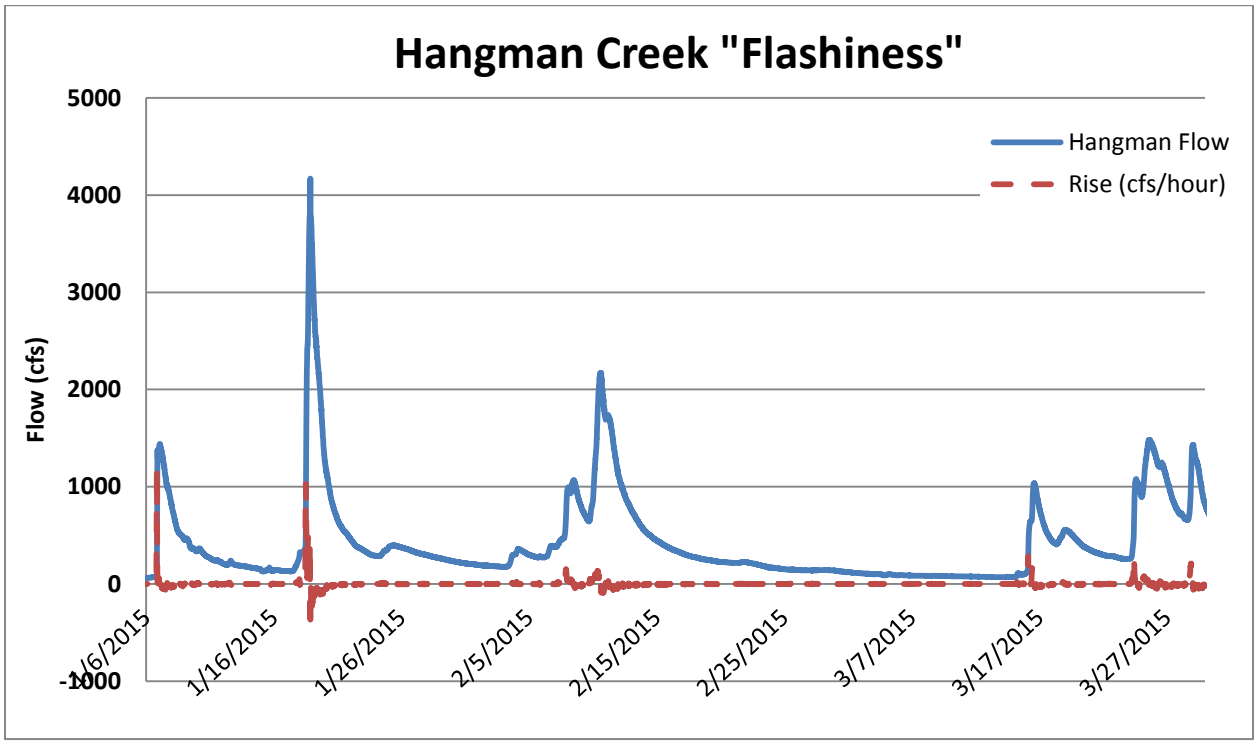


Figure 9. The "flashy" nature of Hangman Creek is defined by its raprid rise and fall of its flows. Data taken from the USGS gage. http://waterdata.usgs.gov/usa/nwis/uv?12424000

Driving around the watershed, we quickly realized why flows are so flashy on Hangman Creek. Poor farming practices, lack of riparian vegetation, and local geography all contribute the problem. Ditching farmland for drainage purposes, as in the picture below, allows water to quickly runoff in our creeks. In addition, leaving farmland fallow without any vegetation further allows water to runoff.

Figure 10. Ditching fields and fallow fields contribute to the flashy nature of Hangman Creek.

Low flows also were a problem in Hangman Creek this year. Summer flows ranked near the bottom 10 % of recorded flows, although the creek was above its historical minimum flows. Given that it was one of the driest summers on record, this is to be expected. However, much of the surface water that should be soaking into the ground and feeding the creek during summer, flows off of the fields via ditches.

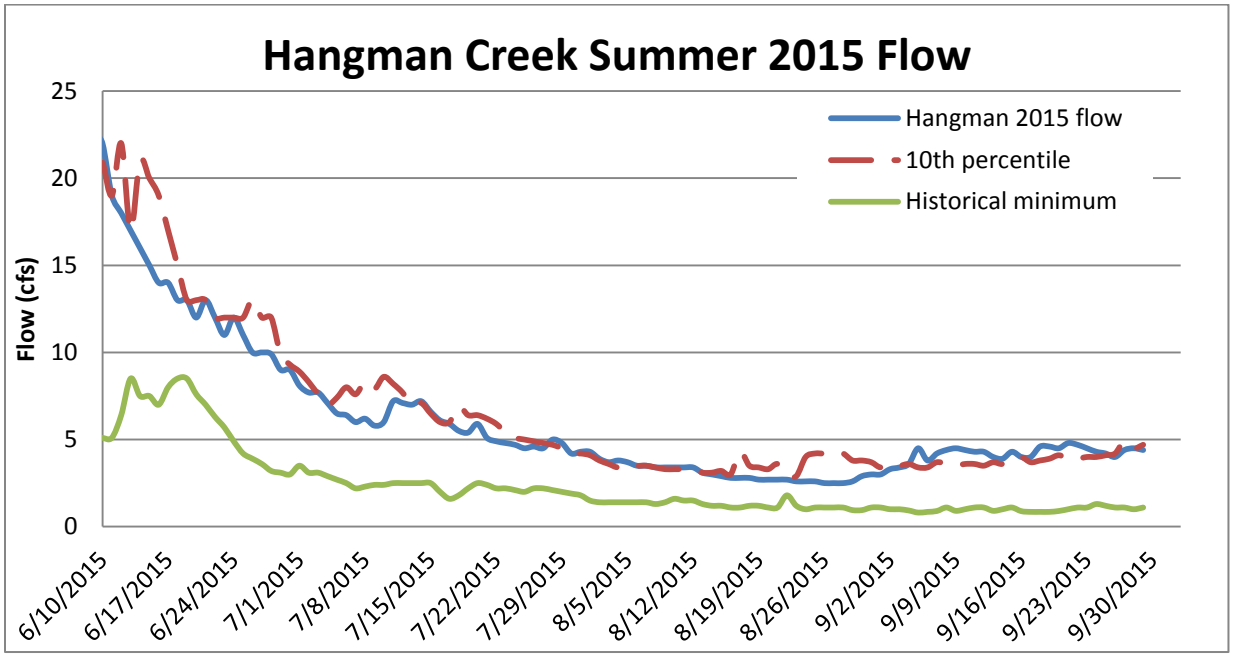
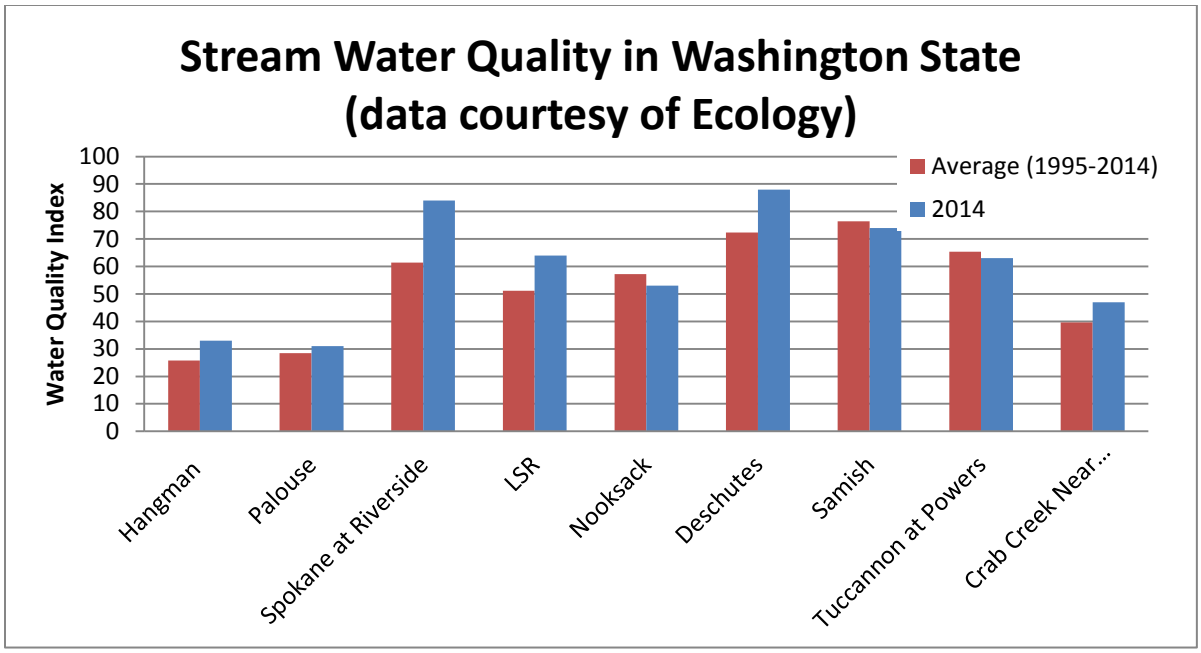


Figure 11. Summer 2015 flows in Hangman Creek. Flows ranked in the bottom 10% during the duration of the summer months.

Ecology WQI Index: **Based on 20 years of data collected by Ecology, Hangman Creek has the worst water quality in Washington State. This is primarily due to high levels of nutrients and sediment in the river. These data do not include long term temperature data, only point temperature measurements.**

The Washington State Department of Ecology has been monitoring Hangman Creek at the mouth for many water quality. From these data they calculate a "Water Quality Index" which essentially rates the water quality based on established regional standards. They then calculate a number for each stream, indicating the overall water quality of that stream.

Based on the previous 20 years of data (1995-2014) Hangman Creek has the worst water quality in Washington State, with a Water Quality Index Score of 26. The Palouse River and Crab Creek, the only two streams Washington State with WQI's close to Hangman's were 29 and 40, respectively. In 2014, Hangman's WQI had a value of 33.



These low WQI's in Hangman Creek are due to the high levels of nutrients, turbidity, and suspended solids in the creek. These high levels of pollutants are due to the poor farming practices in this fragile area where soils are highly erodible. Water flows directly off of farmland, carrying sediment from plowed fields which explains the high turbidity and suspended sediment levels in Hangman Creek. The sediment and surface water contains high levels of fertilizer, explaining the high levels of nitrogen and phosphorous.

Table 6. Hangman Creek Water Quality Index scores calculated by the Washington State Department of Ecology showing the poor water quality in Hangman Creek.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
fecal coliform bacteria	64	71	61	72	48	68	84	80	52	74	78	68	75	84	83	84	71	87	72	85
oxygen	92	90	78	89	93	94	91	81	52	59	56	64	74	91	94	82	86	91	95	92
pH	63	50	88	67	83	76	65	76	87	78	85	44	71	77	74	73	78	63	60	70
suspended solids	48	25	19	52	20	48	56	41	53	66	59	33	41	49	37	56	35	66	43	66
temperature	66	43	75	52	79	59	33	75	81	68	73	74	69	75	76	76	80	59	52	56
total persulf nitrogen	1	1	1	1	1	1	1	1	1	22	1	1	1	1	1	1	1	1	1	1
total phosphorus	38	28	2	32	8	28	35	21	38	64	58	31	41	35	12	28	12	39	23	48
turbidity	26	15	10	29	14	38	42	28	34	54	45	22	28	37	21	24	24	46	28	44
overall WQI	22	13	12	14	8	24	27	33	15	47	44	27	29	39	28	35	21	31	21	40
adjusted for flow	10	13	13	5	17	14	22	44	1	40	31	34	48	42	37	34	38	24	15	33

KEY

blue - good beige - moderate red - poor n/a - not sampled or not calculated

higher scores -> better water quality, maximum possible score: 100

2009 Hangman (Latah) Creek Watershed Fecal Coliform, Temperature, and Turbidity Total Maximum Daily Load (TMDL) update:

The Washington State Department of Ecology lists Hangman Creek as not meeting standards for fecal coliform, temperature, and turbidity. The clean-up plan, called a total maximum daily load (TMDL), lists the extent of the impairments and how to go about meeting state standards. Currently, it is hard to judge to what extent this clean-up plan is working. Ecology does not monitor water quality in Hangman Creek other than at the mouth. In addition, the timeline of much of the work needing to be done is long term. For example, planting trees to shade the creek takes years to see the benefit. Our analysis of Ecology's data from the river mouth shows no improvement in any of the parameters listed in Hangman Creek. In some cases, it appears that phosphorous levels are decreasing in the creek, but that correlates well with reductions in flows. Phosphorous binds to sediment and sediment quantity in the creek is linked to flows, making the two correlated.