Coeur d'Alene Lake Tributaries
2008-2009 Nutrient and Sediment Monitoring
Final Report

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INTRODUCTION

Mining and ore processing activity in the past 100 years, primarily in the South Fork Coeur d'Alene River Basin, has resulted in deposition of millions of tons of sediment contaminated with zinc, cadmium, lead, mercury, and other metals on the bottom of Lake Coeur d'Alene. In 1983, the U.S. EPA listed the 21-square-mile Bunker Hill "box" area as well as the metals-contaminated areas in the Coeur d'Alene River corridor, adjacent floodplains, downstream water bodies, tributaries and fill areas on the National Priorities List, qualifying it for CERCLA action (USEPA FIRP/EA). The focus of CERCLA activities within the Coeur d'Alene Basin is to reduce human and ecological exposures to metals contamination, primarily from lead, cadmium and zinc. Coeur d'Alene Lake is not included in the CERCLA action, rather the metals contamination is addressed under the Coeur d'Alene Lake Management Plan developed in 2009 by the Coeur d'Alene Tribe (Tribe) and the State of Idaho Department of Environmental Quality (DEQ). The goal of the Coeur d'Alene Lake Management Plan is: *to protect and improve lake water quality by limiting basin-wide nutrient inputs that impair lake water quality conditions, which in turn influence the solubility of mining-related metals contamination contained in lake sediments.* Limiting nutrient inputs into Lake Coeur d'Alene will slow the eutrophication process which could otherwise lead to water quality conditions favorable to release of metals from lake-bottom sediments. The nutrient of concern for the Coeur d'Alene Lake Management Plan is phosphorus.

In 2008-2009, Idaho DEQ conducted instantaneous suspended solids and nutrient monitoring of 13 tributaries to Coeur d'Alene Lake in an effort to understand nutrient loading of some tributaries to Coeur d'Alene Lake. With this effort, nutrient mitigation efforts can be prioritized according to those streams that have higher loads and greatest opportunity for improvement.

BACKGROUND

The federal Clean Water Act requires states and tribes to restore and maintain the chemical, physical, and biological integrity of the nation's waters and to adopt water quality criteria necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible (33 USC § 1251.10). Water quality criteria have been established by the Idaho legislature and approved by the U.S. Environmental Protection Agency (EPA). These criteria are designed to protect, restore, and preserve water quality for specific beneficial uses such as cold water aquatic life, agricultural water supply, recreation, and wildlife habitat.

Beneficial uses are protected by a set of water quality criteria, which include narrative criteria for pollutants such as sediment and nutrients and numeric criteria for pollutants such as bacteria, dissolved oxygen, temperature, and turbidity (IDAPA 58.01.02.250).

Narrative criteria for excess nutrients are described in IDAPA 58.01.02.200.06, which states: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." The concentration of phosphorus is low in surface water so that algae and aquatic

growth is limited. However, excessive growth of algae often results when phosphorus is introduced from uplands into a stream through increased runoff and stream erosion processes. Phosphorus primarily exists as inorganic phosphate compounds that are very insoluble and not available to plants or as organic compounds that are resistant to mineralization by microorganisms in the soil. However, chemical, physical and biological processes in soil and water can release dissolved orthophosphate into solution — a form easily utilized by plants.

Idaho's water quality standard for sediment is also narrative, "Sediment shall not exceed quantities which impair designated beneficial uses." (IDAPA 58.01.02.200.08). A numeric standard does exist which states, "below any applicable mixing zone set by the Department, shall not exceed background turbidity by more than fifty (50) NTU instantaneously or more than twenty-five (25) NTU for more than ten (10) consecutive days." (IDAPA 58.01.02.250.01) Sedimentation occurs through increased runoff and stream erosion processes. Excessive sedimentation clouds the water, covers fish spawning areas, and clogs the gills of fish. In addition, other pollutants like phosphorus are attached to the sediment and are introduced to the waterbody.

PURPOSE

In 2008-2009, Idaho DEQ conducted seasonal monitoring of suspended sediment and nutrients of 13 tributaries to Coeur d'Alene Lake. The objectives of this monitoring effort were to conduct a general reconnaissance study to begin to understand the TP loading of some tributaries to Coeur d'Alene Lake as a part of the 5-year review of the Coeur d'Alene Lake and River TMDL and as a joint effort to the Coeur d'Alene Lake Management Plan.

MONITORING

Water Quality

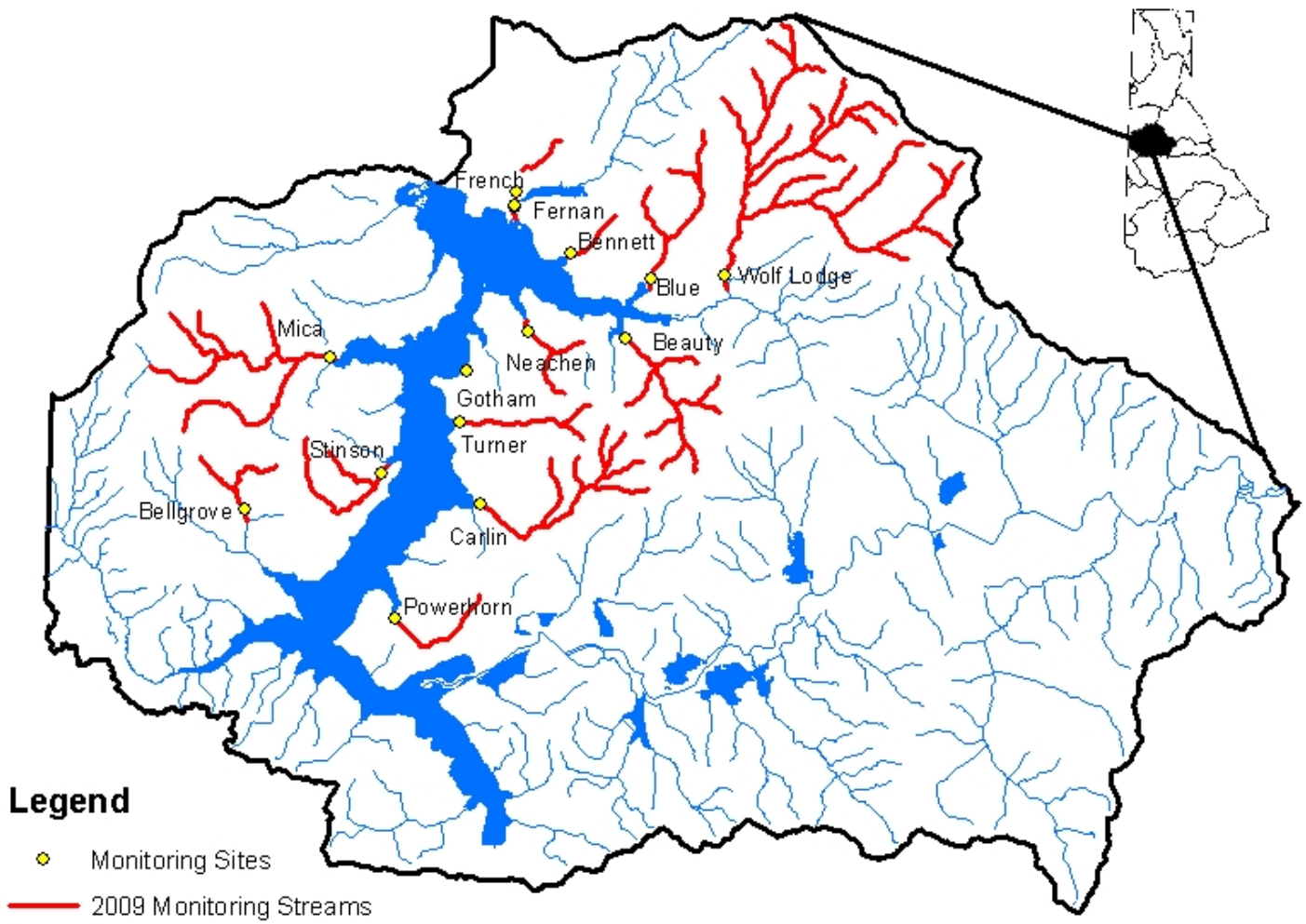
In 2008-2009, Idaho DEQ conducted instantaneous suspended sediment and nutrient monitoring of 13 tributaries to Coeur d'Alene Lake during winter rain-on-snow events, spring runoff, and during the summer low-flow season. Monitoring was conducted in response to the first rain-on-snow events, because previous studies suggest during these events, the highest concentrations of nutrients and sediment is delivered to the stream. Depending on the rainfall magnitude and duration, a lag time was estimated in order to catch the peak in the hydrograph during the climatic event. During runoff, an attempt was made to capture the ascending limb, descending limb, and peak of the hydrograph.

Data collected under the EPA Coeur d'Alene Basin Environmental Monitoring Plan show nutrient concentrations are highest on the ascending limb or peak of the hydrograph, then decreases rapidly thereafter. However, because there were no gauged streams in the project area, visual observations had to be made in order to estimate timing of these conditions on the streams. Streams were also sampled during low flow conditions. Sampling locations were at the mouths of Beauty Creek, Bellgrove Creek, Carlin Creek, Fernan Creek, Gotham Creek (into Gotham Bay), Mica Creek, Neachen

(previously Squaw) Creek, Stinson Creek, Turner Creek, an unnamed creek into Bennett Bay, and an unnamed creek into Powderhorn Bay, (Figure 1).

Fernan Creek has two significant storm water inputs below Fernan Lake — a City of Coeur d'Alene storm water drain and French Gulch. To better understand the nutrient and suspended sediment inputs from these sources in relation to input from the Fernan Creek watershed, both sources were monitored during select rain-on-snow and runoff events. The City of Coeur d'Alene storm water outfall site is approximately 50 feet upstream of the monitoring site on Fernan Creek. French Gulch is a creek which drains a large developed area into Fernan Creek downstream of the outlet of Fernan Lake.

Figure 1: Coeur d'Alene Lake tributaries monitored during 2009 study



METHODS

Depth-integrated and equal-width-increment sampling techniques were used to collect nutrient and suspended sediment samples. Samples were collected in 250 ml bottles after complete mixing with a churn splitter. Samples were kept cool with ice then submitted to SVL Analytical for laboratory analysis of total suspended solids (TSS), total phosphorus (TP), dissolved ortho-phosphorus (dissolved ortho-P), and total nitrogen (TN). Analytical methods and reporting limits are provided in Table 1. Flow was calculated from the stream cross section and water velocity measured with a dopper flow meter on wadeable streams. On the non-wadeable streams, Mica and Wolf Lodge Creeks, a Price AA flow meter and a crane were used to collect water velocity.

Table 1: Analytical methods and reporting limits for

Parameter	Method	Reporting Limit (mg/L)	Detection Limit (mg/L)
Total Nitrogen	ASTMD-5176	0.100	0.031
Total Suspended Solids	SM 2540-D	5.0	1.7
Total Phosphorus	SM4500-P-E	0.002	0.002
Orthophosphate	SM4500-P-E	0.002	0.002

QUALITY ASSURANCE

Duplicate samples were taken on 10 percent of the samples. The results of duplicate sampling shows good precision in terms of Relative Percent Difference (RPD) for all constituents measured except TSS (Table 1). Data Quality Objectives (DQO) RPD for this project was 25 percent. While approximately every tenth sample was a duplicate, only samples taken the same day were excluded from analysis if the duplicate did not meet DQO. Therefore, TSS data for February 25, March 4, and April 16 have not been reported because they did not meet DQO. Total nitrogen data for March 4 was also not included in the monitoring data analysis. The reason for these samples being outside data quality objectives may be the high variability during high flow events. Field blanks were all within acceptable limits except for TN on March 4th. These data were already not included due to duplicate data outside data quality objectives. Laboratory quality control for each sample batch was within acceptable limits for blank, duplicate, control and matrix spike. Sample events and their achievement of DQO are summarized in Table 2.

Table 2: Quality Assurance Results of Water Quality Sampling

Duplicate Analysis					
Sample Date	**Site**	**Total P (RPD)**	**Dissolved Ortho-P (RPD)**	**Total N (RPD)**	**TSS (RPD)**
2/24/2009	Gotham Creek	0.9	0.0	9.6	21.7
2/25/2009	Blue Creek	1.3	4.1	7.5	96.9 [a]
3/4/2009	Blue Creek	1.5	3.18	--	117.9 [a]
4/9/2009	Blue Creek	17.8	0.0	4.5	17.7
4/16/2009	Unnamed to Bennett	1.5	0.0	4.9	73.4 [a]
5/4/2009	Blue Creek	3.1	6.9	6.6	0.0
6/4/2009	Carlin Creek	4.4	0.0	1.8	0.0
Deionized Water Field Blanks					
		(mg/L)	(mg/L)	(mg/L)	(mg/L)
2/24/2009	--	<0.002	<0.002	<0.100	<5
3/4/2009	--	0.004	0.002	0.132 [a]	<5
4/9/2009	--	--	<0.002	--	--
4/14/2009	--	<0.002	<0.002	<0.100	<5
5/28/2009	--	0.002	<0.002	<0.100	<5

[a]Data was not included in analysis, as it exceeded data quality objectives.

Table 3: Monitoring Event Schedule

	2008				2009															
	May	**July**	**August**		**January**	**February**		**March**				**April**					**May**			**June**
	6	**3**	**5**	**7**	**9**	**24[c]**	**25**	**3[c]**	**4**	**13**	**24**	**9**	**13**	**16**	**20**	**22**	**4**	**11**	**27**	**4**
Flow Period **Stream**	***Base Flow***				***Ascending Limb***	***Peak***				***Descending Limb***							***Base Flow***			
Beauty Creek						X		X				X			X			X		
Bellgrove Creek				X		X			X[ab]			X	X							X
Blue Creek					X		X[a]	X				X			X		X			X
Carlin Creek						X		X		X					X					
Fernan Creek		X					X[a]		X[ab]				X			X		X		
French Gulch							X[a]	X					X							
Gotham Creek						X		X			X	X		X[a]						
Mica Creek				X		X		X		X						X		X		
Neachen Creek						X		X				X		X[a]					X	
Stinson Creek						X			X[ab]		X	X					X			
Turner Creek			X			X		X				X		X[a]	X					X
Unnamed Creek to Bennett Bay							X[a]	X				X		X[a]			X			
Unnamed Creek to Powderhorn Bay						X		X			X	X		X[a]			X			
Flow Period	***Base Flow***				***Ascending Limb***			***Peak***									***Descending Limb***			
Wolf Lodge Creek	X						X[a]	X					X					X		
					Ascending Limb			***Peak***			***Descending***			***Base Flow***						
Gotham Creek						X		X			X	X		X[a]						

a: TSS exceeded DQO; b: Total Nitrogen exceeded DQO

c: Rain on Snow Event

MONITORING RESULTS

Overall, instantaneous suspended solids and nutrient loads were greatest during spring runoff; however, the highest observed turbidity and nutrient concentrations were observed during early rain-on-snow events. The first rain-on-snow event occurred on February 24th. On this day, the USDA Natural Resources Conservation Service (NRCS) Snotel site at Mica Creek recorded 1 inch of precipitation. The second rain-on-snow event occurred on March 3rd, where 0.3 inches of rain was recorded at the USDA NRCS Snotel site at Mica Creek. The following section provides a description of monitoring results on the project streams.

Beauty Creek

Beauty Creek drains an 11.2 mile^2 watershed, most of which is in the Coeur d'Alene National Forest. At its mouth, Beauty Creek is a third order stream, which drains into Beauty Bay on the northeast end of Coeur d'Alene Lake. During the summer months, Beauty Creek flows are limited to sub-surface flow in the vicinity of the U.S. Forest Service campground; however, just upstream of the campground, Beauty Creek is a perennial stream. Maximum flow observed during monitoring was 75 cfs during spring runoff.

The water quality monitoring site on Beauty Creek was located at the U.S. Forest Service campground less than 1 mile upstream from the mouth of the creek. Monitoring results show that total suspended solids and nutrient concentrations in Beauty Creek were consistently lower than all the other tributaries in the project area (Figure 2). Except during the rain-on-snow event on March 3, where TP concentrations in Beauty Creek were 0.063 mg/L, TP never exceeded 0.030 mg/L. Dissolved ortho-P concentrations remained relatively constant throughout the monitoring period, near 0.010 mg/L. Total nitrogen was highest during the first rain-on-snow event at 0.107 mg/L; it then stabilized at 0.050 mg/L during spring runoff on into the "low flow" sampling event in May, just prior to flow going to subsurface.

Beauty Creek channel in August 2008. All flows are subsurface.

Bellgrove Creek

Bellgrove Creek drains a 6.1 mile^2 watershed on the southwest side of Coeur d'Alene Lake. It is a second order stream at its confluence with Lake Creek, which flows into Rockford Bay in Coeur d'Alene Lake. Most of the land through which Bellgrove Creek flows is privately owned, except near its mouth, where it is within the Coeur d'Alene Indian Reservation. Like most tributaries around Coeur d'Alene Lake, Bellgrove Creek flow is subsurface near its mouth in the summer. Maximum flow observed during monitoring was 34 cfs during both rain-on-snow events.

Bellgrove Creek on August 7, 2009

The water quality monitoring site on Bellgrove Creek was located less than 1 mile upstream from the Coeur d'Alene Indian Reservation boundary. Monitoring results show that total suspended solids and nutrient concentrations in Bellgrove Creek throughout the monitoring period were consistently much higher than all the other tributaries in the project area (Figure 3). During the February 24th rain-on-snow event, the TP concentration was 0.605 mg/L. During that same storm event, dissolved ortho-P was 0.130 mg/L and TN was 1.41 mg/L, and TSS was 306 mg/L. Although suspended solids and nutrient concentrations were lower throughout the remainder of the monitoring season, they were still an order of magnitude above concentrations observed in other creeks in the project area. For example, the low flow TP was 0.153 mg/L in August 2008, and 0.084 mg/L in June 2009. In June 2009, the TN concentration was 0.237 mg/L. However, low-flow TN during August 2008 was elevated to 1.66 mg/L.

Blue Creek

Blue Creek is a stream that drains a 7.9 mile^2 watershed on the northeast side of Coeur d'Alene Lake. The headwaters of Blue Creek are within the Coeur d'Alene National Forest. Downstream of the national forest, the creek flows within private property. At its mouth, Blue Creek is a second order stream that flows within Bureau of Land Management (BLM) property, before it flows into Blue Creek Bay. While the channel upstream of the BLM property flows subsurface in early summer, recharge of the channel from the shallow aquifer within the BLM property provides flow in this reach of the channel year-round. Maximum flow observed during monitoring was 130 cfs, during the March 3rd rain-on-snow event.

The water quality monitoring site on Blue Creek was located within the BLM property at the mouth of the Creek. Monitoring results show that nutrient concentrations in Blue

Creek were highest during the March 3rd rain-on-snow event with TP at 0.248 mg/L, dissolved ortho-P at 0.031 mg/L, and TN at 0.431 mg/L (Figure 4). Concentrations of all parameters decreased during spring runoff. Low-flow TP concentrations were 0.033 mg/L in May 2009. On June 23rd excessive unidentified visible growth was observed in Blue Creek, primarily within the reach flowing through the BLM property.

Excess visible slime growth on Blue Creek. Photos taken June 23, 2009

Figure 2: Beauty Creek — 2009 Monitoring Results

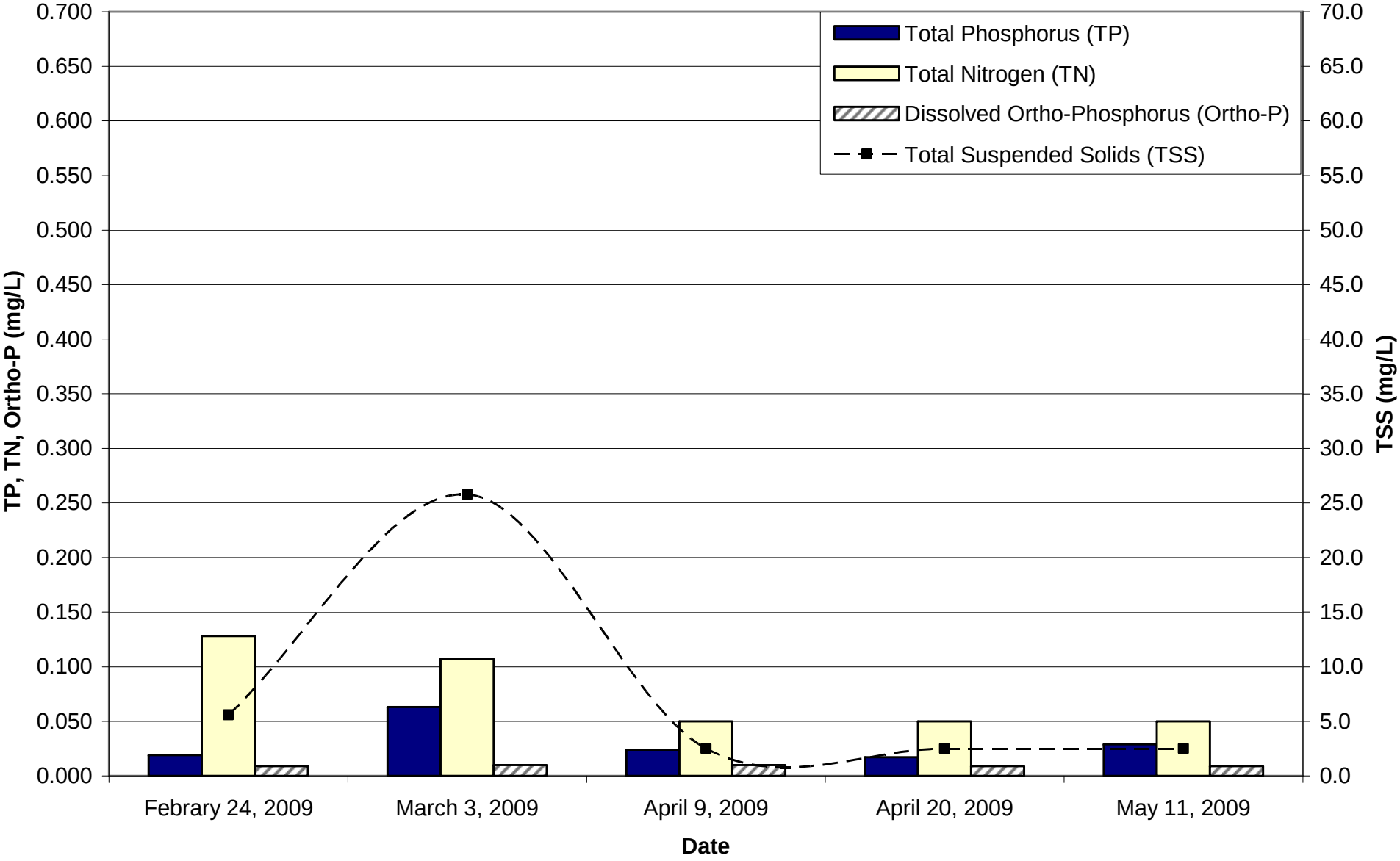
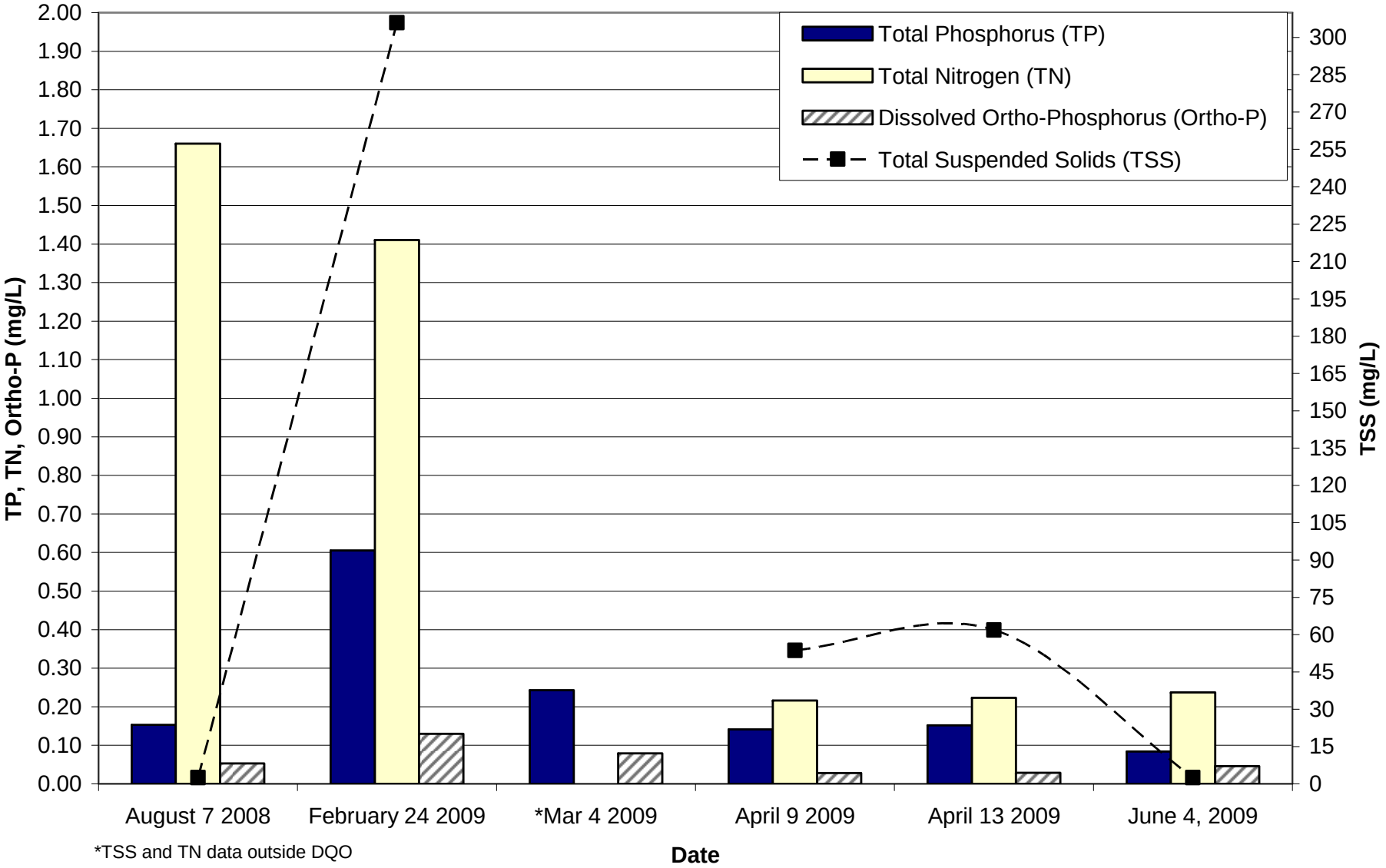
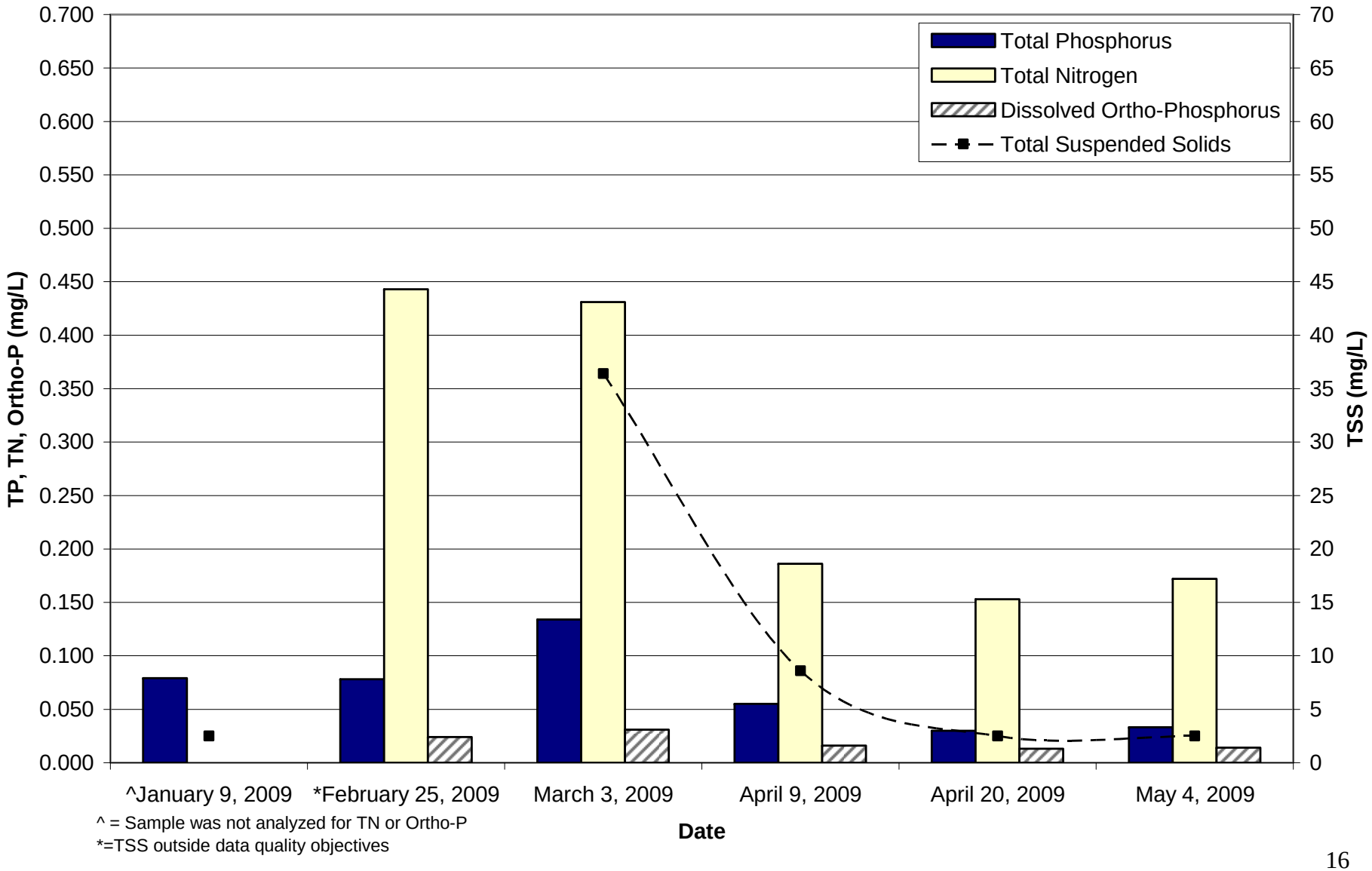


Figure 3: Bellgrove Creek — 2009 Monitoring Results



*TSS and TN data outside DQO

Figure 4: Blue Creek — 2009 Monitoring Results



^ = Sample was not analyzed for TN or Ortho-P
*=TSS outside data quality objectives

Carlin Creek

Carlin Creek is a stream, which drains a 10.8 mile^2 watershed on the southeast side of Coeur d'Alene Lake. At its mouth, Carlin Creek is a 3rd order stream where it flows into Carlin Bay. Like other tributaries to Coeur d'Alene Lake, flow is subsurface in the lower reaches during the summer months. The headwaters of Carlin Creek are within the Coeur d'Alene National Forest, and the lower portions of the creek flow within private property. Maximum flow observed during monitoring on Carlin Creek was 120 cfs, during a March 3rd rain-on-snow event.

Carlin Creek on June 26, 2009

The water quality monitoring site on Carlin Creek was located less than 1 mile upstream from Highway 97 near the mouth of the Creek. Monitoring results show that the highest TP concentration in Carlin Creek was during the February 24th rain-on-snow event at 0.127 mg/L (Figure 5). The TSS was 60.6 mg/L. Total nitrogen concentration was highest during the March 3rd rain-on-snow event at 0.382 mg/L. The dissolved ortho-P concentration was elevated slightly to 0.036 mg/L during both rain-on-snow events, but then leveled off around 0.008 mg/L for the descending limb, low flow and base flow.

Fernan Creek

Fernan Creek is a perennial stream, which drains a 19.1 mile^2 watershed on the north side of Coeur d'Alene Lake. The headwaters of Fernan Creek are within the Coeur d'Alene National Forest and the lower reaches of the creek flows within private property before flowing into Fernan Lake. From the outlet of Fernan Lake, the creek flows as a third-order stream through a golf course before flowing into Coeur d'Alene Lake. Maximum flow observed during monitoring on Fernan Creek was 88 cfs during spring runoff.

The water quality monitoring site on Fernan Creek was located downstream of the entrance bridge to the golf course. During the February 25th rain-on-snow event, the TP concentration was the highest at 0.232 mg/L (Figure 6). Total nitrogen was also high at 0.717 mg/L. On the same day, dark, turbid water was observed coming out of the storm drain into Fernan Creek immediately upstream of the monitoring site. Total Phosphorus concentration from the storm drain was 0.660 mg/L. Total phosphorus in French Gulch, which also flows into Fernan Creek upstream of the monitoring site, was 0.130 mg/L. No samples for total nitrogen were taken on that same day. Due to the proximity of the monitoring site to the storm drain and to the confluence with French Gulch, both were assumed to be the sources of the TP observed in Fernan Creek.

During the March 3rd rain-on-snow event, the storm drain was not discharging into Fernan Creek. On that day, the TP concentration in Fernan Creek was 0.047 mg/L, and the TN concentration was 0.392 mg/L. The TP concentration in French Gulch was 0.102 mg/L, which was much lower than those observed in February, suggesting the storm drain and French Gulch are likely to be significant sources of nutrients and sediment to Fernan Creek.

Total phosphorus and TN concentrations decreased in Fernan Creek within spring runoff; however, they increased slightly from April to May. No low-flow sample was taken in 2009. However, in July 2008, low-flow TP and TN were 0.340 mg/L and 0.484 mg/L, respectively.

Fernan Creek in August 2008.

Figure 5: Carlin Creek — 2009 Monitoring Results

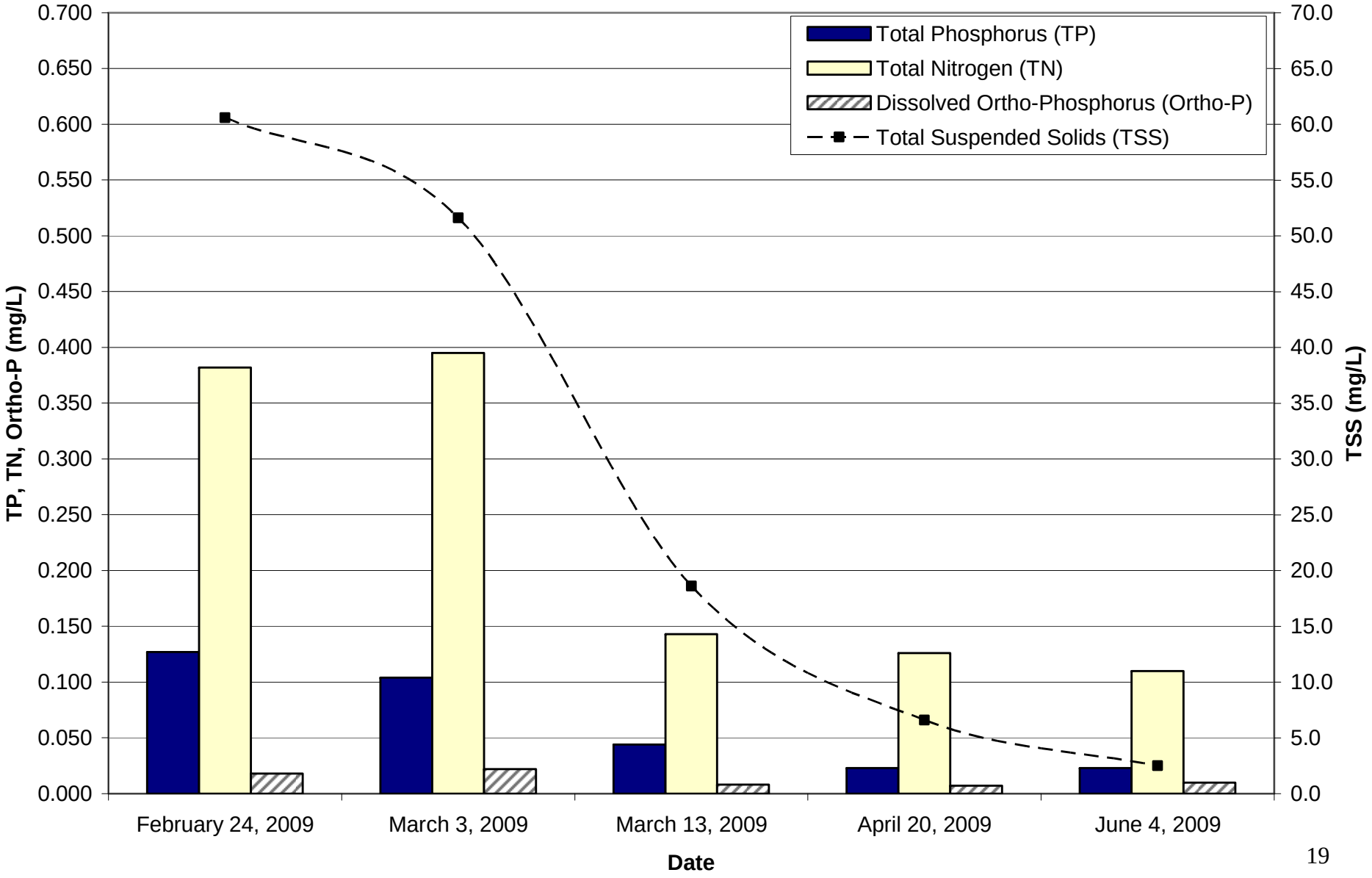
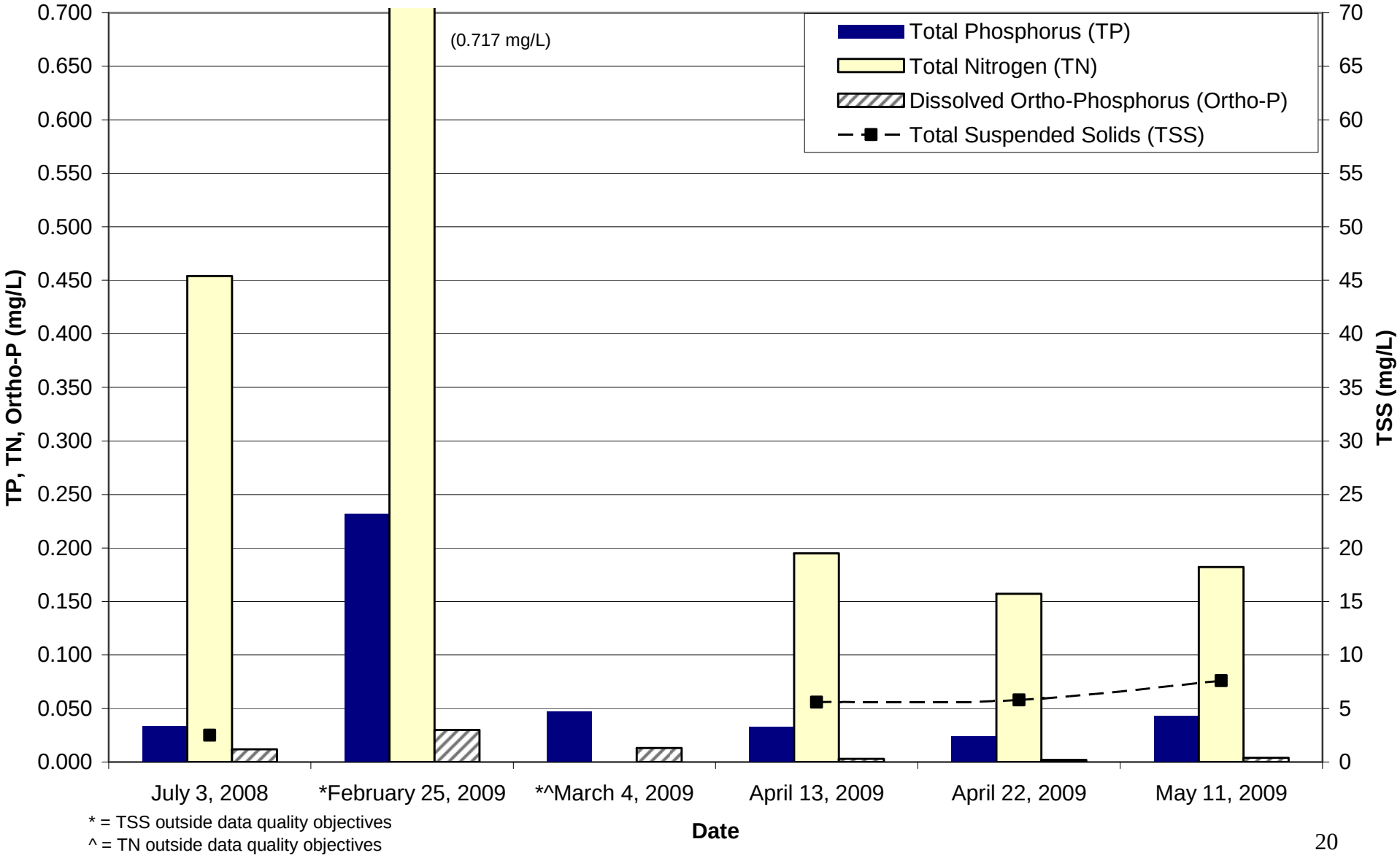


Figure 6: Fernan Creek — 2009 Monitoring Results



* = TSS outside data quality objectives
^ = TN outside data quality objectives

Gotham Creek

Gotham Creek is a small, first-order intermittent stream that is dry in late spring/early summer. In 2009, Gotham Creek went dry in early May. It drains approximately 0.9 mile^2 of private property on the east side of Coeur d'Alene Lake. Maximum flow observed on Gotham Creek was 6 cfs during a March 3rd rain-on-snow event.

Dry stream channel of Gotham Creek. Photo taken in August 2009.

The water quality monitoring site on Gotham Creek was at the mouth of the creek located just downstream of Highway 3 and then discharges into Gotham Bay. Throughout the monitoring season, TP and dissolved ortho-P concentrations were high (Figure 7). During the March 3rd rain-on-snow event, nutrient concentrations were highest. Total phosphorus was 0.250 mg/L and dissolved ortho-P was 0.070 mg/L. During low flow in early May TP concentration was the lowest at 0.084 mg/L and dissolved ortho-P was 0.050 mg/L.

Mica Creek

Mica Creek is a perennial stream that drains a 26.1 mile^2 watershed into Mica Bay on the northwest side of Coeur d'Alene Lake. The watershed of Mica Creek is within private property with a state highway thoroughfare. At its mouth, Mica Creek is a 3rd order stream. The highest flow measured in Mica Creek was during runoff at 230 cfs.

Mica Creek during March 2009 runoff.

The water quality monitoring site on Mica Creek had to be moved and was originally off a bridge on Loffs Bay Road near the mouth of a stream. This site became the backwater of Coeur d'Alene Lake. The site was moved upstream and samples were taken from both Mica Creek and SF Mica Creek above their confluence just downstream from Highway 95. Like many other tributaries to Coeur

d'Alene Lake, nutrient and TSS concentrations were highest during the first rain-on-snow event — with a TP concentration of 0.147 mg/L, a dissolved ortho-P of 0.032 mg/L, TN of 0.454 mg/L, and TSS of 68.6 mg/L (Figure 8). Concentrations of all parameters except TSS decreased with each monitoring event. Low flow samples were collected in August of 2008, where TP and TN were elevated somewhat at 0.041 mg/L and 0.160 mg/L, respectively.

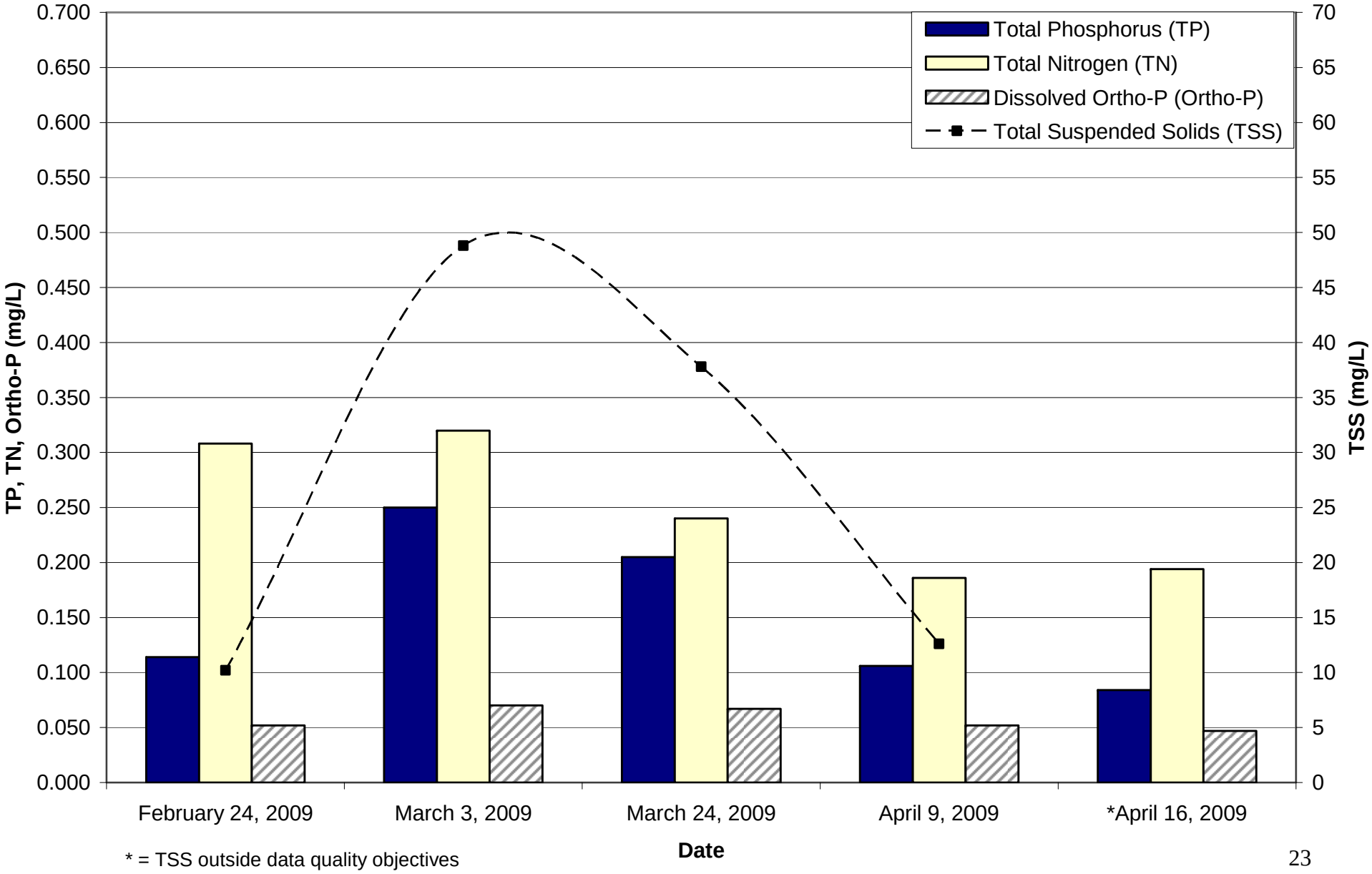
Neachen Creek

Neachen Creek is a second order stream that drains a 4.1 mile^2 watershed into a bay on the northeast side of Coeur d'Alene Lake. Like other creeks in the watershed, Neachen Creek flow is subsurface near its mouth in the summer, and the entire watershed of Neachen Creek is primarily within private property. Peak flows in Neachen Creek were during runoff at 41 cfs.

The water quality monitoring site on Neachen Creek was located adjacent to Highway 97 just after the creek goes under the road. Nutrient and TSS concentrations were highest during the second rain-on-snow event — with a TP concentration of 0.145 mg/L, a dissolved ortho-P of 0.039 mg/L, a TN of 0.422 mg/L, and TSS at 50 mg/L (Figure 9). Concentrations of all parameters, except TP, decreased with each monitoring event. Low flow samples were collected in May of 2009, where TP and TN were 0.71 mg/L and 0.161 mg/L, respectively.

Neachen Creek during March 2009 runoff.

Figure 7: Gotham Creek — 2009 Monitoring Results



* = TSS outside data quality objectives

Figure 8: Mica Creek — 2009 Monitoring Results

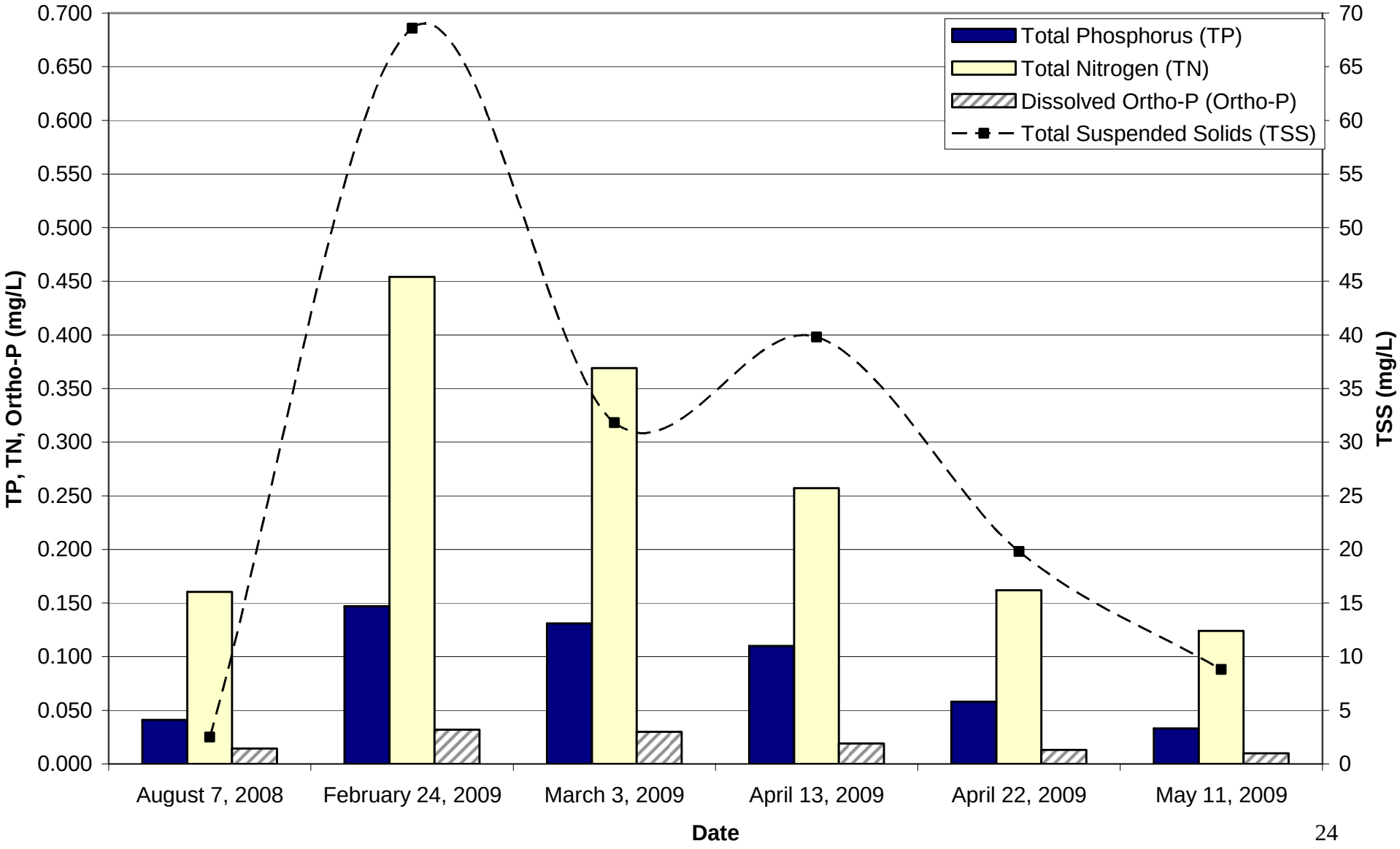
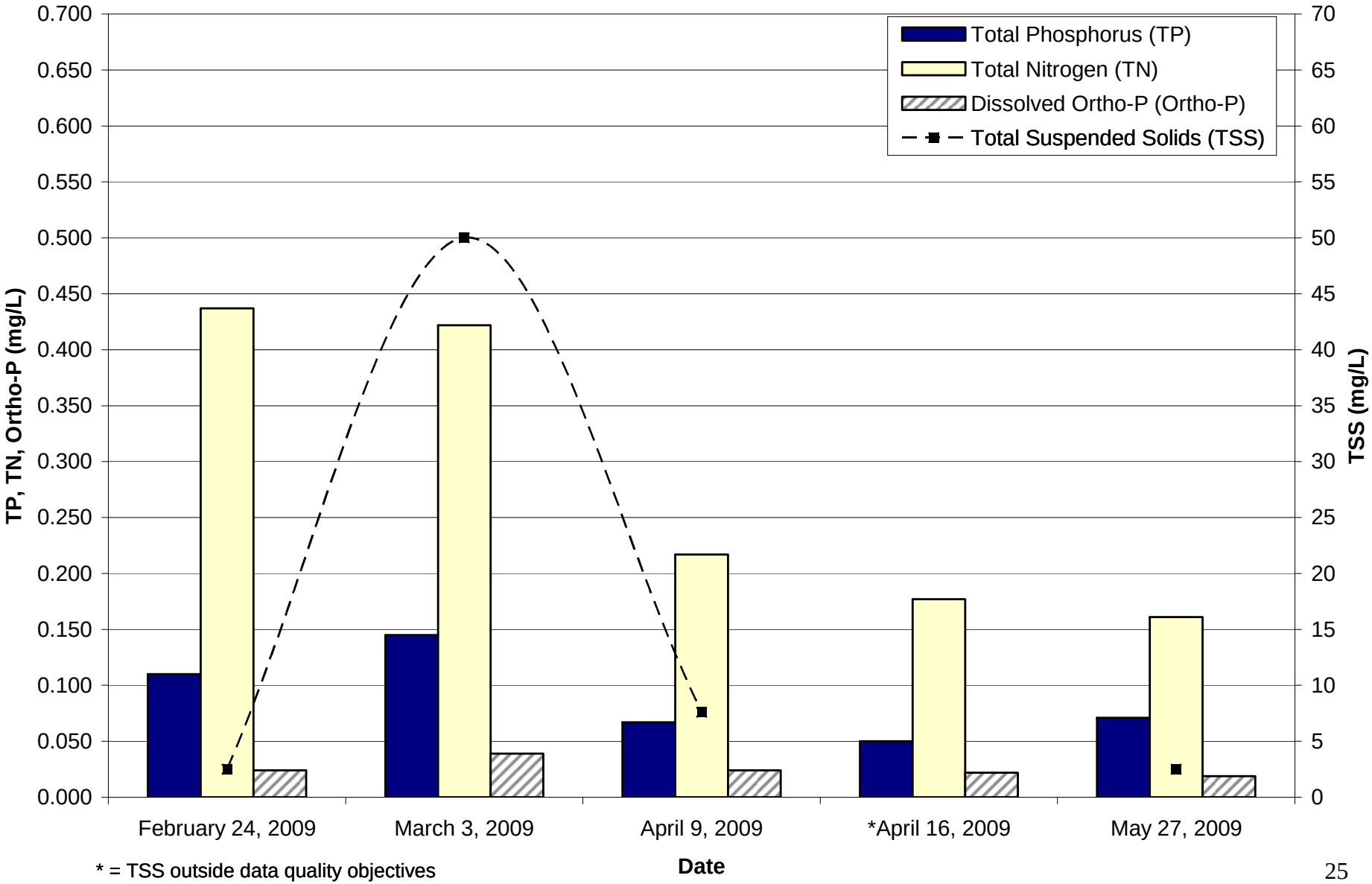


Figure 9: Neachen Creek — 2009 Monitoring Results



* = TSS outside data quality objectives

Stinson Creek

Stinson Creek is a stream that drains a 5.4 mile^2 watershed on the west side of Coeur d'Alene Lake. Like other tributaries to Coeur d'Alene Lake, flow in Stinson Creek is subsurface near it's mouth early in the summer. While, the upper reaches of the creek flows within private property, at its mouth, Stinson Creek is a second order stream that flows into a wetland within Bureau of Land Management (BLM) property. At its mouth, it flows into Loffs Bay of Coeur d'Alene Lake. Maximum flow observed during monitoring was 41 cfs, during the March 3rd rain-on-snow event.

The water quality monitoring site on Stinson Creek was located within the BLM property just upstream of the mouth of the Creek. Monitoring results show that total suspended solids and nutrient concentrations in Stinson Creek were the highest during February 24th rain-on-snow event, then they decreased during the monitoring period (Figure 10). On February 24th, TP was 0.103 mg/L, dissolved ortho-P was 0.042 mg/L, TN was 0.357 mg/L, and TSS was 44.2 mg/L. During low-flow conditions in May, TP and TN were elevated compared to other streams around the lake at 0.047 mg/L and 0.171 mg/L, respectively.

Stinson Creek during March 2009 runoff.

Turner Creek

Turner Creek in July 2008.

Turner Creek is a stream that drains a 6.4 mile^2 watershed on the east side of Coeur d'Alene Lake. Like other tributaries to Coeur d'Alene Lake, Turner Creek flow is subsurface near its mouth during the summer months. Headwaters of the creek are in the Coeur d'Alene National

Forest, but after less than a mile, the creek flows within private property. At its mouth, Turner Creek is a second order stream that flows into Turner Bay of Coeur d'Alene Lake. Maximum flow observed during monitoring was 54 cfs during the March 3rd rain-on-snow event.

The water quality monitoring site on Turner Creek was located just upstream of the mouth of the creek. Monitoring results show that total suspended solids and nutrient concentrations in Turner Creek were the highest during the second rain-on-snow event on March 3rd, then they decreased during the monitoring period (Figure 11). On March 3rd, TP was 0.139 mg/L, dissolved ortho-P was 0.037 mg/L, TN was 0.321 mg/L, and TSS was 52.6 mg/L. Low-flow TP in August 2008 was 0.037 mg/L and in June 2009 was 0.031 mg/L. In both years, TN was 0.050 mg/L.

Unnamed Creek to Bennett Bay

The unnamed creek to Bennett Bay is a small, intermittent stream whose flow goes sub-surface in the summer. In 2009, the creek had no flow by late June. It drains a 2.2 mile^2 watershed on the north side of Coeur d'Alene Lake, and the entire creek flows within private property. Maximum flow observed during monitoring was 32 cfs during the March 3rd rain-on-snow event.

The water quality monitoring site on this creek was located adjacent to Sunnyside road directly under the Highway 90 Bridge. Monitoring results show that total suspended solids and nutrient concentrations were elevated throughout the monitoring period (Figure 12). On March 3rd, TP was highest at 0.248 mg/L, dissolved ortho-P was 0.071 mg/L, TN was 0.871 mg/L, and TSS was 0.072 mg/L. During low-flow conditions in May 2009, TP and TN were 0.050 mg/L and 0.237 mg/L, respectively.

Unnamed Creek into Bennett Bay during February 2009 rain-on-snow event.

Figure 10: Stinson Creek — 2009 Monitoring Results

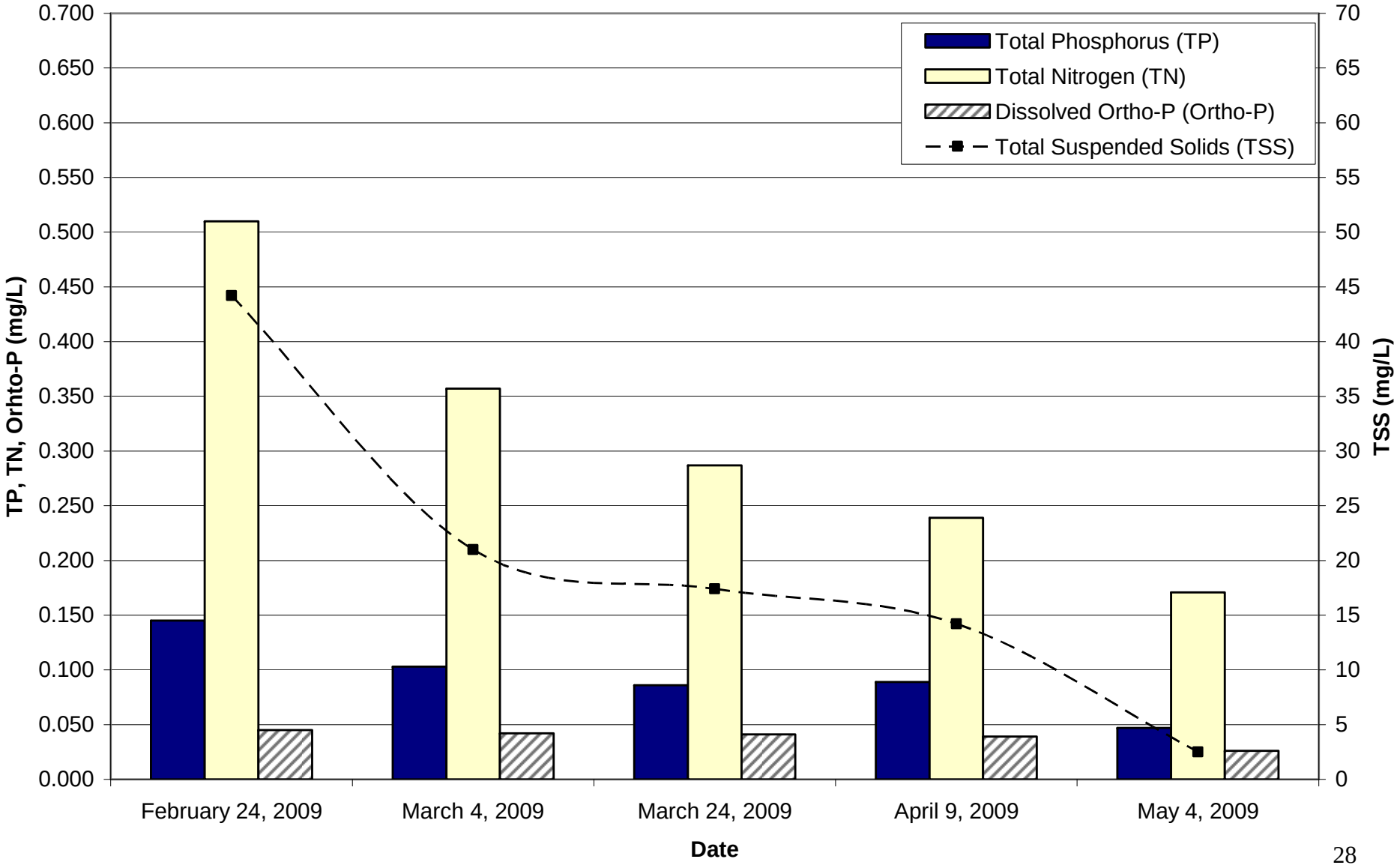


Figure 11: Turner Creek — 2009 Monitoring Results

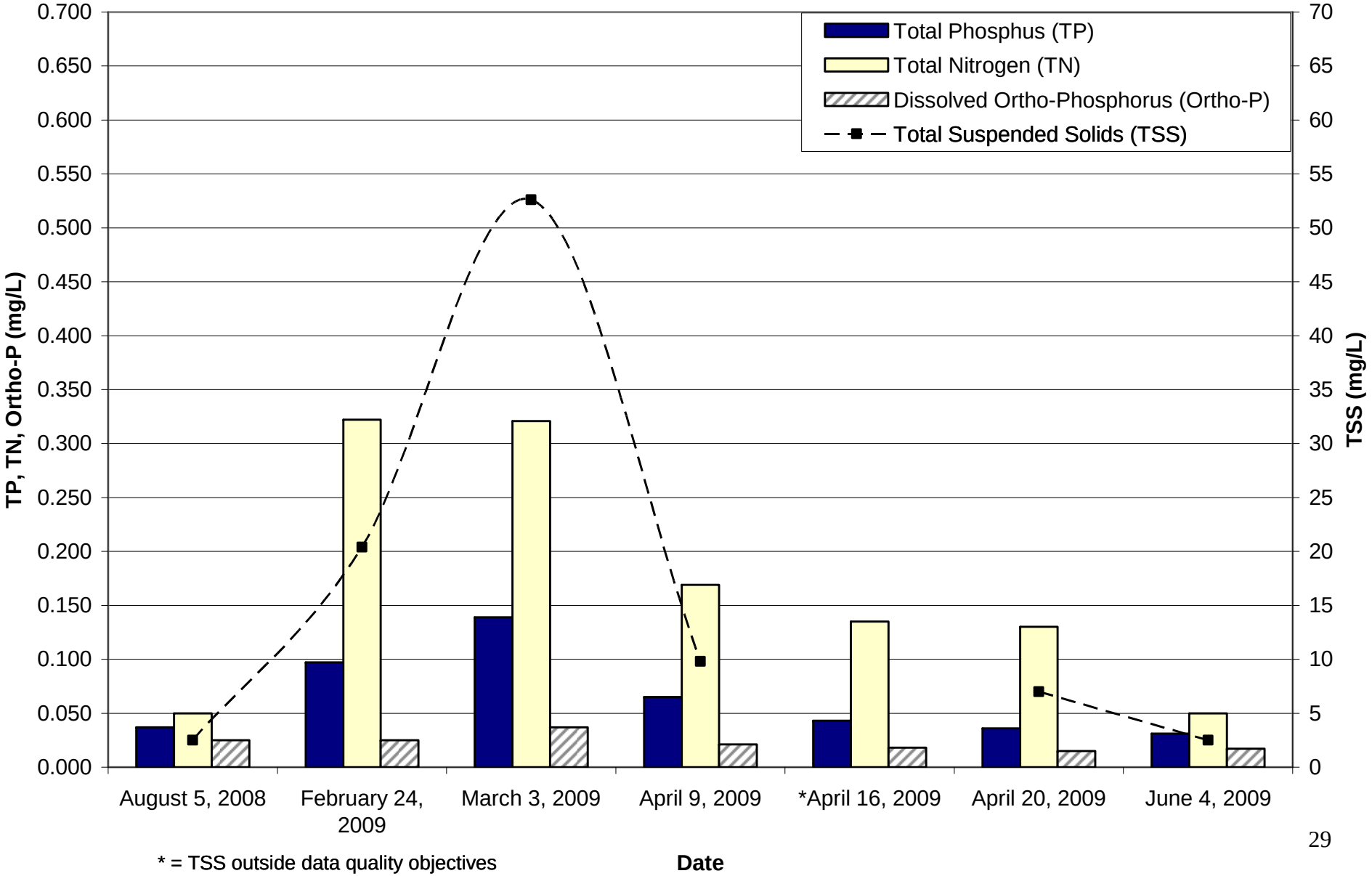
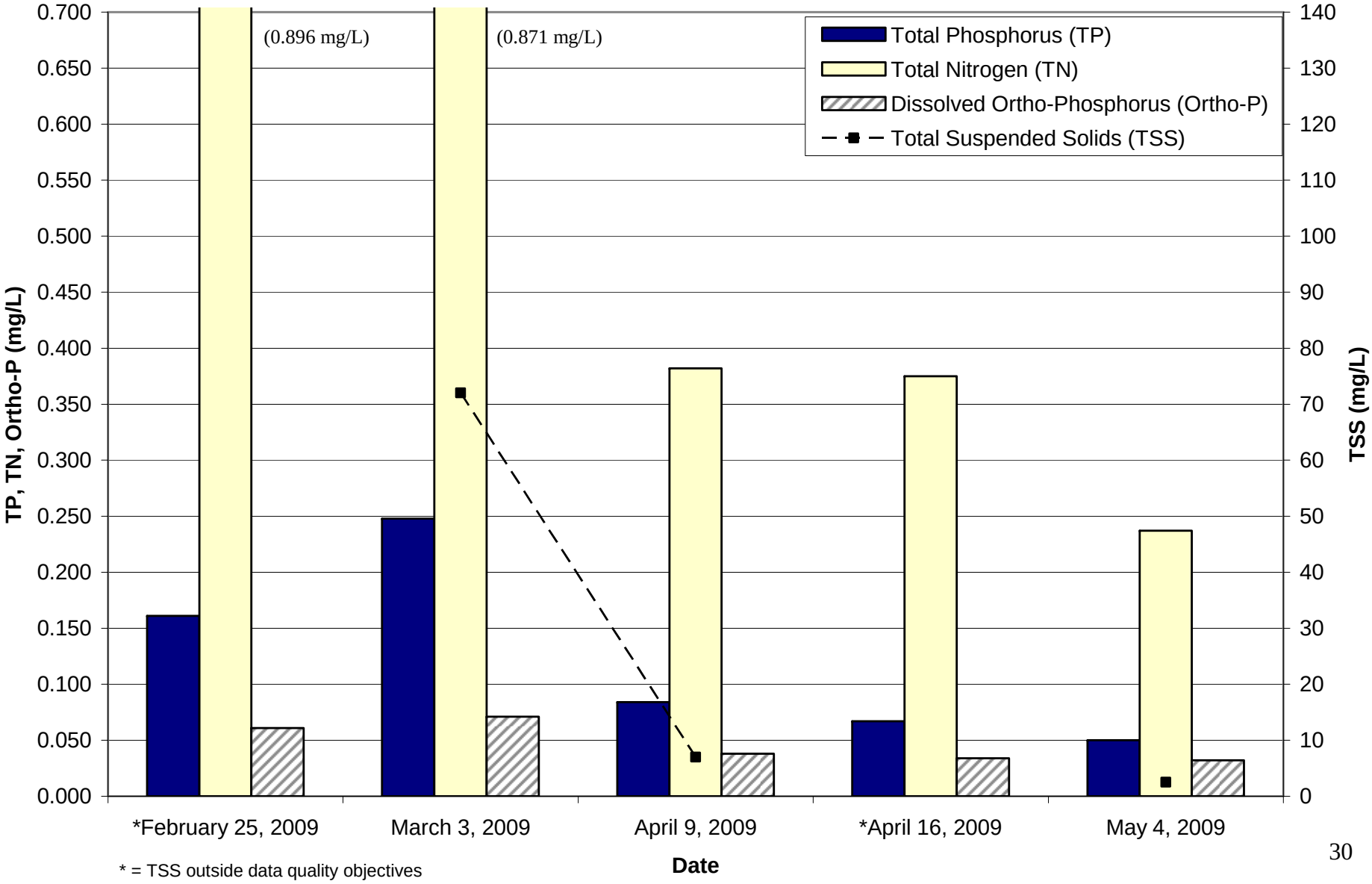


Figure 12: Unnamed Tributary to Bennett Bay — 2009 Monitoring Results



* = TSS outside data quality objectives

Unnamed Creek to Powderhorn Bay

The unnamed creek to Powderhorn Bay is a small stream that drains a 3.5 mile^2 watershed on the southeast side of Coeur d'Alene Lake. Like many tributaries to Coeur d'Alene Lake, flow in this creek is subsurface near its mouth during the summer. The entire creek is located within private property. Maximum flow observed during the monitoring period was 43 cfs during the March 3rd rain-on-snow event.

Unnamed Creek into Powderhorn Bay in June 2009.

The water quality monitoring site on this creek was originally located at the mouth of the creek until lake levels went up and backwater conditions existed at the monitoring site. Then it was upstream from the mouth about a mile at a bridge on private property. Monitoring results show that total suspended solids and nutrient concentrations were elevated throughout the monitoring period (Figure 13). On March 3rd, nutrient and TSS concentrations were highest, with TP at 0.174 mg/L, TN at 0.513 mg/L, and TSS at 45.0 mg/L. Dissolved ortho-P remained high throughout the monitoring period at concentrations near 0.050 mg/L. Prior to flow going subsurface in May 2009, TP was 0.083 mg/L.

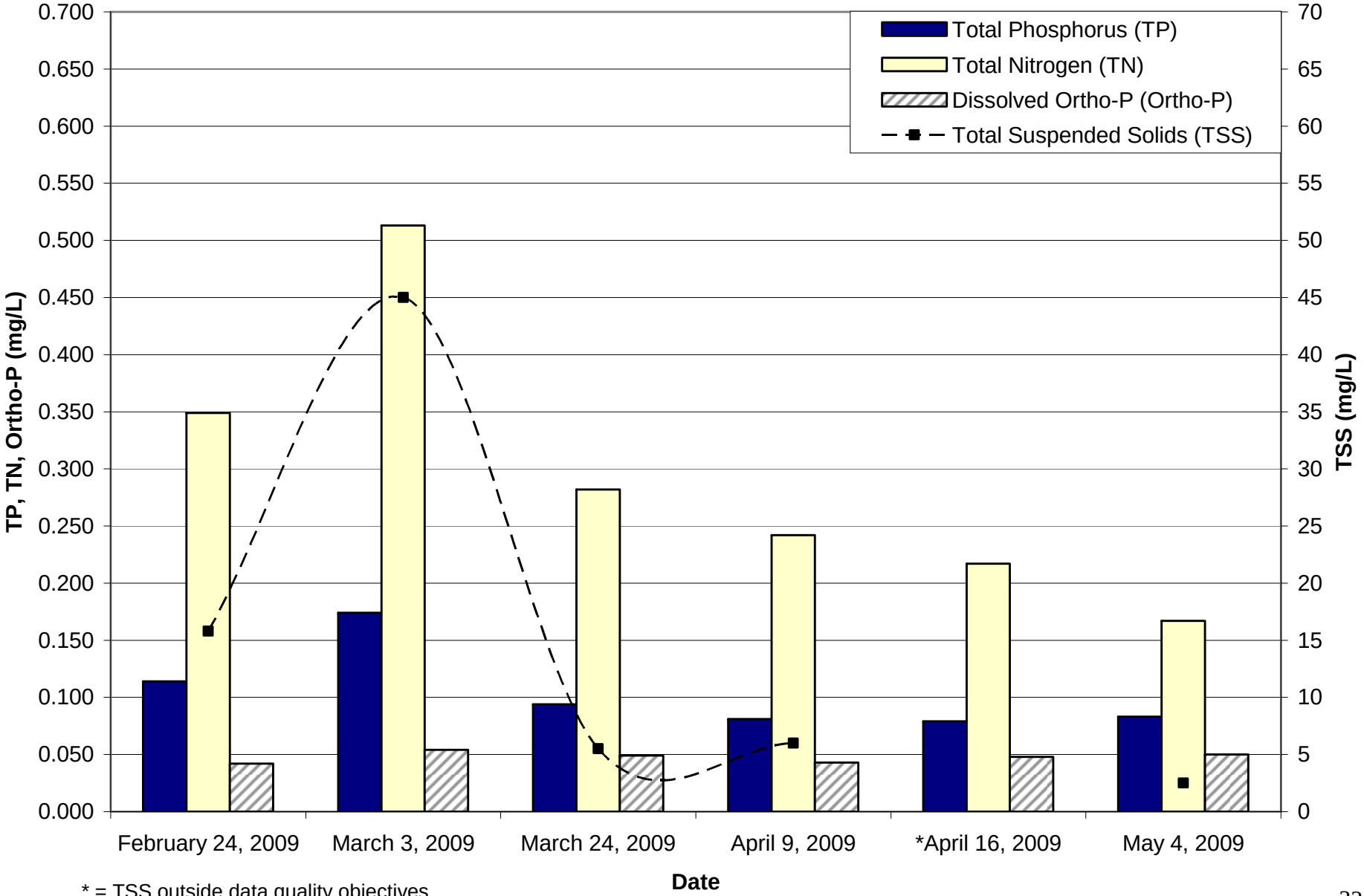
Wolf Lodge Creek

Wolf Lodge Creek is a 3rd-order perennial stream that drains a 40 mile^2 watershed into Wolf Lodge Bay on the northeast side of Coeur d'Alene Lake. The headwaters of Wolf Lodge Creek are within the Coeur d'Alene National Forest. Upstream of the confluence with Lonesome Creek it then flows into private property all the way to the mouth. The highest flow measured in Wolf Lodge Creek was 770 cfs runoff.

Wolf Lodge Creek during March 2009 runoff.

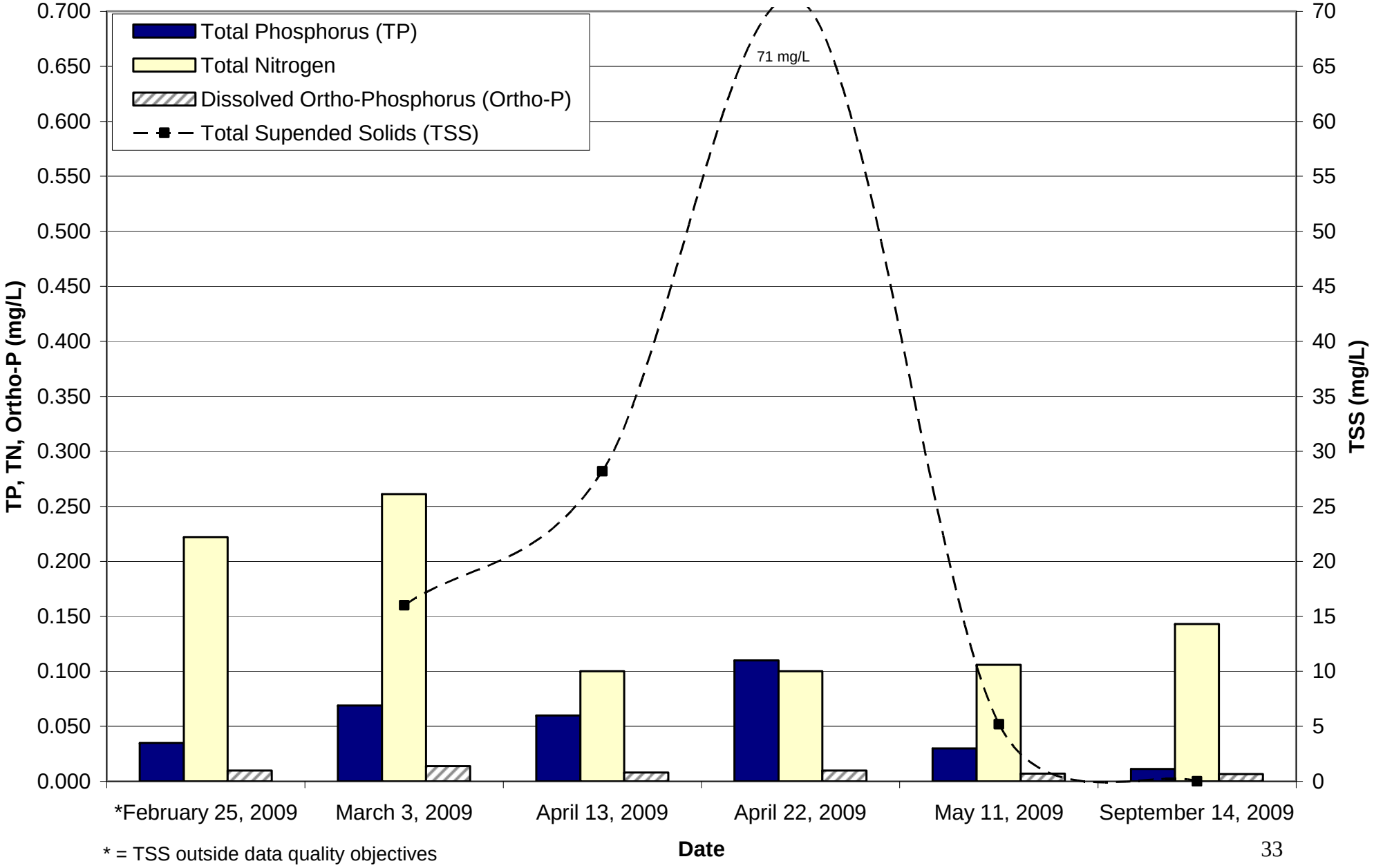
The water quality monitoring site on Wolf Lodge Creek was from a bridge on Wolf Lodge Creek Road upstream o where Wolf Lodge Creek flow into a grazing/wetland area at the mouth. Nutrient and TSS concentrations were highest during spring runoff. On April 22, TP was 0.110 mg/L, dissolved ortho-P was 0.010 mg/L, TN was 0.100 mg/L, and TSS was 71.0 mg/L (Figure 14). Concentrations of all parameters except TSS decreased with each monitoring event. Low flow samples collected in August of 2008, where TP and TN were 0.011 mg/L and 0.143 mg/L, respectively.

Figure 13: Unnamed Creek into Powderhorn Bay — 2009 Monitoring Results



* = TSS outside data quality objectives

Figure 14: Wolf Lodge Creek — 2009 Monitoring Results



* = TSS outside data quality objectives

LOADING ANALYSIS TO COEUR D'ALENE LAKE

Loading analyses were done to make a gross approximation of TP loads to Coeur d'Alene Lake. To perform a more thorough loading analysis of TP from streams, it is best to have a multiple-year TP dataset with continuous flow data to extrapolate loads between nutrient sampling events. Because there is no continuous flow data for the watersheds, and there is only one year of TP data, a loading analysis was done using a 24-hour TP load calculated using Equation 1. Results are represented in Figures 15 – 27. Using this approach, the results were used to prioritize watersheds for efforts to mitigate phosphorus delivered by tributaries into Coeur d'Alene Lake.

Equation 1:

Load in pounds per day = (Flow converted to liters per day) x (TP in lbs per liter)

Figure 15: Beauty Creek — Total Phosphorus Load

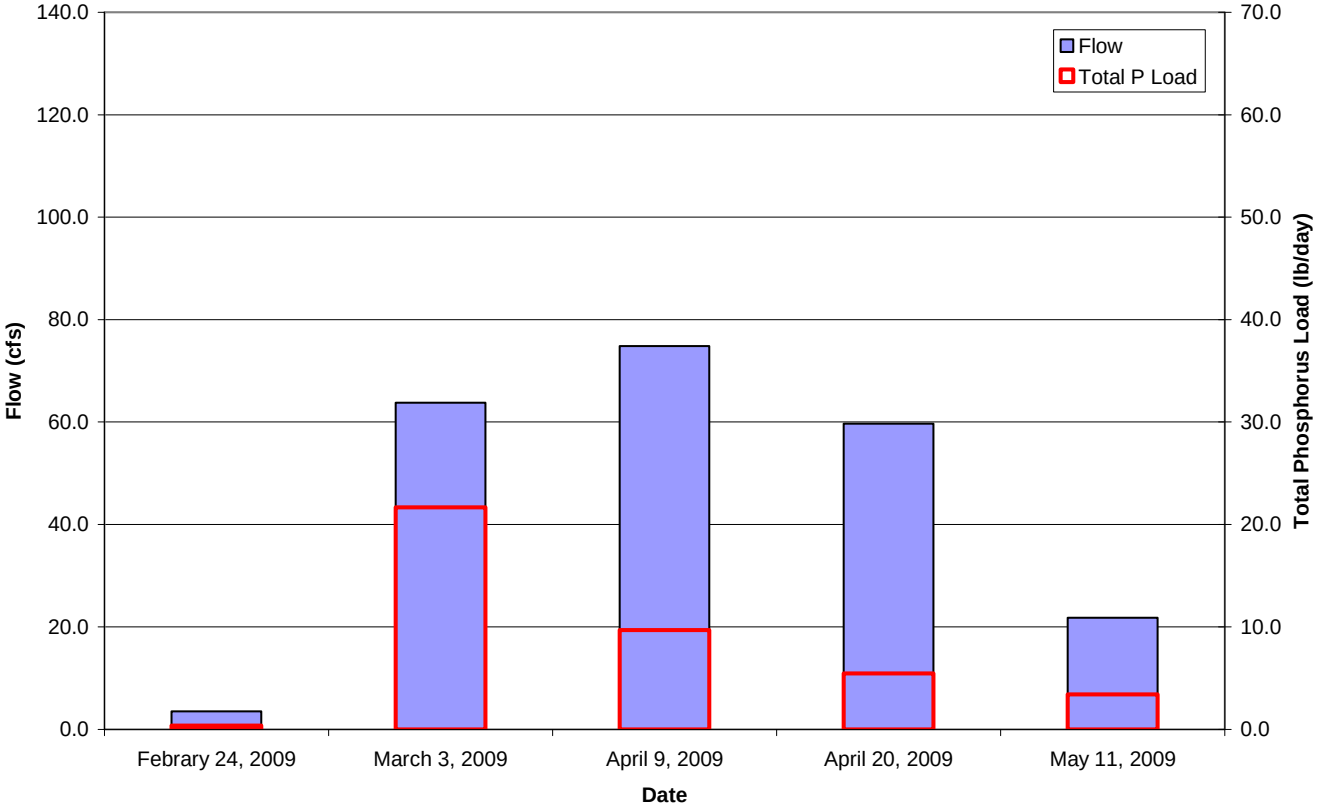


Figure 16: Bellgrove Creek — Total Phosphorus Load

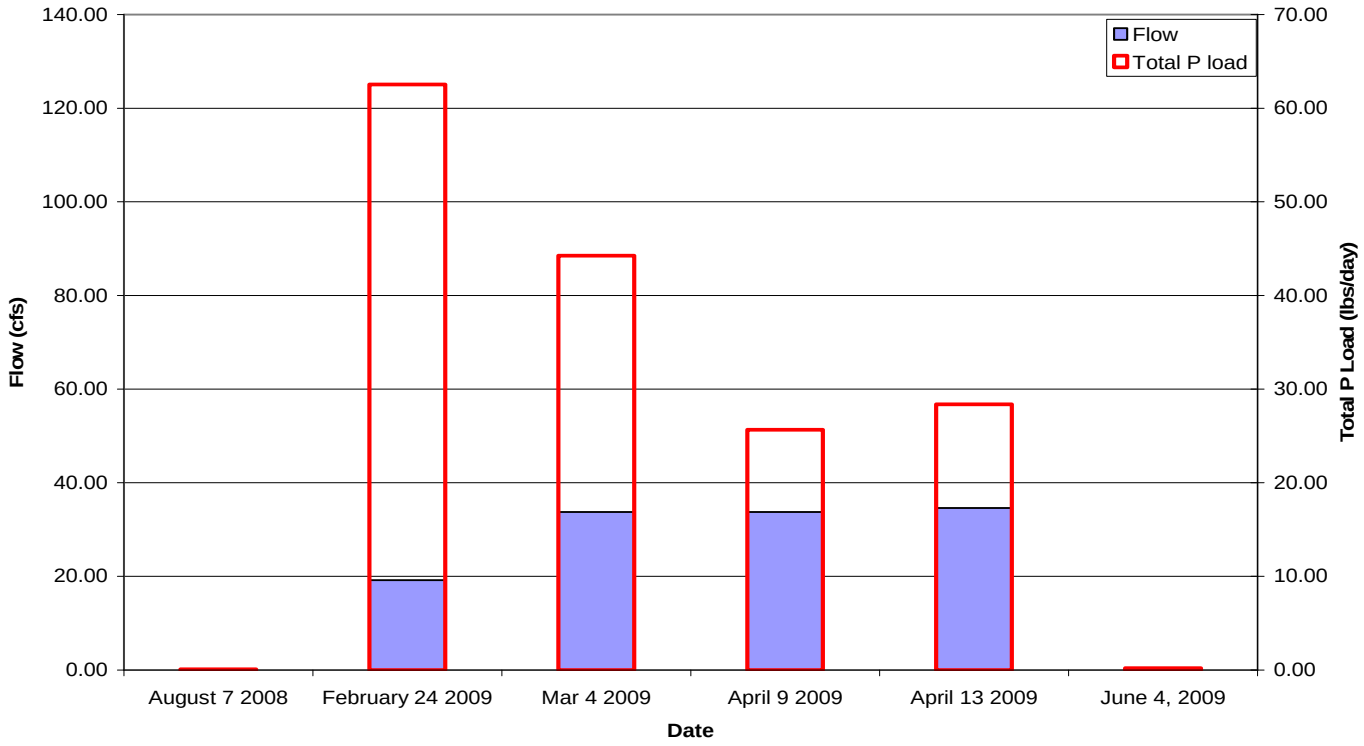


Figure 17: Blue Creek — Total Phosphorus Load

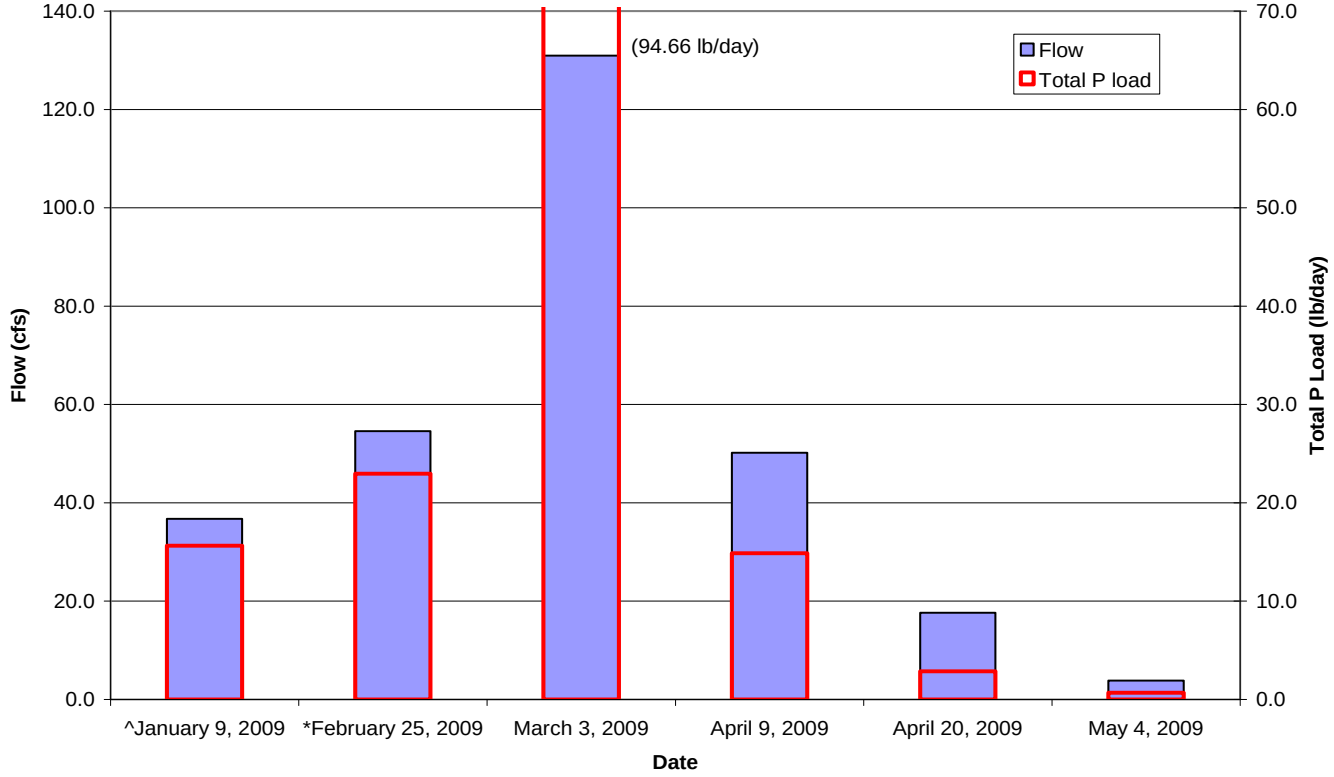


Figure 18: Carlin Creek — Total Phosphorus Load

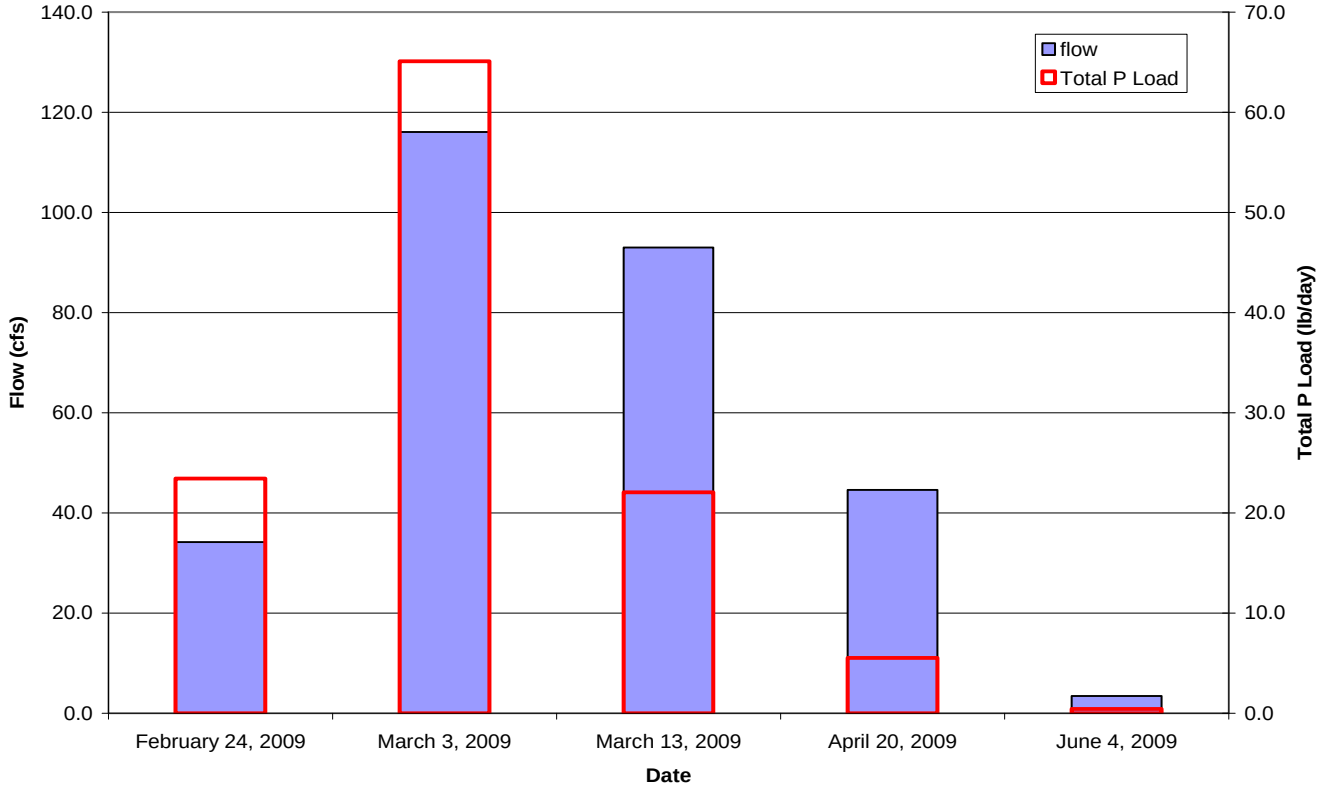


Figure 19: Fernan Creek — Total Phosphorus Load

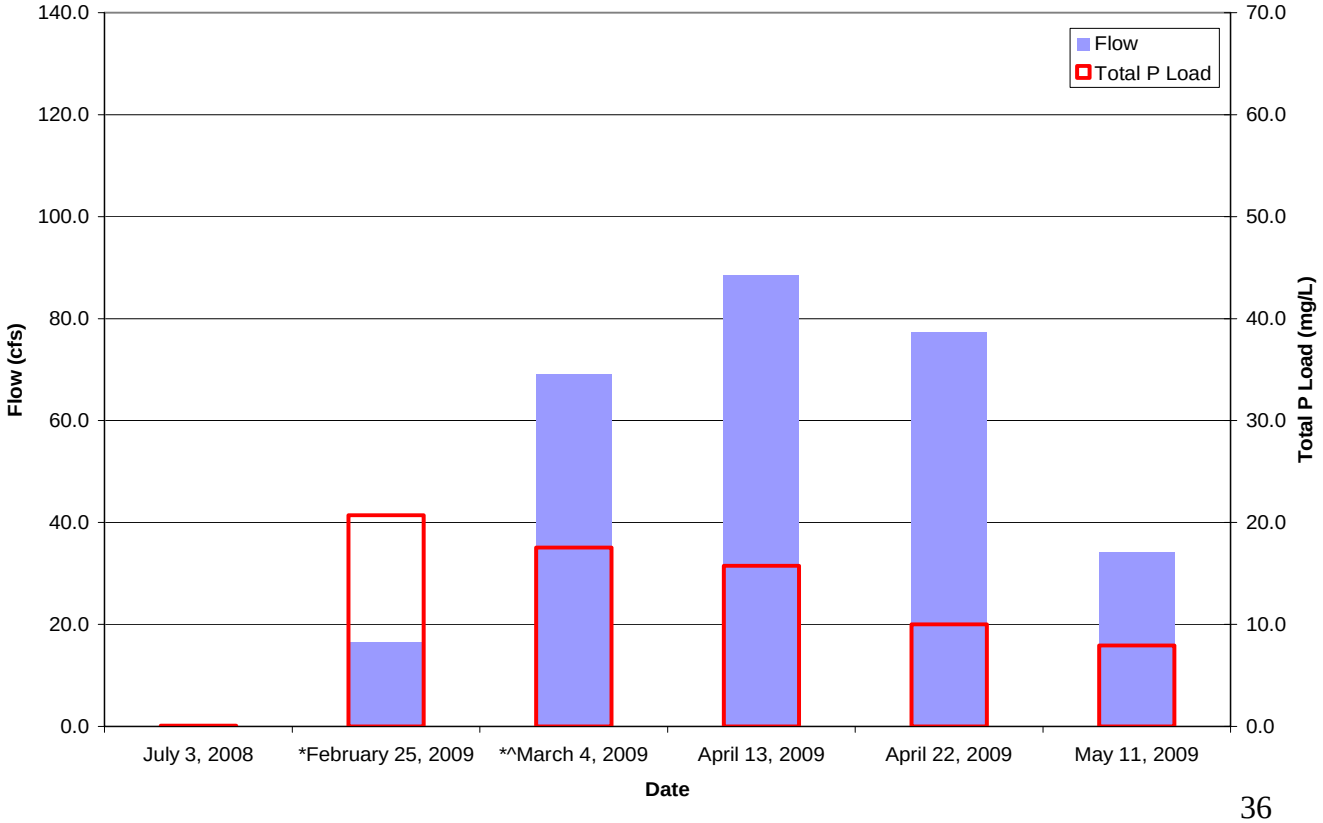


Figure 20: Gotham Creek — Total Phosphorus Load

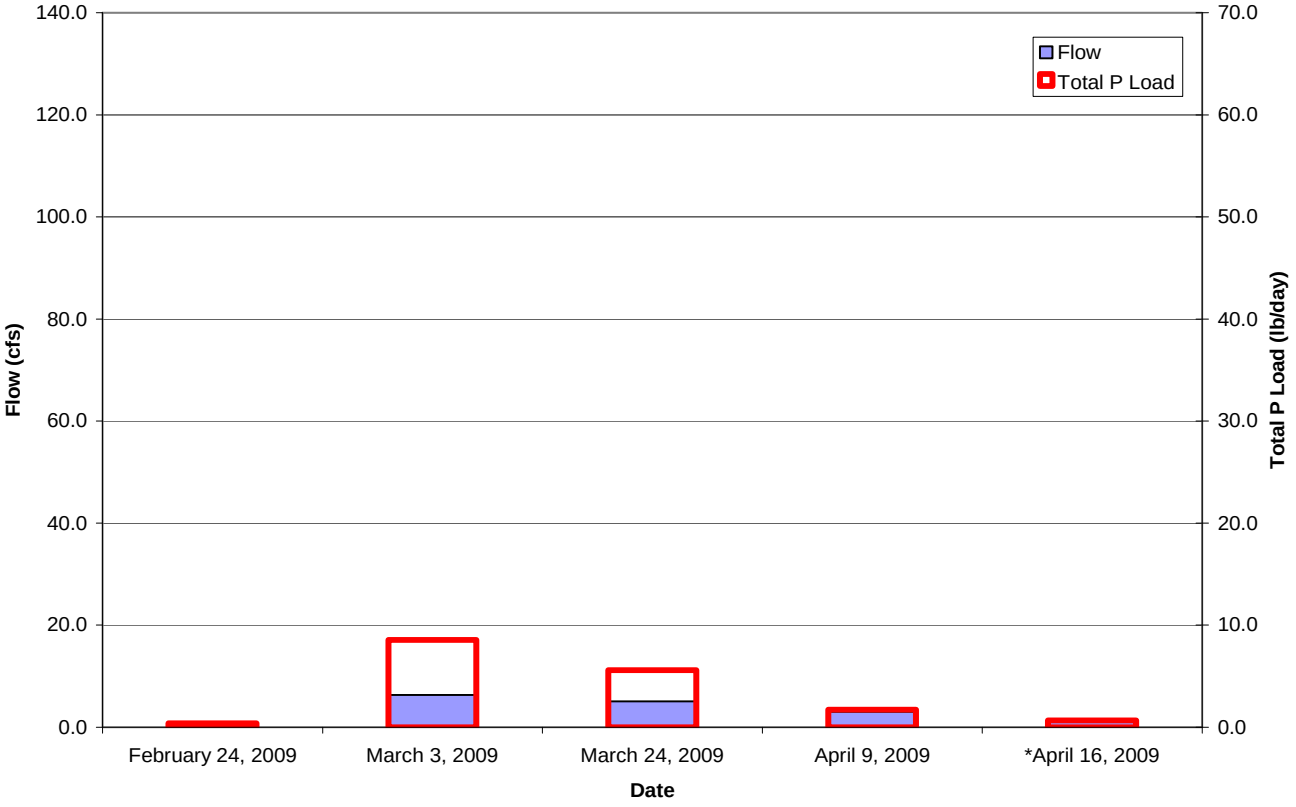


Figure 21: Mica Creek — Total Phosphorus Load

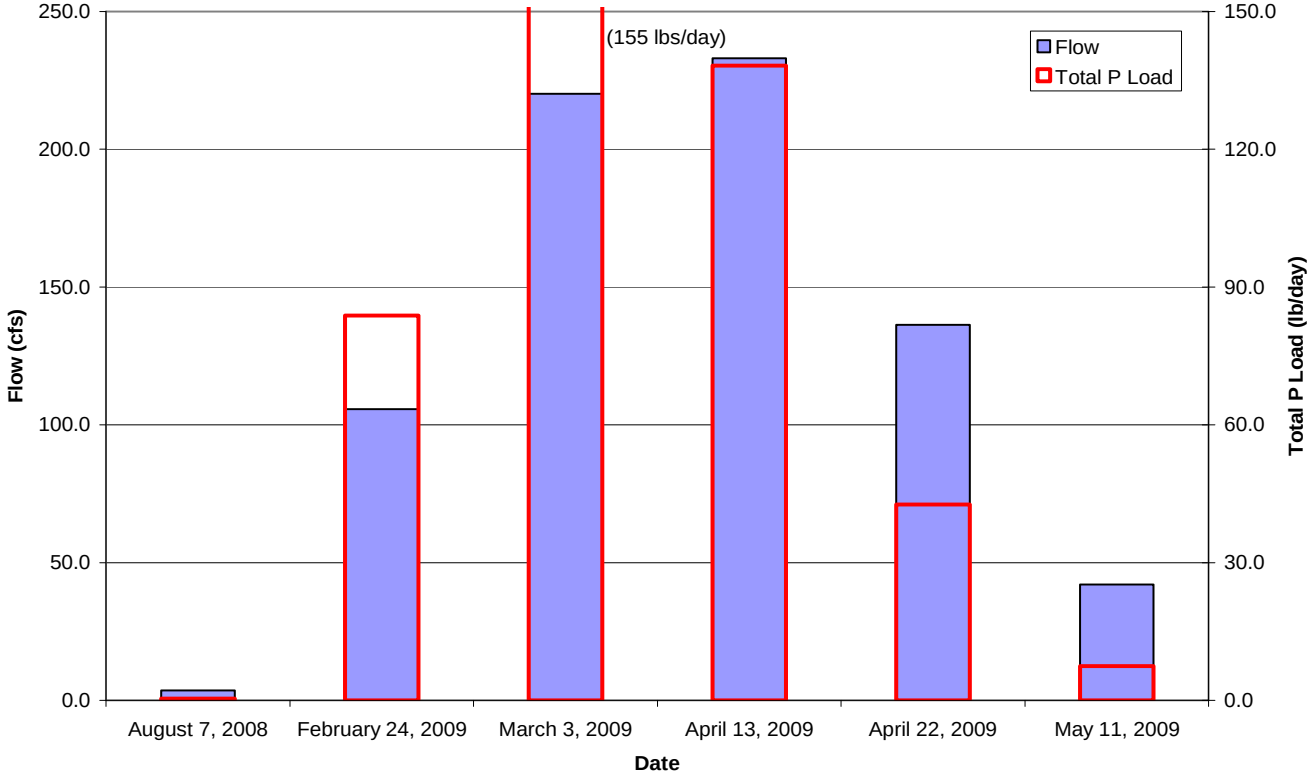


Figure 22: Neachen Creek — Total Phosphorus Load

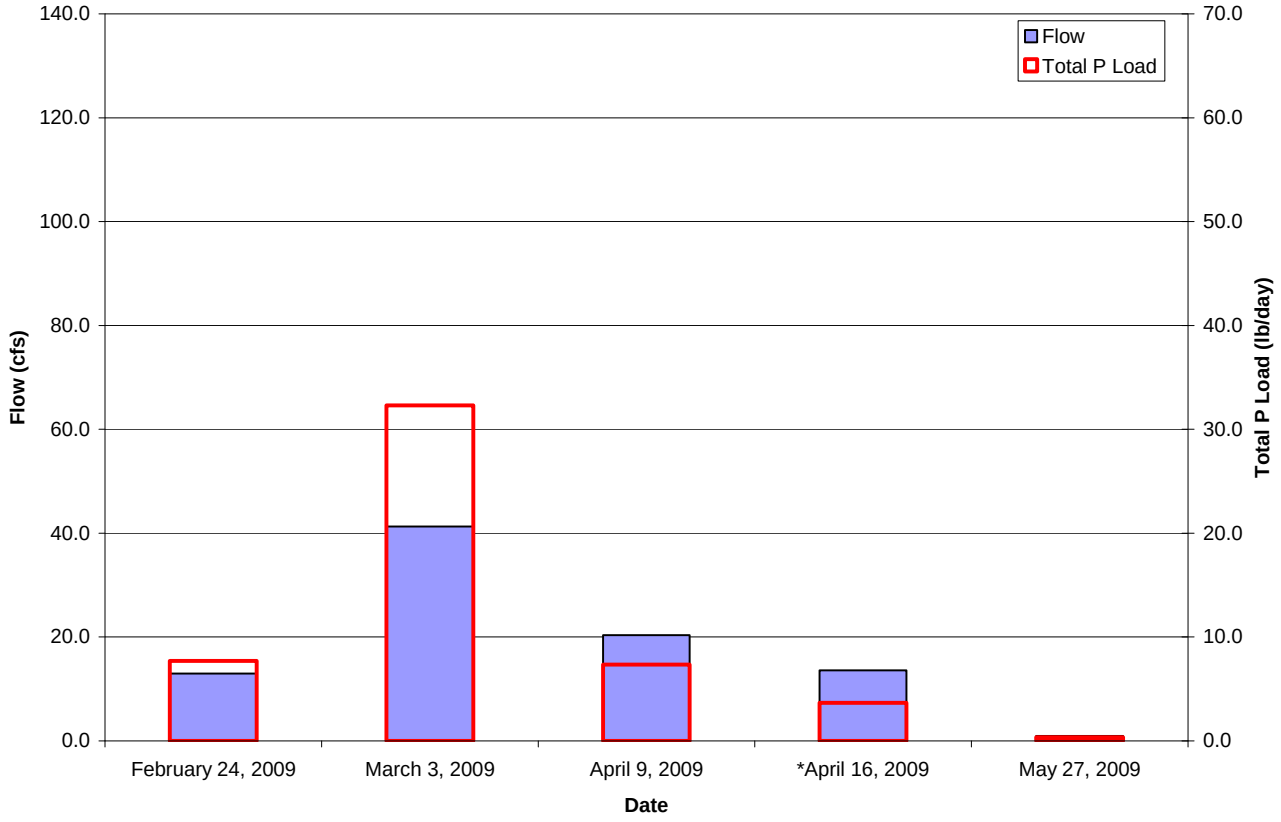


Figure 23: Stinson Creek — Total Phosphorus Load

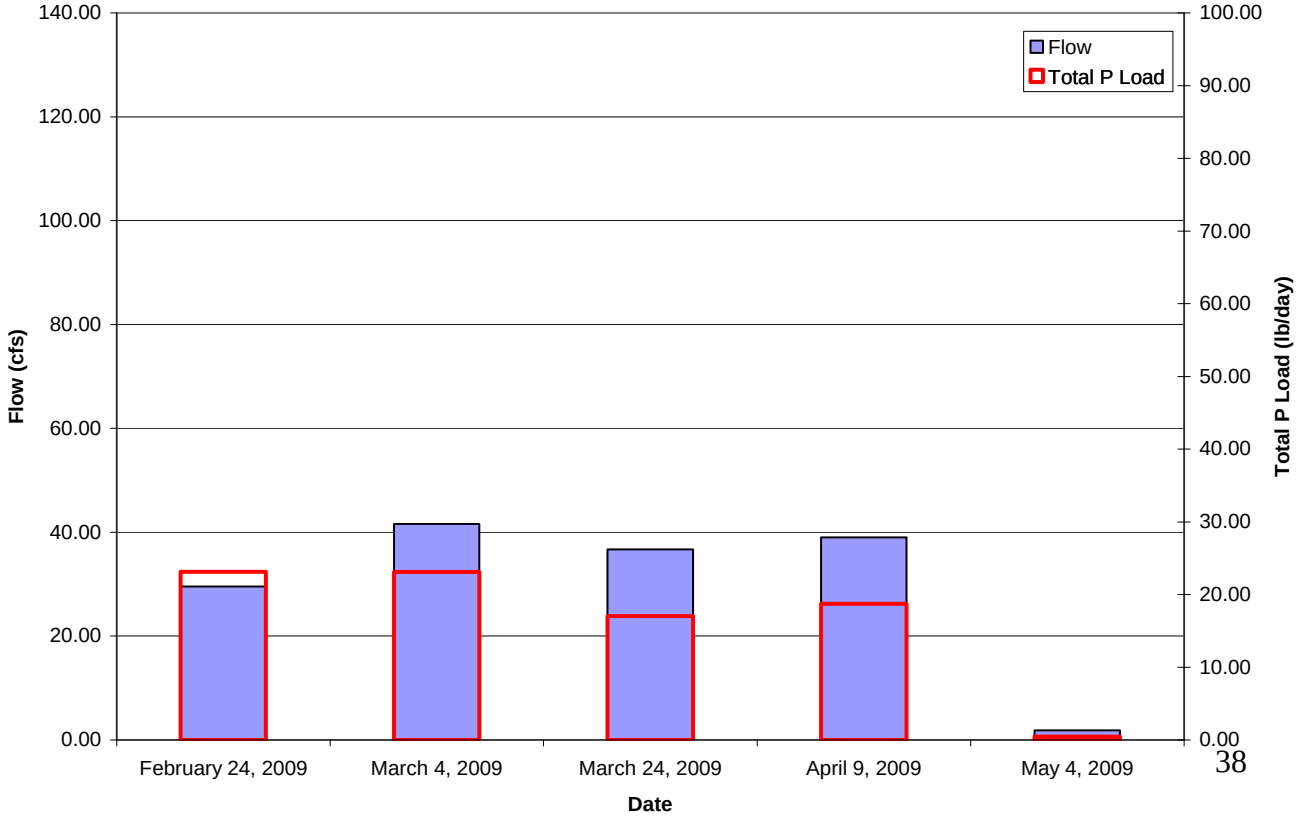


Figure 24: Turner Creek — Total Phosphorus

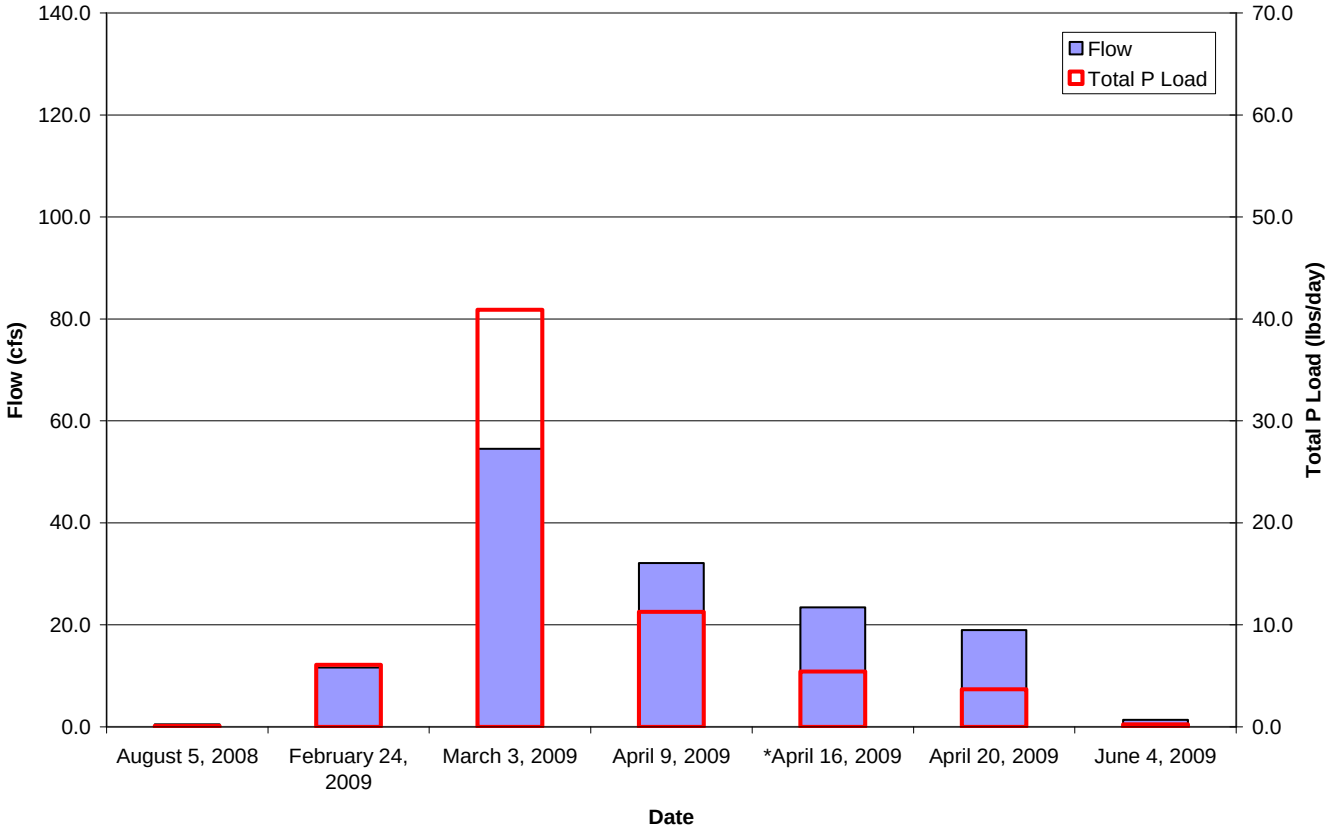


Figure 25: Unnamed Tributary to Bennett Bay Total Phosphorus Load

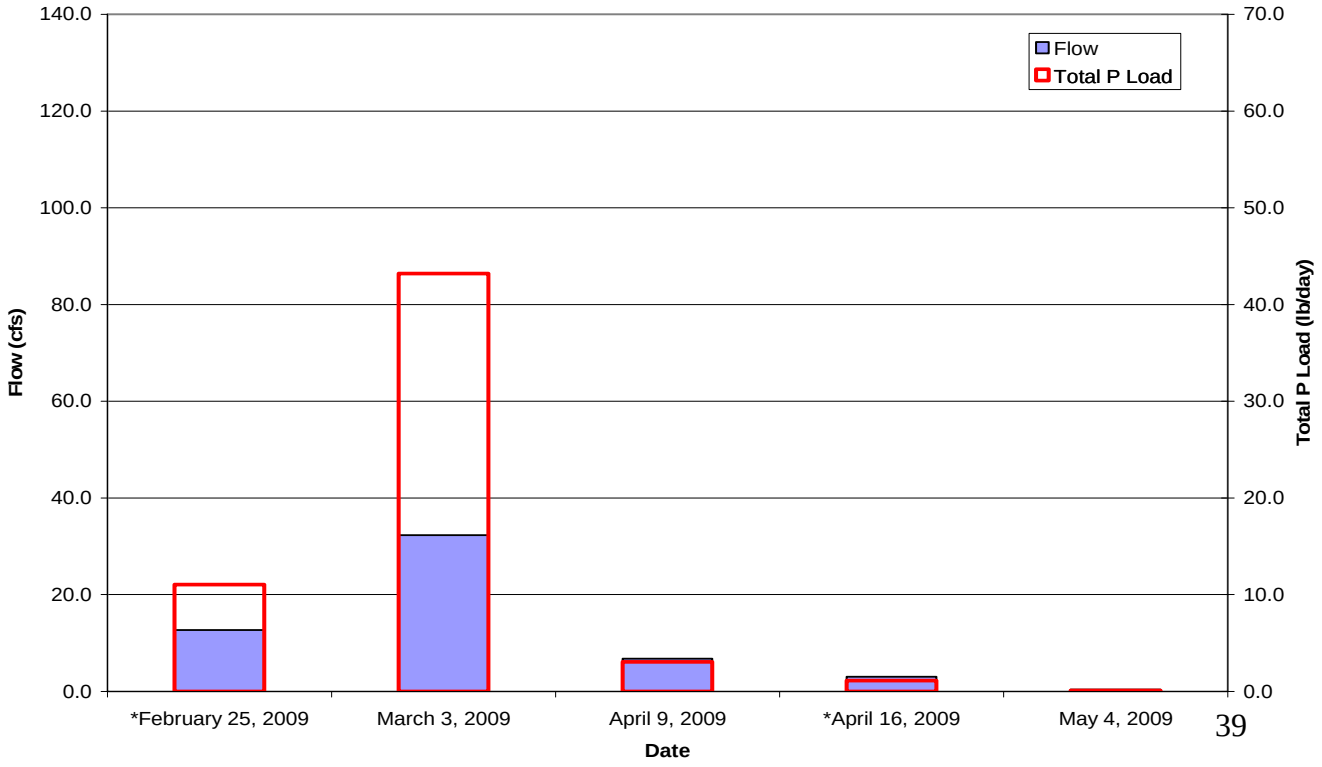


Figure 26: Unnamed Creek to Powderhorn Bay

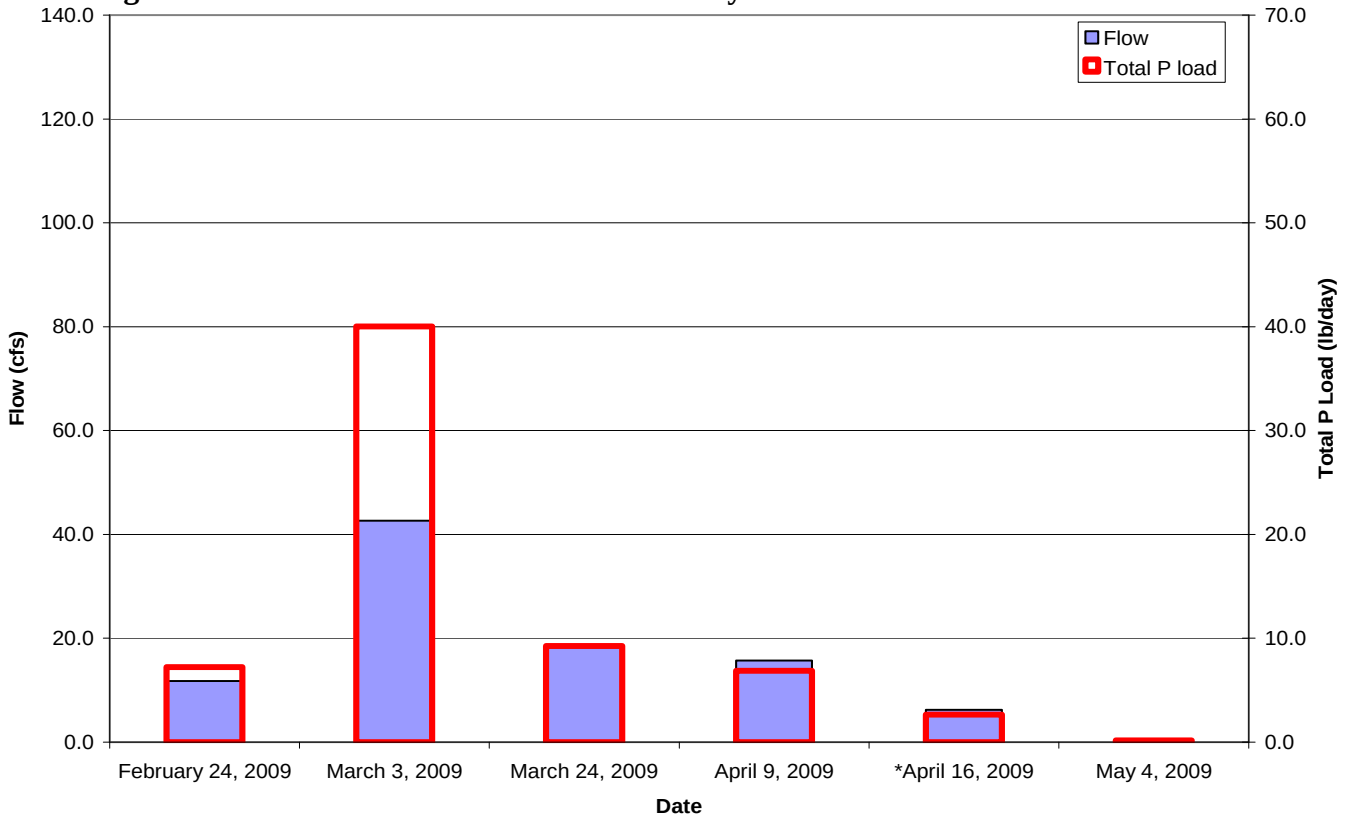
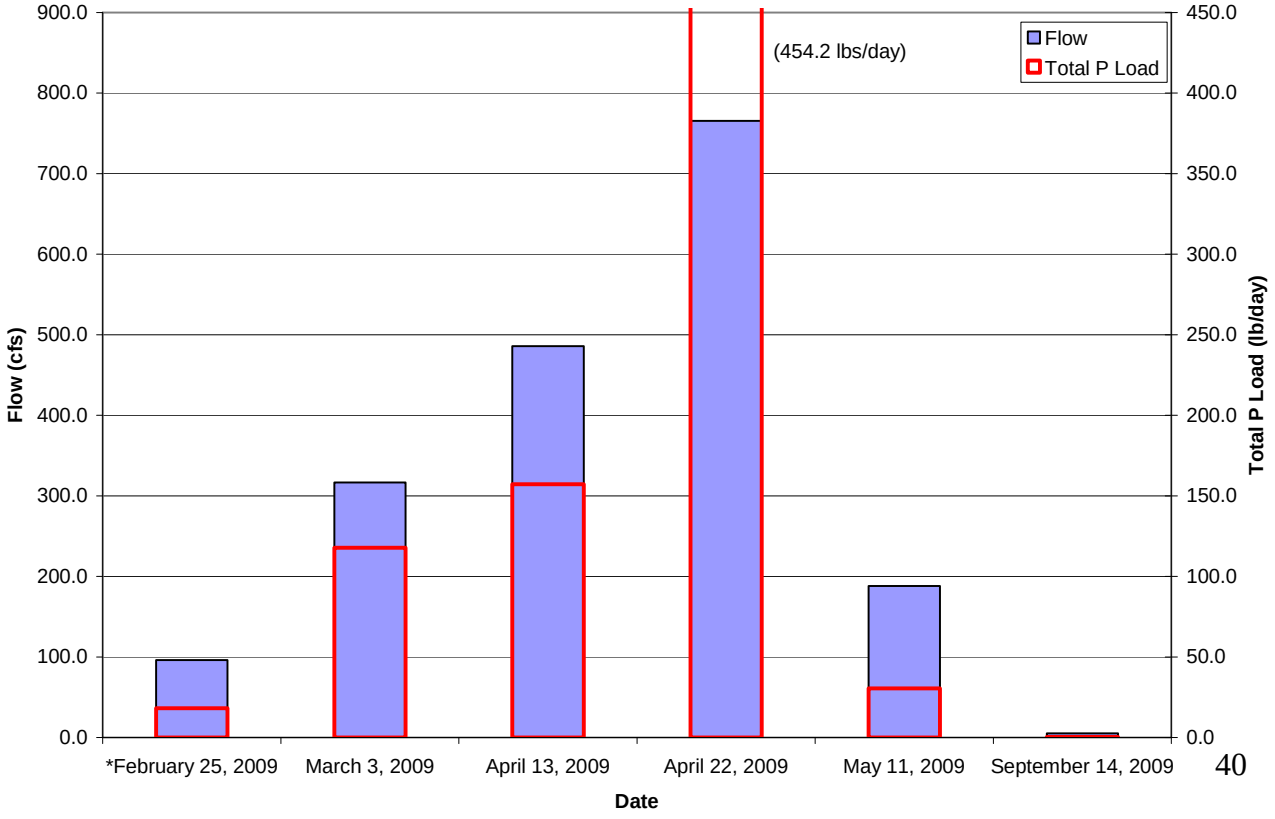


Figure 27: Wolf Lodge Creek — Total Phosphorus Load



An initial loading analysis was done to calculate an annual TP load (in lb/year) using the 24-hour TP load for the flow period and an estimate of days for the various flow periods (Table 4). Numbers of days in the flow period were estimated using hydrographs from historical data collected by USGS on Carlin Creek, Wolf Lodge Creek, and Fighting Creek (Figure 30, hydrogeology section). To rank the 13 streams by annual TP load to Coeur d'Alene Lake, a more qualitative analysis was done by assigning a weighted value to the stream load based on distribution of the 75/25 percentiles. Highest annual TP loads based on this analysis were from Mica Creek, Bellgrove Creek, Blue Creek, and Carlin Creek (Table 5).

Table 4: Estimated average number of days for each flow condition.

	Tributaries		Wolf Lodge Creek		Gotham Creek	
Flow period	**Estimated Days**	**Percent of year**	**Estimated Days**	**Percent of year**	**Estimated Days**	**Percent of year**
Ascending Limb	30	8.2	30	8.2	30	8.2
Rain on Snow	7	1.9	7	1.9	7	1.9
Peak Flow	30	8.2	30	8.2	30	8.2
Descending Limb	60	16.4	90	24.7	60	16.4
Base Flow	238	65.2	208	57.0	30	8.2

Table 5: [1]Annual TP load for watersheds draining into Coeur d'Alene Lake in lb/yr.

	Ascending Limb	Base Flow	Rain on Snow	Peak Flow	Descending Limb
Beauty Creek	--	--	3	650	580
Bellgrove Creek	--	44	440	1300	1700
Blue Creek	470	160	160	2800	890
Carlin Creek	--	101	160	2000	1300
Fernan Creek	--	15	150	530	940
Gotham Creek	--	1	3	250	100
Mica Creek	--	190	590	4700	8300
Neachen Creek	--	85	54	970	440
Stinson Creek	--	110	160	690	1100
Turner Creek	--	55	43	1200	680
Unnamed Creek to Bennett Bay	--	24	77	1300	180
Unnamed Creek to Powderhorn Bay	--	38	51	1200	410
Wolf Lodge Creek	--	64	130	1400	2700

[1]Annual TP load rounded to 2 significant figures.

When prioritizing watersheds for efforts to mitigate phosphorus delivered by tributaries into Coeur d'Alene Lake, the focus should be on watersheds where human activity has resulted in excess pollution. Although total load into Coeur d'Alene Lake is important in determining which tributaries are contributing the most phosphorus, the total load is biased towards large watersheds by their size. Total phosphorus loading occurs in a natural/undisturbed state, and a large natural/undisturbed watershed could have a higher loading than a small highly-disturbed watershed — if total load is the only element of prioritization.

The goal for setting priorities for phosphorus restoration efforts was to have the largest benefit for the lowest cost. Therefore, an alternative analysis was performed to evaluate TP loading rate (in lb/mi^2/yr) of individual watersheds by using TP load, the number of days in the flow period, and watershed area information. With this information, we were able to make predictions on the load per square mile per day for tributaries that drain into Coeur d'Alene Lake (Table 6). TP loading rate may be useful for predicting loads from non-monitored watersheds as well for establishing a prioritization schedule that is less biased by watershed size.

Table 6: [1]TP loading rates for watersheds that flow into Coeur d'Alene Lake.

	TP Load Rate (lbs/mi2/yr)				
	Ascending Limb	**Base Flow**	**Rain on Snow**	**Peak Flow**	**Descending Limb**
Beauty Creek	--[a]	7	0.2	58	52
Bellgrove Creek	--[a]	7	72	220	280
Blue Creek	60	21	20	360	110
Carlin Creek	--[a]	9	15	180	120
Fernan Creek	--[a]	0.8	8	27	49
Gotham Creek	--[a]	1	3	280	110
Mica Creek	--[a]	7	22	180	320
Neachen Creek	--[a]	21	13	240	110
Stinson Creek	--[a]	20	30	130	210
Turner Creek	--[a]	9	7	190	110
Unnamed Creek to Bennett Bay	--[a]	11	35	590	83
Unnamed Creek to Powderhorn Bay	--[a]	11	14	340	120
Wolf Lodge Creek	--[a]	2	3	340	69

[1]Annual TP load rounded to 2 significant figures.
a: no sample was taken for the ascending limb of the hydrograph

Woods and Beckwith (1997) calculated loading from Carlin Creek and Wolf Lodge Creek, using 1991-1992 monitoring data and a computer program (FLUX) developed by Walker (1987) that stratifies streamflow and nutrient concentration data. The stratified data were then used to compute load with the smallest coefficient of variation. The 1991-1992 annual TP loads for Carlin Creek and Wolf Lodge Creek were compared to 2009

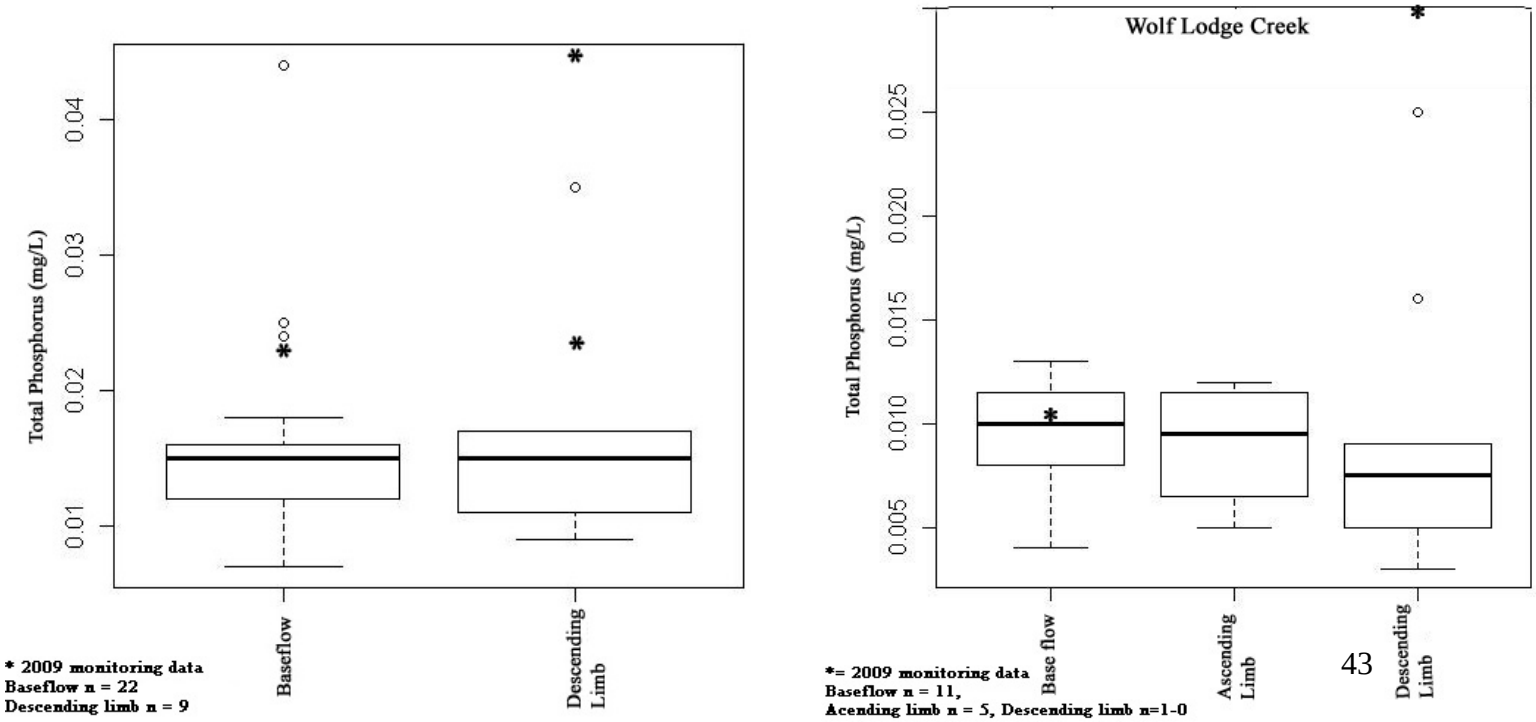
TP loads. Results of the comparison show an order of magnitude difference in the loads (Table 7). This discrepancy may be explained by the difference in TP concentration and flow between 1991-1992 and 2009.

In 2009, base flow (Carlin Creek and Wolf Lodge Creek) and descending limb (Carlin Creek only) TP concentration was much higher than the median for these flow periods in 1991-1992 (Figure 28). The number of samples taken during rain-on-snow and peak flow events was not large enough to calculate a median; however, in Carlin Creek, rain-on-snow TP concentration in 1992 was 0.026 mg/L compared to 0.127 mg/L in 2009; peak flow TP concentration in 1992 was 0.026 mg/L compared to 0.104 mg/L in 2009. In Wolf Lodge Creek, rain-on-snow TP concentration in 1992 was 0.016 mg/L compared to 0.035 mg/L in 2009; mean peak flow TP concentration in 1992 was 0.005 mg/L compared to 0.080 mg/L in 2009. In addition, flows were significantly higher in 2009 than in 1991 and 1992 in Carlin Creek, particularly during the peak and descending limb of the hydrographs where there was almost an order of magnitude difference. Flows in Wolf Lodge Creek were similar during the two time periods, except during peak flow, where there was a 400 cfs difference in mean flow.

Table 7: Loading comparison for years 1991, 1992, 2009

Carlin Creek 1991 (USGS)	Carlin Creek 1992 (USGS)	Carlin Creek 2009	Wolf Lodge Creek 1991 (USGS)	Wolf Lodge Creek 1992 (USGS)	Wolf Lodge Creek 2009
Total Phosphorus Load (lbs)					
452	234	1,881	1,300	478	18,655

Figure 28: Box and whisker plot of USGS TP data taken from Carlin and Wolf Lodge Creeks in 1991-1992 & 2009.



To determine the watersheds where human activity has resulted in excess pollution to the stream, watersheds were identified whose TP loading rates for each individual watershed flow period (event rate) exceeded the average TP loading rate for Coeur d'Alene subbasin for each flow period (Table 6). The event rate was given a score based on the magnitude that the event rate was greater than the average rate. The watershed was then ranked according to a sum of the scores (Table 7). The scores were determined by the percentile distribution of all the values greater than the average rate. In cases where multiple events occurred during a flow period, the larger event rate was used. The sum of the score is dimensionless and has only relative significance.

Sometimes the event rate was less than the average TP loading rate, and in these cases we can assume that those streams were not a priority for efforts to mitigate phosphorus delivered to Coeur d'Alene Lake. Other times the event rate was more than the average rate, and in these cases we can assume human-caused pollution is impacting those streams and they are a higher priority for TP mitigation efforts. The values in Table 7 relate to the magnitude that the event rate was greater than the average rate — the higher the number, the worse the potential for human-caused pollution in the watershed. Blank cells depict conditions where the event rate was less than the average rate. The final ranking determined the highest priority watersheds for efforts to mitigate phosphorus to Coeur d'Alene Lake, and priority watersheds are Bellgrove Creek, Mica Creek, Blue Creek, and the unnamed creek into Bennett Bay.

Table 6: Average TP load rates for Coeur d'Alene Lake subbasin.

Flow Period	**TP load rate ($lb/mi^2/day$)**
Ascending Limb	2.0
Rain on Snow	2.7
Peak Flow	6.8
Descending Limb	1.6
Base Flow	0.1

These rates are for Coeur d' Alene Lake tributary watersheds 40 square miles and smaller.

Table 7: Total Phosphorus Priority Schedule for Tributaries to Coeur d'Alene Lake

			Score				
	Stream	**Priority**	**Rain On Snow**	**Peak Flow**	**Descending Limb**	**Base Flow**	**Total**
1	Bellgrove	Very High	4	2	4		10
2	Mica Creek	High	2		4	1	7
3	Blue Creek	High	1	4	2		7
4	Bennett Creek	High		4	3		7
5	Stinson Creek	Moderate			3	3	6
6	Powderhorn Creek	Moderate		4		2	6
7	Gotham Creek	Moderate		3	2		5
8	Wolf Lodge Creek	Moderate		4			4
9	Neachen Creek	Moderate		3		1	4
10	Fernan Creek	Low				2	2
11	Carlin Creek	Very Low			1		1
12	Turner Creek	Very Low			1		1
13	Beauty Creek	Very Low				1	1

Score of 1 = within the 25%tile of the range of values that exceed average load rate (lb/mi2/day) (0-0.28)
Score of 2 = between the 25 and 50%tile of the range of values that exceed average load rate (0.28-0.54)
Score of 3 = between the 50 and 75%tile of the range of values that exceed average load rate (0.54-2.86)
Score of 4 = greater than 75%tile of the range of values that exceed average load rate (>2.86)

HYDROGEOLOGY OF TRIBUTARIES TO COEUR D'ALENE LAKE

Collection of meaningful water quality data has been challenging on the tributaries to Lake Coeur d'Alene. DEQ's Beneficial Use Reconnaissance Program (BURP) is the primary method to make beneficial use support status determinations. It relies heavily upon biological parameters and monitoring data collected in the summer. However, only 3 of the 13 tributaries in this project have been evaluated within the last 10 years under this program. This is due to the fact that flow was subsurface in most tributaries to Coeur d'Alene Lake when an attempt was made to monitor the stream using the BURP protocol. Rather than attributing this observation to intermittent stream flow, it is likely that flow is subsurface in the summer near the mouth of most tributaries to Coeur d'Alene Lake. This subsurface flow is explained by geologic history of the area.

During Coeur d'Alene Lake's history, the elevation of the lake has been variable. Coeur d'Alene Lake was formed by periglacial processes due to contact with the terminus of the glacier that flowed south in the Purcell Trench (10k - 15k years ago). Glacial moraines forced the St. Joe River south and westward to its current location. Glacial processes are likely to have resulted in different static water elevations, one of these significant elevations (52 feet above current full pool) allowed for delta-like deposition to occur in flooded v-shaped stream valleys of the tributaries to the newly-formed Coeur d'Alene Lake. Glacial activity was predominantly north of what is now Coeur d'Alene Lake, so these watersheds were dominated by fluvial processes.

Today most tributaries to the Lake have a wedge of water-deposited alluvium (delta) occupying their watershed from the Post Falls Dam maintained “full pool” of 2128’ to 2182’ (Figure 42). These wedges vary in length with the following examples: Beauty Creek 5,000 ft, Wolf Lodge Creek 19,000 ft, Blue Creek 8550 ft, Fernan Creek 11,600 ft (Fernan Lake), Cougar Creek 12,100 ft, Kid Creek, 4,000 ft, Mica Creek 11,700 ft, Rockford Creek 3,700 ft. We observe relatively coarse aggregate has accumulated over portions of the emergent delta formations and further upstream areas, and we suspect these accumulations are due to the change in knick point since Coeur d’Alene Lake has dropped to the 2128 elevation. Stream energy may not be enough to carry larger particles across these low-gradient emergent delta formations because it is typical to see cobble-dominated substrate extending up the watershed.

As a result of the low-gradient wedge of deltaic sediments between 2128 and 2182, the tributaries to Coeur d’Alene Lake have a unique hydrograph (Figure 43). Latour Creek and Big Creek are nearby stream gauges that show “normal” stream hydrography for the area. Fighting Creek, which is a tributary to Coeur d’Alene Lake shows a similar hydrograph to Latour and Big Creeks; however, it does not have a low-gradient deltaic wedge between 2128’ and 2182’. Plummer Creek and Carlin Creek may represent most of the Coeur d’Alene Lake tributary flow conditions as affected by the low-gradient wedge of deltaic sediments between the 2128’ and 2182’ elevations. It is predicted that Beauty, Blue, Carlin, Cougar, Fernan, Kid, Lyle, Mica, Neachen, Turner, unnamed to Bennett Bay, and unnamed to Powderhorn Bay act similarly — with peak flows in February or March and base flows in May and June. Further verification of this hydrography was from a comparison between base flows modeled by USGS Stream Stats with base flows observed during the months of May and June, where the two values were consistent — except on Beauty Creek, where flows were much higher just prior to going subsurface.

Figure 29: Map of deltaic sediments between 2128 and 2182 on tributaries to Coeur d'Alene Lake.

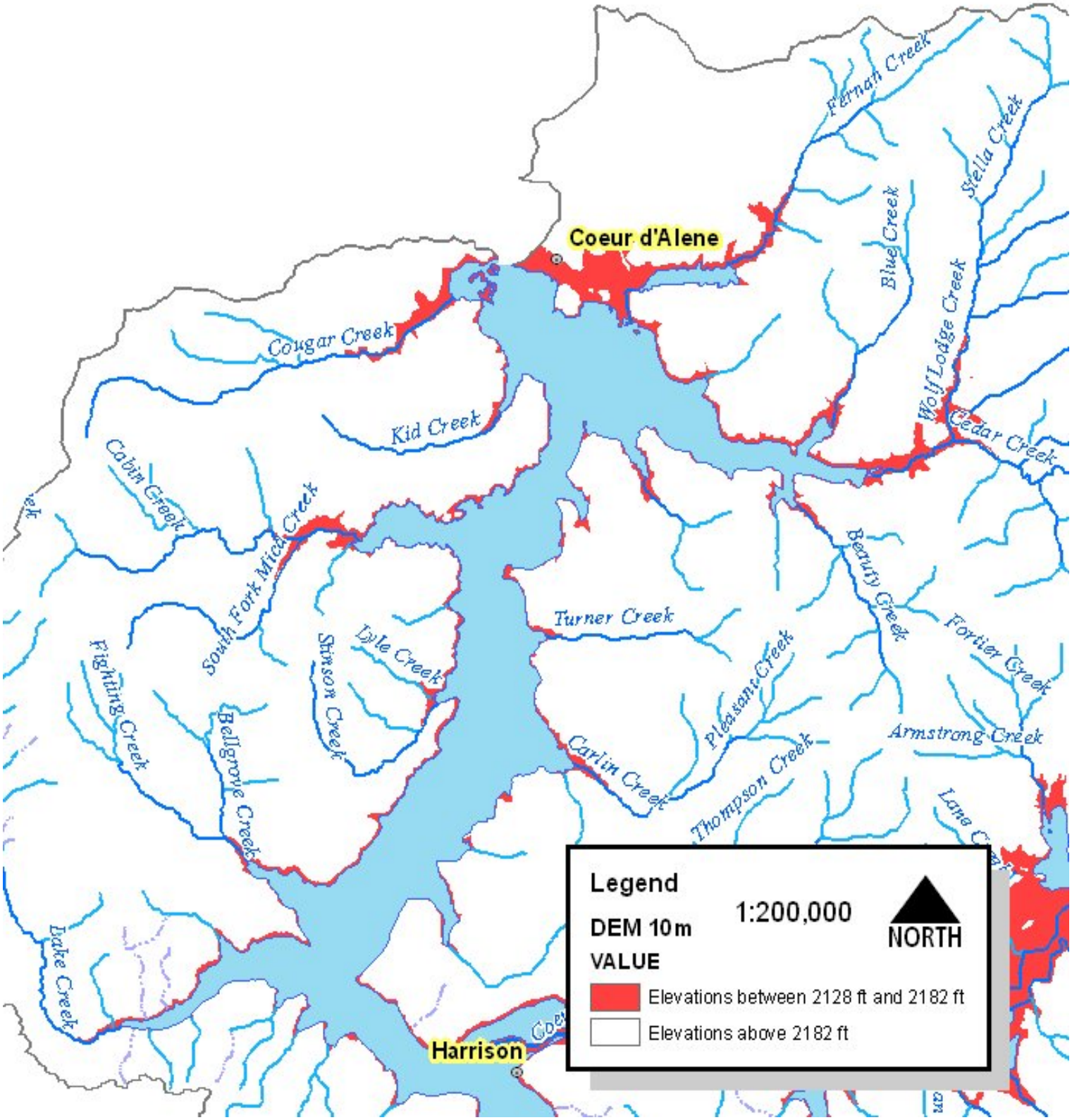
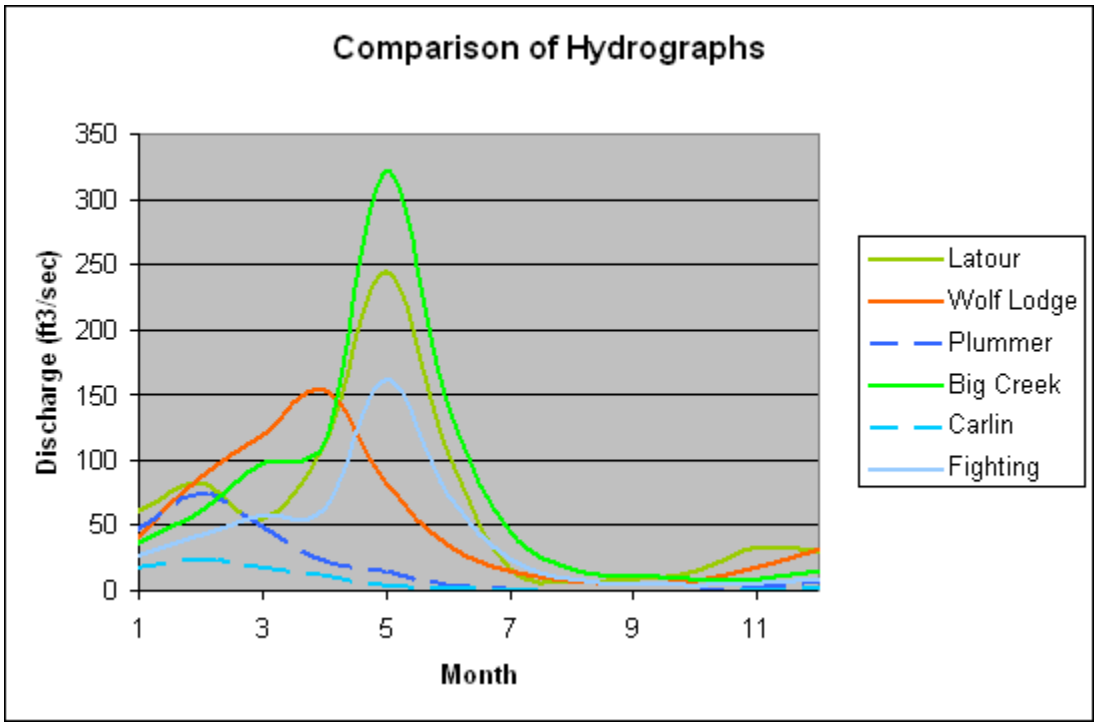


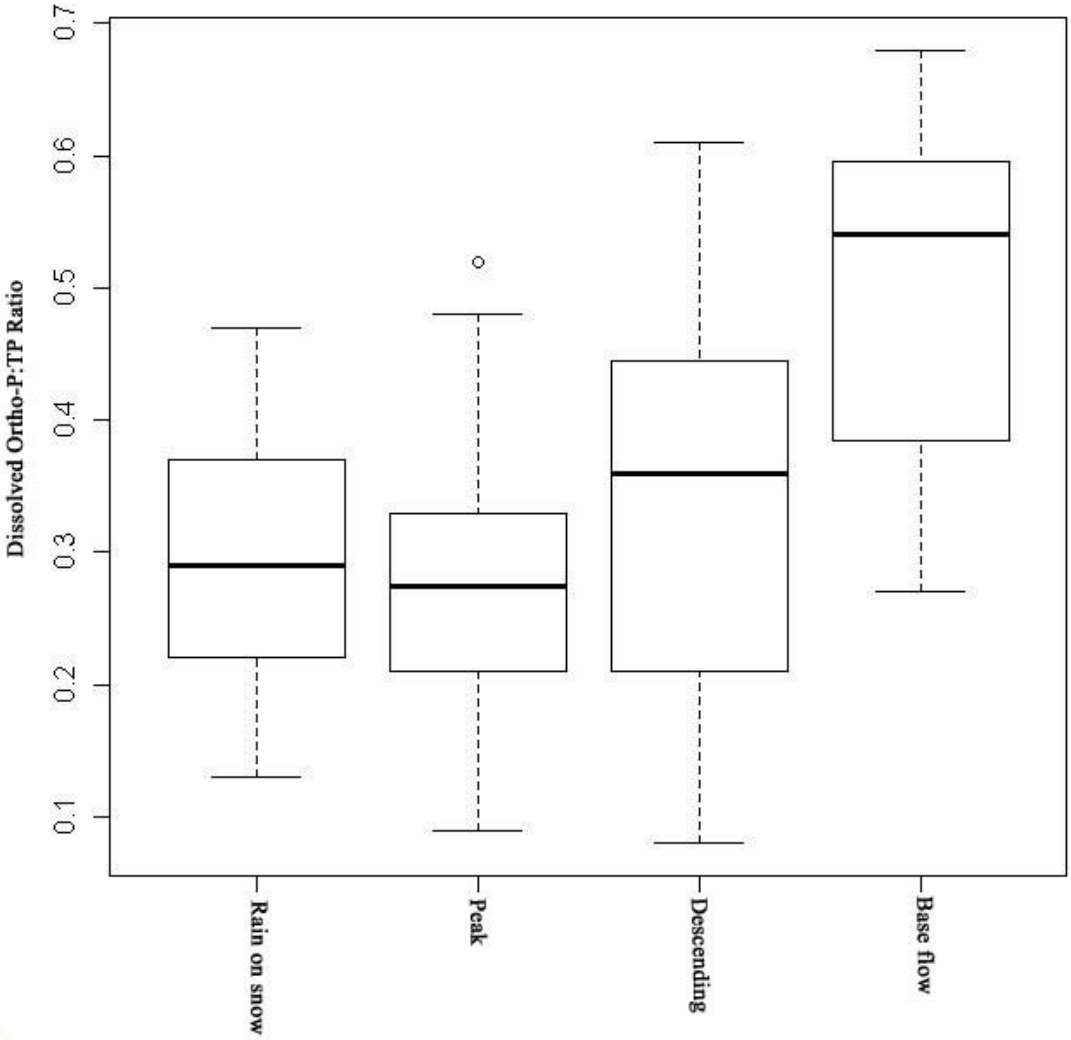
Figure 30: Comparison of hydrographs from creeks in the Coeur d'Alene watershed.



EVALUATION OF ORTHO-P:TOTAL P RATIO

Orthophosphate is the phosphorus form that is directly taken up by algae. The concentration of Ortho-P to TP is an index of the amount of phosphorus immediately available for algal growth. Long term monitoring at river and stream sites in Montana show the ratio of Ortho-P to TP (Ortho-P:TP) ranges from 0.26 to 0.5. An acceptable Ortho-P:TP ratio for the 90th percentile of reference streams in the Northern Rockies Ecoregion in Montana (Omernick III Ecoregion) was 0.35 (Suplee & Watson, et. al 2008). When evaluating dissolved Ortho-P:TP ratios by flow period in our project streams, ratios were highest during the base flow period (Figure 44). The median dissolved Ortho-P:TP of 0.54 during base flow was above that of reference streams in the same ecoregion and above the 90th percentile of Montana streams. This suggests tributaries to Coeur d'Alene Lake support more bioavailable phosphorus during the growing season than what typical reference streams in the region would support.

Figure 31: Box and Whisker plots of dissolved Ortho-P:TP ratios of tributaries to Coeur d'Alene Lake



SEDIMENT

The Idaho numeric standard for sediment impairments in streams is specific to turbidity. This standard is most often utilized when assessing sediment pollution from a source on a stream. For example, turbidity levels are measured above and below a feed lot. It seemed reasonable to evaluate for turbidity pollution during the rain on snow events, since turbidity was measured on every stream during each of these events. A comparison was made with individual stream turbidity measurements to the average turbidity of streams in the watershed. Turbidity data on February 24th from Bellgrove Creek and Fernan Creek were excluded from the average as they were outliers — Bellgrove Creek turbidity was an order of magnitude greater than the other streams, and the data concluded turbidity in Fernan Creek was primarily attributed to pollution from the City of Coeur d'Alene storm drain. Average turbidity of Coeur d'Alene Lake Tributaries for the

February and March rain-on-snow events are 27.9 NTU and 36.0 NTU respectively. Results of this evaluation suggest Bellgrove Creek likely exceeded and Turner Creek may have exceeded Idaho's standard for turbidity during these rain-on-snow events (Table 8).

Table 8. Comparison of turbidity measurement to the Idaho numeric standard for turbidity on tributaries to Lake Coeur d'Alene.

Date	Average Turbidity (NTU)	Instantaneous Turbidity Standard (NTU)	10-day Turbidity Standard (NTU)
Feb 24 & 25, 2009	27.9	57.9	52.9
Mar 3 & 4, 2009	36.0	86.0	60.9

Date	Creek Name	Turbidity (NTU)
2/24/09	Bellgrove Creek	167.0
2/24/09	Fernan Creek	79.2
2/24/09	City of Ceour d'Alene storm drain to Fernan Creek	351
2/24/09	French Gulch (tributary to Fernan creek)	33.8
3/3/09	Turner Creek	75.7

Turbidity/TSS regression curves were generated for each of the streams. Although more data needs to be collected to have relative confidence in such a correlation, initial results show high correlation on a number of the streams (Table 9).

Table 9. Regression analysis of Turbidity vs. TSS on tributaries to Lake Coeur d'Alene.

Creek Name	R^2 value
Beauty Creek	0.798
Bellgrove Creek	0.995
Blue Creek	0.855
Carlin Creek	0.091
Fernan Creed	0.497
Gotham Creek	0.952
Mica Creek	0.744
Neachen Creek	0.408
Stinson Creek	0.985
Turner Creek	0.996
Unnamed Creek to Bennett Bay	0.696
Unnamed Creek to Powderhorn Bay	0.954

CONCLUSION/DISCUSSION

It is well documented that excess nutrients can accelerate the eutrophication process in surface water. A common effect of eutrophication in streams is an increased fluctuation of DO and pH due to the elevated aquatic plant growth. Such fluctuations, if severe enough, can have a direct negative effect on aquatic life and other beneficial uses. Local differences in climate, geology, soils have a combined effect on stream nutrient concentrations and eutrophication, which makes it a challenge to determine instream nutrient concentrations that are above natural background levels and harmful to beneficial uses.

Suspended sediment and nutrient monitoring of 13 tributaries to Coeur d'Alene Lake during winter rain-on-snow events, spring runoff, and during the summer low-flow season concluded the highest instantaneous suspended sediment and nutrient concentrations were observed during early rain-on-snow events. Although this is a concern for TP loading to Coeur d'Alene Lake, the higher flows and colder temperature are not conducive to aquatic plant growth during the winter and early spring months. However, dissolved Ortho-P:TP during base flow period in tributaries to Coeur d'Alene Lake are above that of reference streams in the region suggesting bioavailable phosphorus may be a concern for beneficial uses for the streams and for loading to the lake. After a very high runoff year, field observations were inconclusive for excess aquatic vegetation growth — except on Blue Creek, where growth was abundant. Future field monitoring will focus on answering this question.

Loading from tributaries to Coeur d'Alene Lake is significant. A loading analysis to calculate total phosphorus load from tributaries to the lake determined nutrient loads were greatest during spring runoff. When combining the loads from all flow periods, the highest annual TP loads were from Mica Creek, Bellgrove Creek, Blue Creek and Carlin Creek. However, this analysis was biased toward watershed size. When prioritizing watersheds for efforts to mitigate phosphorus delivered by tributaries into Coeur d'Alene Lake, the focus should be on watersheds where human activity has resulted in excess pollution. Therefore, an alternative analysis was performed to evaluate TP loading rate, which looks at TP load per square-mile. Results of this analysis determined Bellgrove Creek, Mica Creek, Blue Creek, and Bennett Creek to be high priority waters where efforts of improvement would most likely reduce loads.

A comparison of 2009 TP loads with 1991-1992 TP loads calculated by the USGS, determined the 2009 loads are an order of magnitude higher. This may be explained by the higher TP concentrations and flows observed in 2009, particularly during the high flow events.

TP loading of the tributaries to Coeur d'Alene Lake are very likely affected by seasonal subsurface flows. Many of the tributaries to the lake have a wedge of water-deposited alluvium (delta) at the lowest portions of the watershed. These wedges influence the hydrologic characteristics and cause water to flow subsurface into Coeur d'Alene Lake. Future loading studies should include the use of peizometers for collection of subsurface water quality samples along with modeling using USGS Streamstats, under the assumption of perennial flow to the lake. In addition, the seasonal flow through

interstitial spaces may allow chemical reactions such as adsorption/desorption of phosphorus, which would affect TP loading to the lake.

Because flow is subsurface during low-flow conditions on many of the tributaries to the lake, conventional tools for evaluation of beneficial use support may not be appropriate in stream reaches flowing within ancient delta deposits, and other methods for evaluation of beneficial use support should be utilized on these streams. For example, DEQ's Beneficial Use Reconnaissance Program (BURP), the primary method to make beneficial use support status determinations, relies heavily upon biological parameters and monitoring data collected during low-flow conditions in the summer. Because flow is subsurface during low flow conditions on these streams, more often than not the opportunity for collection of data under the BURP program has been missed on these streams. Planning for data collection under this program should include identifying sites upstream of the ancient delta deposits (above 2182') where there is perennial flow.

Another conventional tool for evaluation of beneficial use impairments due to excess nutrients includes developing a numeric interpretation of nutrient narrative criteria. Application of this criterion during base flow conditions coupled with any observations of visible slime growth in the stream helps with understanding any nutrient impairment and provides a basis for setting nutrient targets for loading analyses.

Recently, DEQ has defined a numerical guideline for TP of 9 ug/L in a northern Idaho stream. This was done using reference stream TP data from streams in the Idaho Panhandle region (DEQ, 2007). This guideline is comparable to EPA-suggested Ecoregional Criteria (EPA 2000), nutrient criteria guidelines recommended by Oregon State University (OSU 2007), and Montana Department of Environmental Quality (Suplee et. al. 2008). Numeric nutrient guidelines will likely be proposed by DEQ on other Panhandle streams. However, making an evaluation of nutrient impairment using his approach may not be appropriate on tributaries to Coeur d'Alene Lake where base flow can go subsurface. Total phosphorus must be evaluated from a water quality sample taken during base flow conditions. Water quality samples during this project were taken at higher flows than base flow conditions as defined by the USGS StreamStats model. Future monitoring efforts to capture TP at base flow may be worth while on the unnamed tributary to Bennett Bay, Gotham Creek, Neachen Creek, and the unnamed tributary to Powderhorn Bay where TP concentrations were above 50 ug/L during low-flow conditions.

Water quality monitoring for sediment is a challenge at high flows. Results from duplicate samples taken in response to rain on snow events were outside data quality objectives. During such high flow events, more sand-sized sediment is suspended in the water column. A study by the US Geological Survey showed relatively large variance in TSS for 3 sets of quality control samples high in sand. The same study showed analysis of two quality control data sets for suspended sediment concentration (SCC) were within variance outlined in their National Sediment Laboratory Quality Assurance Program. They conclude "The method for determining TSS, which was originally designed for analyses of wastewater samples, is shown to be fundamentally unreliable for the analysis of natural-water samples. In contrast, the method for determining SSC produces

relatively reliable results for samples of natural water, regardless of the amount or percentage of sand-size material in the samples" (USGS 2000). Should funds allow, future water quality monitoring at high flows should include SCC instead of TSS.

With enough data, turbidity/TSS regression curves are a good tool to predict TSS in a stream using just a turbidity meter. Although more data needs to be collected to have relative confidence in such a correlation, initial results show high correlation on a number of the tributaries to Coeur d'Alene Lake. However, given the data quality problems discussed above, this correlation should be generated at lower flows on these streams.

Although phosphorus-bound sediment is a concern for Coeur d'Alene Lake, further evaluations need to be conducted to evaluate beneficial use impairment due to sedimentation on the tributaries to Coeur d'Alene Lake. It is likely Bellgrove Creek did exceed turbidity standards during rain-on-snow events. Turner Creek may have exceeded the standard as well. The City of Coeur d'Alene storm drain that discharges to Fernan Creek was a significant source of sediment to Fernan Creek, causing it to exceed turbidity standards during a February rain-on-snow event. The City of Coeur d'Alene has just been approved by the EPA for an MS4 storm water permit with the EPA which will regulate discharges from their storm drain system. Under this permit, the city will be required to monitor and manage discharge from storm drains to comply with the permit.

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APPENDIX A

Data

Sampling Date	Inst. Flow (cfs)	Turbidity NTU	TP (mg/L)	Dissolved OrthoP (mg/L)	TSS (mg/L)	TN (mg/L)	TP load (lbs/ day)	Dissolved OrthoP (lbs/ day)	TSS (tons/ day)	TN load (lbs/ day)
Beauty Creek										
2/24/2009	3.52	4.5	0.019	0.009	5.6 [b]	0.128	0.36	0.17	0.05[b]	2.43
3/3/2009	63.78	13.0	0.063	0.010	25.8	0.107	21.67	3.44	4.12	36.81
4/9/2009	74.84	6.1	0.024	0.010	2.5	0.050	9.69	4.04	0.47	20.18
4/20/2009	59.68	2.9	0.017	0.009	2.50	0.050	5.47	2.90	0.37	16.09
5/11/2009	21.80	1.9	0.029	0.009	2.50	0.050	3.41	1.06	0.14	5.88
Bellgrove Creek										
8/7/2009	0.10	--	0.153	0.053	2.5	1.660	0.08	0.03	0.00	0.90
2/24/2009	19.16	167.0	0.605	0.130	306.0 [b]	1.410	62.52	13.43	14.69 [b]	145.72
3/4/2009	33.75	39.9	0.243	0.079	78.0	--	44.24	14.38	6.60	129.79
4/9/2009	33.75	37.0	0.141	0.028	53.6	0.216	25.67	5.10	4.53	39.32
4/13/2009	34.6	36.6	0.152	0.029	61.80	0.223	28.38	5.42	5.36	41.64
6/4/2009	0.41	49.3	0.084	0.046	2.50	0.237	0.19	0.10	0.00	0.52
Blue Creek										
1/9/2009	36.72	18.2	0.079	--	2.5	--	15.65	--	--	--
2/25/2009	54.57	21.5	0.078	0.024	--	0.443	22.96	7.06	--	130.39
3/3/2009	130.97	44.1	0.134	0.031	36.4	0.431	94.66	21.90	11.95	304.47
4/9/2009	50.17	13.4	0.055	0.016	8.6	0.186	14.88	4.33	1.08	50.33
4/20/2009	17.67	7.1	0.030	0.013	2.50	0.153	2.86	1.24	0.11	14.58
5/4/2009	3.84	5.7	0.033	0.014	2.50	0.172	0.68	0.29	0.02	3.56

[b]Data outside data quality objectives

Sampling Date	Inst. Flow (cfs)	Turbidity NTU	TP (mg/L)	Diss. OrthoP (mg/L)	TSS (mg/L)	TN (mg/L)	TP load (lbs/ day)	Diss. OrthoP (lbs/ day)	TSS (tons/ day)	TN load (lbs/ day)
Carlin Creek										
2/24/2009	34.2	39.3	0.127	0.02	60.60 [b]	0.382	23.43	3.32	5.19 [b]	70.47
3/3/2009	116.1	35.2	0.104	0.02	51.60	0.395	65.12	13.77	15.01	247.31
3/13/2009	93.0	14.5	0.044	0.01	18.60	0.143	22.07	4.01	4.33	71.72
4/20/2009	44.59	7.8	0.023	0.007	6.60	0.126	5.53	1.68	0.74	30.30
6/4/2009	3.43	49.3	0.023	0.010	2.50	0.110	0.43	0.19	0.02	2.04
Fernan Creek										
7/3/08	0.34	--	0.034	0.012	2.5	0.454	0.06	0.02	--	0.83
2/25/09	16.56	79.2	0.232	0.030	--	0.717	20.72	2.68	--	64.04
3/4/09	69.15	11.1	0.047	0.013	10.8	--	17.53	4.85	1.87	146.21
4/13/09	88.44	6.9	0.033	0.003	5.60	0.195	15.74	1.43	1.24	93.02
4/22/09	77.31	5.2	0.024	0.002	5.80	0.157	10.01	0.83	1.12	65.47
5/11/09	34.19	7.8	0.043	0.004	7.60	0.182	7.93	0.74	0.65	33.56
French Gulch										
2/25/2009	8.42	33.8	0.130	--	--	--	5.90	--	--	--
3/3/2009	20.58	25.0	0.102	--	8.40	--	11.32	--	0.43	--
4/13/09	9.13	14.7	0.069	--	11.20	--	15.74	--	0.26	--
Gotham Creek										
2/24/2009	0.60	27.2	0.114	0.052	10.2 [b]	0.308	0.37	0.17	0.02 [b]	1.00
3/3/2009	6.33	59.0	0.250	0.070	48.8	0.320	8.54	2.39	0.77	10.93
3/24/2009	5.05	57.8	0.205	0.067	37.8	0.240	5.58	1.82	0.48	6.54
4/9/2009	3.00	19.9	0.106	0.052	12.6	0.186	1.72	0.84	0.09	3.01
4/16/2006	1.47	14.2	0.084	0.047	--	0.194	0.67	0.37	--	1.54

[b]Data outside data quality objectives

Sampling Date	Inst. Flow (cfs)	Turbidity NTU	TP (mg/L)	Diss. OrthoP (mg/L)	TSS (mg/L)	TN (mg/L)	TP load (lbs/ day)	Diss. OrthoP (lbs/ day)	TSS (tons/ day)	TN load (lbs/ day)
Mica Creek										
8/7/2008	3.59	--	0.041	0.014	2.5	0.160	0.39	0.15	0.01	1.72
2/24/2009	105.7	29.7	0.147	0.032	68.60	0.454	83.79 [b]	18.24	18.17 [b]	258.79
3/3/2009	220.2	27.4	0.131	0.030	31.80	0.369	155.58	35.63	17.55	438.22
3/13/2009	233.0	24.1	0.110	0.019	39.80	0.257	138.25	23.88	23.24	323.01
4/22/2009	136.32	12.7	0.058	0.013	19.80	0.162	42.65	9.56	6.76	119.11
5/11/2009	42.06	6.5	0.033	0.010	8.80	0.124	7.49	2.27	0.93	28.13
Neachen Creek										
2/24/2009	12.97	34.0	0.110	0.024	2.5 [b]	0.437	7.70	1.68	0.08	30.57
3/3/2009	41.29	58.8	0.145	0.039	50.0	0.422	32.29	8.69	5.17	93.98
4/9/2009	20.35	15.6	0.067	0.024	7.6	0.217	7.35	2.63	0.39	23.82
4/16/2009	13.59	11.5	0.050	0.022	--	0.177	3.67	1.61	--	12.97
5/27/2009	0.93	--	0.071	0.019	2.50	0.161	0.36	0.10	0.01	0.81
Stinson Creek										
2/24/2009	29.57	37.7	0.145	0.045	44.2 [b]	0.510	23.13	7.18	3.28 [b]	81.34
3/4/2009	41.61	23.4	0.103	0.042	21.0	--	23.12	9.43	2.19	80.12
3/24/2009	36.71	20.7	0.086	0.041	17.4	0.287	17.03	8.12	1.60	56.83
4/9/2009	39.02	16.7	0.089	0.039	14.2	0.239	18.73	8.21	1.39	50.30
5/4/2009	1.83	7.1	0.047	0.026	2.50	0.171	0.46	0.26	0.01	1.69

[b]Data outside data quality objectives

Sampling Date	Inst. Flow (cfs)	Turbidity NTU	TP (mg/L)	Diss. OrthoP (mg/L)	TSS (mg/L)	TN (mg/L)	TP load (lbs/ day)	Diss. OrthoP (lbs/ day)	TSS (tons/ day)	TN load (lbs/ day)
Turner Creek										
8/5/2008	0.50	--	0.04	0.03	2.50	0.05	0.10	0.07	0.00	0.13
2/24/2009	11.63	32.5	0.097	0.025	20.4 [b]	0.322	6.08	1.57	0.59 [b]	20.20
3/3/2009	54.56	75.7	0.139	0.037	52.6	0.321	40.91	10.89	7.19	94.46
4/9/2009	32.13	16.5	0.065	0.021	9.8	0.169	11.26	3.64	0.79	29.29
4/16/2009	23.42	11.2	0.043	0.018	--	0.135	5.43	2.27	--	17.05
4/20/2009	18.96	9.6	0.036	0.015	7.00	0.130	3.68	1.53	0.33	0.00
6/4/2009	1.39	49.3	0.031	0.017	2.50	0.050	0.23	0.13	0.01	0.37
Unnamed Creek to Bennett Bay										
2/25/2009	12.72	39.2	0.161	0.061	--	0.896	11.05	4.19	--	61.47
3/3/2009	32.30	0.8	0.248	0.071	72.0	0.871	43.21	12.37	5.83	151.74
4/9/2009	6.73	17.2	0.084	0.038	7.0	0.382	3.05	1.38	0.12	13.87
4/16/2009	3.04	12.4	0.067	0.034	--	0.375	1.10	0.56	--	6.15
5/4/2009	0.38	7.1	0.050	0.032	2.50	0.237	0.10	0.07	0.00	0.49
Unnamed Creek to Powderhorn Bay										
2/24/2009	11.75	32.0	0.114	0.042	15.8 [b]	0.349	7.22	2.66	0.47 [b]	22.12
3/3/2009	42.63	54.4	0.174	0.054	45.0	0.513	40.01	12.42	4.81	117.96
3/24/2009	18.23	24.2	0.094	0.049	5.5	0.282	9.24	4.82	0.25	27.73
4/9/2009	15.70	18.7	0.081	0.043	6.0	0.242	6.86	3.64	0.24	20.49
4/16/2009	6.21	15.2	0.079	0.048	--	0.217	2.65	1.61	--	7.27
5/4/2009	0.36	16.2	0.083	0.050	2.50	0.167	0.16	0.10	0.00	0.32

[b]Data outside data quality objectives

Sampling Date	Inst. Flow (cfs)	Turbidity NTU	TP (mg/L)	Diss. OrthoP (mg/L)	TSS (mg/L)	TN (mg/L)	TP load (lbs/ day)	Diss. OrthoP (lbs/ day)	TSS (tons/ day)	TN load (lbs/ day)
Wolf Lodge Creek										
5/6/2008	708.23	--	--	--	36.4	--	--	--	--	--
2/25/2009	96.12	9.2	0.035	0.010	--	0.222	18.15	5.18	--	115.10
3/3/2009	316.45	24.0	0.069	0.014	16.0	0.261	117.77	23.90	12.69	445.49
4/13/2009	486.1	13.2	0.060	0.008	28.20	0.100	157.30	20.97	34.35	262.17
4/22/2009	765.55	30.3	0.110	0.010	71.00	0.100	454.21	41.29	136.22	412.92
5/11/2009	188.32	2.9	0.030	0.007	5.20	0.106	30.47	7.11	2.45	107.67
9/14/2009	5.03	--	0.011	0.007	--	0.143	0.31	0.18	--	3.88

[b]Data outside data quality objectives