Final Report

WATER QUALITY STATUS AND TRENDS MONITORING SYSTEM FOR THE CLARK FORK-PEND OREILLE WATERSHED

Summary Monitoring Report 2007

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

FIGURES

TABLE OF CONTENTS (Continued)

TABLES

APPENDICES

CLARK FORK-PEND OREILLE WATERSHED MONITORING, 2007

EXECUTIVE SUMMARY

This report summarizes water quality data collected in the Clark Fork-Pend Oreille Basin during the 2007 calendar year by the Tri-State Water Quality Council. Analyses presented in the report describe the spatial and temporal variability in concentrations of algal nutrients (nitrogen and phosphorus), heavy metals and periphyton (attached algae) in the Clark Fork-Pend Oreille watershed.

The Tri-State Water Quality Council established seven priority water quality monitoring objectives for the Clark Fork-Pend Oreille watershed in 1998. These include:

1) Evaluating time trends in nutrient concentrations in the mainstem Clark Fork River and selected tributaries;
2) evaluating time trends for algal standing crops in the Clark Fork River;
3) monitoring compliance with established summer nutrient concentration target levels in the Clark Fork River;
4) estimating nutrient loading rates to Lake Pend Oreille from the Clark Fork River;
5) evaluating time trends for algal standing crops in near-shore areas of Lake Pend Oreille;
6) evaluating time trends for Secchi transparency in Lake Pend Oreille; and
7) evaluating time trends for nutrient concentrations in the Pend Oreille River.

Nutrient constituents monitored over the past 10 years have included total phosphorus, total nitrogen (total Kjeldahl nitrogen plus nitrate + nitrite nitrogen), total soluble inorganic nitrogen (dissolved nitrate + nitrite plus ammonia nitrogen), and soluble reactive phosphorus (dissolved ortho-phosphorus). For monitoring sites on the Pend Oreille River, total persulfate nitrogen replaces total Kjeldahl nitrogen in the suite of nutrient constituents and is used as a direct measure of total nitrogen. Metals constituents have included total recoverable and dissolved fractions of copper, zinc, cadmium, lead and arsenic. Levels of attached algae are measured in terms of chlorophyll *a* and ash-free dry weight from natural substrate samples. Water quality-monitoring results for the above parameters for 15 river stations and 9 lake stations over a three-state area are analyzed in this report.

This summary report focuses on water quality status and spatial patterns reflected in instream concentrations of the selected monitoring variables. The report does not provide an in-depth assessment of long-term time trends in the data set, nor does it include an appraisal of nutrient loading to Lake Pend Oreille. Those monitoring objectives are addressed in separate five-year trends analysis reports, the first representing monitoring during the 1998-2002 time period (Land & Water 2004). The data presented in this report will be analyzed for time trends later this year as part of a second five-year trends evaluation addressing the 2003-2007 time period.

In general, nutrient concentrations in 2007 were lowest at the Pend Oreille River monitoring sites, and more variable at sites on the Thompson River and Clark Fork River. Generally speaking, nitrogen variables measured at lower Clark Fork River sites from Thompson Falls

Dam to below Cabinet Gorge Dam showed an increasing spatial trend, while phosphorus variables exhibited a decreasing spatial trend.

Total recoverable and dissolved metals constituents were generally low at all monitoring locations during the 2007 calendar year, with median values often at or below the analytical detection limits. Concentrations above the limits of detection were documented, however, and these were usually associated with high flow events occurring during the late-winter or spring periods. The Clark Fork River site below Thompson Falls typically displayed the highest median concentrations of metals, and had the highest number of samples above detection, when compared to the other lower Clark Fork monitoring sites. In general, the frequency of detectable metals parameters (primarily copper and zinc) in the lower Clark Fork River showed a decreasing spatial trend from Thompson Falls Dam to below Cabinet Gorge Dam.

Measured summer nutrient concentrations in the Clark Fork River from the headwaters to the Flathead River confluence generally exceeded the established nutrient target levels during 2007. Median total nitrogen concentrations exceeded the instream target of 300 μg/L at four of nine monitoring stations. Median total phosphorus concentrations exceeded the instream target of 20 μg/L at three stations above Missoula. Median total soluble inorganic nitrogen and soluble reactive phosphorus concentrations each exceeded the instream targets of 30 μg/L and 6 μg/L, respectively, at four of nine monitoring sites in 2007. Target level compliance was attained for total nitrogen in the Clark Fork River below Warm Springs and above Missoula. Target level compliance was attained for total phosphorus at three Clark Fork River sites - below Missoula, at Huson, and above the Flathead River confluence. Only the Clark Fork River above the Little Blackfoot River site attained the established target for total soluble inorganic nitrogen, while the Clark Fork site above the Flathead River confluence met the target level for soluble reactive phosphorus. To fully attain the established nutrient targets, no more than one of ten samples can exceed the target value.

Algal standing crops in the Clark Fork River, measured as chlorophyll *a*, were generally in the mid-range to slightly lower during 2007 when compared to previous sampling years. This trend was evident when all sites were pooled and for individual sample locations. Mean chlorophyll *a* values were slightly higher than in 2006, but were consistent with or lower than other prior monitoring years. Of the three sites that had sampling events in July 2007, two recorded their highest mean chlorophyll *a* values during that month. When reviewing the sample data collected in August and September, five of the sample sites experienced their highest mean chlorophyll *a* values in August, while two sites showed peak values in September. When all of the summer 2007 data are combined to create a summer mean chlorophyll *a* value for each site, two stations, the Clark Fork River at Huson and above the Flathead River, showed chlorophyll *a* values below the established in-stream summer mean target level.

Mean chlorophyll *a* values for attached algae samples collected from natural substrates at near-shore locations in Lake Pend Oreille in 2007 were within the mid-range when compared to previous sample years (1998-2003 and 2006). Two of the long-term sampling sites (Kootenai and Trestle) exhibited their lowest yearly mean concentrations in 2007 when compared to the historical period of record, while sites at Springy Point and Bayview showed mean values equaling the highest and second highest yearly means on record, respectively. The site at Springy Point has shown a consistent increase in chlorophyll *a* concentrations throughout the period of record. When comparing the nine stations monitored in both 2006 and 2007, three stations had higher mean chlorophyll *a* values in 2006, two stations had higher mean values in 2007, and four stations had nearly identical mean values between the two years. In 2007 the Telache and Trestle sites had the lowest mean chlorophyll *a* concentrations of the nine sites, while Springy Point had the highest mean concentration.

Mean Secchi transparency measurements at the Bayview site during 2007 were within mid-range values when compared to the historical data set. Sampling locations at Oden Bay and Sunnyside exhibited the lowest mean Secchi transparency readings during 2007, indicating lower water clarity. Conversely, the near-shore site at Bayview had the highest mean measurements during 2007.

In addition to the basic monitoring program elements described above, this 2007 report includes the results of limited special studies, namely chlorophyll *a* monitoring in Rock Creek and the lower Clark Fork River and crayfish tissue metals analysis for the lower Clark Fork River. It also includes the results of nutrient, chlorophyll *a* and field constituent monitoring on Lake Pend Oreille during the June through September 2007 period. Results for the latter monitoring are provided in this report but are not interpreted relative to spatial or temporal trends or compliance with lake water quality targets.

Mean periphyton concentrations at lower Clark Fork and Rock Creek monitoring locations were highest in the Clark Fork at the Avista Compound and lowest in Rock Creek near its mouth. Two sites, including the East Fork of Rock Creek and Rock Creek near its mouth, had individual replicate samples below the analytical detection limit (1.0 mg/m^2). None of the samples collected in 2007 exceeded the annual maximum instream concentration (150 mg/m^2) for the Clark Fork River above the confluence of the Flathead River. These targets were developed by the Tri-State Water Quality Council and subsequently adopted as site-specific water quality standards by the State of Montana (ARM 17.30.631). Although this criterion does not apply to this section of the river, the 150 mg/m^2 target is generally considered a threshold value for nuisance algae growth.

Concentrations of heavy metals in crayfish tissue were generally quite variable during the 2007 sampling event and did not display any discernible spatial pattern between the two sampling sites. This was especially true for copper and zinc in all tissue types. Cadmium in crayfish tissue was below the analytical detection limit (<1.00 µg/g) for all exoskeleton tissue and most gill tissue samples.

As noted earlier, the 2007 monitoring year reflected in this report is the fifth year of a second five-year data collection cycle. Following completion of the second cycle of trends analyses later this year, the monitoring program will be reevaluated for any needed changes and redesigned, as needed, for initiation in January 2009.

1.0 INTRODUCTION

1.1 Background

1.1.1 History

The mission of the Tri-State Water Quality Council (Council) has been to develop and implement a management strategy to restore and protect designated water uses within the Clark Fork-Pend Oreille Basin. The Tri-State Water Quality Council's Clark Fork-Pend Oreille Watershed water quality monitoring program was begun in 1998 and employs a statistically-based sampling design derived from an analysis of previous nutrient and periphyton data collected for the watershed by the state agencies. Through this design approach, monitoring locations, sampling frequencies and data analysis methods have been optimized to provide reliable information for watershed management decision-making while minimizing operational costs.

The 2007 monitoring program represents the fifth year of a second five-year monitoring program managed by the Council. The previous five-year monitoring program, conducted from 1998-2002, provided the basis for a statistical analysis of water quality time trends reflected in the Council's and the state agencies' data (Land & Water 2004). The 2003-2004 and 2006-2007 monitoring program consisted of monitoring at a relatively small network of stations, while the 2005 monitoring program was temporarily expanded to include a more extensive network of stations previously monitored throughout the watershed. A metals comparability study was also conducted during 2005 to compare different analytical methods for heavy metals. Furthermore, several heavy metal constituents were added to the sampling protocol in 2005, including cadmium, arsenic and lead, in order to provide a baseline of conditions throughout the watershed prior to the planned removal of Milltown Dam upstream of Missoula beginning the following year.

The 2006 monitoring program also included supplemental monitoring on Rock Creek and the Clark Fork River near Noxon, Montana to address citizen concerns about potential cumulative effects of a proposed major metals mine in the Rock Creek drainage. Results of those special studies were presented in a stand alone summary report (PBS&J 2007). The 2007 monitoring program described in this report included the same basic monitoring approach used in most prior years, but with a continuation of a subset of the special mine-related studies that were done in 2006. This 2007 report includes the results of those limited special studies, namely chlorophyll a monitoring in Rock Creek and the lower Clark Fork River and crayfish tissue metals analysis for the lower Clark Fork River, in addition to the basic monitoring program elements.

This report also presents but does not interpret the results of summer (June-September) 2007 monitoring at a network of three open water and six nearshore stations on Lake Pend Oreille that was sponsored by the Idaho Department of Environmental Quality. Monitoring variables included water column concentrations of nutrients and chlorophyll *a*, depth profile information for water temperature and dissolved oxygen, and other field measurements including pH and electrical conductance. These data will be interpreted in a future statistical trends analysis report and subsequent annual summary monitoring reports.

1.1.2 Monitoring Program Goals

The Tri-State Water Quality Council's Water Quality Monitoring Committee has established seven primary monitoring goals for the Clark Fork-Pend Oreille Watershed derived from the Council's tri-state water quality management plan (EPA 1993). These monitoring goals include:

1) Evaluating time trends in nutrient concentrations in the mainstem Clark Fork River and selected tributaries;
2) evaluating time trends for algal standing crops in the Clark Fork River;
3) monitoring compliance with established summer nutrient concentration target levels in the Clark Fork River;
4) estimating nutrient loading rates to Lake Pend Oreille from the Clark Fork River;
5) evaluating time trends for algal standing crops in near-shore areas of Lake Pend Oreille;
6) evaluating time trends for Secchi transparency in Lake Pend Oreille; and
7) evaluating time trends for nutrient concentrations in the Pend Oreille River.

1.2 Project Description

The study area includes 24 monitoring locations on the Clark Fork River, selected tributaries, Lake Pend Oreille, and the Pend Oreille River within the Clark Fork-Pend Oreille watershed of western Montana, northern Idaho and northeastern Washington (**Appendix A**). The locations selected for water quality monitoring provide distributed spatial coverage for evaluating the effects of point and non-point pollution sources, and the influences of major population centers and tributary inflows. This design provides for a cost effective and reasonably sensitive assessment of nutrient and metals inputs and effects throughout the basin. A summary of monitoring locations and associated sampling frequencies are provided in **Table 1-1**.

Table 1-1. ***Monitoring locations and sampling frequency.***

Station	Name	Sampling Frequency
2.5	Silver Bow Creek at Opportunity	S10
07	Clark Fork below Warm Springs Creek	S10
09	Clark Fork at Deer Lodge	P10, S10
10	Clark Fork above Little Blackfoot River	P10, S10
12	Clark Fork at Bonita	P10, S10
15.5	Clark Fork above Missoula	P10, S10
18	Clark Fork below Missoula (Shuffields)	P10, S10
22	Clark Fork at Huson	P10, S10
25	Clark Fork above Flathead River	P10, S10
27.5	Thompson River near mouth	N12
28*	Clark Fork below Thompson Falls	NM12
28.1	West Fork Rock Creek	P11
28.2	East Fork Rock Creek	P11
28.3	Rock Creek near mouth	P11
29*	Clark Fork at Noxon Bridge	NM12
29.1	Clark Fork above Rock Creek	CR10, P11
29.2	Clark Fork below Rock Creek	CR10, P11
30*	Clark Fork below Cabinet Gorge Dam	NM18, P11

Station	Name	Sampling Frequency
	Pend Oreille River at Newport, WA	N12
	Pend Oreille River at Metaline Falls, WA	N12
	Lake Pend Oreille: Lakeview	P10, NSD
	Lake Pend Oreille: Telache	P10, NSD
	Lake Pend Oreille: Midlake	P10, NSD
	Lake Pend Oreille: Garfield Bay	P10, NSD
	Lake Pend Oreille: Bayview open water	P10, NSD
	Lake Pend Oreille: Bayview nearshore	P10, NSD
	Lake Pend Oreille: PDO North	P10, NSD
	Lake Pend Oreille: Oden Bay	P10, NSD
	Lake Pend Oreille: Sunnyside	P10, NSD

CR10 = Crayfish metals, 10 replicates per site
N12 = Nutrients and field constituents, monthly samples
NM12 = Nutrients, metals and field constituents, monthly samples
NM18 = Nutrients, metals and field constituents, monthly samples and 6 peak flow samples
P10 = Periphyton, 10 replicates per site, July, August and September
P11 = Periphyton 11 replicates per site, August
S10 = Summer nutrients and field constituents, 10 samples during 3 months in summer
NSD = Nutrients, chlorophyll *a*, Secchi depth and field constituents (4 sampling events during 2007)
* These sites sponsored by Avista Corp., pursuant to 401 certification requirement

The 2003-2007 program included a basic monitoring component and several annual or periodic rotational add-on elements. The basic program consisted of the highest priorities for annual monitoring, while the add-ons represented options for additional monitoring that were contingent on annual funding availability. The 2007 basic monitoring program included each of the tasks described below:

1. monthly collection of nutrient and heavy metals samples and field measurements at three lower Clark Fork River sites, and monthly collection of nutrient samples and field measurements at a single site on the Thompson River and two sites on the Pend Oreille River (January through December 2007);
2. summer collection of periphyton standing crop samples at seven Clark Fork River sites (July, August and September);
3. summer collection of nutrient samples and field constituents at nine sites on Silver Bow Creek and the Clark Fork River (10 samples over 3 months);
4. spring collection of nutrient and heavy metals samples at the Clark Fork River below Cabinet Gorge Dam during spring peak flow (six samples over a one-month period from May to June);
5. summer collection of Secchi transparency at nine Lake Pend Oreille sites (monthly from June-September); and
6. summer collection of periphyton standing crop samples at nine Lake Pend Oreille sites (September).

Monitored field constituents included: water temperature (˚C), pH (standard units), specific conductance (µs/cm), dissolved oxygen (mg/l), turbidity (NTU) and, in the case of Lake Pend Oreille, Secchi transparency (m). Streamflow (instantaneous, cubic feet per second (cfs)) and river stage (ft) were also recorded where gauging stations coincided with monitoring stations. Nutrient constituents included: total phosphorus (TP), total Kjeldahl nitrogen (TKN) or total persulfate nitrogen (TPN, Lake Pend Oreille and Pend Oreille River sites), nitrate + nitrite nitrogen (NO_3+NO_2), total ammonia nitrogen (NH_3+NH_4), and soluble reactive phosphorus (SRP). Heavy metal constituents included dissolved and total recoverable fractions of copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb) and arsenic (As). Samples were also analyzed for hardness (mg/L as $CaCO_3$). Values for total nitrogen (TN) and total soluble inorganic nitrogen (TSIN) were calculated as follows:

TN = TKN plus NO_3+NO_2-N TSIN = NO_3+NO_2-N plus NH_3+NH_4-N

Periphyton samples from natural substrates were analyzed for chlorophyll *a* (mg/m^2) and ash-free dry weight (g/m^2). Secchi transparency was recorded in meters (m).

Rock Creek Mine related mine supplemental monitoring that was conducted in 2007 included chlorophyll *a* sampling at three sites in the Rock Creek drainage and at three sites in the Clark Fork River (11 replicates analyzed separately at each site), and collection and analysis of metals concentrations in crayfish tissues (carapace/exoskeleton, gills, hepatopancreas) from two sites in the Clark Fork River (10 replicates analyzed separately for each tissue type from each site).

Supplemental monitoring of Lake Pend Oreille included the monthly collection of water column samples for nutrient and chlorophyll *a* analysis and field measurements, including depth profiles for water temperature and dissolved oxygen, at each of six nearshore and three open water stations during the June-September 2007 period.

This report provides a summary of the water quality and biological data that were collected during the 2007 calendar year. No detailed analyses of time trends in water quality were made as a part of this investigation, nor were statistical comparisons made of water quality between stations. These types of analyses are conducted once every five years on a complete five-year data set. The 2007 calendar year monitoring data will be evaluated for time trends as a part of the 2003-2007 five-year analysis that will be completed later in 2008 and reported in a separate document. The Lake Pend Oreille supplemental monitoring data will be interpreted together with earlier lake data in the 2003-2007 water quality trends report.

1.3 Sampling Methods

1.3.1 Field Constituents - Clark Fork River

Field constituents, including water temperature (˚C), pH (standard units), conductivity (µs/cm), and dissolved oxygen (mg/L) were measured on site using a portable Hach® water quality probe. Turbidity (NTU) levels were measured using a Hach® portable turbidimeter. All field instruments were calibrated each morning and monitored throughout the day to ensure proper performance. Field constituents were recorded on a field form before leaving the site.

1.3.2 Nutrients and Metals - Clark Fork River

Water samples for nutrient and metal constituents were collected using a grab sampling technique by wading in a well-mixed portion of the river. Samples were taken in the upstream direction to avoid entrainment of sediment disturbed by wading.

Water samples for total nutrients (TP and TKN) and total recoverable metals (As, Cd, Cu, Pb, and Zn) were collected directly from the stream in separate polyethylene bottles. Bottles were rinsed three times with native water prior to sampling. During sampling, the sample bottle was positioned to face upstream and was drawn through the water column once, carefully avoiding disturbance of bottom sediments. Samples were acidified with concentrated sulfuric acid (H_2SO_4) for nutrient samples and concentrated nitric acid (HNO_3) for metal samples. Nutrient samples were stored on ice and delivered to the analytical laboratory within 48 hours of collection. Metals samples were delivered to the analytical laboratory within their allowable holding time.

Water for soluble nutrients (NO_3+NO_2-N, NH_3+NH_4-N and SRP) and dissolved metals (dissolved As, Cd, Cu, Pb and Zn) were filtered in the field through a 0.45 µm filter into polyethylene bottles. Bottles were rinsed three times with filtered water, and a small volume of filtrate (30-50 ml) was discarded prior to sample collection to ensure the filter was properly rinsed. Dissolved nutrient samples (NO_2+NO_3-N, NH_3+NH_4-N and SRP) were frozen or stored on ice and transported to the analytical laboratory within 48 hours of collection. Dissolved metals samples were acidified with concentrated nitric acid (HNO_3) and delivered to the laboratory for analysis within their allowable holding time.

Samples were clearly labeled with a waterproof marker or pre-printed labels. Label information included the site identification number, date and time, sample type, preservative, and sampler's initials. Each bottle was recorded on a chain-of-custody form before leaving the site. A summary of sampling protocols is provided in **Table 1-2**.

Table 1-2. ***Nutrient and metals sampling protocols.***

Constituent	Sample Volume	Container	Preservation	Holding Time
TP and TKN	250 ml	Acid-washed polyethylene	H_2SO_4, cool to 4°C	28 days
Total Recoverable Cu, Zn, Cd, Pb, As	250 ml	Acid-washed polyethylene	HNO_3	6 months
Dissolved Cu, Zn, Cd, Pb, As	250 ml	Acid-washed polyethylene	Filter, HNO_3	6 months
NO_2+NO_3 and NH_3+NH_4	250 ml	Acid-washed polyethylene	Filter, cool to 4°C or freeze	28 days (if frozen)
SRP	250 ml	Acid-washed polyethylene	Filter, cool to 4°C or freeze	48 hours

1.3.3 Field Constituents and Nutrients – Lake Pend Oreille

Field measurements were performed and water quality samples were collected for nutrient and chlorophyll *a* analysis at three open water and nine nearshore locations on Lake Pend Oreille. Depth profile information for field constituents including water temperature and dissolved oxygen was recorded at each lake monitoring site. Field measurements also included pH, conductivity and Secchi transparency. Secchi depth was determined with a standard 20 cm Secchi disc and readings were taken on the side of the boat with the least amount of surface roughness. Water transparency was evaluated by lowering the Secchi disc over the side of the boat until the markings were no longer visible. The depth was read after the disc was lowered past the extinction point, and then raised until just visible. Depth was recorded in meters. The sampler also noted time of day, weather, water surface conditions, and any other variables that may have affected the reading. Nutrient and water column chlorophyll samples were depth composited at each site with the use of a Van Dorn depth sampler and a sample churn splitter. The number and depths of individual samples was determined during each sampling event based on the presence or absence of lake stratification and/or anoxic conditions in bottom waters. Lake sampling protocols are described in detail in the Lake Pend Oreille Water Quality Monitoring Program Quality Assurance Project Plan (IDEQ 2006).

1.3.4 Field Constituents and Nutrients – Pend Oreille River

The Washington Department of Ecology collected the water quality samples for field constituents and nutrients at the two monitoring stations on the Pend Oreille River. Sampling protocols were similar, though not identical, to those described above for the Clark Fork stations. Stream sampling protocols, and the Quality Assurance Plan for the river and stream water quality monitoring program in Washington, can be found at: www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html.

1.3.5 Periphyton – Clark Fork River

Two types of periphyton samples were collected: hoop samples (a bulk sampling method) and template samples (a rock scraping method). Hoop samples were collected for filamentous green algae (*Cladophora)* dominated sites (sites above Missoula) and template samples were collected for diatom dominated sites (sites below Missoula). Both chlorophyll *a* and ash-free dry weight (AFDW) were measured from the hoop and template samples. Clark Fork River periphyton samples were collected on two to three separate sampling events, once in July, August, and September for the upper three sites and in August and September for the remainder of the downstream sites, in an attempt to document peak algal standing crops.

1.3.6 Periphyton – Rock Creek and Lower Clark Fork River

Eleven replicate chlorophyll samples were collected in mid-August from natural substrates at each of three Clark Fork River and three Rock Creek monitoring locations. Chlorophyll samples were collected using the template method described by the Montana Department of Environmental Quality (*Water Quality Planning Bureau Sample Collection and Laboratory Analysis of Chlorophyll- a* (Revision 3, May 2007), Chapter VII, Part A). Each replicate sample container was labeled, wrapped in foil to eliminate any light from reaching the sample, and placed in a covered cooler on dry ice for transport to the analytical laboratory. Chlorophyll samples were delivered to the laboratory within 48 hours of collection for analysis of chlorophyll *a* pigment.

1.3.7 Periphyton – Lake Pend Oreille

Periphyton samples were collected at six nearshore locations on Lake Pend Oreille in September using the template method. Additional details of the lake sampling protocols are described in the Lake Pend Oreille Water Quality Monitoring Program Quality Assurance Project Plan (IDEQ 2006).

1.3.8 Crayfish Metals – Lower Clark Fork River

Pacific crayfish (*Pacifastacus trowbridgi*) were collected from paired locations in the Clark Fork River upstream and downstream of the Rock Creek confluence and the proposed location of the mine direct discharge to the Clark Fork River. Several dozen crayfish were collected at each station. Sampling was performed in late summer to avoid the crayfish spring molting period, and any recently molted individual crayfish were excluded from the sample. Crayfish were collected from the entire channel cross-section at each site by hand. Divers were employed for crayfish collection. Immediately following collection, crayfish were stored live on ice in a clean cooler for transport.

The sex and length (measured as rostrum to carapace grove) of each crayfish was recorded. Ten individual crayfish representing the 70^{th} to 80^{th} percentile size class of the bulk sample (i.e. large, mature specimens) were selected for analysis. The sample composite attempted to include 50% male and 50% female specimens, where available within the selected size criteria. Crayfish tissues, including carapace (exoskeleton), hepatopancreas and gill, were isolated from the specimens and analyzed separately for concentrations of heavy metals.

1.4 Analytical Methods

State-certified laboratories, including the Montana Department of Public Health and Human Services chemistry laboratory (Clark Fork River metals analyses), the Missoula wastewater treatment plant laboratory (Clark Fork River nutrient analyses), the SVL Laboratory (Lake Pend Oreille nutrient and chlorophyll analyses) and the Washington Department of Ecology Manchester laboratory (Pend Oreille River nutrient analyses) performed all water chemistry analyses using standard methods. The University of Montana biology laboratory performed the Clark Fork and Lake Pend Oreille periphyton sample analyses. Energy Laboratories in Helena performed the lower Clark Fork and Rock Creek periphyton sample analyses using the MDEQ protocol. The analytical methods and detection limits are listed in **Table 1-3**. Methods used by the Washington Department of Ecology's Manchester Laboratory are comparable though somewhat different and are described at: www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html.

The Montana Department of Public Health and Human Services chemistry laboratory analyzed the crayfish tissue samples. For this analysis, crayfish tissues, including carapace (exoskeleton), hepatopancreas, and gill, were isolated from individual specimens by hand dissection and analyzed separately at the analytical laboratory for concentrations of total metals. Animal dissection was performed using clean instruments and equipment (scalpel, tweezers, scissors, and latex gloves) for each sample. The carapace was removed by cutting with scissors all the way through to the rostrum and cutting the connective tissue. The gills are located under the carapace on both lateral sides, and were removed by cutting at the base. The hepatopancreas is located on the ventral side on both sides of the gonads and contains two lobes. Both lobes of the hepatopancreas were kept intact. Tissues were stored in glass jars and frozen until analysis.

Digestion was performed following an "acid digestion-oxidation under elevated temperature and pressure in a closed system" microwave procedure, consistent with EPA Method 3051. Samples were prepared by weighing, freeze-drying, and homogenizing. Sample wet weight was measured, and following the freeze-drying the samples were dehydrated and re-reweighed. Wet-weight and dry-weight measurements were used to calculate percent moisture content of each tissue sample. The dehydrated samples were ground to a homogenous meal. From the homogenous meal a sub-sample was digested, and the remaining material was stored. Analysis for metals was performed following EPA method 200.8 utilizing inductively coupled plasma mass spectrometry (ICP-MS). EPA method 200.7 may also have been used based on the laboratory's discretion.

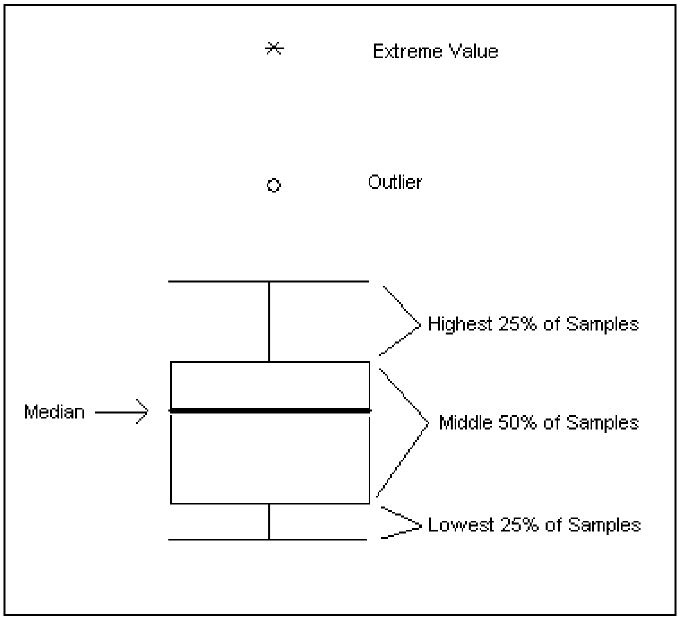
Table 1-3. ***Analytical methods and detection limits.***

Analyte	Method	Detection Limit
Clark Fork River Monitoring Stations (MT DPHHS, Missoula WWTP, UM, Energy Labs)		
Total Phosphorus (TP)	EPA 365.3	4 µg/l
Total Kjeldahl Nitrogen (TKN)	EPA 351.2	100 µg/l
Nitrate + Nitrite-Nitrogen (NO_2NO_3)	EPA 353.2	2 µg/l
Total Ammonia-Nitrogen (NH_3+NH_4)	EPA 350.1	10 µg/l
Soluble Reactive Phosphorus (SRP)	EPA 365.3	4 µg/l
Total Recoverable and Dissolved Copper (Cu)	EPA 200.7	1 µg/l
Total Recoverable and Dissolved Zinc (Zn)	EPA 200.7	0.5 µg/l
Total Recoverable and Dissolved Cadmium (Cd)	EPA 200.7	0.1 µg/l
Total Recoverable and Dissolved Lead (Pb)	EPA 200.7	1 µg/l
Total Recoverable and Dissolved Arsenic (As)	EPA 200.7	1 µg/l
Chlorophyll *a* (Chl-*a*)	SM 10200H	N/A
Lake Pend Oreille Monitoring Stations (SVL Lab)		
Total Nitrogen (TN)	ASTM D-5176	1 µg/l
Total Phosphorus (TP)	SM 4500-P-E	2 µg/l
Chlorophyll *a* (Chl-*a*)	SM 10200H	N/A

1.5 Statistical Methods

This report includes summary statistics and boxplots for visual comparisons of water quality. Statistics include median, mean, minimum, maximum and standard deviation. Boxplots compare water quality and algae data from different monitoring locations (i.e. spatial comparison) or at the same station for different sampling years (i.e. temporal comparison). The shapes of the boxplots are based on median, interquartile, and extreme values of the data. The box encloses the interquartile range, which contains the middle 50 percent of the values. The median value is displayed as the centerline of the box. The top and bottom whiskers display the maximum and minimum observed values, excluding outliers and extreme values. Outliers, defined as values that are 1.5 to 3 times greater than or less than values in the interquartile range, are displayed as circles (○). Extreme values, or those more than 3 times the values in the interquartile range, are displayed with an asterisk (*). The boxplot construction is shown graphically in **Figure 1-1**.

Figure 1-1. ***Boxplot construction.***



2.0 WATER CHEMISRTY DATA SUMMARY

2.1 Field Constituents Spatial Comparison

Field constituents were recorded monthly at 6 sample locations throughout the lower Clark Fork-Pend Oreille watershed in 2007. Measured constituents include stream temperature (^oC), pH, specific conductance (µs/cm), dissolved oxygen (mg/L), and turbidity (NTU). Spatial boxplots presenting 2007 field constituent data are provided in **Appendix B**, and summary statistics are provided in **Appendix C**.

2.1.1 Temperature

Median stream temperature varied from 8.0 ^oC in the Thompson River to 11.3 ^oC in the Clark Fork River at Noxon Bridge. The Pend Oreille River site at Metaline Falls had the highest temperature in the lower Clark Fork-Pend Oreille watershed at 12.6 ^oC, while the site at Newport (10.7 ^oC) was comparable to the Clark Fork River below Cabinet Gorge Dam (11.1 ^oC). Differences between sites are partially an artifact of sampling time of day.

2.1.2 pH

Median pH values were highest in the Pend Oreille River at Metaline Falls (8.47) and lowest in the Thompson River (7.56). Median pH values in 2007 showed an increase in pH moving downstream. pH often increases from morning to evening as plants absorb carbon dioxide during photosynthesis. It is likely that at least some of the station differences in pH were due to diurnal variations.

2.1.3 Conductivity
Conductivity, an indirect measure of dissolved ion concentrations, was lowest in the Thompson River (153.5 µs/cm) and highest in the Clark Fork River below Thompson Falls (179.5 µs/cm). There was very little variation (175.5 µs/cm to 179.5 µs/cm) in conductivity between the Clark Fork River sites. Median conductivity values in the Pend Oreille River at Newport (165.5 µs/cm) and at Metaline Falls (166.5) were higher than the Thompson River site but lower than the three Clark Fork River sites.

2.1.4 Dissolved Oxygen
Median dissolved oxygen (DO) concentrations in 2007 were highest in the Thompson River and lowest in the Clark Fork River below Cabinet Gorge Dam. Median DO concentrations in the Clark Fork River generally decreased in the downstream direction. However, dissolved oxygen concentrations between sampling sites was also likely affected by diurnal fluctuations like for pH.

2.1.5 Turbidity
Median turbidity was lowest in the Pend Oreille River at Metaline Falls (1.15 NTU) and highest in the Clark Fork River below Thompson Falls (2.82 NTU), although values were quite low for all sample locations.

2.2 Algal Nutrients Spatial Comparison

Monthly nutrient samples were collected at six sites throughout the Clark Fork-Pend Oreille watershed in 2007. Samples were analyzed for total nitrogen (comprised of total Kjeldahl and nitrate+nitrite-nitrogen for the four Clark Fork River sites and as total persulfate nitrogen for the two Pend Oreille River sites), total soluble inorganic nitrogen (comprised of nitrate+nitrite and total ammonia nitrogen), total phosphorus, and soluble reactive phosphorus. Ammonia-nitrogen concentration data were not available for the Clark Fork River site at Noxon for the November and December sampling runs. These values have been assumed to be under the detection limit based on the historical data and have been recorded as half the detection limit (0.005 mg/L) in order to calculate total soluble inorganic nitrogen values for these two sampling dates. Boxplots provide a visual comparison of spatial patterns in nutrient concentrations during 2007 (**Appendix B**). Summary statistics, including mean, median, minimum, maximum, and standard deviation, as well as the number of samples are provided in **Appendix C**. For boxplot presentations, stations were ordered (left to right) in the upstream to downstream direction.

2.2.1 Total Nitrogen
Of the six stations monitored monthly during 2007, median total nitrogen (TN) concentrations were highest in the Clark Fork River below Thompson Falls Dam (0.188 mg/L) and decreased in a downstream direction to Pend Oreille River at Newport (0.093 mg/L). The Thompson River site (0.078 mg/L) had a lower median concentration of TN than all other monitoring sites. Of the three Clark Fork River sites, the site below Cabinet Gorge Dam (0.152 mg/L) yielded the lowest median TN concentration during 2007. However, all three sites showed similar concentrations, ranging from 0.152–0.188 mg/L.

2.2.2 Total Soluble Inorganic Nitrogen
Median total soluble inorganic nitrogen (TSIN) concentrations during 2007 increased from Thompson River (0.025 mg/L) to the Clark Fork River at Noxon (0.053 mg/L) and then decreased downstream to the Pend Oreille at Newport and Metaline Falls (0.01 mg/L). The Clark Fork River below Cabinet Gorge Dam (0.043 mg/L) had the lowest median TSIN value of the three Clark Fork River sites.

2.2.3 Total Phosphorous
Median total phosphorus (TP) concentrations were highest in the Clark Fork River below Thompson Falls Dam (0.0111 mg/L) and decreased downstream to the Pend Oreille River sites at Newport (0.0045 mg/L) and Metaline Falls (0.0051 mg/L). Median TP concentration in the Thompson River (0.0092 mg/L) was similar to the lowest value recorded in the Clark Fork River, at the site below Cabinet Gorge Dam (0.0096 mg/L).

2.2.4 Soluble Reactive Phosphorus
Median soluble reactive phosphorus (SRP) concentrations fluctuated throughout the lower watershed. The highest median concentration in 2007 occurred in the Thompson River (0.0079 mg/L), while the lowest median SRP occurred at the Pend Oreille River sites at Newport and Metaline Falls (0.002 mg/L). Of the three Clark Fork River sites, the site below Thompson Falls Dam (0.0039 mg/L) had the lowest median SRP concentration, while the site at Noxon (0.0052 mg/L) had the highest concentration.

2.3 Heavy Metals Spatial Comparison

2.3.1 Total Recoverable Copper
Median total recoverable copper (Cu) concentrations were at or below detection (0.001 mg/L) in the Clark Fork River at sites below Thompson Falls Dam (0.001 mg/L), at Noxon (0.001 mg/L) and below Cabinet Gorge Dam (0.00075 mg/L). The Clark Fork River site below Thompson Falls Dam had four samples above the analytical detection limit, while the site at Noxon had two samples above the analytical detection limit. At both sites all samples above the detection limit were at a concentration of 0.002 mg/L.

2.3.2 Total Recoverable Zinc
Median concentrations of total recoverable zinc (Zn) were highest in the Clark Fork River below Thompson Falls Dam (0.0028 mg/L) and decreased in the downstream direction to the site below Cabinet Gorge Dam (0.0016 mg/L).

2.3.3 Total Recoverable Cadmium
Median total recoverable cadmium (Cd) concentrations were below the analytical detection limit (<0.00008 mg/L) at the three sample locations during 2007. The Clark Fork River site at Noxon had one sample above the detection limit (0.00017 mg/L). All other samples at the three sites were below the analytical detection limit.

2.3.4 Total Recoverable Lead
Median concentrations of total recoverable lead (Pb) were below the analytical detection limit (<0.0005 mg/L) for all three sample locations during 2007. The Clark Fork River site below

Thompson Falls Dam had two samples above detection (0.0014), but all other samples were below the analytical detection limit during 2007.

2.3.5 Total Recoverable Arsenic

Median concentrations of total recoverable arsenic (As) were below the analytical detection limit (0.001 mg/L) for all three sample locations during 2007. The Clark Fork River site below Thompson Falls Dam had two samples above detection, both of which were during the high flow months of May (0.002 mg/L) and June (0.008 mg/L). All samples at the Clark Fork River sites at Noxon and below the Cabinet Gorge Dam were at or below the analytical detection limit during 2007.

2.3.6 Dissolved Metals

Dissolved metals samples were collected at three sites in 2007, including the Clark Fork River below Thompson Falls Dam, at Noxon Bridge, and below Cabinet Gorge Dam. Samples were analyzed for dissolved copper, dissolved zinc, dissolved cadmium, dissolved lead, and dissolved arsenic at these locations. Median dissolved metals concentrations were at or below the analytical detection limit at all sites for dissolved copper, dissolved cadmium, dissolved lead, and dissolved arsenic. Very few samples were above the analytical detection limit. Median concentrations of dissolved zinc ranged from 0.0092 mg/L below Cabinet Gorge Dam to 0.015 mg/L at Noxon Bridge.

2.3.7 Heavy Metals Standards Comparison

Heavy metals concentrations from Clark Fork River sites below Thompson Falls Dam (Site 28) and at Noxon Bridge (Site 29) were compared to published acute and chronic metals toxicity standards for Montana, based on hardness at time of sampling (Montana DEQ, 2007). Metals concentrations from the Clark Fork River site below Cabinet Gorge Dam (Site 30) were compared to acute and chronic metals standards for Idaho (Idaho Administrative Rules Act, 2006). Only one sample from all sites exceeded calculated metals toxicity standards during 2007, including samples collected from below Cabinet Gorge Dam during peak flow sampling. The total recoverable copper sample collected on 5/15/2007 from below Thompson Falls (8.0 µg/L) exceeded the calculated chronic standard (6.6 µg/L). This sample was collected during the regular monthly sampling, but occurred at the onset of spring runoff. Otherwise, all samples at all locations were below the calculated acute and chronic standards for metals toxicity during 2007. A comparison of metals concentrations versus calculated standards for Montana and Idaho is provided in **Appendix C**.

2.4 Summer Nutrient Levels

Intensive summer nutrient monitoring was conducted at one station on Silver Bow Creek and eight stations on the Clark Fork River to evaluate compliance with the established instream target concentrations (**Appendix A, Figure 4**). The following stations were each sampled ten times during summer 2007 by Missoula wastewater treatment plant personnel: Silver Bow Creek at Opportunity, Clark Fork River below Warm Springs Creek, Clark Fork River at Deer Lodge, Clark Fork River above the Little Blackfoot River, Clark Fork River at Bonita, Clark Fork River above Missoula, Clark Fork River below Missoula, Clark Fork River at Huson, and Clark Fork River above the Flathead River.

Samples were collected beginning in June and continuing through September. However, the official compliance period is stated as June 21 – September 21, so several samples collected during summer 2007 fell outside that time period. Hydrographs depicting streamflows during the summer sample dates are provided for Clark Fork sites at Deer Lodge (**Figure 2-1**) and above Missoula (**Figure 2-2**). Samples collected during the early part of June occurred during the falling limb of the spring runoff hydrograph, and may not be representative of summer low-water conditions.

Figure 2-1. ***Hydrograph for Clark Fork River at Deer Lodge showing summer sampling dates.***

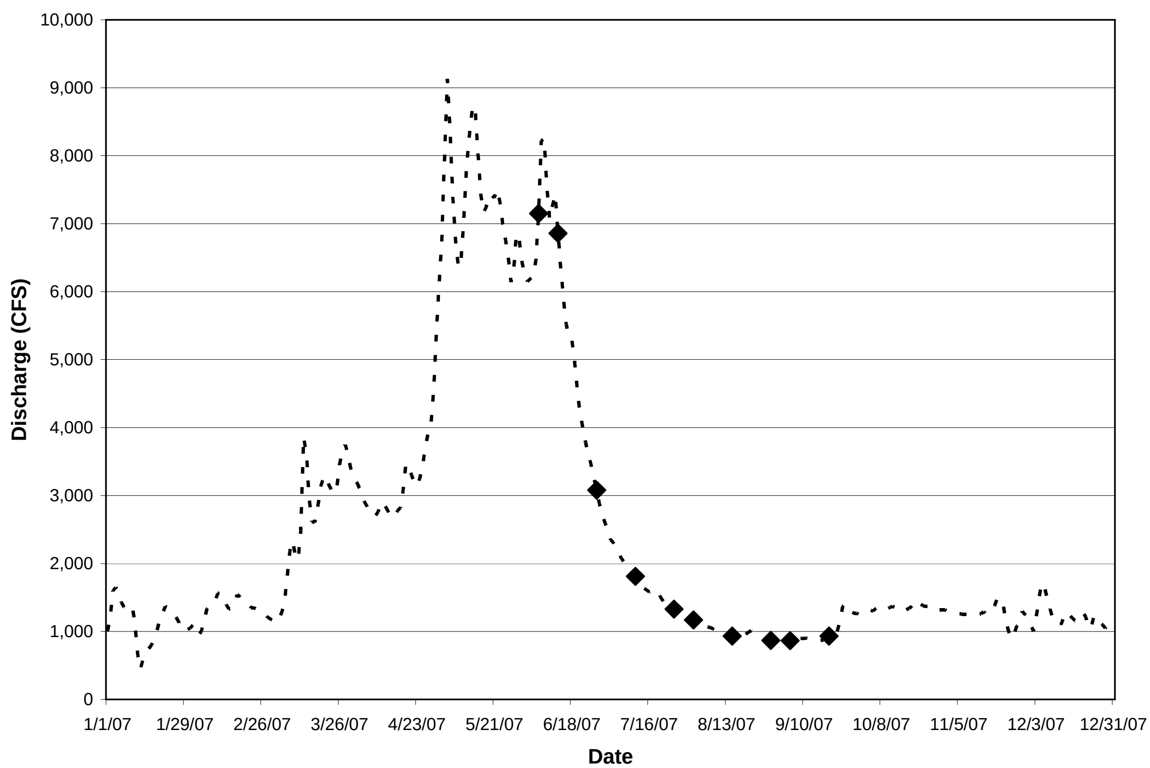
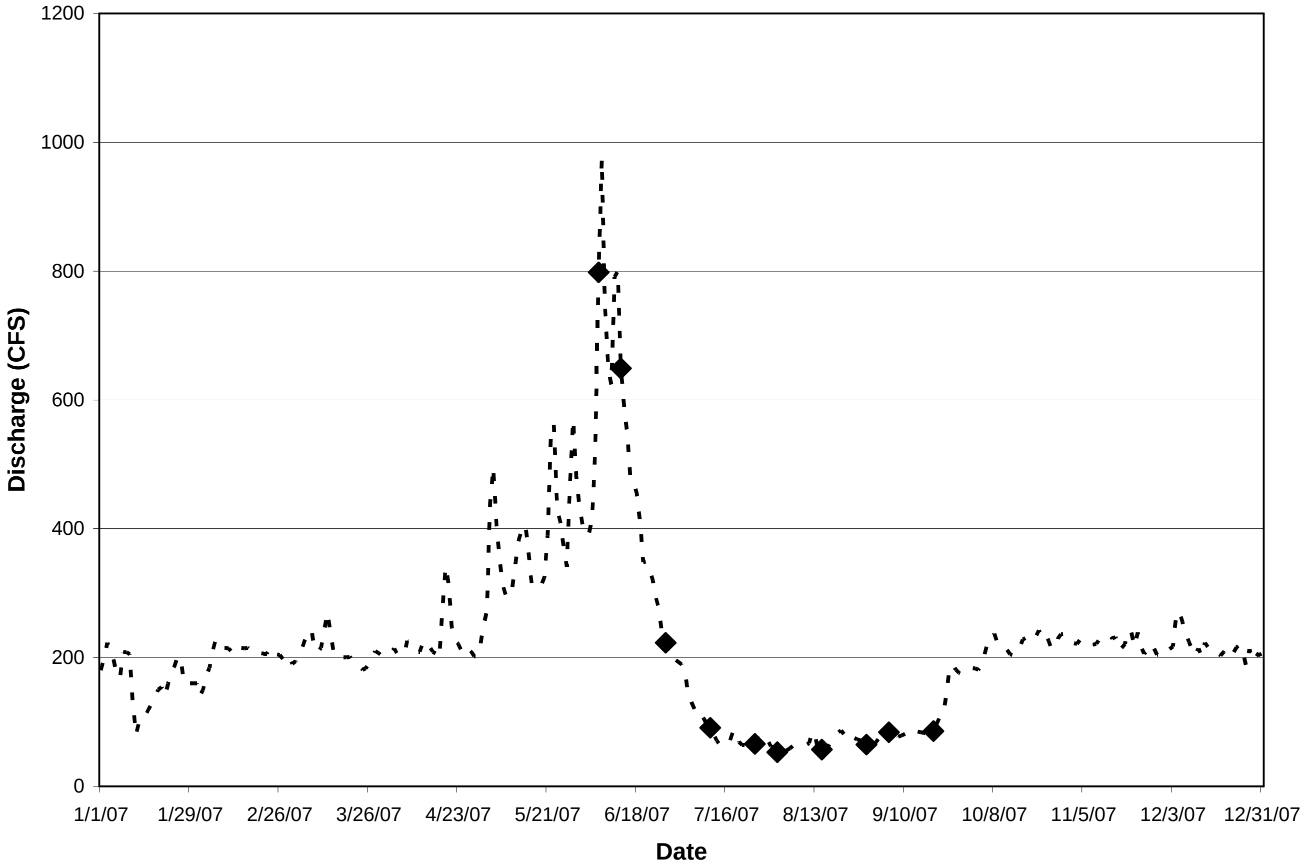


Figure 2-2. ***Hydrograph for Clark Fork River above Missoula showing summer sampling dates.***



The following Clark Fork Basin nutrient targets were developed by the Tri-State Water Quality Council and subsequently adopted as water quality standards by the State of Montana (ARM 17.30.631):

- Total Nitrogen Clark Fork River (headwaters to Flathead River) 300 µg/L
- Total Phosphorus Clark Fork River (headwaters to Missoula) 20 µg/L
- Total Phosphorus Clark Fork River (Missoula to Flathead River) 39 µg/L
- Total Soluble Inorganic Nitrogen 30 µg/L (secondary target)
- Soluble Reactive Phosphorus 6 µg/L (secondary target)

2.4.1 Summer Boxplots

Spatial comparisons of summer nutrient concentrations in Silver Bow Creek and the Clark Fork River are presented using statistical boxplots (**Appendix D**). Where appropriate, boxplots are displayed on two scales to better display the data. The relevant target values are shown as horizontal lines, where available. Boxplots were constructed using all samples collected during summer 2007, including samples from early-June and late-September that fell outside the compliance period.

The total nitrogen (TN) boxplots show that four stations had median values exceeding the target level (300 µg/L) in 2007, including Silver Bow Creek at Opportunity (2338 µg/L) and the Clark Fork River at Deer Lodge (305 µg/L), above the Little Blackfoot River (311 µg/L), and at Bonita (313 µg/L) . Median summer TN was highest at the Silver Bow Creek site, and generally decreased in a downstream direction, although increases were noted at Deer Lodge, Bonita, and below Missoula. The lowest median summer TN concentration was in the Clark Fork River above the Flathead River confluence (168 µg/L).

Median summer total phosphorus (TP) concentrations at stations above Missoula exceeded the 20 µg/L target at three sites in 2007, including Silver Bow Creek at Opportunity (319 µg/L) and the Clark Fork River sites below Warm Springs (55 µg/L), and above the Little Blackfoot River (31 µg/L). Median summer TP in the Clark Fork River generally decreased from below Warm Springs Creek with increases noted above the Little Blackfoot River and below Missoula. As was observed for TN, the lowest median summer TP concentration was observed in the Clark Fork River above the Flathead River confluence (12.3 µg/L).

Median summer total soluble inorganic nitrogen (TSIN) concentrations in 2007 were above the target value of 30 µg/L at four stations. Silver Bow Creek at Opportunity had the highest median value (1460 µg/L). The Clark Fork stations above Deer Lodge (75 µg/L), below Missoula (70 µg/L), and at Huson (48 µg/L) also exceeded the instream target. The Clark Fork River site above the Little Blackfoot River had the lowest median summer TSIN value at 8.9 µg/L.

Median summer soluble reactive phosphorus (SRP) concentrations exceeded the target value of 6 µg/L at four of the nine monitoring stations, including Silver Bow Creek at Opportunity (224 µg/L), and the Clark Fork River sites below Warm Springs Creek (38 µg/L), above Deer Lodge (9.7µg/L), above the Little Blackfoot River (18.5 µg/L), and at Bonita (11.8 µg/L). The lowest median SRP concentration was found in the Clark Fork River above the Flathead River confluence (4.0 µg/L).

2.4.2 Summer Summary Statistics

Summary statistics, including mean, median, minimum, maximum, and standard deviation, were calculated for 2007 nutrient concentrations measured at the nine summer nutrient target sites (**Appendix E**).

Individual nutrient samples from summer 2007 were compared to the previously stated nutrient target levels. Two samples collected during 2007 fell outside the compliance period, so only the eight samples which fell within the period from June 21 – September 21 were compared to nutrient targets. In summer 2007, two of the nine sites had all total nitrogen samples showing concentrations below the target value (300 µg/L), including Clark Fork River sites below Warm Springs Creek, and above Missoula. Three Clark Fork River sites had all total phosphorus samples with concentrations below the target value (39 µg/L for stations below Missoula), including below Missoula, at Huson, and above the Flathead River confluence. The Clark Fork River site above the Little Blackfoot River had all total soluble nitrogen samples below the target level (30 µg/L) during summer 2007. The Clark Fork River site above the Flathead River confluence had all soluble reactive phosphorus samples below the target level (6 µg/L), while all other sites had at least one sample above the target. The number and percentage of samples exceeding the nutrient target levels during the summer compliance period is shown for each monitoring station below in **Table 2-1**.

Table 2-1. ***Summer sample nutrient target attainment summary.***

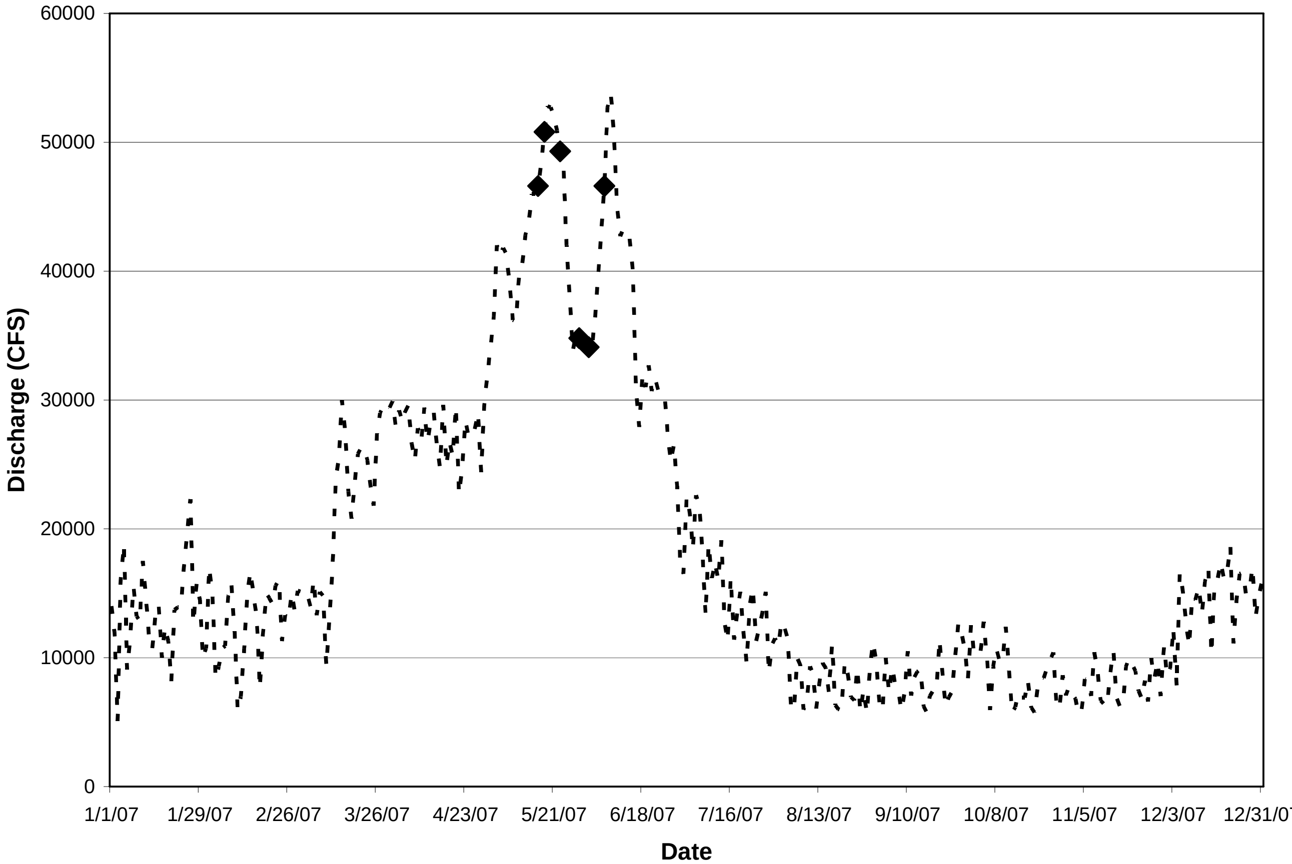
Station	TN		TP		TSIN		SRP	
	# above target	% above target	# above target	% above target	# above target	% above target	# above target	% above target
SBC at Opportunity	8/8	100	8/8	100	8/8	100	8/8	100
CFR bl Warm Springs	0/8	0	7/8	88	1/8	13	7/8	88
CFR at Deer Lodge	4/8	50	1/8	13	8/8	100	8/8	100
CFR ab Ltl Blackfoot	5/8	63	6/8	75	0/8	0	8/8	100
CFR at Bonita	3/8	38	5/8	63	1/8	13	5/8	63
CFR ab Missoula	0/8	0	2/8	25	1/8	13	3/8	38
CFR bl Missoula	2/8	25	0/8	0	8/8	100	2/8	25
CFR at Huson	2/8	25	0/8	0	4/8	50	1/8	13
CFR ab Flathead	1/8	13	0/8	0	2/8	25	0/8	0

2.5 Cabinet Gorge Peak Flow Sampling

Six additional samples were collected from the Clark Fork River below Cabinet Gorge Dam over a one month period in order to characterize nutrient and metals concentrations during the peak flow period. Samples were collected between May 16 and June 6 (**Figure 2-3**).

Median nutrient concentrations were higher during the peak flow period than during the regular monthly sampling. This pattern was evident for all nutrient constituents except for SRP, which had a monthly median concentration of 0.005 mg/L versus a peak flow median concentration of 0.004 mg/L. Total recoverable metals were also typically higher during the peak flow sampling period. While only two copper concentrations were over the detection limit (0.001 mg/L) during monthly sampling, all of the high flow samples were above the detection limit. This was also seen in total recoverable arsenic samples, as all were below the detection limit during monthly sampling, while 4/6 samples were above the detection limit during high flow. Median zinc concentrations were also higher during peak flow (0.0024 mg/L) than during monthly sampling (0.0016 mg/L). Median dissolved zinc concentrations were also much higher during peak flow (0.0247 mg/L) than during monthly sampling (0.0092 mg/L). Analytical results and summary statistics for peak flow samples collected below Cabinet Gorge Dam are provided in **Appendix C**.

Figure 2-3. *Hydrograph for Clark Fork below Cabinet Gorge Dam showing peak flow sampling dates.*



2.6 Lake Pend Oreille Field Constituents and Algal Nutrients

2.6.1 Field Constituents

Field measurements, including water temperature, dissolved oxygen, pH and electrical conductivity, were performed at nine sampling locations on Lake Pend Oreille during 2007. Water temperature and dissolved oxygen were measured at one meter increments to establish profile information used to gauge whether lake stratification was present and whether bottom waters were anoxic, which dictated the sampling composite method for nutrient and chlorophyll sampling. Lake Pend Oreille field data and water temperature and dissolved oxygen profile data are provided in **Appendix I**.

2.6.2 Secchi Transparency

Secchi transparency measurements were collected at nine sampling locations on Lake Pend Oreille during 2007 (**Appendix A, Figure 5**). Measurements were performed at 7 of the 9 locations during June, July, August, and September. At the Oden Bay and Sunnyside stations measurements were taken during June, July, and September. Secchi disc transparency measurements had been collected on Lake Pend Oreille periodically since the 1950s, and the Bayview, Hope, and Granite stations all have over 10 years of historical data. Charts and boxplots (**Appendix I**) show measurements collected during 2007, and fluctuations in median Secchi depth throughout the period of record.

Mean Secchi transparency measurements at the Bayview site during 2007 were among the mid-range when compared to the period of record. Sampling locations at Oden Bay (3.3 m) and Sunnyside (3.4 m) exhibited the lowest mean Secchi transparency readings during 2007, indicating lower water clarity. Conversely, Bayview near-shore (12.5) had the highest mean Secchi transparency measurement during 2007.

2.6.3 Algal Nutrients and Chlorophyll a

Monthly water column nutrient and chlorophyll *a* samples were collected at nine Lake Pend Oreille sites during June through September 2007. Three of the sites were open, deep water locations (Bayview, Midlake and Pend Oreille North) and six sites were nearshore locations (Bayview nearshore, Garfield Bay, Talache, Lakeview, Oden Bay, and Sunnyside). Nutrient samples were analyzed for total nitrogen and total phosphorus. Lake Pend Oreille nutrient and chlorophyll data are presented in **Appendix I**.

3.0 PERIPHYTON DATA SUMMARY

3.1 Clark Fork River Periphyton

Seven Clark Fork River stations were sampled for periphyton standing crops during 2007 (**Appendix A, Figure 5**). Clark Fork River stations have been sampled annually in August and September since 1998. During 2007 a July sampling run was added to the upper three sites (at Deer Lodge, above the Little Blackfoot River, and at Bonita), although the Clark Fork River site at Bonita was not sampled during August. The four downstream sites continued to be sampled during August and September only. Twenty replicate samples were collected at each station, and replicate samples were analyzed for two variables:

- Chlorophyll *a* (Chl *a*) (mg/m^2)
- Ash-free Dry Weight (AFDW) (g/m^2)

3.1.1 Clark Fork River Periphyton Temporal Comparison

Temporal boxplots for chlorophyll *a* and ash-free dry weight in periphyton samples from the Clark Fork River (**Appendix F**) were developed to show changes over the monitoring period. Mean chlorophyll *a* values for algae samples collected from natural substrates were generally mid-range to slightly low during 2007 when compared to previous sampling years, with the exception of the July sampling period which had some of the highest median chlorophyll *a* values recorded under this program. This was the first year that chlorophyll *a* was sampled in July. Median chlorophyll *a* values at most sites were slightly higher than in 2006, but consistent with or lower than the previous years. Chlorophyll *a* at the Clark Fork River site above the Little Blackfoot River significantly decreased in 2007 compared to 2006, yet was still among some of the highest median values recorded. In two of the three sites where sampling was performed in July, the highest median chlorophyll *a* values were recorded during this sampling event. When comparing the August and September sampling events, five sites saw higher median values in

August, while two sites peaked in September. Mean algal biomass values, measured as ash-free dry weight (AFDW), followed a similar pattern to that of chlorophyll *a.*

3.1.2 Clark Fork River Periphyton Spatial Comparison

Periphyton data for the Clark Fork River (**Appendix F**) are depicted as spatial boxplots for years 1998-2007. Clark Fork River chlorophyll *a* boxplots from 2007 include horizontal lines that show the benthic algae chlorophyll *a* targets levels for both a summer mean (100 mg/m^2) and annual maximum (150 mg/m^2) instream concentration. These targets were developed by the Tri-State Water Quality Council and subsequently adopted as site-specific water quality standards by the State of Montana (ARM 17.30.631).

When mean chlorophyll *a* data from all years are pooled (1998-2007), the generally spatial pattern is a downward trend from Clark Fork River at Deer Lodge to the site above the Flathead River confluence. One exception to this trend is a major increase in mean chlorophyll *a* below Missoula.

Of the three sites sampled in July 2007, those at Deer Lodge and at Bonita had values above the mean target level of 100 mg/m^2. In August 2007, two of seven Clark Fork River monitoring locations had mean chlorophyll *a* values below the target level. These included sites at Huson (57 mg/m^2), and above the Flathead River (24 mg/m^2). In September 2007, three of seven monitoring sites produced mean chlorophyll *a* values less than the target level, including above Missoula (67 mg/m^2), at Huson (49 mg/m^2), and above the Flathead River (31 mg/m^2).

When August and September data are combined to create a summer mean chlorophyll *a* value, two stations, including the Clark Fork at Huson and above Flathead, were below the instream summer mean target level of 100 mg/m^2. The Clark Fork site above Missoula (105 mg/m^2) had a summer mean just above the target level. Additionally, the individual sample replicate data for chlorophyll *a* in the Clark Fork River during 2007 showed that at least one replicate for August and September surpassed the target for maximum growth (150 mg/m^2) at six of the seven sites. The Clark Fork River site at Huson did not have any individual sample replicates above the target maximum (150 mg/m^2) during summer 2007. Summer mean chlorophyll *a* concentrations and the number of samples above the target maximum are depicted below in **Table 3-1**.

Table 3-1. *Summer chlorophyll a target attainment summary.*

Site	Summer Mean Chlorophyll *a* (mg/m2)	# of Samples Above Target Maximum (150 mg/m2)	% of Samples Above Target Maximum (150 mg/m2)
CF at Deer Lodge	185	23/53	43.4 %
CF ab Ltl Blackfoot	170	30/54	55.6 %
CF at Bonita	226	28/40	70.0 %
CF above Missoula	105	11/43	25.6 %
CF below Missoula	145	17/42	40.5 %
CF at Huson	53	0/40	0.0 %
CF ab Flathead	28	2/41	4.9 %

3.2 Rock Creek and Lower Clark Fork River Periphyton

3.2.1 Rock Creek and Lower Clark Fork River Periphyton Temporal Comparison

Three lower Clark Fork River stations and three Rock Creek stations were sampled for periphyton standing crops during August 2007 (**Appendix A, Figure 1**). Eleven replicate samples were collected at each station and analyzed for chlorophyll *a* (mg/m^2).

Sample results and boxplots depicting spatial variations in periphyton data for the Rock Creek and lower Clark Fork River stations in 2007 and summary statistics, including mean, median, minimum, maximum and standard deviation, are provided in **Appendix H** and summarized below in **Table 3-2**.

Table 3-2. ***Summary of chlorophyll a analysis results for Rock Creek-Lower Clark Fork River monitoring locations.***

Station	Chlorophyll *a* (mg/m^2)				
	Mean	Median	Minimum	Maximum	Std. Dev.
West Fork of Rock Creek near mouth	4.7	4.0	3.0	8.0	1.7
East Fork of Rock Creek near mouth	8.8	3.0	0.5	25.0	9.0
Rock Creek near mouth	2.3	2.0	0.5	5.0	1.2
Clark Fork at Avista Compound	49.7	54.0	21.0	73.0	16.5
Clark Fork at Noxon Bridge	21.3	18.0	14.0	34.0	7.0
Clark Fork below Cabinet Gorge Dam	35.2	32.0	25.0	57.0	9.8

Of the six sites monitored, mean periphyton concentrations were highest in the Clark Fork River at the Avista Compound (49.7 mg/m^2) and lowest in Rock Creek near the mouth (2.3 mg/m^2). Two sites had individual replicate samples below the analytical detection limit (1.0 mg/m^2) including the East Fork of Rock Creek and Rock Creek near the mouth. These values were recorded as half the detection limit (0.5 mg/m^2) for purposes of computing the summary statistics. The Avista Compound had the highest individual replicate concentrations (65 and 73 mg/m^2) during 2007. None of the samples collected in 2007 exceeded the annual maximum instream concentration (150 mg/m^2) established for the Clark Fork River above the confluence of the Flathead River. These targets were developed by the Tri-State Water Quality Council and subsequently adopted as site-specific water quality standards by the State of Montana (ARM 17.30.631), and although not applicable to this stretch of river, the 150 mg/m^2 target is generally considered a threshold value for nuisance algae growth.

3.3 Lake Pend Oreille Periphyton

Nine Lake Pend Oreille stations were sampled for periphyton during 2007. This summary report includes boxplots and summary statistics for 2007 data. This report includes a comparison of periphyton levels during 2006 and 2007 in each of the 9 stations. Lake Pend Oreille stations were previously sampled from 1998-2003 (5 sites only) and during 2006 (9 sites) in the month of September.

3.3.1 Lake Pend Oreille Periphyton Temporal Comparison

Temporal boxplots for chlorophyll *a* and ash-free dry weight in periphyton samples from Lake Pend Oreille (**Appendix G**) were developed to show changes over the monitoring period. Mean chlorophyll *a* values for algae samples collected from natural substrates in Lake Pend Oreille in 2007 were among the mid-range when compared to previous sample years (1998-2003 and 2006). Of the long term sampling sites Bayview exhibited the second highest median chlorophyll *a* value recorded, and Springy Point had an identical median value to 2006, which was also the highest recorded. The site at Springy Point has shown a consistent increase in chlorophyll *a* concentration throughout the period of record, but the 2007 was nearly identical to that of 2006. The site at Kootenai had the lowest median chlorophyll *a* value ever recorded, as did Trestle, whose value was identical to that recorded in 2001. In both 2006 and 2007 nine stations were monitored for periphyton. Out of those nine stations, two (Bayview and Lake view) had higher median chlorophyll *a* values in 2007, while three (Kootenai, Oden Bay, and Sunnyside had higher median values in 2006. Median values at the sites at Garfield, Telache, and Trestle were very similar in 2006 and 2007. Temporal patterns for attached algae measured as mean ash-free dry weight concentrations were similar to those for chlorophyll *a*.

3.3.2 Lake Pend Oreille Periphyton Spatial Comparison

Periphyton data for Lake Pend Oreille (**Appendix G**) are depicted as spatial boxplots for years 1998-2007. In 2007, mean chlorophyll *a* values from attached algae samples collected from natural substrates in Lake Pend Oreille were lowest at the Telache and Trestle sites (3.0 mg/m^2), and highest at the Springy Point site (32.4 mg/m^2) located near the outlet of Lake Pend Oreille. The Sunnyside site had the lowest mean ash-free dry weight in 2007 (1.5 g/m^2), while Kootenai had the highest mean (9.3 g/m^2). Among sites sampled for the entire period of record (1998-2003, 2006-2007), the Springy Point site has the highest mean chlorophyll *a* (15.1 mg/m^2) and AFDW (12.6 g/m^2) values. The lowest mean chlorophyll *a* and AFDW for the entire period of record was attributed to the Bayview site (6.7 mg/m^2 and 6.7 g/m^2, respectively).

4.0 CRAYFISH METALS DATA SUMMARY

Results of total recoverable metals analyses performed on crayfish tissue samples are provided in **Appendix J** and include sample results, summary statistics and boxplots depicting statistical distribution of metal concentrations.

Crayfish specimens were collected in mid-August at locations in the Clark Fork River above and below the confluence of Rock Creek **(Appendix A, Figure 1)**. Ten replicates from each site were analyzed for heavy metals in tissue samples. Crayfish tissues, including carapace (exoskeleton), gill and hepatopancreas, were isolated from each animal and analyzed separately for total recoverable concentrations of cadmium, copper and zinc. A summary of crayfish tissue results is provided below in **Table 4-1**.

Table 4-1. *Summary of 2007 Clark Fork River crayfish tissue metals analysis results.*

Tissue	Analyte	Clark Fork above Rock Creek			Clark Fork below Rock Creek		
		Min	Max	Mean	Min	Max	Mean
Exoskeleton	Cadmium (µg/g)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Copper (µg/g)	5.6	18.3	11.0	5.6	26.1	7.7
	Zinc (µg/g)	5.5	16.9	12.7	8.2	17.8	13.3
	Moisture (%)	37.6	58.5	48.2	35.4	57.2	49.9
Gill	Cadmium µ (µg/g)	<1.0	1.5	1.1	<1.0	1.6	1.1
	Copper (µg/g)	159	375	280	206	722	306
	Zinc (µg/g)	39.3	140.0	78.9	43.2	145.0	77.2
	Moisture (%)	86.1	93.2	90.0	86.4	92.0	89.6
Hepatopancreas	Cadmium (µg/g)	1.4	18.0	10.2	3.0	13.8	7.5
	Copper (µg/g)	239	4360	2082	319	4290	2351
	Zinc (µg/g)	211	717	408	198	670	333
	Moisture (%)	67.9	87.8	79.1	69.4	86.7	77.0

Concentrations of heavy metals in crayfish tissue were generally quite variable during the 2007 sampling event and did not display any discernible spatial patterns. This was especially true for copper and zinc in all tissue types. Cadmium in crayfish tissue was below the analytical detection limit (<1.00 µg/g) for all exoskeleton and most gill samples.

5.0 DATA QUALITY ASSURANCE REVIEW

The quality of the monitoring data generated and reported under this project depended on many factors, including: 1) sampling design; 2) selection of parameters; 3) sampling technique and procedures; 4) analytical methodologies; and 5) data review, assessment and data management. Each of these factors was carefully considered and defined within the respective Clark Fork River, Lake Pend Oreille, Pend Oreille River and Rock Creek Supplemental Monitoring project quality assurance project plans, or QAPPs (PBS&J 2005, PBS&J 2007, IDEQ 2006 and WDOE 2003).

Following their collection, data generated under this program were subjected to a data validation procedure outlined in the project QAPP. The data validation process involves an assessment and documentation of the quality of the generated data in relation to the specific data quality objectives that were established in the project QAPP. The data validation process included the following elements: 1) data verification; 2) systems audits and review procedures; 3) performance evaluations; 4) review of laboratory credentials; and 5) quality control checks and corrective action.

Data quality objectives established for the 2007 Clark Fork monitoring program and reviewed for their attainment included precision, accuracy, representativeness, completeness, and comparability. The following paragraphs summarize the results of this review and describe the outcomes and corrective actions that were taken to address identified deficiencies.

5.1 Sample Handling

Proper sample handling is defined in the project QAPP and is essential to the production of valid analytical data. Correct sample handling was verified for the Clark Fork project through a review of the project chain-of custody forms and laboratory data sheets to verify that: 1) sample custody was maintained until delivery to the lab, 2) samples were properly preserved and stored until analysis, 3) samples were analyzed within specified holding times, and 4) that the desired parameters were analyzed. No excursions were noted from these procedures and the 2007 data set was in full compliance with established sample handling goals.

5.2 Laboratory Precision

Precision refers to the degree of variability in replicate measurements. Precision for laboratory samples was evaluated by examining the relative percent differences (RPDs) of duplicate samples. Duplicate analyses were performed by the analytical laboratories for each analytical parameter and sampling event. For this project, a precision goal of +/- 15% was established for water chemistry and chlorophyll samples. Laboratory precision during the 2007 monitoring year is summarized in the quality control reports included in **Appendix K**.

A total of 152 laboratory duplicate sample analyses were completed for this project during 2007. For Clark Fork River metals water sample analyses, 105 of 133 duplicate analyses produced RPDs of 0% (i.e. the duplicate analyses generated the same number as the original sample). A total of 23 of the remaining duplicate sample analyses produced RPDs less than the +/- 15% goal. Thus, a total of 96% of all duplicate samples met the analytical precision goals established in the supplemental monitoring project quality assurance project plan.

Six of the 133 duplicate sample analyses (or 4% of the total) exceeded the laboratory precision goals. Five duplicate samples outside of the lab precision goal were for zinc. Four of these were total recoverable zinc samples while one was a dissolved zinc sample. The RPDs for the noncompliant total recoverable zinc samples ranged from 20% to 32%. The dissolved zinc sample had an RPD of 20.00%. The remaining noncompliant laboratory duplicate analysis was for TSS, with an RPD of 27% (14.2 vs. 18.7 mg/L).

For total phosphorus, total nitrogen, and chlorophyll *a* samples taken from Lake Pend Oreille, 17 of 19 duplicates analyzed produced RPDs of less than the +/- 15%. Both laboratory precision outliers were chlorophyll samples with RPDs of 15.4% and 18.8%.

In summary, analytical precision was rated as excellent for most parameters analyzed for this project during the 2007 calendar year, with 145 of 152 duplicate analyses (or 95.4% of all tests) meeting or exceeding the established acceptance limits. Total recoverable zinc samples will be flagged in STORET for monitoring events in which the laboratory duplicate sample analyses did not meet the analytical precision goal.

5.3 Laboratory Accuracy

Accuracy is a measure of confidence that describes how close an analytical measurement is to its "true" value, or the combination of high precision and low bias. Potential bias in the program procedures were minimized through appropriate site selection and strict adherence to the QAPP. Because the "true" value of a field sample cannot be known, the primary tool for assessing accuracy of laboratory analyses is the percent recovery of matrix spikes and the analysis of reference samples run concurrently with actual field samples. For this project, an initial accuracy goal of +/- 10 percent was established for water chemistry and sediment metals analyses.

The results of the laboratory analysis of matrix spike and reference samples are summarized in **Appendix K**. With one exception, percent recovery of spike samples for Clark Fork River metals water analyses were within the accuracy goals established for the project, with a range from 91% to 107.7%. One spike sample analysis out of 133 tests, for dissolved cadmium, was out of the control limits at 86% during the July 2007 sampling event.

Percent recovery of laboratory matrix spikes for Lake Pend Oreille water samples had 64% (7 of 11 samples) compliance in 2007. Two total nitrogen samples (114% and 116%) and two total phosphorus samples (55% and 86%) had spike percent recoveries outside the laboratory accuracy acceptance limits established in the QAPP.

Reference sample analyses for Clark Fork River water samples (N=133) showed percent recoveries ranging from 93.5 to 105%. One reference sample analysis for dissolved lead was marginally out control limits at 111% during the June 2007 sampling event.

Reference sample analysis for Lake Pend Oreille water samples failed to meet accuracy goals established for this project for all but one sample. Total nitrogen was slightly below the accuracy goal at 88% during the September sampling event. Reference sample analyses for chlorophyll *a* produced three percent recoveries outside of the acceptance limits at 85%, 117%, and 121% during the July and September monitoring events.

Overall analytical precision for Clark Fork River samples was rated as excellent for most of the parameters analyzed for this project during the 2007 calendar year, with 139 of 144 spike recovery analyses (or 96.5% of the tests) and 137 of 142 reference sample analyses (or 96.5%) meeting or exceeding the established acceptance limits. It is interesting to note, and possibly worth considering for future QAPP revisions, that changing the analytical precision goal to +/- 15 percent would have validated all but three of the independent lab precision tests.

Analytical precision for Lake Pend Oreille samples was rated as fair to poor relative to the established lake monitoring data quality objectives during the 2007 calendar year, with 7 of 11 spike recovery analyses (or 64% of the tests) and 4 of 7 reference sample analyses (or 57%) failing to meet the established acceptance limits.

5.4 Analysis of Laboratory Blanks

Laboratory blanks were routinely analyzed for each project parameter during each sample analysis event to evaluate for the presence of outside contamination. Laboratory blank analysis results must be less than or equal to the minimum analytical detection limit for the parameter of interest in order to validate the data. The results of the 2006 laboratory blank sample analyses are summarized in **Appendix K**. For the Clark Fork River metals water samples all but two total recoverable zinc samples were below the analytical detection limit. Total recoverable zinc samples during the November and December sampling events had blank analysis results of 0.0007 mg/L compared to the detection limit of 0.0005 mg/L. All Lake Pend Oreille water samples had blank analyses below the detection limit for the parameters of interest.

5.5 Sample Representativeness

Representativeness is the extent to which the measurements actually represent the true environmental conditions. For this monitoring effort, the sample locations were chosen to best represent the stream or lake segment of interest and to minimize any potential site-specific bias. Samplers adhered to all sampling guidelines provided in the QAPP during 2007, and did not deviate from designated sample locations. Statistical water quality spatial and temporal trends analysis of the historical data for Clark Fork monitoring stations has previously verified the site characteristics from the standpoint of mixing and the influences of incoming tributaries and wastewater discharges (Land & Water Consulting 2003).

It should be noted that this project relied on grab sampling techniques for most water column parameters. The project QAPP describes measures that were taken to ensure representative sampling within the water column. However, there exists some small but unquantifiable risk that sediment or sediment-associated parameters (such as phosphorus and metals) could be somewhat under-represented during high flow events when suspended sediment concentrations are elevated and not evenly distributed throughout the water column. This issue could be addressed in the future through full cross-sectional sampling techniques but at a significantly greater cost to the program.

5.6 Sample Completeness

Completeness is the comparison between the amounts of data that were planned to be collected versus how much usable data was actually collected. This data quality objective is evaluated by looking at the each monitoring variable for each station during each sampling event. The project QAPP does not establish specific project completeness goals but the intent is to secure and validate 100% of the desired measurements unless this is prevented by unforeseeable circumstances beyond human control.

Two sample analyses for total ammonia nitrogen were not reported by the Missoula WWTP laboratory. For analysis of total soluble inorganic nitrogen these samples were assumed to be less than the detection limit and reported as half the detection limit. Otherwise, all remaining samples intended for laboratory analysis were successfully received, analyzed, and reported by the lab.

Within the several hundred field parameter measurements that were made in 2007 for this project, turbidity was not measured during the July 10 sampling run due to unavailability of meter. Dissolved oxygen was not measured during the January 17, February 20, and March 20 sampling runs and total dissolved solids was not measured from the April 16 sampling run to the December 18 sampling run due to equipment problems.

Additional field meter maintenance and attention to scheduling can prevent field measurement completeness problems encountered in 2007.

Two sampling sites on Lake Pend Oreille (Oden Bay and Sunnyside nearshore stations) were not sampled during the August monitoring event because the field staff person became ill. Full depth field measurement profile data were not completed at several deep water lake sites during the June sampling event because of field meter probe cord length limitations which were subsequently resolved by purchasing a 100 m cord for the HydroLab unit.

5.7 Sample Comparability

Comparability was achieved for this project through consistent sampling locations, procedures, and analyses as outlined in the project QAPP.

5.8 Analysis of Field Blanks

Field blanks were collected using the same sampling protocol as river samples, but de-ionized water was submitted as a sample. Field blanks are intended to detect any possible contamination which could result from dirty sample bottles, storage coolers, sample filters, or from environmental fallout. Field blanks must be less than five times the minimum (low level) analytical detection limit for the parameter of interest to meet the project data quality objectives. Otherwise, the data should be flagged to indicate potential bias.

A total of 180 field blank sample analyses were run in 2007. Of these, five analyses were outside the acceptance limits, for an overall compliance average of 97%. The non-conforming blank sample analyses and corrective measures are described below.

All Lake Pend Oreille nutrient and chlorophyll sample field blanks produced non-detectable concentrations of the respective analytes and were in full compliance with the lake monitoring data quality objectives during 2007.

For Clark Fork River metals samples, field blanks showed detectable concentrations of dissolved zinc on nine of twelve occasions. The measured dissolved zinc concentrations were also greater than the total recoverable zinc concentrations on each of these occasions. Of the nine field blank samples, only three samples exceeded EPA's suggested 0.0025 mg/L threshold (5X detection limit) for evaluating noncompliant low level zinc quality assurance samples. These occurred on September (0.0039 mg/L), October (0.0093 mg/L) and December (0.0028 mg/L) sampling events. Field blanks showed detectable concentrations of total recoverable zinc on five of twelve occasions, but none of the measured concentrations exceeded the EPA guidelines.

Overall, field blank sample analysis results showed good field QA performance, except for dissolved zinc. Suspected low level zinc contamination from disposable filters and possibly laboratory analysis vessels has been a recurring issue with this sampling program, and corrective measures will continue to be explored. Fortunately, the low levels of contamination, and the measured concentrations of zinc in the environmental samples, are consistently well below the relevant water quality standards thresholds and do not interfere with the identification of potential problems.

Response actions taken to address the above field blank sample excursions will consist of flagging the corresponding water sample analysis data for the particular monitoring run and problem analytical parameter in the project database and in the STORET database comment/result field.

5.9 Analysis of Field Duplicates

Field precision was evaluated by examining relative percent differences (RPDs) of duplicate samples. A duplicate sample was collected from one site during each sampling event and analyzed for nutrients and metals. For this project, a precision goal of +/- 15% was established for field duplicate samples.

Of the 156 field duplicate sample analyses that were performed throughout the sampling year, 11 had RPDs greater than +/- 15%, for an overall compliance average of 93%. For Clark Fork River metals 9 samples were out of specifications. Eight of these samples were for total recoverable (4 samples) and dissolved zinc (4 samples). The RPDs for the non-conforming zinc analyses ranged from a low of 17.7% to a high of 40%. During the July sampling run dissolved lead did not meet compliance with an RPD of 33.3%. For Lake Pend Oreille nutrient and chlorophyll field duplicate samples, 2 of 12 samples had RPDs greater than +/- 15%. Both outliers were total phosphorus samples with RPDs of 15.4% and 22.2%. Technically, only the second chlorophyll field duplicate sample, or one of 12 analyses (8%) constitutes a data quality objective non-compliance problem.

All of these 2007 analysis results for the respective Clark Fork monitoring stations will be flagged to indicate that analysis of field duplicates for the parameters noted exceeded relative percent differences of +/- 15%. This fact does not necessarily call the quality of the actual sample analysis results into question because duplicate samples are in fact that – separate samples collected from what may be a relatively non-homogeneous water body depending on the conditions during sampling.

All other 2007 project data should be considered validated relative to field precision data quality objectives.

5.10 Data Validation Response Actions and Recommendations

Overall, most of the 2007 data validation reviewed showed good or excellent conformance with data quality objectives established in the respective project QAPPs. More than 90% of all analysis results for the 2007 monitoring program were validated without a need for qualifiers or annotations. Additional corrective measures that are warranted and which were described earlier include making a concerted effort to eliminate field contamination problems with dissolved zinc analyses, including additional filter and bottle rinsing, continued experimentation with replacement filters, and additional prep and decontamination of sample bottles, in order of priority. The laboratory performing the Lake Pend Oreille water column nutrient and chlorophyll sample analyses should be approached about the occasionally problematic laboratory accuracy problems for total phosphorus and chlorophyll *a*. Idaho DEQ may also want to revisit their stated lake monitoring program data quality objectives in light of those conversations to determine if they are too stringent. Lastly, a concerted effort will be made in 2008 to eliminate the completeness deficiencies which were identified in 2007.

6.0 REFERENCES

Administrative Rules of Montana. 2002. Numeric Algal Biomass and Nutrient Standards for the Clark Fork River. ARM 17.30.631, Effective August 16, 2002.

Idaho Administrative Procedures Act. 2006. Numeric Criteria for Toxic Substances For Waters Designated For Aquatic Life, Recreation, or Domestic Water Supply Use. IDAPA 58.01.02.210.02, updated April 12, 2006.

Idaho DEQ. 2006. Lake Pend Oreille Watershed Water Quality Monitoring Program Quality Assurance Project Plan (QAPP). June 2006. Coeur d'Alene, ID.

Land & Water Consulting, Inc. 1995. Water quality status and trends monitoring system for the Clark Fork-Pend Oreille Watershed. Prepared for the Tri-State Implementation Council. Missoula, MT.

Land & Water Consulting, Inc. 2004. Water Quality Status and Trends Monitoring System for the Clark Fork-Pend Oreille Watershed – Trends Analysis from 1984-2002. Prepared for Tri-State Water Quality Council. Missoula, MT.

Montana DEQ. 2007. Montana Numeric Water Quality Standards, Circular DEQ-7. Helena, MT.

Montana DEQ. 2007. Water Quality Planning Bureau Sample Collection and Laboratory Analysis of Chlorophyll *a* (Revision 3, May 2007), Chapter VII, Part A. Helena, MT.

PBS&J. 2007. Clark Fork-Rock Creek Supplemental Monitoring Program, 2006 Monitoring Summary Report. Prepared for Idaho DEQ and the Tri-State Water Quality Council. Helena, MT.

PBS&J. 2005. Clark Fork-Pend Oreille Watershed Water Quality Monitoring Program Quality Assurance Project Plan (QAPP) - Update for 2005 Sampling Year. November 2005. Helena, MT.

Tri-State Implementation Council (now the Tri-State Water Quality Council). 1998. Clark Fork River Voluntary Nutrient Reduction Program, August 1998. Sandpoint, Idaho.

U.S. Environmental Protection Agency. 1993. Clark Fork-Pend Oreille Basin Water Quality Study – A Summary of Findings and a Management Plan. Conducted under Section 525 of the Clean Water Act of 1987. U.S. Environmental Protection Agency, Regions 8 and 10, State of Montana, State of Idaho, State of Washington. Seattle, WA.

Appendix A

WATER QUALITY MONITORING STATIONS AND SAMPLING FREQUENCY/FIGURES

Appendix B

2007 WATER QUALITY DATA SPATIAL BOXPLOTS

Clark Fork-Pend Oreille Watershed Summary Monitoring Report

Appendix C

2007 WATER QUALITY DATA
SUMMARY STATISTICS TABLES

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix D

2007 Summer Water Quality Data
Spatial Boxplots

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix E

2007 SUMMER WATER QUALITY DATA SUMMARY STATISTICS TABLES

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix F

2007 Clark Fork River Periphyton Boxplots

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix G

2007 Lake Pend Oreille Periphyton Boxplots

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix H

2007 Rock Creek Periphyton Boxplots and Summary Statistics Tables

Clark Fork-Pend Oreille Watershed Summary Monitoring Report

Appendix I

2007 Lake Pend Oreille Nutrient, Chlorophyll and Field Measurement Data

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix J

2007 Lake Pend Oreille Secchi Depth Boxplots

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix K

2007 CRAYFISH METALS

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report

Appendix L

2007 Laboratory and Field QA/QC Results

Clark Fork-Pend Oreille Watershed
Summary Monitoring Report