PEND OREILLE RIVER WATER QUALITY MONITORING

Summary of Findings

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1. INTRODUCTION AND BACKGROUND

Section 303(d) of the Federal Clean Water Act (CWA) requires states to prepare a list of waters not meeting state water quality standards. These are impaired waters which do not fully support one or more of their beneficial uses of: cold water biota; salmonid (trout) spawning; domestic water supply, recreation in or on the water, and aesthetics. The Pend Oreille River is currently on the State of Idaho's 303(d) list for sediment, total dissolved gas (TDG), and temperature. TDG was not addressed in this study as it continues to be the focus of the relicensing and State 401 Certification processes on Avista Corporations hydroelectric dams in Idaho.

The Pend Oreille River begins at the outlet of Lake Pend Oreille in northern Idaho and drains the Clark Fork – Pend Oreille watershed encompassing approximately 26,000 square miles. The Clark Fork – Pend Oreille watershed spans three states, including Montana, Idaho, Washington as well as a portion of British Columbia, Canada, before entering the Columbia River (Figure 1). The Pend Oreille River is the sole outlet for Lake Pend Oreille, Idaho's largest and deepest natural lake, with an average daily discharge of about 20,226 cubic feet per second (cfs) for the 2003 water year (USGS, 2004). Pend Oreille Lake and River levels are controlled by the U.S. Army Corps of Engineers (COE) through the dam at Albeni Falls.

Data collected as part of the Clark Fork – Pend Oreille Basin Water Quality Study in the late 1980s determined that water quality of the Pend Oreille River was in the oligo-mesotrophic range based on nitrogen and phosphorus concentrations, chlorophyll a, and Secchi disk transparency (EPA, 1993). The study also determined that the primary water quality concern on the Pend Oreille River was the proliferation of Eurasian Milfoil, a very aggressive, invasive plant. The majority of water quality data collected on the Pend Oreille River to date has been in Washington State with limited data specific to the Idaho reach.

The overall objective of this project was to monitor physical, chemical, and biological water quality parameters in the Pend Oreille River, Idaho, to provide the State of Idaho Department of Environmental Quality (IDEQ) with baseline information to aid in the determination of beneficial use support status. Monitoring was conducted during the critical summer conditions from June through September 2004.

2. WATERSHED CHARACTERIZATION

Information pertaining to climate and hydrology was derived from United States Geological Survey (USGS) in cooperation with the COE. The USGS operates a gauging station located on the Pend Oreille River at Albeni Falls:

USGS 12395400
Latitude: 48° 10’ 48” North
Longitude: 117° 1’ 48” West

Information on geology, soils, and land use was obtained through previous studies, publications and research from cited references.

2.1. Climate

Air temperature, water temperature, and precipitation data for the months of June through September 2003 and 2004 are listed in Table 1.

Table 1. Summary of data from gauging station USGS12395400

Year / Month	Average daily air temperature (°F)	Average daily water temperature (°F)	Average precipitation (inches)
2003			
June	70.3	52.8	0.040
July	79.4	64.1	0
August	82.5	74.6	0.017
September	72.1	64.5	0.040
2004			
June	75.1	56.3	0.055
July	82.5	68.6	0.009
August	82.0	72.8	0.088
September	68.5	64.1	0.073

2.2. Hydrology

The Pend Oreille River from its origin at Lake Pend Oreille to the Idaho state line lies in the fourth order USGS hydrologic unit code (HUC) 17010214. The largest tributary to the Pend Oreille River is the Priest River, which drains approximately 902 square miles in USGS HUC 17010215. The Priest River Subbasin had an average daily discharge of approximately 1,470 cfs for the 2003 water year (USGS, 2004). The Priest River Subbasin Assessment and Total Maximum Daily Load (TMDL) was published in October 2001. The pollutants of concern in the Priest River Basin are sediment and temperature. Several smaller tributaries also flow into the Pend Oreille River in Idaho shown in Figure 2.

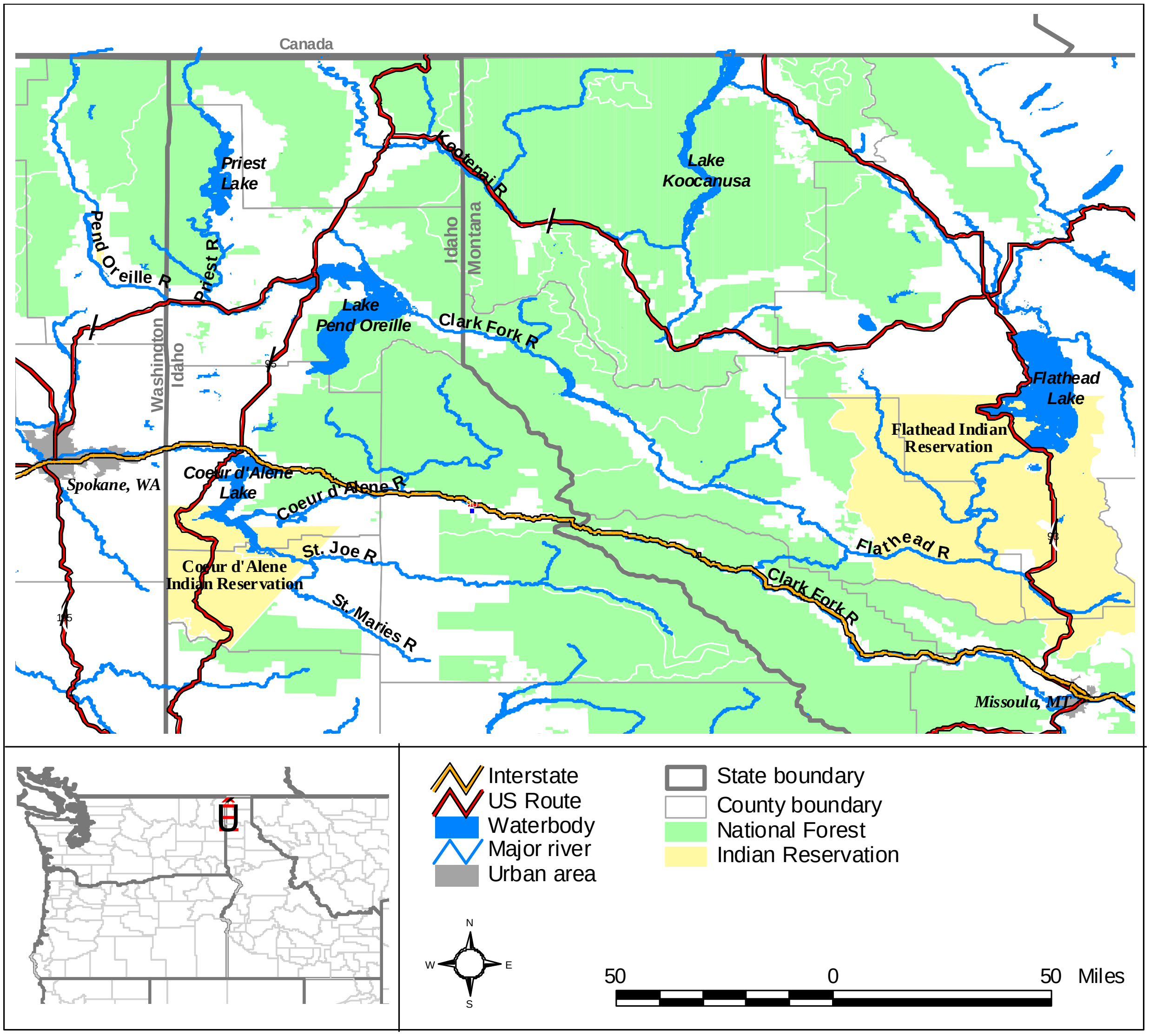


Figure 1. Clark Fork-Pend Oreille watershed

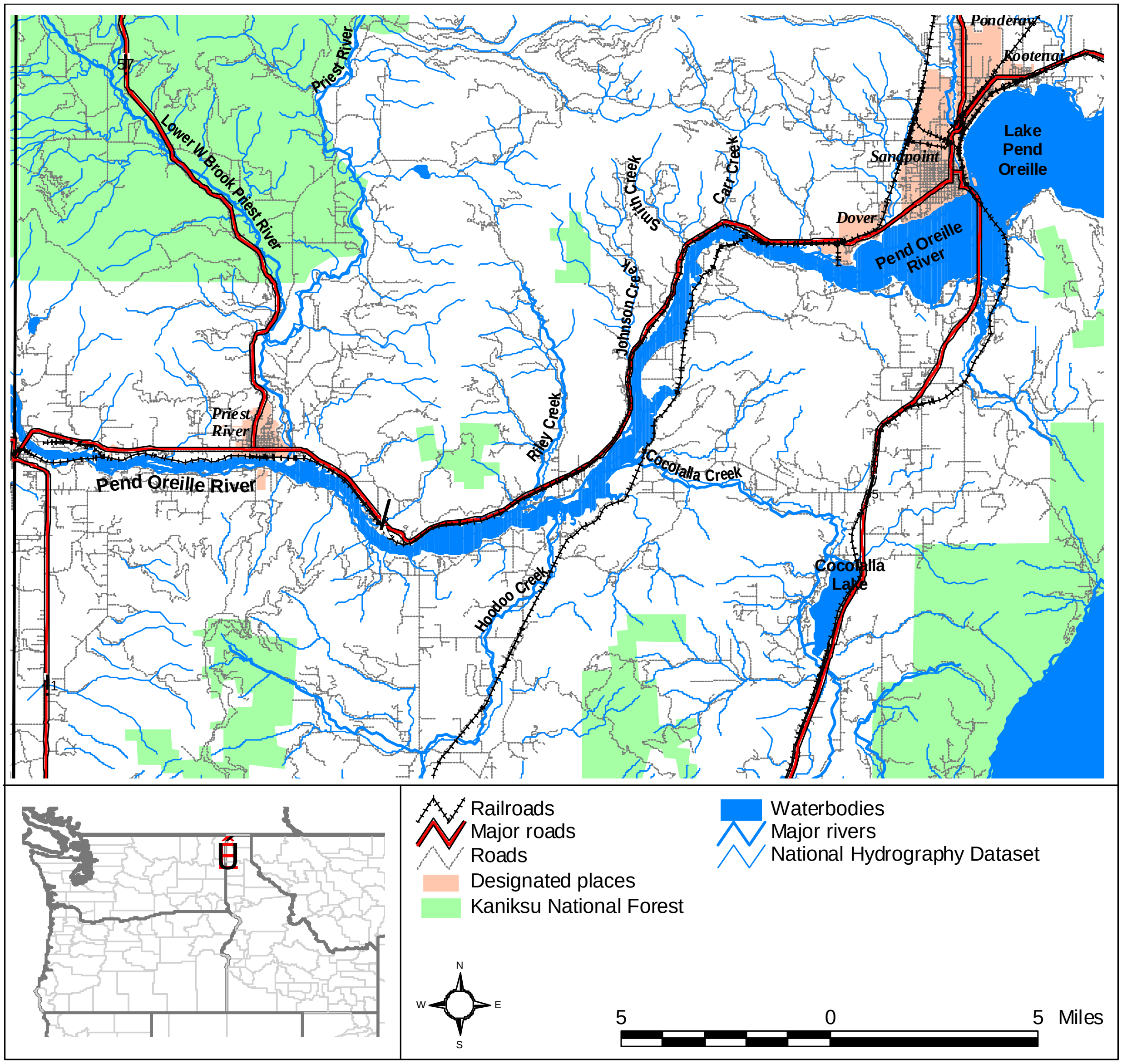


Figure 2. Tributary streams to Pend Oreille River, Idaho

2.3. Geology

The geology of northern Idaho and the Pend Oreille basin is complex with parent materials comprised of igneous, sedimentary, and metamorphic rocks ranging in age from Precambrian to present time (Savage, 1965). The geology specific to the Pend Oreille River in Idaho is described and is presented in Figure 3.

The geology of the Pend Oreille River in Idaho can essentially be broken into two broad categories—sedimentary deposits of more recent times and igneous/metamorphic parent materials.

The geology near the outlet of Lake Pend Oreille is comprised primarily of Pleistocene outwash deposits of gravel and sand on both sides of the river. Repeated advances and recessions of glacial ice during the early and late Wisconsin periods from about 70,000 to 90,000 years ago and 10,000 to 20,000 years ago, respectively, are responsible for the current morphology of the watershed. Smaller amounts of glacial till and unsorted glacial debris associated with a terminal moraine of the Cocolalla sublobe are found on the south side of the Pend Oreille River near the outlet of Lake Pend Oreille. Geologic evidence suggests that during the Pleistocene the current channel of the Pend Oreille River was completely covered by glacial ice (Savage, 1965).

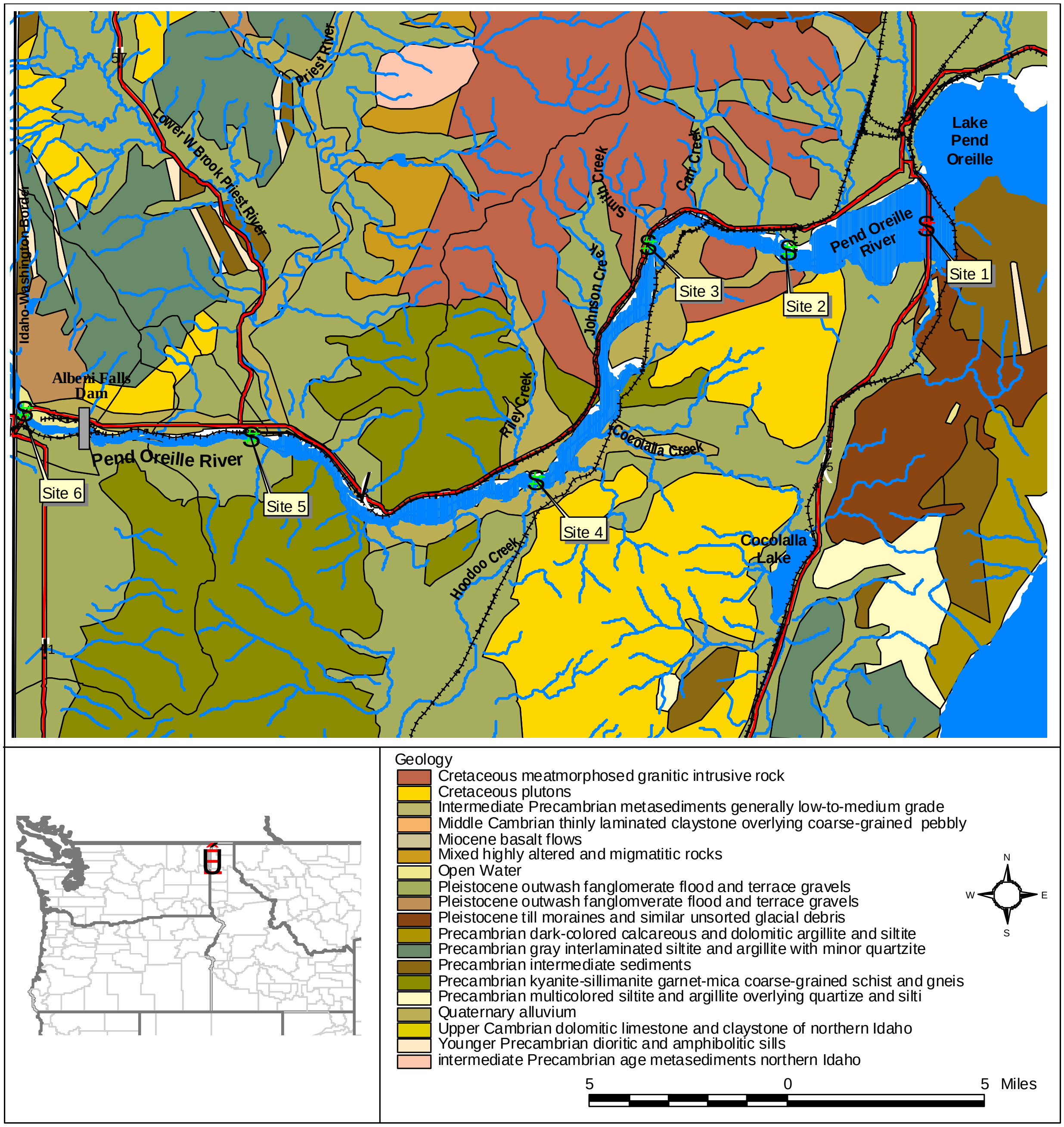


Figure 3. Geology of the Pend Oreille River, Idaho

A few miles downstream from the outlet of Lake Pend Oreille are prominent ridges of Cretaceous granite and metamorphic intrusive rock, which make up portions of the riverbank and bottom. These outcrops represent a small part of the much larger Kaniksu Batholith. Still further downstream on both sides of the Pend Oreille River are substantial outcrops of coarse-grained schist and gneiss believed to be of Precambrian age. These rocks are the oldest in the region and represent Pre-Belt Series rocks, which dominate much of eastern Idaho and Western Montana.

Approaching the border of Idaho and Washington the geology is again made up of Pleistocene glacial outwash gravel and sand with some minor outcrops of Precambrian metamorphosed rock and Cretaceous granite to the north. Along the entire river channel are the most recent Quaternary alluvial deposits. The two largest outcrops of Quaternary alluvial material on the north side of the river are found near the outlets of the Priest River and Riley Creek. The two largest outcrops of Quaternary alluvial material on the south side of the River are a few miles below the outlet of Lake Pend Oreille and about midway downstream towards the border of Idaho and Washington. The impacts of geology on sediment loading are discussed in Section 4.

2.4. Land Use

Land use has been previously described in the Pend Oreille Subbasin Assessment as agriculture on the lowland plains, including grain crops, hay, pasture, and livestock (IDEQ, 2000). A somewhat more detailed description of the land use along the Pend Oreille River is provided in the following paragraph based on a Geographical Information System (GIS) coverage of the National Land Cover Dataset (NLCD). The NLCD was a joint effort of the USGS and the USEPA as part of the Multi-Resolution Land Characteristics (MRLC) consortium, a multi-agency consortium developed to acquire satellite-based remotely sensed data for their environmental monitoring programs. The 1992 NLDC was derived from the early to mid-1990s Landsat Thematic Mapper satellite data.

The NLCD includes 21 land use classifications that were grouped into the following broader categories:

- Open Water
- Developed
- Barren
- Forested
- Shrubland
- Other Vegetated (grassland)
- Pasture and Cropland
- Transitional
- Wetlands

Land use surrounding this segment of the Pend Oreille River is a primarily forested with concentrated areas of development and agriculture. Urban development area includes the cities of Sandpoint, Dover, and Laclede, all located on the north side of the river. However, development along both sides of the river is increasing rapidly. Riparian vegetation adjacent to the river is limited to those areas that have either not been developed or where the river bank is bedrock.

Site-specific information from field observations on land use along the river is discussed in Section 4.

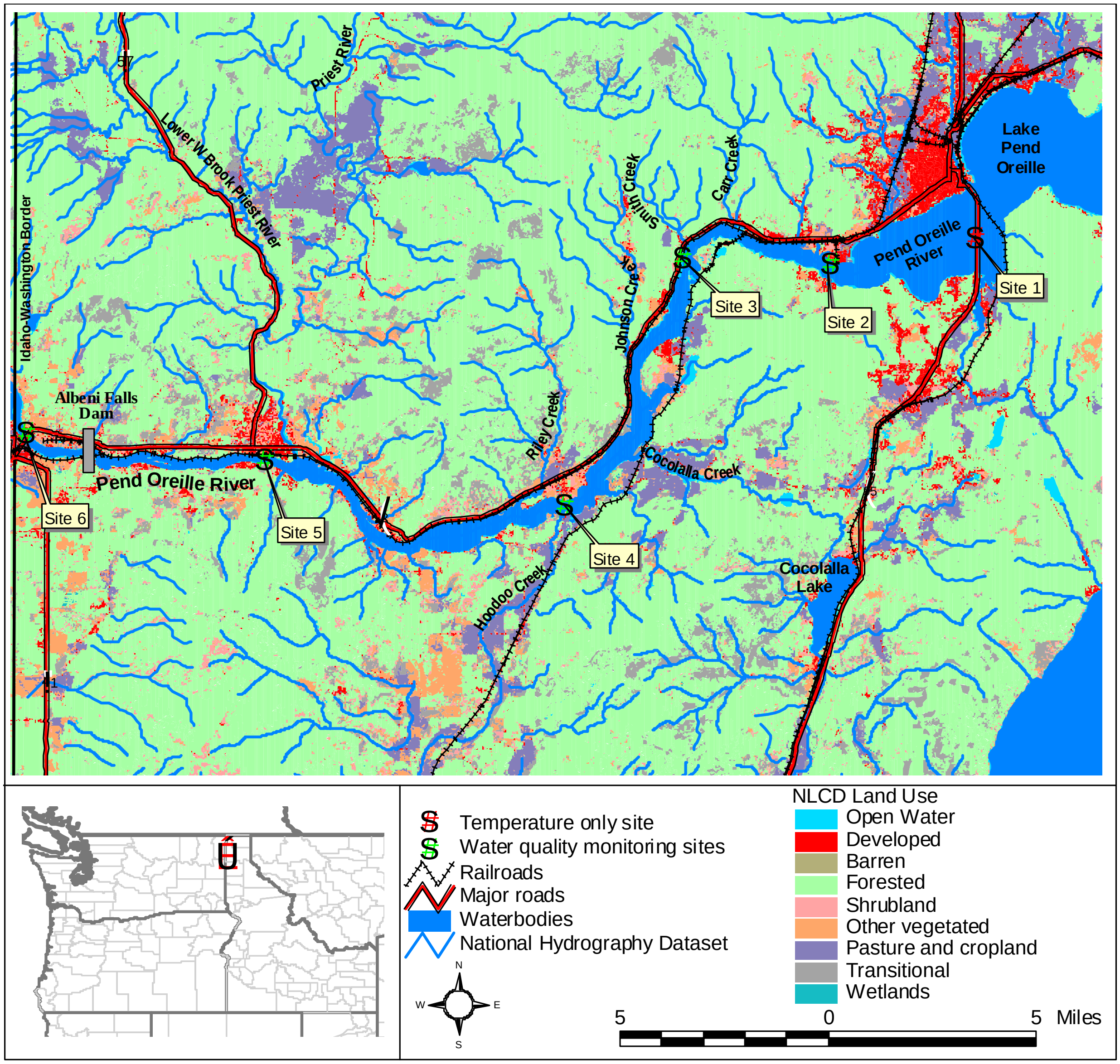


Figure 4. Land use adjacent to the Pend Oreille River, Idaho

3. METHODOLOGY

A review of previous research in the study area and numerous field investigations were conducted to aid in characterizing the watershed. Field investigations included:

- Physical water quality monitoring
  - Temperature
  - Total suspended solids
  - Eurasian Milfoil identification and mapping
  - River substrate characterization
- Chemical water quality monitoring
  - Dissolved oxygen (DO)
  - pH
  - Conductivity
  - Total nitrogen (TN)
  - Total phosphorus (TP)
- Biological water quality monitoring
  - Chlorophyll *a*

Six sites along the Pend Oreille River were established for the field investigations. Figure 5 shows the site locations and Table 2 provides their coordinates.

Table 2. Coordinates for Pend Oreille River monitoring sites

Site	Latitude	Longitude	Latitude (decimal degrees)	Longitude (decimal degrees)	Corresponding Township, Range, Section[1]
Site 1[2]	48.15.09N	116.32.19W	48.25250	-116.53861	N/A[3]
Site 2	48.14.37N	116.36.50W	48.24361	-116.61389	57N02W31
Site 3	48.14.45N	116.41.28W	48.24583	-116.69111	57N03W34
Site 4	48.09.37N	116.45.11W	48.16028	-116.75306	56N03W31
Site 5	48.10.35N	116.54.32W	48.17639	-116.90889	56N05W25
Site 6	48.11.08N	117.01.58W	48.18556	-117.03278	56N06W24

[1]Based on Bureau of Land Management's Public Land Survey System
[2]Temperature monitoring only (at the "long" bridge)
[3]Located between 57N02W35 (to south) and 57N02W23 (to north)

Continuous temperature data loggers were deployed at the six sites during the summers of 2003 and 2004. Data were retrieved and useable from loggers at Sites 2 and 5 for July 2003 through October 2003 and from loggers at Sites 1, 2 and 3 for May 2004 through September 2004. Water samples were collected four times at Sites 2 through 6 during the summer of 2004 and were analyzed for total suspended solids, chlorophyll *a*, TN and TP. DO, pH, conductivity and secchi depth were measured in the field during the four events and Eurasian Milfoil identification was also conducted during each of the four sampling events. Standard techniques and procedures were used in water quality monitoring and river sediment substrate analysis as discussed in the following sections.

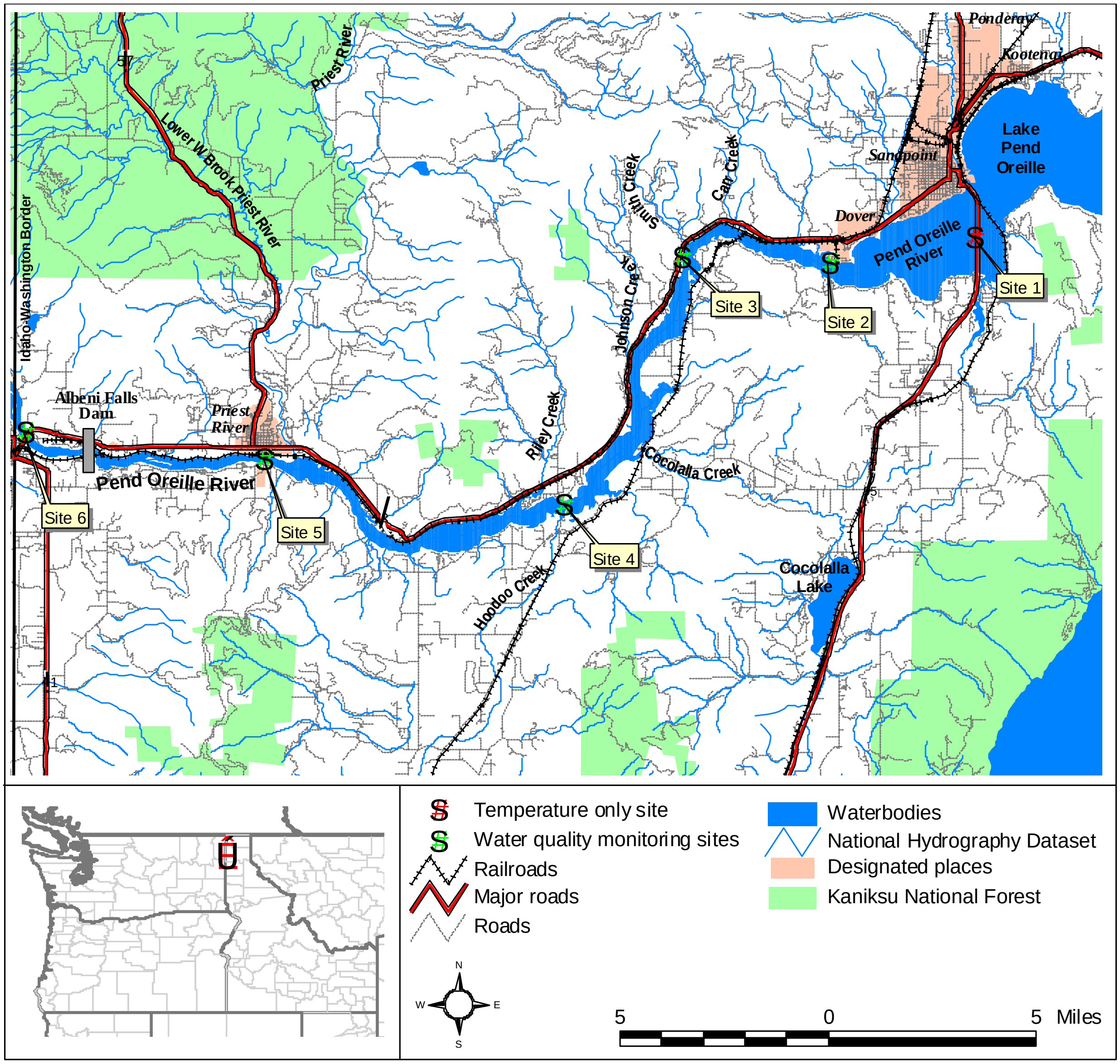


Figure 5. Water quality sampling sites, Pend Oreille River, Idaho

Also included as part of the scope of this project was to conduct a literature search and compile references from fisheries studies conducted in the Pend Oreille River. These references are included in Appendix A, in the list of water quality studies conducted on Pend Oreille River.

In addition, macroinvertebrate data previously collected by IDEQ in the Pend Oreille River were compiled for interpretation. However, the data were not adequate to develop an appropriate interpretation for the river. The data were collected based on protocols for collecting and interpreting macroinvertebrate data in rivers; but IDEQ indicated that the sampling site is located in a portion of the river that exhibits characteristics of a lake. Currently, there is no protocol to interpret macroinvertebrate data for a lake in Idaho. To evaluate the data as a lake without a protocol, it is necessary to have reference data or data from another similar system that is well characterized in terms of stressors and that were collected using the same sampling methodology. Because these data are not readily available, the Pend Oreille data could not be interpreted.

3.1. Water Quality Monitoring

A Quality Assurance Project Plan (QAPP) was developed for this project and approved by all parties involved prior to sampling. As outlined in the QAPP, water quality monitoring goals for the Pend Oreille River included physical, chemical, and biological monitoring at five locations with one additional temperature monitoring site near the outlet of Lake Pend Oreille. Specific information pertaining to field and laboratory equipment and analyses can be found in the QAPP, included as Appendix B.

3.1.1. Physical Water Quality Monitoring

Physical water quality parameters included temperature, total suspended solids, and Eurasian milfoil identification and mapping. Temperature data were collected June through September in 2003 and 2004 using data loggers and field measurements. Temperature data loggers were set at a depth of one meter below the water surface whenever possible. Data loggers were set approximately 1 meter away from the riverbank, as it was not possible to secure temperature loggers at one-meter depths in the open channel of the river. Temperature data was recorded at one-hour intervals in 2003 and 1.5-hour intervals in 2004.

Total suspended solids were collected in 250 milliliter (ml) acid-washed polyethylene containers at a depth of 1 to 2 meters below the water surface in the main channel of the river whenever possible. Eurasian milfoil identification was conducted by boat during each sampling event in 2004 using a hand held Global Positioning System (GPS). Milfoil sites were then placed in a GIS coverage of the Pend Oreille River. Additional Eurasian milfoil sites obtained from Bonner County Weed Department were also included in the GIS coverage; however, no GPS locations were provided for these data (Figure 6).

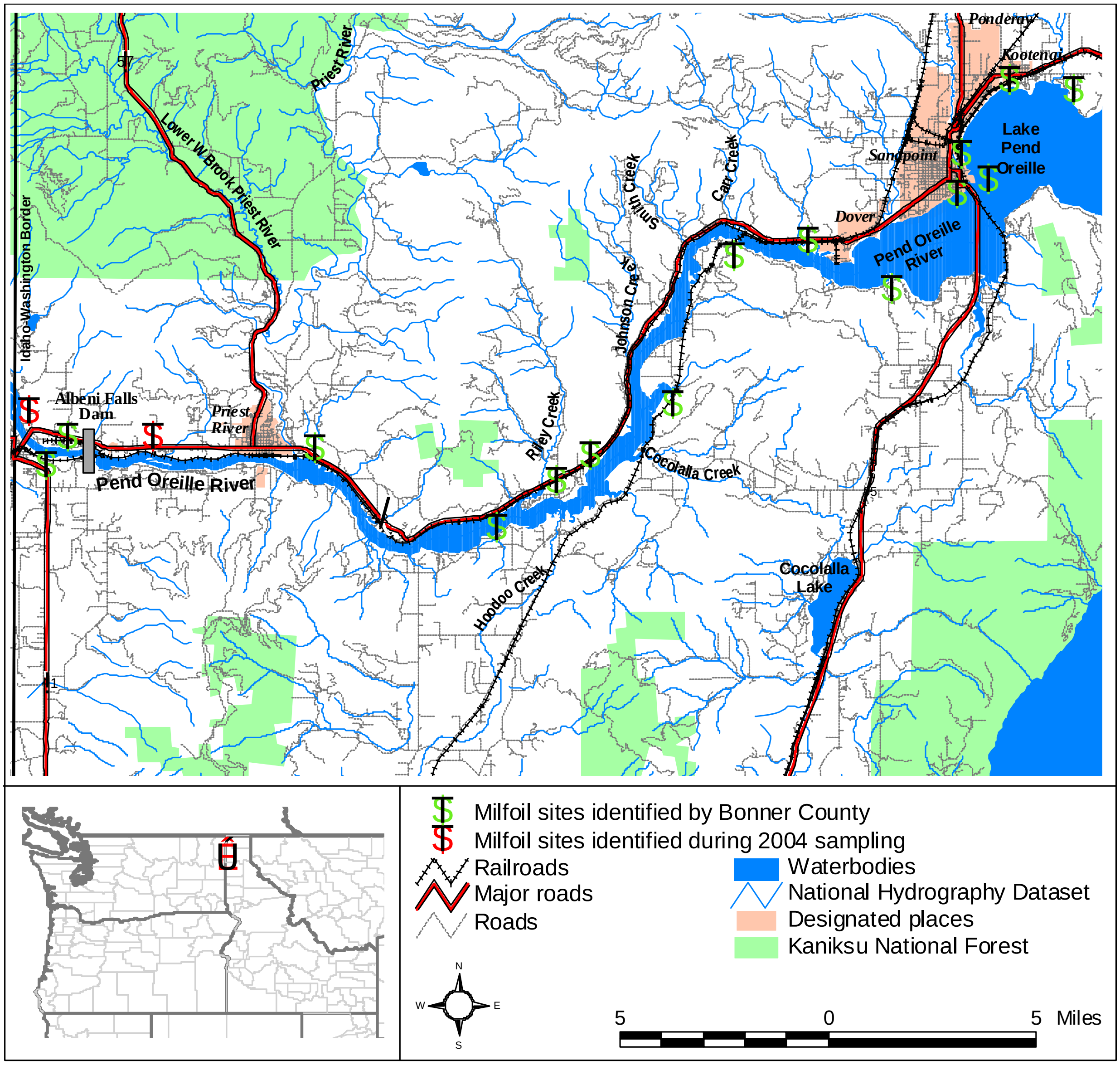


Figure 6. Eurasian milfoil sites on the Pend Oreille River, Idaho

3.1.2. Chemical Water Quality Monitoring

Chemical water quality parameters included field measurements of DO, pH, and conductivity using a SPER Scientific multimeter. Laboratory analyses included TP and TN with nitrate + nitrite nitrogen (NO_2+NO_3) and total ammonia-nitrogen (NH_3+NH_4). Samples were collected using Kemmerer type sampler at a depth of 1 to 2 meters from the water surface. Samples were placed in 250 ml acid-washed polyethylene containers.

3.1.3. Biological Water Quality Monitoring

Biological water quality parameters included chlorophyll *a*. In addition, field observations of the riparian vegetation and riverbank conditions were made at each sampling location.

3.2. River Sediment Substrate Analysis

The mean particle size of the river substrate was determined by a one-time sampling of river bottom sediments using a mini ponar grab sampler at each water quality sampling location. Three sediment samples were collected along a cross section of the river representing north, center, and south at each sampling site. The mini ponar sampler was lowered using a rope marked with one-meter increments until reaching the river bottom. Sediment samples were collected to a depth of approximately six inches on the river bottom. Depth below the water surface was recorded in the field notes as well as documenting the type and quantity of macro invertebrates present. Samples were placed in clean 2 gallon buckets for initial inspection and then transferred to 2 gallon freezer bags for transport and air drying prior to sieve analysis. The dried samples were weighed prior to being passed through a series of sieves to determine particle size distribution following American Society of Testing Methodology (ASTM) standards. ASTM standards for particle size boundaries are determined by sieve size and are broken into five major categories—cobbles, gravel, sand, silt, and clay. ASTM particle size distributions are as follows:

Boulders = Particle of rock that will not pass a 12 inch square opening.
Cobbles = Particle of rock that will pass a 12 inch square opening and be retained on a 3 inch U.S. standard sieve.
Gravel = Particles of rock that will pass a 3 inch sieve and be retained on a Number 4 U.S. standard sieve.
Sand = Particles of rock that will pass a Number 4 U.S. standard sieve and be retained on a Number 200 U.S. standard sieve.
Silt = Soil passing a Number 200 standard sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when dry.
Clay = Soil passing a Number 200 standard sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents and that exhibits considerable strength when dry.

4. RESULTS AND DISCUSSION

The following sections discuss the results of the physical, chemical and biological monitoring and evaluations on the Pend Oreille River conducted during summer of 2003 and 2004.

4.1. Physical Water Quality

This section discusses the results of the physical monitoring, including temperature, total suspended solids, Eurasian Milfoil identification and mapping, and river substrate characterization.

4.1.1. Temperature

A total of six temperature data loggers were first deployed on July 30, 2003. Only two of the six temperature loggers were retrieved in early October 2003. It is not known if the four missing loggers were lost or stolen. Previous experience with temperature monitoring using data loggers throughout northern Idaho suggest that data loggers are often tampered with or stolen if not very well hidden. Data from 2003 temperature monitoring of the Pend Oreille River are shown in Figures 7 and 8.

A total of six temperature data loggers were deployed in late May of 2004. Four of the six temperature loggers were retrieved in early September 2004. As in 2003, it is not known if the two missing temperature loggers in 2004 were lost or stolen. Temperature loggers were recovered in early September rather than October to ensure the loggers would not be left visible near the waters surface after the drafting of Lake Pend Oreille. Data collected at sampling site #6 was not usable as the temperature logger was not placed deep enough to anticipate the drop in water levels below the dam during the summer months and was not fully submerged when retrieved. The temperature logger would have to have been placed approximately two to three meters below the waters surface to account for the drop in water level at this location. Data from 2004 temperature monitoring are shown in Figures 9 through 11.

The maximum temperature recorded from temperature data loggers in the Pend Oreille River during 2003 was 25.9 degrees Celsius at site #2. Maximum temperatures at this site were recorded during late July and early August. The maximum temperature recorded further downstream below the confluence with the Priest River at site #5 was slightly lower at 25.6 degrees Celsius.

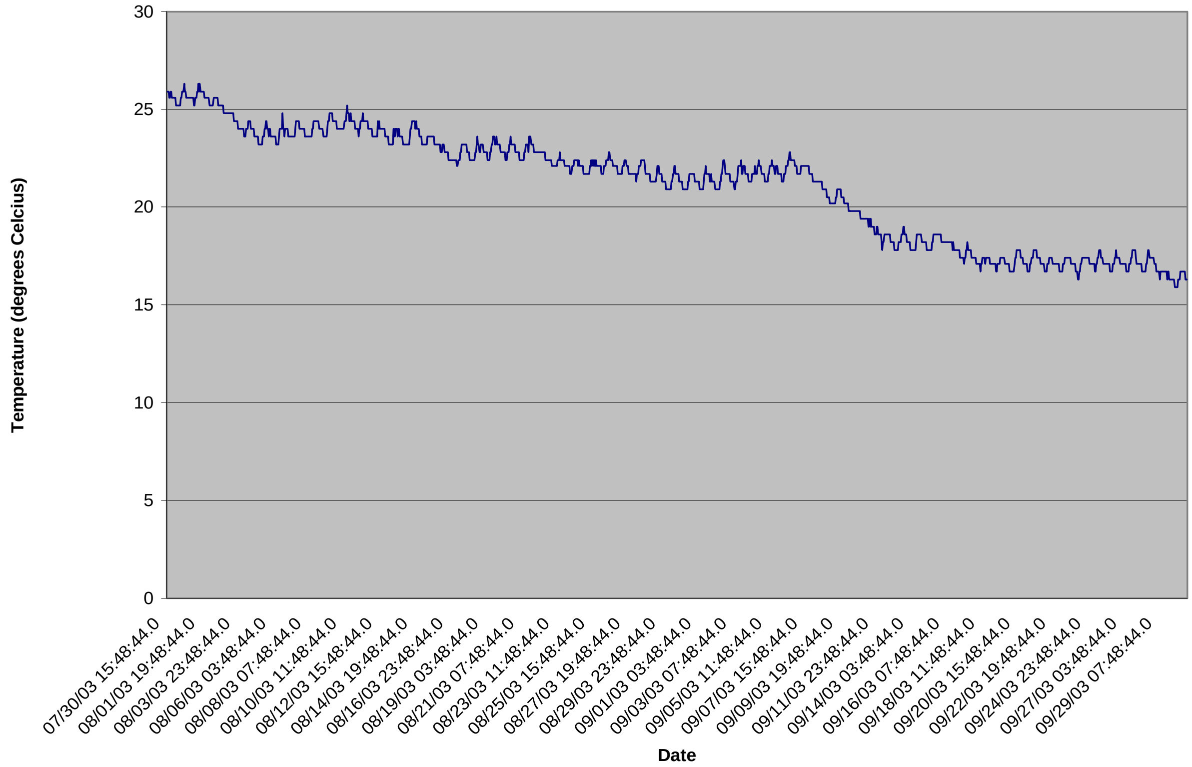


Figure 7. Temperature logger data, site #2, Pend Oreille River, Idaho, 2003

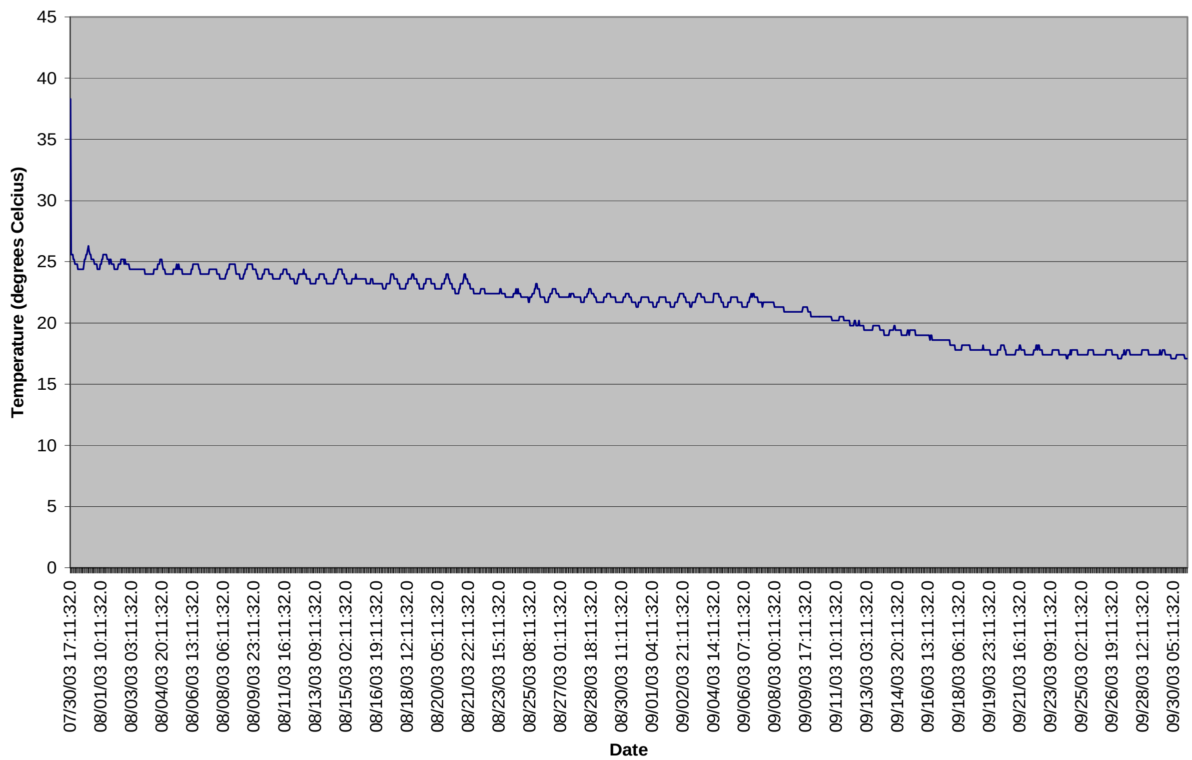


Figure 8. Temperature logger data, site #5, Pend Oreille River, Idaho, 2003

During the 2004 field season the maximum temperature recorded in the Pend Oreille River was 25.2 degrees Celsius, again at site #2. As with the previous year, the maximum temperature recorded at this site was late July and early August. The maximum temperature downstream above the confluence with the Priest River at site #3 was 24.8 degrees Celsius.

The primary purpose for monitoring temperature of the Pend Oreille River was to determine whether or not current water quality standards are being achieved as defined in Idaho Administrative Procedures Act (IDAPA). IDAPA 58.01.02.250.02b states for cold water biota that water temperatures shall be twenty-two (22) degrees Celsius or less with a maximum daily average of no greater than nineteen (19) degrees Celsius. Under this definition it would appear that the Pend Oreille River does not meet current water quality standards for temperature. The IDEQ 2000 Subbasin Assessment for the Pend Oreille River did not find exceedances of temperature water quality standards; however, the temperature data collected in 1985 and 1986 were at one location and at a depth of approximately five meters (16.4 feet) (IDEQ, 2000).

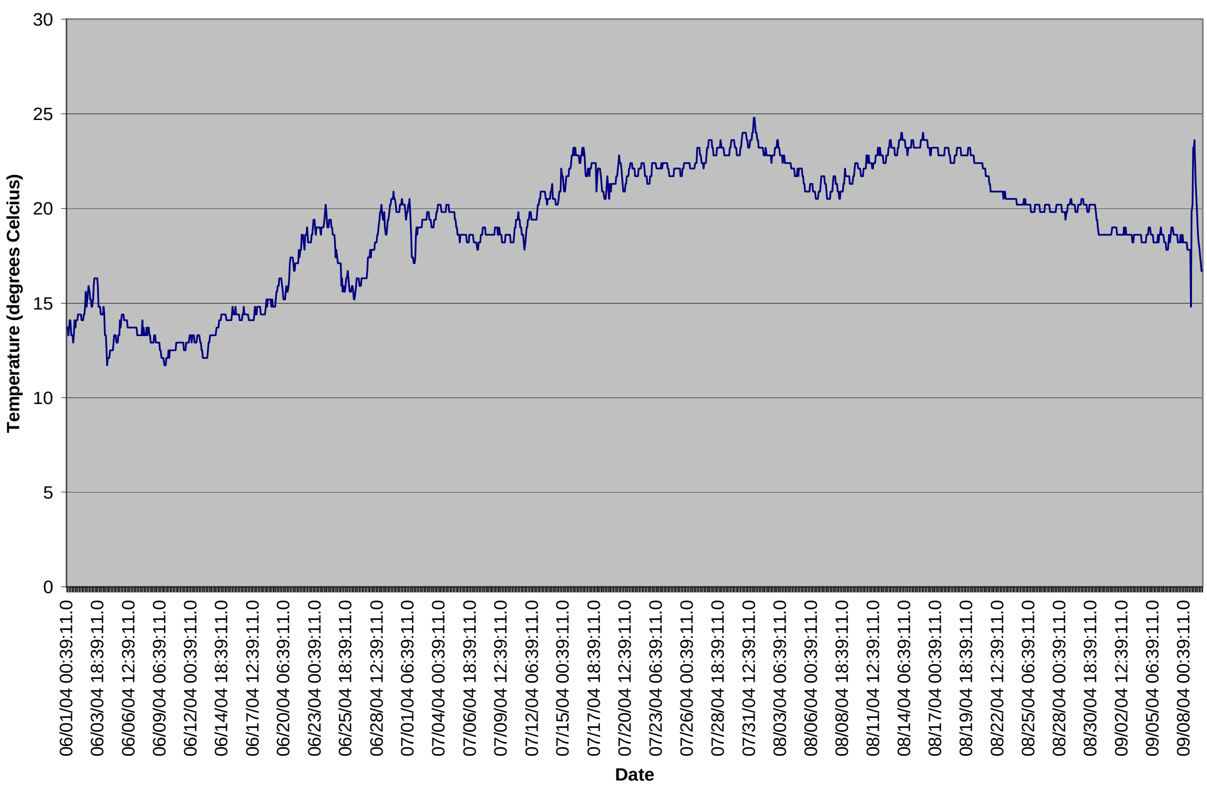


Figure 9. Temperature logger data, site #1, Pend Oreille River, Idaho, 2004

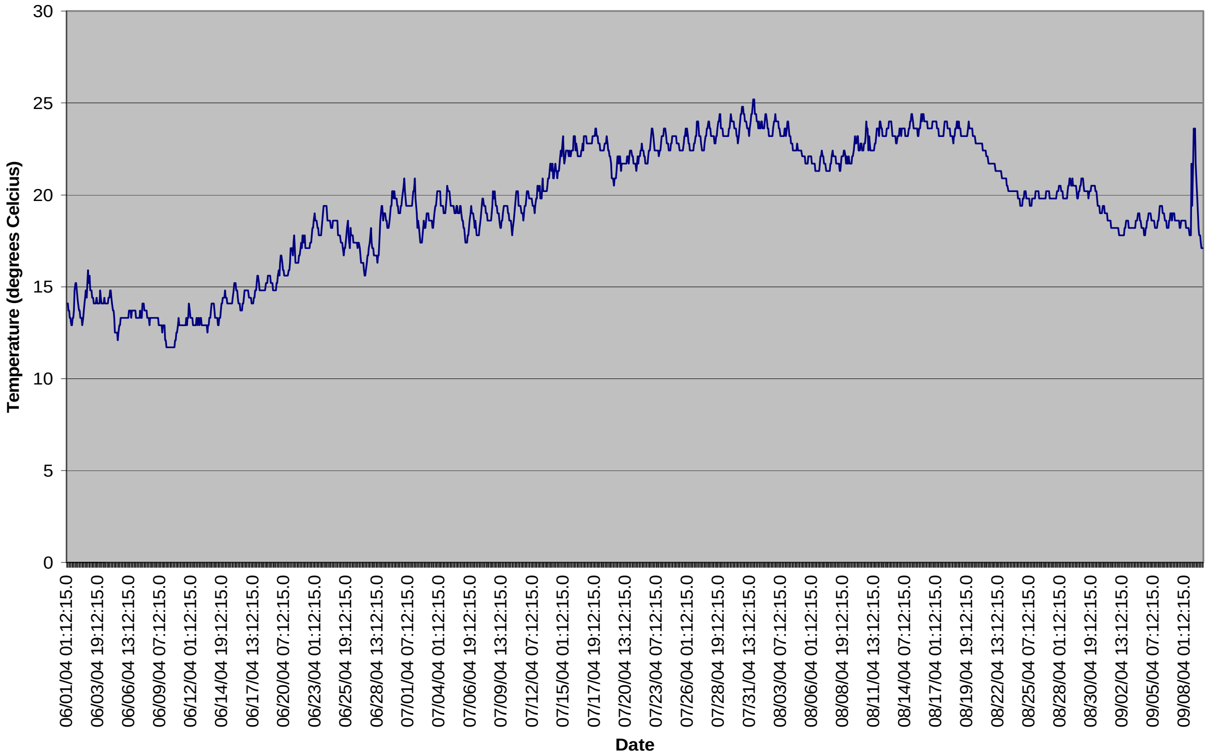


Figure 10. Temperature logger data, site #2, Pend Oreille River, Idaho, 2004

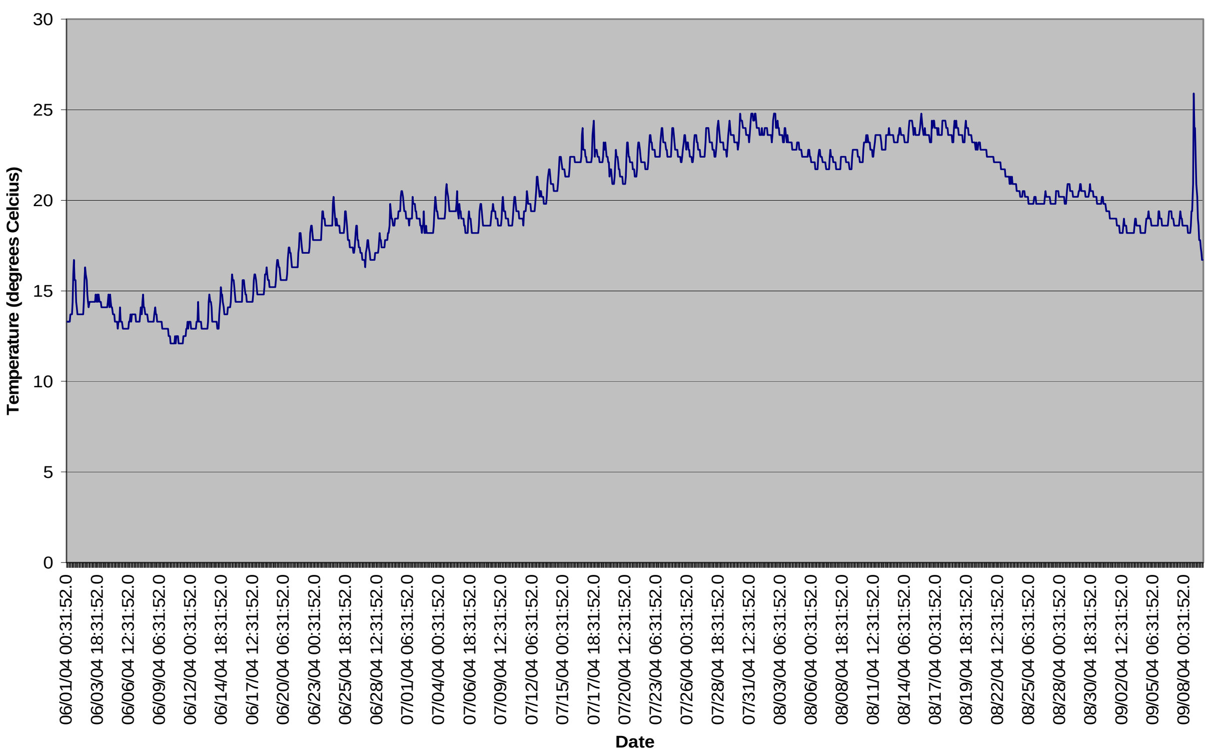


Figure 11. Temperature logger data, site #3, Pend Oreille River, Idaho, 2004

4.1.2. Total Suspended Solids

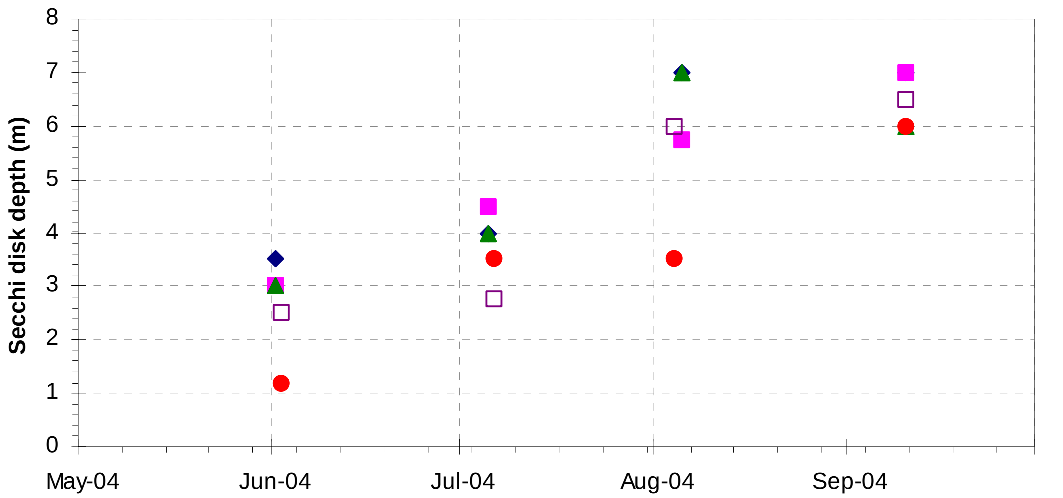
The primary purpose for monitoring total suspended solids (TSS) was to establish background TSS values in the upper water column which may help in determining sediment load and delivery allocations should the IDEQ determine a TMDL for sediment in the Pend Oreille River is required. TSS data collected by IDEQ in 1985 and 1986 near Laclede, Idaho, on the Pend Oreille River were below detection limits of 2.0 mg/l. TSS data collected as part of this study were all below the detection limit of 5.0 mg/l with the exception of site #5 and the duplicate sample taken at this station on June 2, 2004. The sample at site #5 was 6.9 mg/l and the duplicate sample was 8.9 mg/l. This site consistently experienced visible sediment plumes near the northern riverbank above and in the vicinity of the public swimming area and boat launch. It is not known if the sediment in this area is due to human activity or naturally occurring phenomena related to river flow characteristics. There is a large pump house of some sort near the boat launch as well and it is possible that river water is being pumped which may cause disturbance of river bottom sediments. A large lumber mill is located on the south side of the river in this location and may also be associated with the sediment plume in this area.

4.1.3. Eurasian Milfoil Identification

Eurasian Milfoil was identified in the field each month during 2004 and then mapped to a GIS coverage along with Eurasian Milfoil data obtained from Bonner County Weed Department (Figure 6). There were three areas of Eurasian Milfoil growth not identified by Bonner County Weed Department and most were within close proximity to public boat launches and or recreational areas on the Pend Oreille River. The first area not identified by Bonner County Weed Department is below the Albeni Falls dam near sampling site #6 along the Idaho-Washington border. Heavy milfoil growth around the public boat launch and floating dock maintained by the COE interfere with recreational activities according to many of the patrons of this facility (personal communication). The second site not identified by Bonner County Weed Department is near sampling site #4 and is a popular swimming area and boat launch, although not well publicized. Milfoil growth in this area was found upstream of the boat ramp. The third location not identified by Bonner County Weed Department was near sampling site #2 just downstream of the Springy Point recreation area on the north side of the Pend Oreille River. The other areas of milfoil growth identified during this study were already identified by the Bonner County Weed Department. It is clear that Eurasian Milfoil has already migrated from the Pend Oreille River in Washington throughout the Pend Oreille River in Idaho and is now a matter of identification and management. It is also clear from the information obtained through this study and that of the Bonner County Weed Department that the Pend Oreille River in Idaho is currently experiencing impacts to recreational uses from the growth of Eurasian Milfoil. Furthermore, Eurasian Milfoil growth will only worsen over time in the Pend Oreille River without appropriate identification and management efforts.

4.1.4. Secchi Disk Measurements

Secchi disk measurements were conducted at each sampling location throughout the monitoring season and are shown in Figure 12. As expected, secchi disk readings were lowest in June and became increasingly deeper through the summer. During August and September at site #6 shallow river conditions did not allow for a true secchi reading and reflect the depth to the river bottom.



	6/1/04	6/2/04	7/5/04	7/6/04	8/4/04	8/5/04	9/10/04
◆ #2	3.5		4			7	7
■ #3	3		4.5			5.75	7
▲ #4	3		4			7	6
● #5		1.2		3.5	3.5		6
□ #6		2.5		2.75	6		6.5

Figure 12. Secchi disk measurements in the Pend Oreille River, Idaho, 2004

4.2. Chemical Water Quality

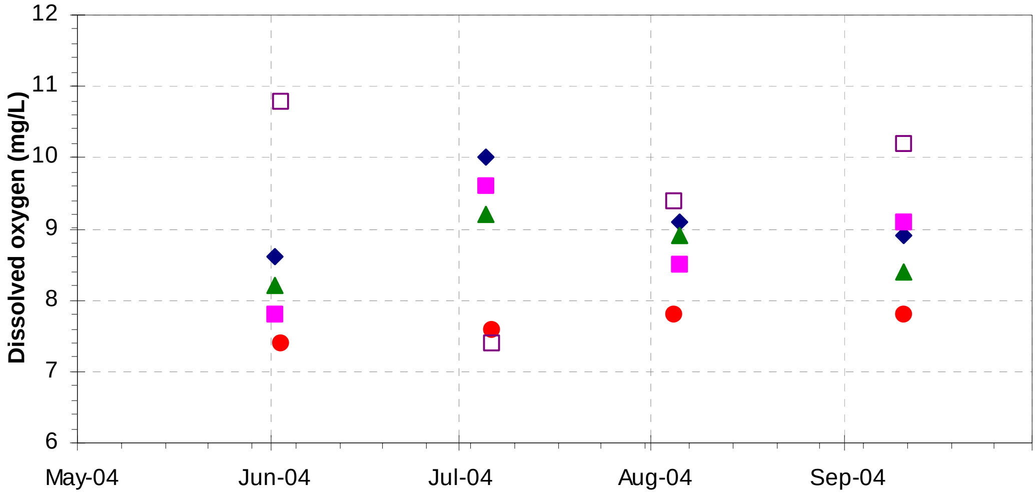
This section discusses the results of the chemical water quality monitoring conducted during the summer of 2004, including DO, pH, conductivity, TP, and TN.

4.2.1. Dissolved Oxygen

No violations of the 6.0-mg/l water quality standards for DO as outlined in IDAPA 58.01.02.250.02 were documented during this study (Figure 13). However, at site #6 near the border of Idaho and Washington, one sample (July 6, 2004) violated Washington State DO standards of 8.0 mg/l. Although other sites on the Pend Oreille River in Idaho experienced DO levels below Washington State standards, they were all several miles upstream of the state line. The violation of Washington State standards near the border is noteworthy because the state of Idaho is required to meet all Washington State water quality standards at the border.

Site #5 consistently experienced the lowest DO levels averaging about 7.6 mg/l. Low DO levels at this location may be due in part to the pulp mill located on the south side of the river contributing runoff water laden with natural wood waste byproducts (e.g., tannins and lignins).

DO levels at this location may also be influenced by occasional higher levels of suspended sediment as noted in Section 4.1.2.

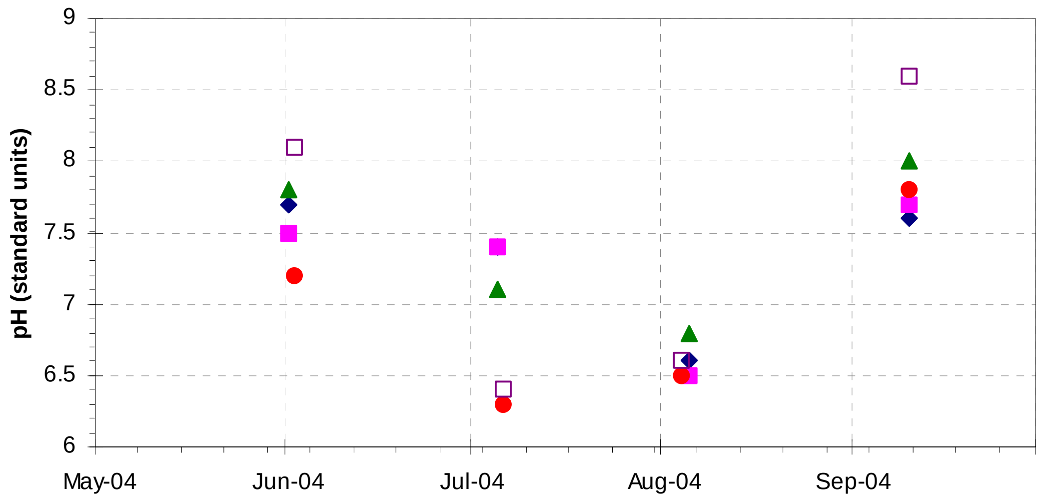


	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
◆ #2	8.6		10			9.1	8.9
■ #3	7.8		9.6			8.5	9.1
▲ #4	8.2		9.2			8.9	8.4
● #5		7.4		7.6	7.8		7.8
□ #6		10.8		7.4	9.4		10.2

Figure 13. Dissolved oxygen levels in the Pend Oreille River, Idaho, 2004

4.2.2. pH

The pH values obtained during the 2004 sampling are listed in Figure 14. Overall pH values averaged just above neutral with no large deviations on either side of the pH scale at any time and all values were within acceptable fresh water levels. Currently there are no pH standards for surface waters of Idaho under IDAPA 58.01.02.250.



	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
◆ #2	7.7		7.4			6.6	7.6
■ #3	7.5		7.4			6.5	7.7
▲ #4	7.8		7.1			6.8	8
● #5		7.2		6.3	6.5		7.8
□ #6		8.1		6.4	6.6		8.6

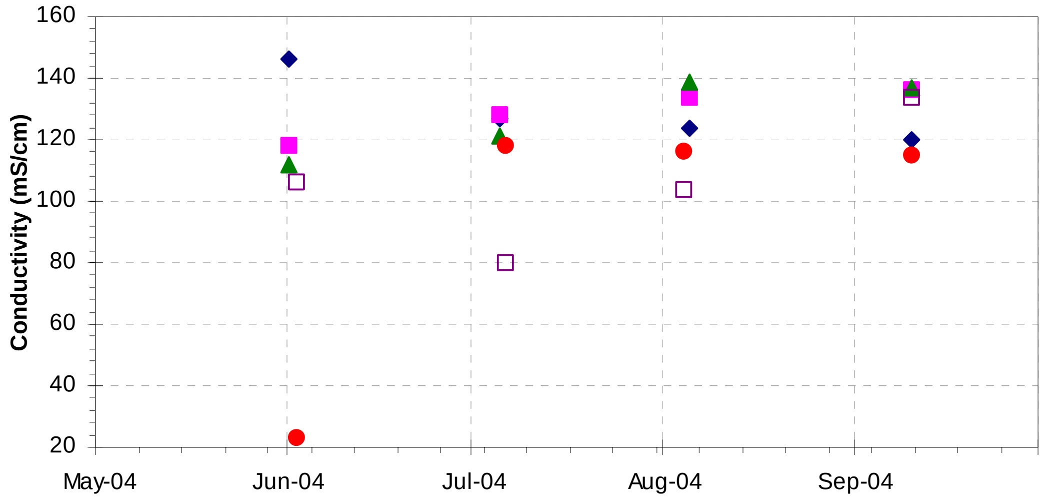
Figure 14. pH levels in the Pend Oreille River, Idaho, 2004

4.2.3. Conductivity

Electrical conductivity is a standard field measurement that can be used to better understand the amount of total dissolved solids in the water column. Conductivity values expressed as micro Siemens per centimeter (mS/cm) are listed in Figure 15. To convert the electrical conductivity of a sample into the approximate concentrations of total dissolved solids (TDS) in parts per million (ppm) the following equation was used:

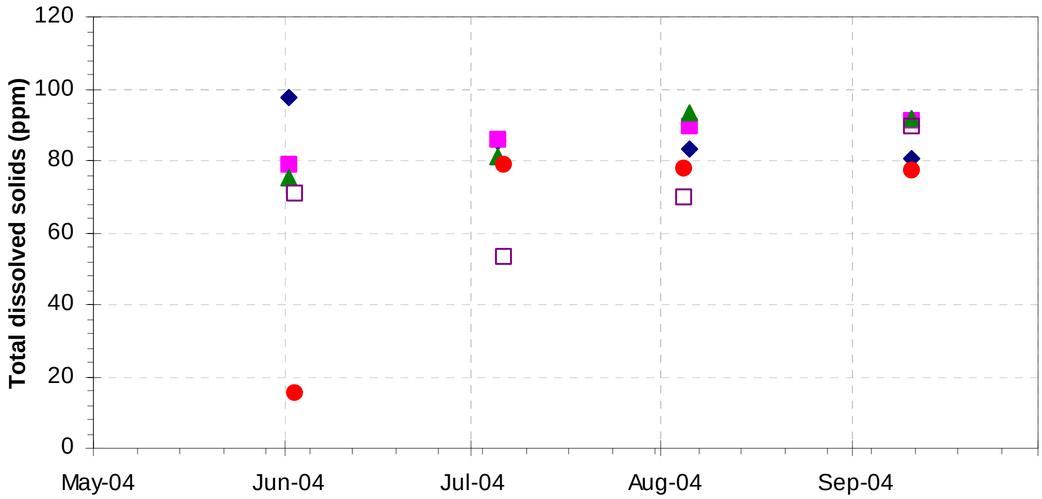
$$\text{TDS (ppm)} = \text{Conductivity (mS/cm)} \times 0.67$$

The conversion factor depends on the chemical composition of the dissolved solids and ranges from 0.59 to 0.96. A conversion factor of 0.67 is commonly used when the actual conversion factor is not known. Calculated TDS values are included in Figure 16. Conductivity values for the Pend Oreille River are within generally accepted fresh water values of 0 to 1,500 mS/cm. Currently there are no electrical conductivity standards for surface waters of Idaho under IDAPA 58.01.02.250.



	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
◆ #2	146		127			124	120
■ #3	118		128			134	136
▲ #4	112		121			139	137
● #5		23		118	116		115
□ #6		106		80	104		134

Figure 15. Electrical conductivity levels in the Pend Oreille River, Idaho, 2004

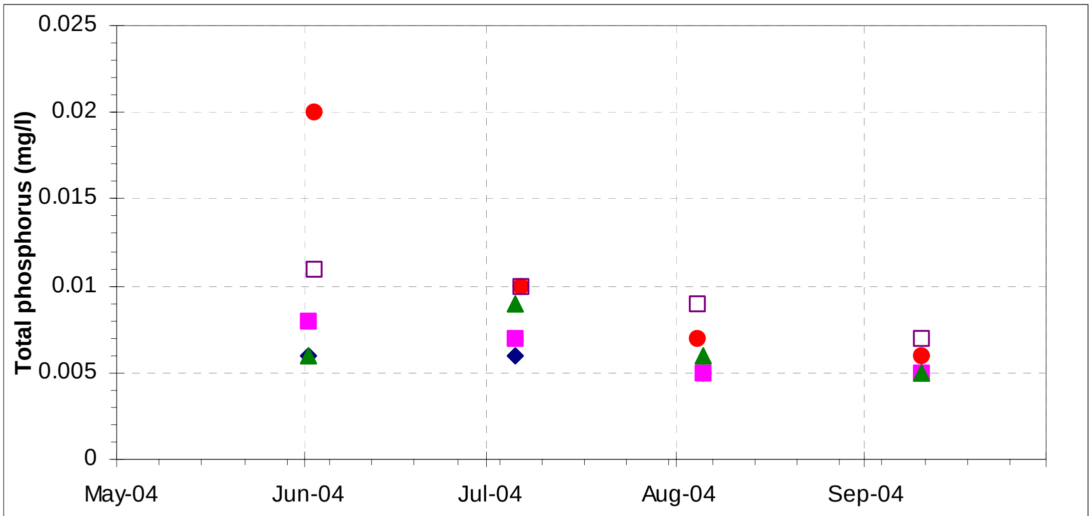


	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
◆ #2	97.8		85.1			83.1	80.4
■ #3	79.1		85.8			89.8	91.1
▲ #4	75		81.1			93.1	91.8
● #5		15.4		79.1	77.7		77.1
□ #6		71		53.6	69.7		89.8

Figure 16. TDS levels in the Pend Oreille River, Idaho, 2004

4.2.4. Total Phosphorus

TP data are provided in Figure 17. Based on the limited data from this study, levels of TP in the Pend Oreille River, Idaho, appear to have a minor increasing trend from the outlet of Lake Pend Oreille to the Idaho-Washington border. Sites #5 and #6 were consistently higher than sites further upstream and the highest level found was 0.020 mg/l at site #5 during the June sampling event. The suggested TP values for the open waters of Lake Pend Oreille are 0.0073 mg/l (TSWQC, 2001) and most of the values in the river are either at or below this target with the exception of sites #5 and #6. The nearshore areas rather than the open waters of Lake Pend Oreille are more comparable to conditions in the Pend Oreille River and the nearshore nutrient TMDL for Lake Pend Oreille set a TP limit of 0.009 mg/l (IDEQ, 2003). Furthermore, EPA has recommended nutrient criteria for Ecoregion II, including TP at 0.010 mg/l (USEPA, 2000). Based on the target levels established in the nearshore TMDL and EPA suggested criteria, only sites #5 and #6 would have exceedances for TP.

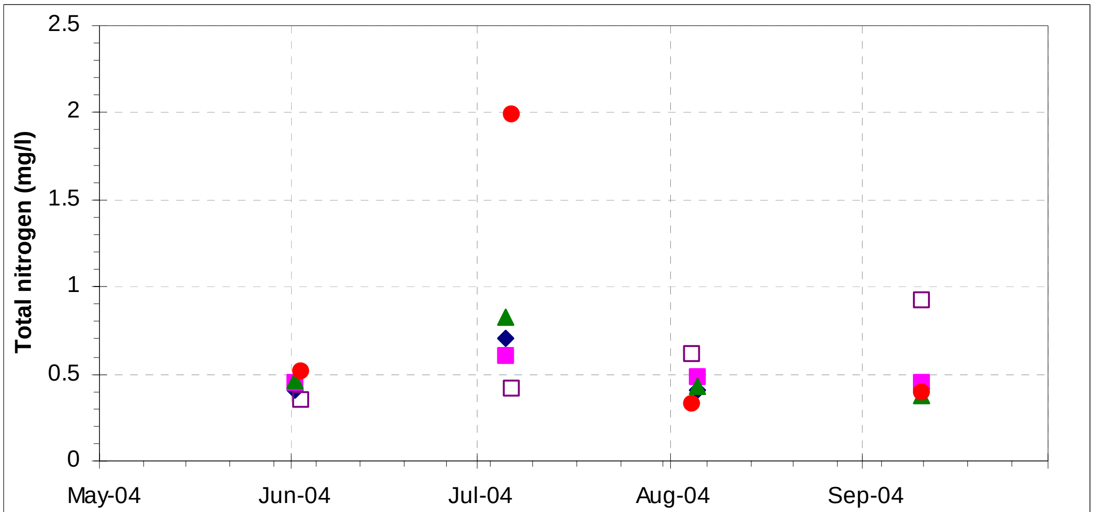


	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
◆ #2	0.006		0.006			0.005	0.006
■ #3	0.008		0.007			0.005	0.005
▲ #4	0.006		0.009			0.006	0.005
● #5		0.02		0.01	0.007		0.006
□ #6		0.011		0.01	0.009		0.007

Figure 17. Total phosphorus levels in the Pend Oreille River, Idaho, 2004

4.2.5. Total Nitrogen

TN values were determined by taking the sum of nitrate (NO_3), nitrite (NO_2), organic nitrogen and ammonia from laboratory analyses. Total Kjeldahl Nitrogen (TKN) analyses comprise both organic nitrogen and ammonia (NH_3). Therefore, the values listed in Figure 18 are a sum of NO_3, NO_2 and TKN. All samples were below the laboratory's reporting limit of 0.020 mg/l for NO_3-NO_2. A value equal to one-half of the reporting limit (0.010 mg/l) was used to derive TN values. The levels of TN in the Pend Oreille River are above the EPA recommended nutrient criteria of 0.12 mg/l established for Ecoregion II (USEPA, 2000). With a few exceptions, the majority of the nitrogen in the Pend Oreille River is in the organic form, as indicated by low levels of NO_3-NO_2, NH_3, and higher levels of TKN. Two samples had NH_3 levels higher than the TKN values and personnel at SVL Analytical, Inc., were not able to provide an explanation for this. It does not appear that ammonia levels exceed criterion maximum concentrations (CMC) or criterion chronic concentrations (CCC) based on IDAPA 58.01.02.250.02d; however, a more detailed investigation and interpretation of the water quality standards specific to ammonia would be necessary.



	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
◆ #2	0.41		0.71			0.41	0.42
■ #3	0.45		0.61			0.49	0.45
▲ #4	0.46		0.83			0.43	0.37
● #5		0.52		1.99	0.33		0.4
□ #6		0.35		0.42	0.62		0.93

Figure 18. Total nitrogen levels in the Pend Oreille River, Idaho, 2004

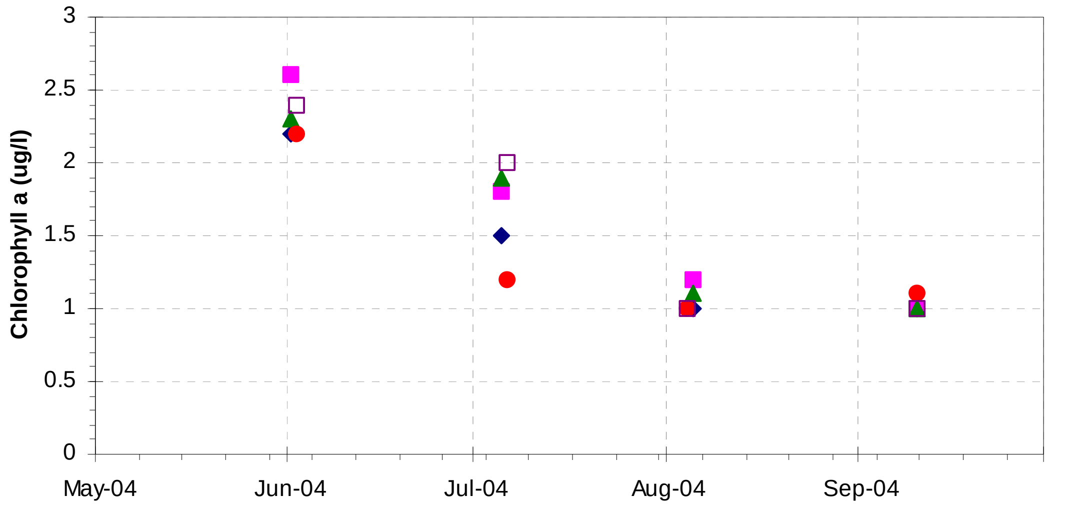
4.3. Biological Water Quality

This section discusses the chlorophyll *a* data collected during the summer of 2004 and also includes information on the riparian vegetation and riverbank conditions observed during the sampling.

4.3.1. Chlorophyll *a*

Chlorophyll a levels were highest in June and decreased over the field season (Figure 19). EPA nutrient criteria for Ecoregion II suggest chlorophyll a reference conditions be 1.08 micrograms per liter (ug/l). Based on the EPA suggested standard, the Pend Oreille River is above reference conditions for Ecoregion II for chlorophyll a at all sampling sites during the months of June and

July. Sampling conducted in the open waters of Lake Pend Oreille during 2004 also showed the same decreasing trend of chlorophyll a levels from a high in June to a low in September.



	6/1/2004	6/2/2004	7/5/2004	7/6/2004	8/4/2004	8/5/2004	9/10/2004
#2	2.2		1.5			1	1
#3	2.6		1.8			1.2	1
#4	2.3		1.9			1.1	1
#5		2.2		1.2	1		1.1
#6		2.4		2	1		1

Figure 19. Chlorophyll a levels in the Pend Oreille River, Idaho, 2004

4.3.2. Riparian Vegetation and River Bank Conditions

Although not specifically included as a task in the scope of work for this project, riparian vegetation at each sampling site was observed to characterize vegetation types and abundance. River bank conditions were also observed to evaluate the susceptibility for erosion and sediment delivery to the Pend Oreille River. The information was noted during site reconnaissance to provide background information on site conditions and potential sources of sediment. At site #2 the north shore was composed primarily of rounded granite cobbles with the banks consisting of fine sand. Eroding banks were observed on the north side of the river for approximately one half (1/2) mile in this area. The riparian vegetation on the north bank consisted of grasses and ferns with scattered deciduous trees including birch, poplar, and cottonwood. A few large fir trees and fewer pines were also observed in this vicinity. A bald eagle was also sited at this location. The south side of the river was composed of solid granite type rock to the waters edge and shore was composed of large angular granite type boulders. The granite at this location was well covered with a variety of evergreen trees, including ponderosa pines, lodge pole pines, and fir.

At site #3 the north shore was made up of granite type boulders to the waters edge with a railroad track located approximately 10 vertical feet above and 20 feet away from the river. The dominant vegetation was lodge pole pines and fir trees with scattered shrubs and alder. Moose droppings were observed in the riparian area and along the railroad tracks. The south shore consists of a prominent sand bar, which gently slopes up to the riverbank. Several homes are situated above the south bank in this location with evidence of future development, including cleared lots and recent construction activity. The riparian area at this location is primarily lawn grass up to the waters edge with some natural grasses growing on and near the point bar creating a small wetland. Potential sediment delivery from this area is high and visibly exacerbated by recreational watercraft.

At site #4, the north shore had visible bank erosion, which is typical of what was seen in many places along the north bank of the Pend Oreille River (Figure 20). The riparian vegetation in this area consisted of tall grasses with scattered shrubs and noxious weeds, including spotted knapweed growing in fine sand and silt. There is a dock at this location that seems to be well used by locals for recreation. The south shore at this location was primarily lawn grass with large riprap boulders and a private boat ramp consisting of large cobbles. Natural riparian vegetation consisted of tall grasses and shrubs where it could grow undisturbed.

Site #5 is near the public boat launch, dock, and park along the Pend Oreille River at the City of Priest River. Spotted knapweed was common just upstream from the park and transitioned into mixed forest and grassland. The riverbanks in this area were steep and comprised primarily of sand and silt. Approximately a half-mile of riverbank upstream of the park is experiencing serious erosion problems. The south shore has relatively steep banks that have been reinforced with large boulders and is the site of a large lumber mill still in operation. The riparian vegetation upstream of the mill and above the riverbank is primarily pine forest, grass and shrubs. There is little riparian vegetation downstream on either side of the river at this location.

Site #6 is just above the public boat launch and dock built and maintained by the COE. The north shore in this location consists of fine sand and silt with riparian vegetation consisting almost exclusively of tall grasses and a few scattered shrubs. Fluctuating water levels from dam operations upstream seem to influence the type and location of riparian vegetation. The southern riverbank at this location is steep and consists of mixed cobbles, pebbles, and sand. There is little riparian vegetation until reaching the flood plain approximately twenty plus vertical feet from the waters surface. Large bridge abutments are in the river downstream to support Highway 2 at the border of Idaho and Washington.

In summary, the riverbank conditions of the Pend Oreille River are highly susceptible to erosion where the banks do not consist of bedrock or large boulders. Field observations indicate that recreational watercraft usage on the river is high to very high and has noticeable impacts to bank erosion. Much of the Pend Oreille River banks and flood plains in Idaho do not support the type and quantity of vegetation that can provide stability and strength to the sandy soils and help in preventing erosion from both natural river conditions as well as recreational impacts. Moreover, disturbing trends of development along the banks of the Pend Oreille River are not using any form of natural vegetation for bank stabilization. Large rip rap boulders are becoming more common and valuable habitat along the Pend Oreille River appears to be rapidly declining.

Figure 20. Riverbank erosion, site #4, Pend Oreille River, Idaho

4.4. Sieve Analyses

The primary purpose for river bottom substrate sampling was to better understand and characterize the types of sediment found in the Pend Oreille River. Three samples of river bottom sediments were collected once at each sampling location and sieved to determine particle size distributions (Figures 21 through 33). Each sample was carefully inspected for macro invertebrates, however, none were found in any of the samples collected.

On the north side of the river at site #2, sample 2-1North was collected at a depth of 4 meters. Over 55 percent of the sample collected was sand (20.6 percent coarse, 8.8 percent medium, and 26.5 percent fine), 35 percent of the sample was silt, and just over 8 percent of the sample was clay. There was considerable wood debris in the sediments at this sampling site. Site 2-2Middle was collected at a depth of 12 meters and contained approximately 65 percent silt, 28 percent sand (6 percent coarse, 6 percent medium, and 16 percent fine), and 6 percent clay. Unlike the previous sample, there was little to no woody debris at this location and the coarse sand contained a few very small pebbles. Site 2-3South was collected at a depth of 12 meters and contained almost 83 percent sand (56.9 percent coarse, 15.5 percent medium, and 10.3 percent fine). The sand at all of these sampling sites appeared to be relatively new in age as indicated by the angular rather than rounded particles and was made up of the granite type parent material found in the local watershed.

At site #3 the north and middle samples (3-1North, and 3-2Middle) were solid granite bedrock at a depth of 7 meters and 15 meters respectively. Sample 3-3South was collected at a depth of 6 meters and contained approximately 34 percent sand (1.9 percent coarse, 5.7 percent medium, and 26.7 percent fine), 65 percent silt, and 1 percent clay. As with site #2, the sand appeared to be relatively young in age and freshly weathered from the parent material along the river and in the local watershed.

At site #4 the north sample, 4-1North was collected at 3 meters depth and contained over 62 percent sand (26.4 percent coarse, 7.2 percent medium, and 28.8 percent fine), 21 percent silt, and almost 16 percent clay. There was considerable wood debris in this sample. Sample 4-2Middle was collected at 14 meters and contained over 35 percent sand (1 percent coarse, 4 percent medium, and 29.7 percent fine), 64 percent silt, and 1 percent clay with little to no organics. Sample 4-3South was also collected at a depth of 14 meters and contained over 29 percent sand (4.9 percent coarse, 4.9 percent medium, and 19.7 percent fine), 65 percent silt, and nearly 5 percent clay with little to no organics.

The north shore at site #5, sample 5-1North, was collected at 6 meters and contained approximately 38 percent sand (11.5 percent coarse, 4.9 percent medium, and 21.3 percent fine) with noticeable organics, 59 percent silt, and just over 3 percent clay. Sample 5-2Middle contained approximately 64 percent sand (19 percent coarse, 17.1 percent medium, and 38.1 percent fine) with noticeable woody organic debris, 31 percent silt, and nearly 5 percent clay. Sample 5-3South contained over 81 percent sand (47.2 percent coarse, 13.2 percent medium, and 20.8 percent fine), 17 percent silt, and almost 2 percent clay.

Sample 6-1North contained over 39 percent sand (6.3 percent coarse, 8.3 percent medium, and 25 percent fine) with little organic matter, 54 percent silt, and over 6 percent clay. Sample 6-2Middle contained approximately 37 percent sand (2 percent coarse, 7 percent medium, and 28 percent fine), 62 percent silt, and 1 percent clay. Sample 6-3South contained over 68 percent sand (35.8 percent coarse, 9 percent medium, and 23.9 percent fine), nearly 30 percent silt, and just over 1 percent clay.

Based on the results of this sampling effort, the Pend Oreille River channel substrate is dominated by granitic type sands and silt with areas of heavy woody organic debris. The areas of woody debris almost always occurred on the north shore and were generally absent from the main river channel. This is not surprising since many of the historic lumber mills were located on the north shore of the Pend Oreille River. Although the substrate sampling was somewhat limited in scope, it was surprising that very little gravel was found on the river bottom, and the gravel that was encountered was buried within sand and silt. The river bottom substrate clearly reflects the parent material of the Pend Oreille River basin in Idaho and suggests that the river bottom is easily scoured and able to transport large quantities of sediment under high flow conditions. This along with the overall absence of macro invertebrates and large gravel may be a factor when considering the overall health of fish habitat and proposed fisheries management actions for the Pend Oreille River in Idaho.

5. RECOMMENDATIONS FOR FUTURE WORK

There are several recommendations for future work on the Pend Oreille River that would be helpful to better understand whether or not the designated beneficial uses are being met and support development of TMDLs, if necessary. Monitoring recommendations include the following:

- A stream bank inventory should be completed for the Pend Oreille River in Idaho to identify problem areas and determine lateral recession rates where appropriate.

- Turbidity monitoring should be conducted during the summer months in identified sensitive shoreline areas to see if violations of turbidity standards and or excessive bank erosion rates are being caused by boat traffic. This type of data would be extremely helpful not only to IDEQ, but also to the Bonner County Planning Department when considering potential impacts from proposed development.

- The Bonner County Sheriff patrols the Pend Oreille River almost daily during the summer months and could record occurrences of Eurasian Milfoil for the Bonner County Weed Department. The Sheriff may be equipped with GPS and be able to record exact locations.

- Monitoring should be conducted regularly during the summer months at the Idaho-Washington border to better understand DO fluctuations and potential State of Washington water quality violations.

- Additional monitoring for TN and TP should be conducted to ensure water quality targets established in the near shore nutrient TMDL for Lake Pend Oreille are being met in the Pend Oreille River.

- Information specific to sediment accumulation behind Albeni Falls Dam may provide good historic sediment transport rates for the Pend Oreille River and sediment coring at the dam would also provide additional information concerning bed load transport.

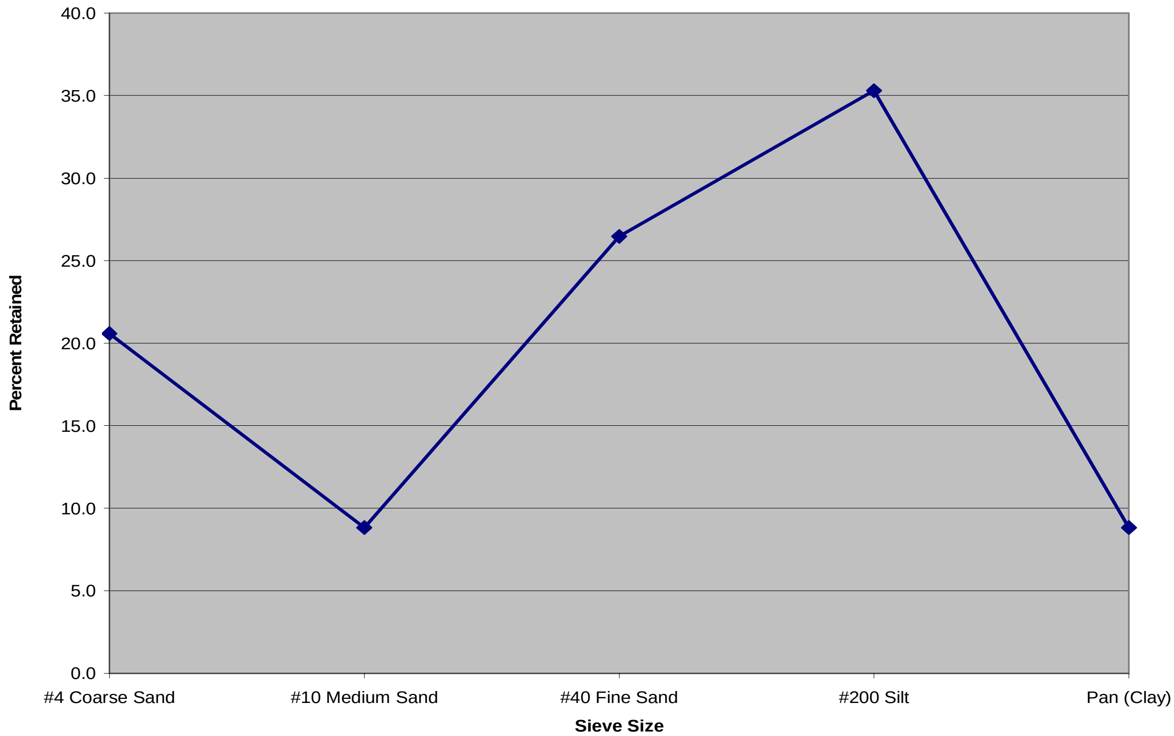


Figure 21. Sieve analysis, site 2-1 North

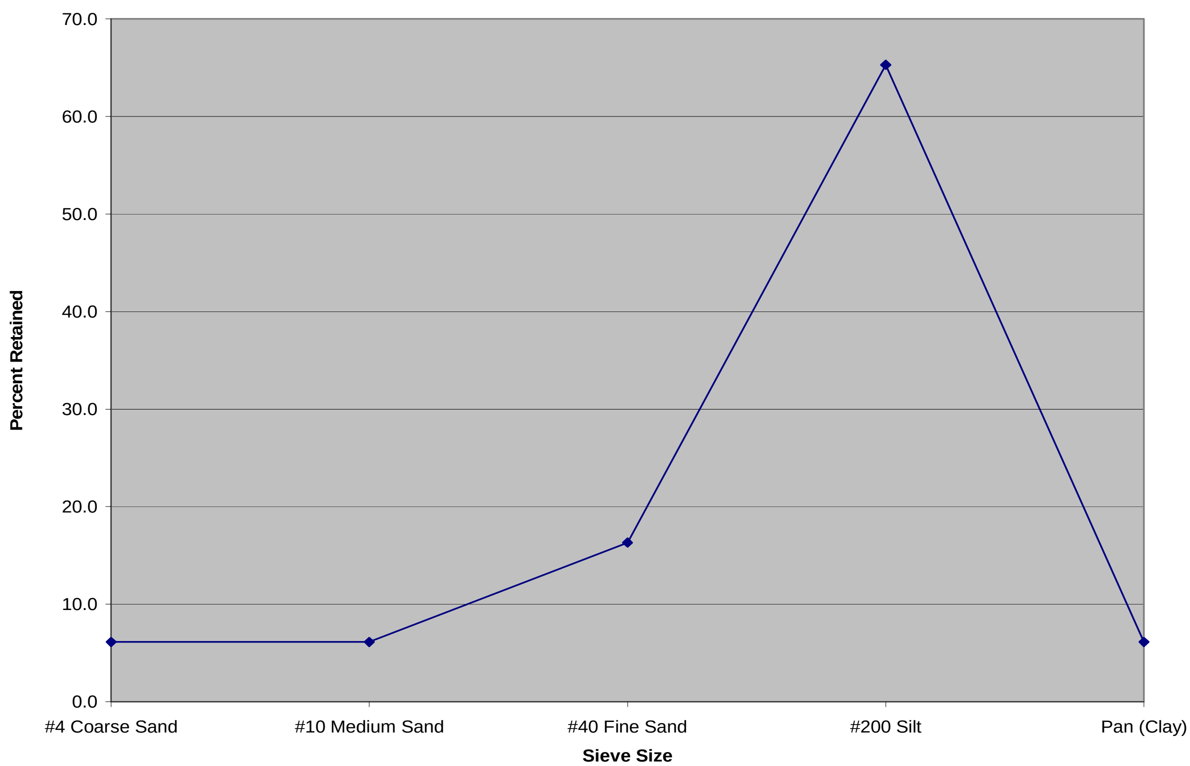


Figure 22. Sieve analysis, site 2-2 Middle

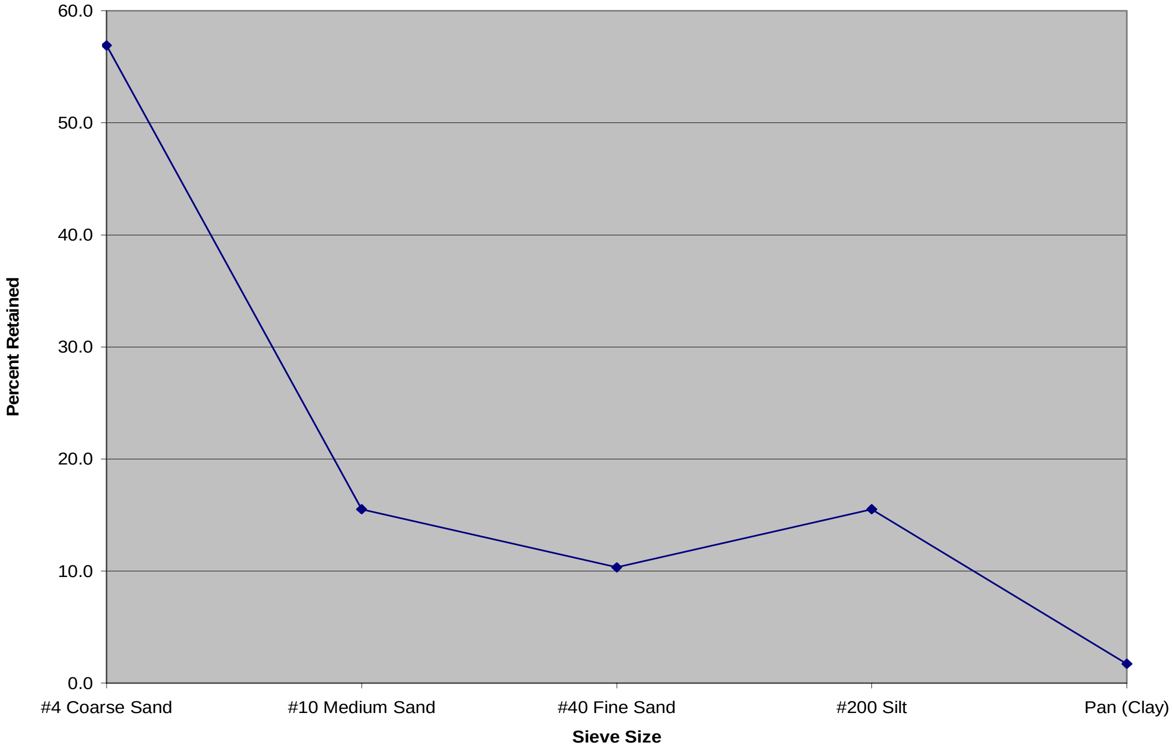


Figure 23. Sieve analysis, site 2-3 South

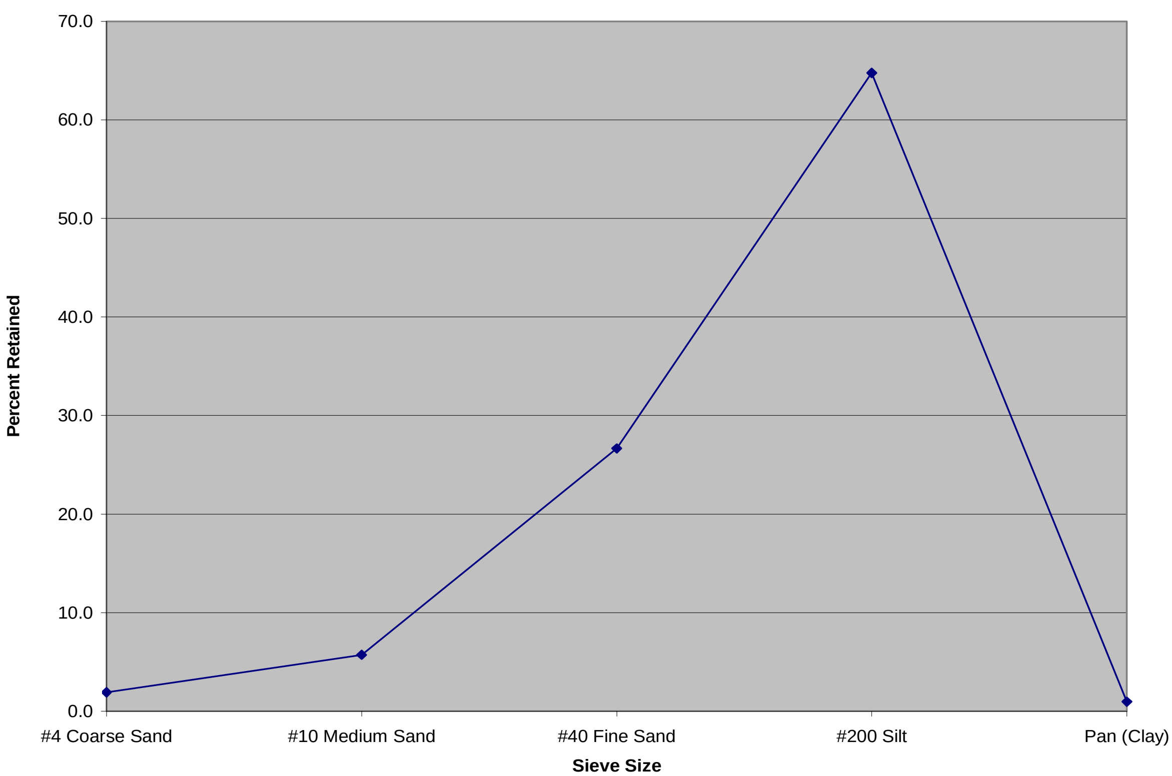


Figure 24. Sieve analysis, site 3-3 South

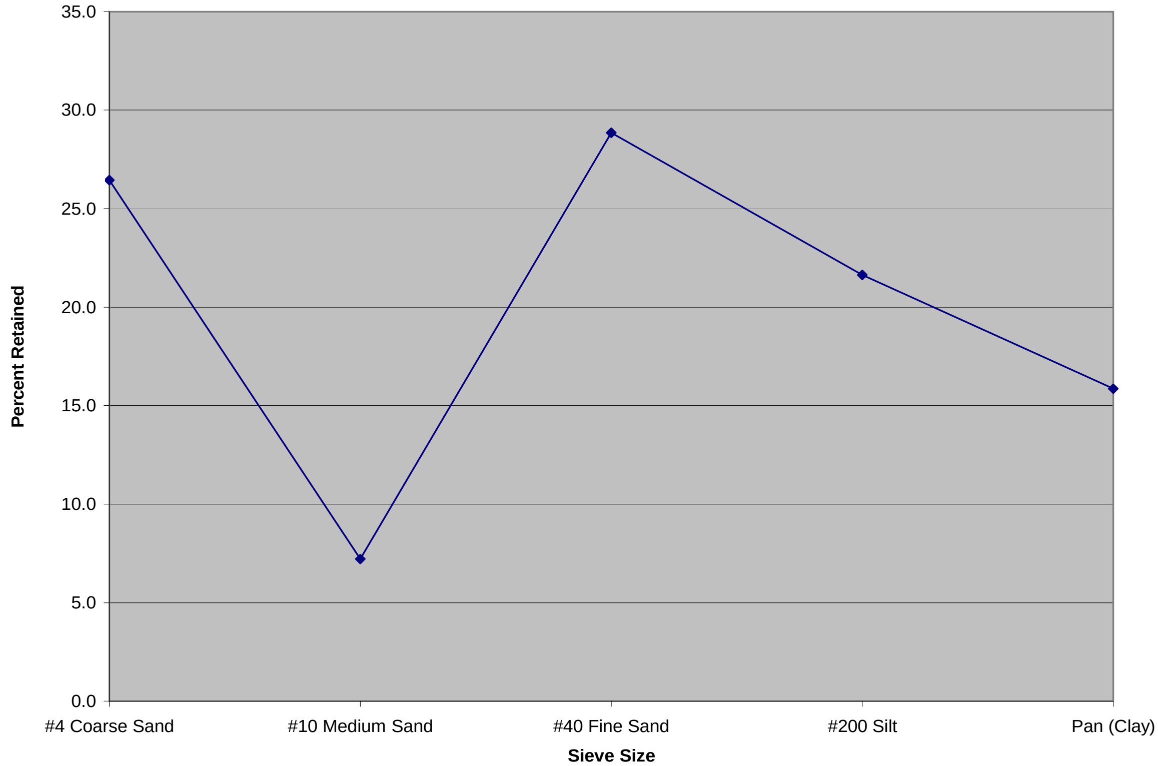


Figure 25. Sieve analysis, site 4-1 North

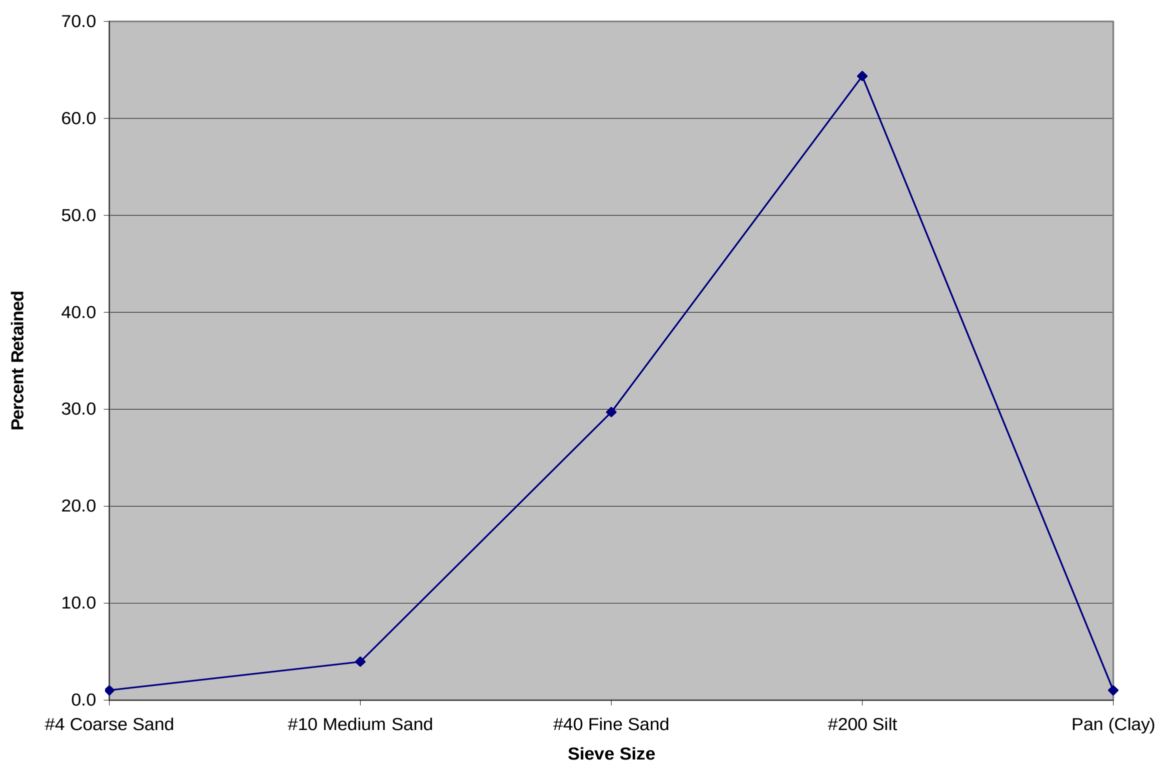


Figure 26. Sieve analysis, site 4-2 Middle

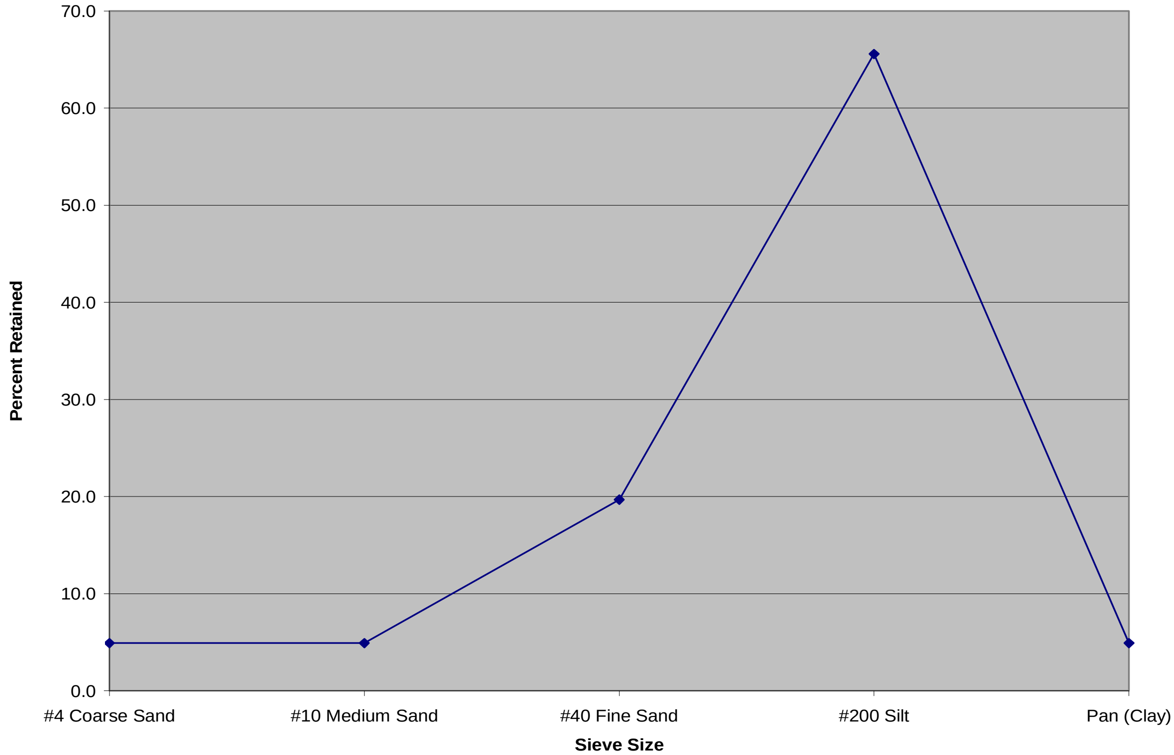


Figure 27. Sieve analysis, site 4-3 South

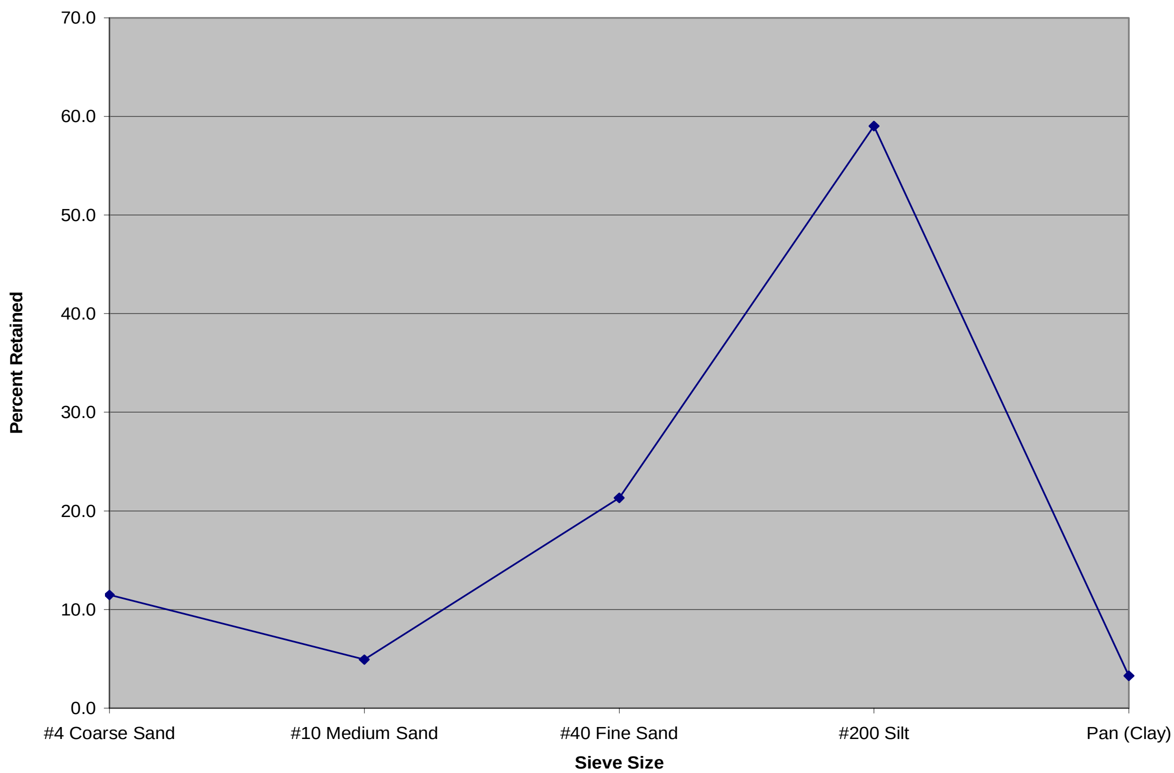


Figure 28. Sieve analysis, site 5-1 North

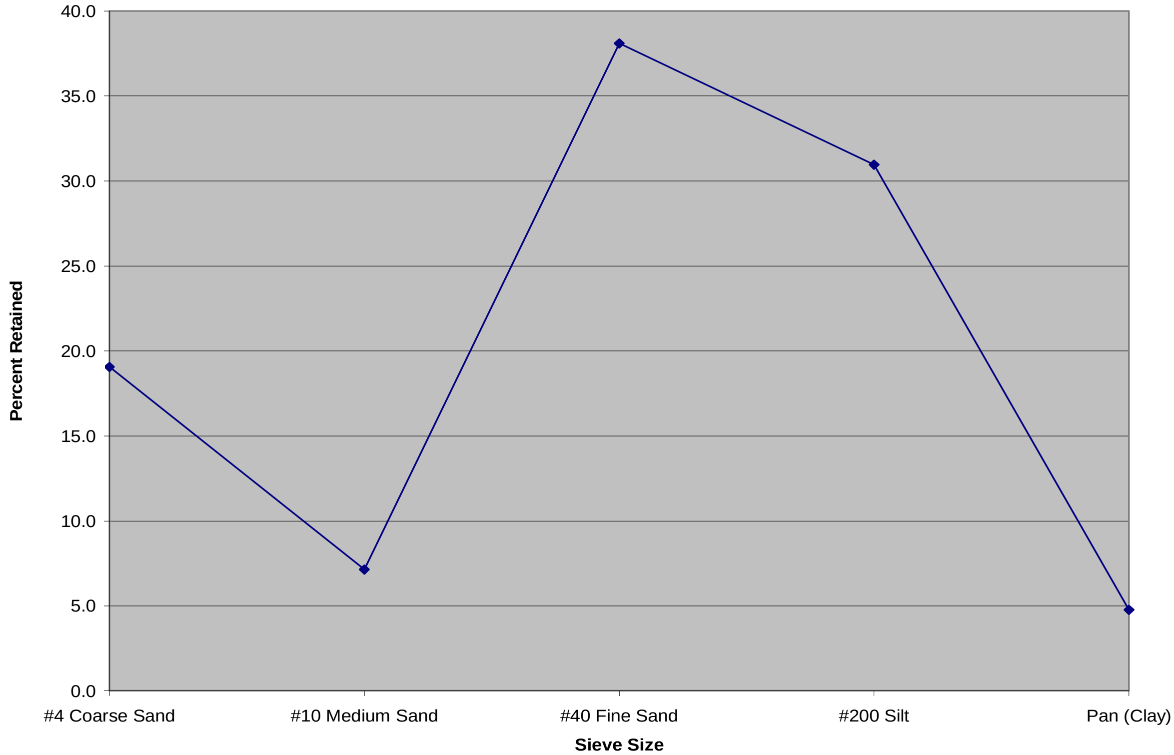


Figure 29. Sieve analysis, site 5-2 Middle

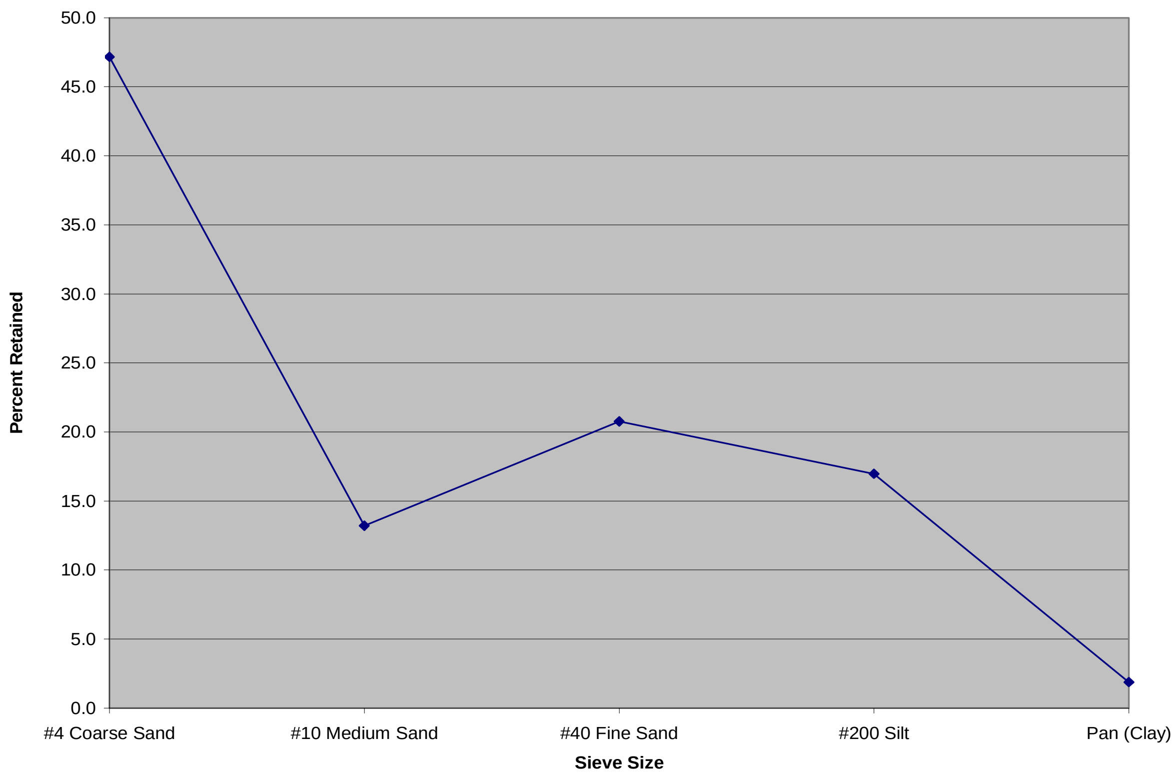


Figure 30. Sieve analysis, site 5-3 South

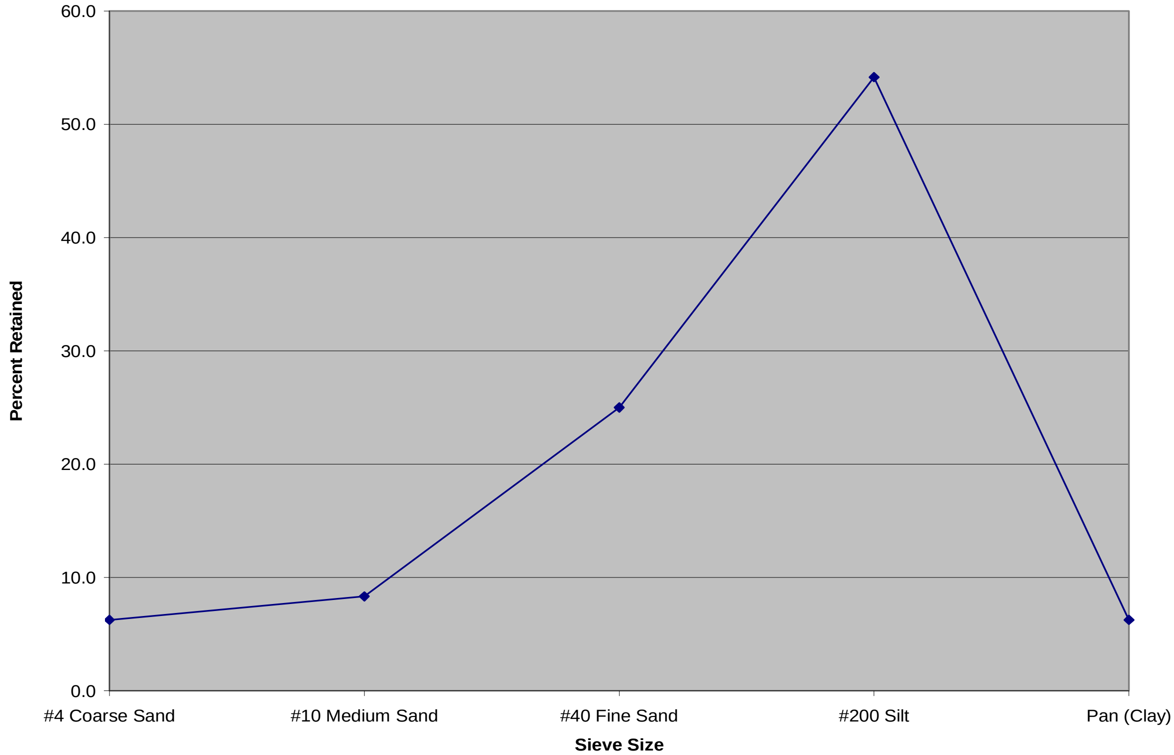


Figure 31. Sieve analysis, site 6-1 North

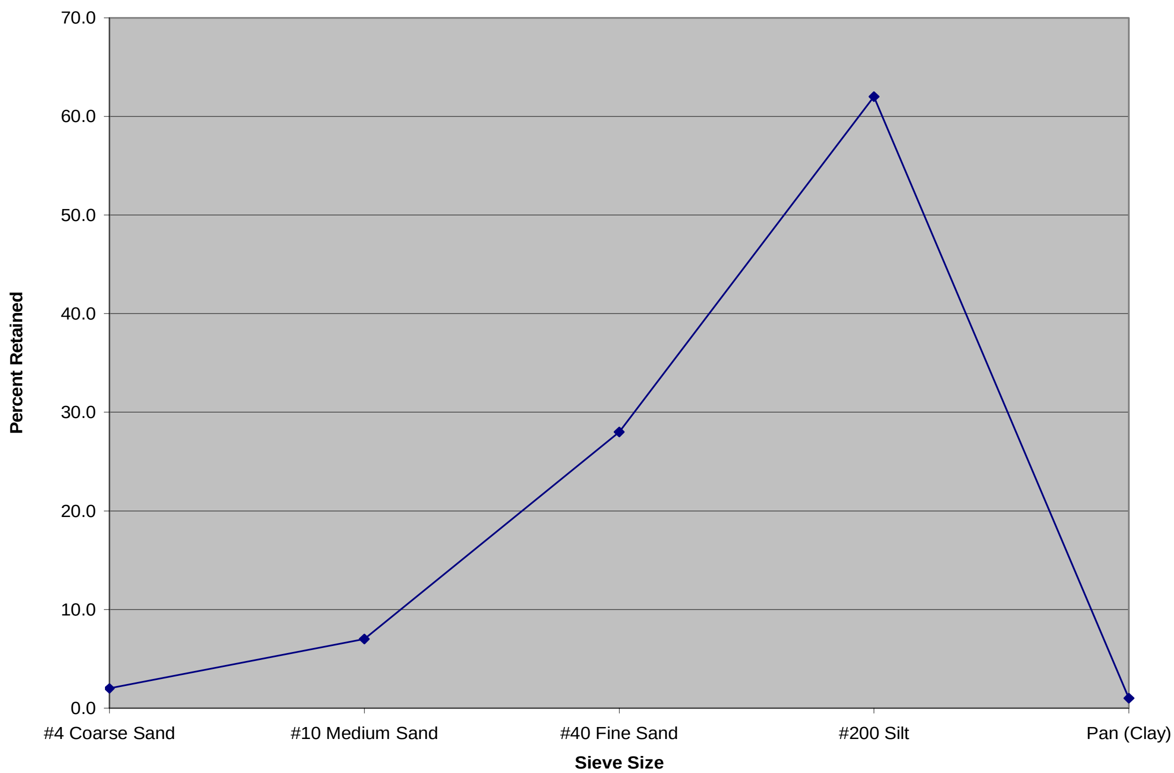


Figure 32. Sieve analysis, site 6-2 Middle

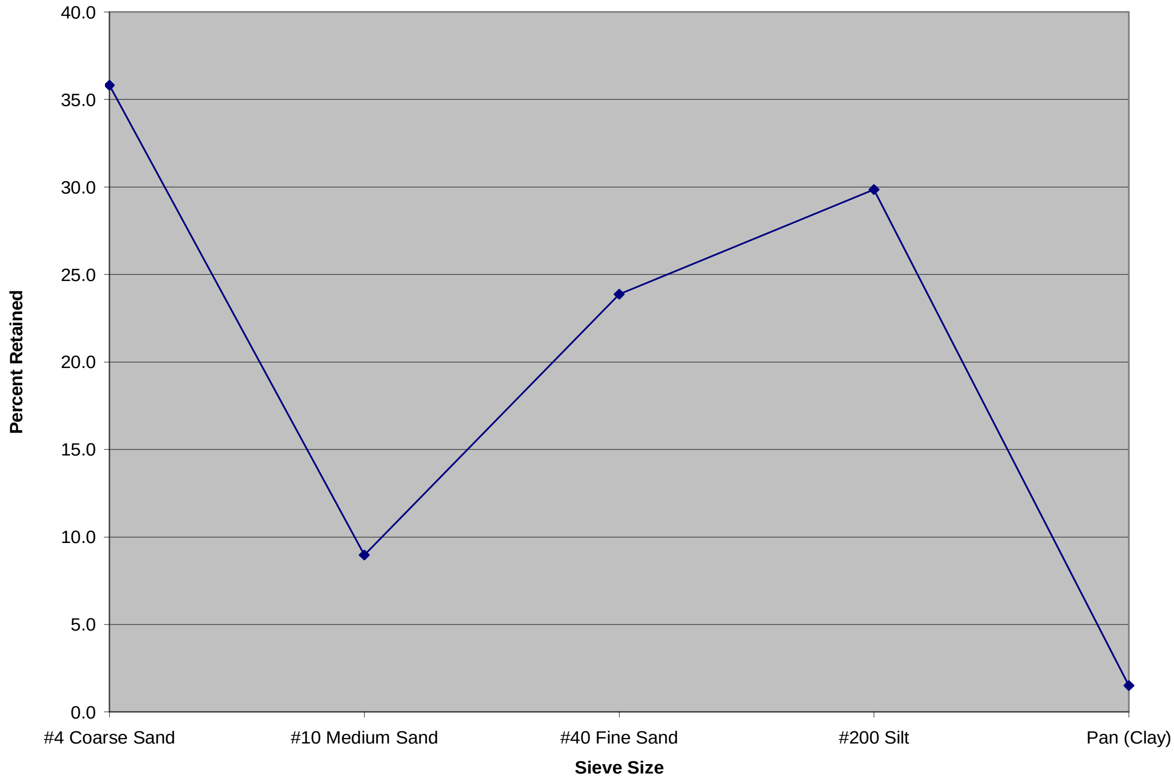


Figure 33. Sieve analysis, site 6-3 South

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APPENDIX A: LIST OF WATER QUALITY REFERENCES FOR THE PEND OREILLE RIVER

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APPENDIX B: PEND OREILLE RIVER QUALITY ASSURANCE PROJECT PLAN