

Quality Assurance Project Plan

Pend Oreille River Temperature Total Maximum Daily Load Technical Study

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September 2004

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Abstract

This Quality Assurance (QA) Project Plan describes monitoring for temperature in the Pend Oreille River in Washington State in support of a temperature Total Maximum Daily Load (TMDL). Temperature will be monitored continuously in the Pend Oreille River from the Idaho State Line to below Box Canyon Dam. The monitoring data will be available, in combination with data from other entities, to support future development of a revised Pend Oreille River water temperature model. An overall TMDL approach is described, which includes the initial phase of 2004 monitoring and review of existing models of Box Canyon Dam reservoir, and potential future work on the effect of conditions in Idaho and on temperature impairments in the Boundary Dam reservoir, tributaries, and potential Bull Trout habitat. Data quality, analytical, and reporting procedures are also described.

Project Description

Ecology is determining a TMDL for temperature in the mainstem Pend Oreille River from the Idaho border to the international boundary with Canada (Figure 1). Water quality data from the Pend Oreille River shows that water temperatures exceed the site-specific criterion of 20°C from the state water quality standards. Therefore, the state of Washington has included the Pend Oreille River on Ecology's 1998 303(d) list. Because temperature levels have been observed above the water quality standards criterion of 20°C at multiple locations in the river and because the available information does not show temperature being reduced below the criterion between the monitoring points, the entire Pend Oreille River in Washington State must be considered impaired for temperature. This TMDL will evaluate tributaries at their mouths as inputs to the mainstem, but will not address impairments in the tributaries themselves.

Description of Study Area

The Pend Oreille River is part of the Pend Oreille/Clark Fork Watershed (Figure 2). The Clark Fork and its tributaries drain the Rocky Mountains in Western Montana and Northern Idaho. The Clark Fork empties into Lake Pend Oreille and the Pend Oreille River begins at the outlet of the lake. The Pend Oreille River is listed for temperature on the state of Idaho's 1998 303(d) list of impaired waters, and the Idaho Department of Environmental Quality (Idaho DEQ) has recently received funding to begin a study of temperature in this reach. The entire Pend Oreille/Clark Fork Watershed upstream of the Washington-Idaho state line covers over 24,000 square miles.

The river enters Washington near the city of Newport and flows northward towards the international border with Canada. Downstream of Newport, the river passes through the reservation of the Kalispel Tribe of Indians. A short reach of the river flows through Canada to its confluence with the Columbia River just upstream of the international border.

The Pend Oreille River Watershed in Washington State encompasses about 1,000 square miles and represents most of Water Resource Inventory Area (WRIA) 62 (upper watershed areas of the

Priest and Salmo Rivers are in WRIA 62 but drain out of the state). The watershed is bounded on the east by the Selkirk Mountains and on the west by the Colville Mountains. The watershed is geologically complex, with extensive meta-sedimentary rock formations rich in minerals and a surface formed by glacial scouring and deposition (Entrix, 2001).

Elevations range from 1,700 feet at Boundary Dam, to 2,150 feet at Newport, to over 7,300 at the mountain tops. The river historically flowed through a wide, level valley bottom from Newport north to about Jared, then cut through the mountains in a series of canyons and waterfalls (e.g. Box Canyon, Metaline Falls, and Z Canyon) with a few local alluvial terraces.

Many small tributaries enter the Pend Oreille in Washington (Table 1). The largest is Sullivan Creek, with a watershed area of 142 square miles and the other larger tributaries include Calispell, LeClerc, Lost, Skookum, Slate, and Tacoma Creeks. Most of the flow in the Pend Oreille River enters Washington from upstream, while the tributaries in Washington represent only a tiny fraction of the total flow. The seven-day average low flow with a ten year average recurrence (7Q10) for the Pend Oreille River below Box Canyon Dam is about 12,300 cfs, while the 7Q10 for Sullivan Creek is about 66 cfs, which represents about 0.5% of the river flow.

Table 1. Summary of Significant Pend Oreille River Tributaries in Washington.

Creek Name	USFWS Designated Bull Trout Habitat?	Maximum Observed Temperature (deg C)	Estimated or Observed Minimum Flow (cfs)	303d List Status (Temperature)		
				1996	1998	2002/2004 ¹ (draft)
Indian	yes	14.6	2			1
Skookum		15.6	2.4			1
Calispell	yes	30.3	20			5
Cee Cee Ah		18.5	2			1
Tacoma	yes	17.7	5.6			1
Mill	yes	22.6	1.7			1
Middle		15.9	1.2			
LeClerc	yes	18.9	8.7			5
Ruby	yes	20.7	2.4			5
Lost		21.9	<1	listed	listed	5
SF Lost		17.6	0.9			2
Big Muddy		18.1	0.5			1
Little Muddy		19.0	0.2			5
Cedar	yes	20.7	1.2	listed	listed	5
Sullivan	yes	17.9	45			5
Slate	yes	15.4	--			1

¹ 1 = Meets standards; 2 = Waters of concern; 5 = Requires a TMDL

Data sources: Kalispel Tribe, Pend Oreille Public Utility District, U.S. Geological Survey, Pend Oreille Conservation District.

Climate in the Pend Oreille River watershed is characterized by summer air temperatures at Newport averaging 17°C (63°F) with an average daily maximum air temperature of 26°C (79 °F) and temperatures sometimes into the 30's °C (90's °F). Annual precipitation in the watershed averages 65 cm (26 inches) in the valley and over 125 cm (50 inches) in the higher elevations. Only eleven to eighteen percent of annual precipitation falls during the summer (July-August).

The population of Pend Oreille County is about 12,000 with 2,000 living in Newport; about 1000 spread between the incorporated areas of Cusick, Ione, Metaline, and Metaline Falls; and the rest in the unincorporated county. It is the eighth-smallest county in population and the seventh-smallest in population density. Almost 60% of the county is National Forest Lands; another 5% are state, tribal, or local government lands; leaving about 35% in private hands. Forest lands make up about 93% of land use while agriculture and range lands make up about 6%, mostly concentrated in the river and tributary valley bottoms.

There are two hydroelectric projects in the TMDL area (Figure 1): Box Canyon Dam (Pend Oreille Public Utility District) and Boundary Dam (Seattle City Light). Just upstream of the TMDL area in Idaho is Albeni Falls Dam (Army Corps of Engineers – Seattle District), which regulates Lake Pend Oreille water levels and controls downstream flows. Other major dams in the Clark Fork upstream of Lake Pend Oreille include Noxon and Cabinet Gorge Dams (Avista) and Hungry Horse Dam (U.S. Bureau of Reclamation).

Box Canyon Dam is a run-of-the-river dam with very little active storage capacity. The reservoir has inundated areas along the banks and flood plain of the original river, and the head of the reservoir at times can extend to the foot of Albeni Falls Dam. Reservoir water levels are managed to maximum heights at Cusick and Newport.

Boundary Dam is operated for peak load-following and providing operating reserves, meaning water is most often released during the day and the reservoir refills at night. Therefore, reservoir levels experience fluctuations. The reservoir has inundated the historic Z Canyon and Metaline Falls, and the head of the reservoir can extend to Box Canyon during high water. Because of the canyon areas that were flooded, the reservoir tends to be deep rather than broad.

Timber and recreation are the primary economic activities in the watershed. Mining is a significant activity - several large zinc/lead mines are located in the Metaline Falls area. Limestone was also historically mined for cement production at a plant in Metaline Falls, but the production plant was demolished in 1996 (although the silos are still in use). Ponderay Newsprint operates a pulp mill near the town of Usk.

Several of the tributaries have been diked to prevent flooding from runoff events and from the dam impoundments (Trimble, Calispel, Cusick, Gardiner, and Middle Creeks). Pumps at Trimble and Calispel Creeks are operated to control stream levels by moving water into the reservoir.

Two tributaries are listed on the 1998 303(d) list for temperature impairments. The draft 2002/2004 303(d) list includes a total of 25 Category 5 listings of temperature impairment on ten tributaries. Temperature TMDLs are being developed by the U.S. Forest Service (USFS) for

several of the tributaries under their jurisdiction. Most of these streams are in the higher elevations, so these TMDLs will often not connect directly with the mainstem temperature TMDL. The balance of the tributaries with temperature impairments outside of USFS Land will be addressed through processes under the Forest & Fish Law (for private forest lands) or through individual TMDLs (for mixed use lands).

Two local efforts are investing significant levels of effort into water quality issues. The WRIA 62 Watershed Planning Unit (<http://www.ecy.wa.gov/watershed/62.html>) is including water quality as a parameter, has completed a Phase II, Level 1 Assessment (Entrix, 2001) and is currently completing the Phase II, Level 2 Assessment and writing the Phase III plan. The WRIA 62 Watershed Planning Unit is also currently monitoring sixteen tributaries under state grants.

The Tri-State Water Quality Council (<http://www.tristatecouncil.org/index.html>) includes membership from Montana, Idaho, and Washington. Their primary focus has been nutrient loading from the Clark Fork Watershed to Lake Pend Oreille, but they also have had an interest in the Pend Oreille River and may be a forum for discussion of TMDL implementation.

Water Quality Standards and Beneficial Uses

Washington State Water Quality Standards

The Washington State Water Quality Standards, set forth in Chapter 173-201A of the Washington Administrative Code, include designated beneficial uses, waterbody classifications, and numeric and narrative water quality criteria for surface waters of the state. A revised version of the standards was adopted in 2003 and is currently awaiting approval by U.S. EPA.

Under the new standards, the mainstem Pend Oreille River is protected for “non-core salmon and trout.” The new standards contain a special condition for temperature:

Temperature shall not exceed a 1-day maximum (1-DMax) of 20.0°C due to human activities. When natural conditions exceed a 1-DMax of 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed $t=34/(T+9)$. (“T” represents the background temperature as measured at a point, or points, unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.)

This special condition is identical to conditions in the previous version of the standards.

Under the previous version of the standards, all tributaries in USFS lands are Class AA and the criterion is 16°C, while all tributaries outside USFS lands are Class A with a criterion of 18°C. Under the new standards, certain tributaries of the Pend Oreille River are protected for “char,” and a criterion of 12°C applies as a 7-day average daily maximum (7-DADMax). Tributaries not protected for char are protected for core salmonid habitat if in USFS lands or protected for noncore salmon habitat if outside USFS lands, with 7-DADMax criteria of 16.0°C and 17.5°C, respectively.

As with the criteria for the mainstem, if tributary natural conditions are above the criterion, then temperature increases above natural conditions are limited to an increment of 0.3°. For all tributary criteria at all times, the maximum temperature increase above natural conditions is limited to 2.8°C. These incremental increases are the same in both the previous and new standards. The new standards also include a variety of other conditions, which can be found in WAC 173-201A-200(1)(c).

Kalispel Tribal Water Quality Standards

The Kalispel Tribe has adopted water quality standards, which U.S. EPA approved on June 24, 2004. The Pend Oreille River is designated to meet the use of adult salmonid migration. The criteria for salmon migration are a 7-DADMax of 18°C and 1-DMax of 20.5°C. For all designated uses, if natural conditions are above criteria then human influences can raise water temperatures by no more than 0.3°C.

Idaho Water Quality Standards

Idaho's water quality standards designate the Pend Oreille River for the designated use of "Cold Water/General." Temperature criteria are 19°C as a daily average and 22°C as a daily maximum. When natural background conditions exceed the water quality criteria, the criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions except under certain conditions with permitted wastewater discharges.

British Columbia Water Quality Guidelines

British Columbia has established joint federal-provincial water quality guidelines for temperature based on fish species present and life stage. Applicable criteria for the Pend d'Oreille River under British Columbia guidelines (BCMWLAP, 2001) are a 7-DADMax of 18°C, a 1-DMax of 19°C, an hourly rate of change not to exceed 1 °C, and a Maximum Incubation Temperature of 12°C (in the spring and the fall).

Exceedance of temperature guidelines could be the basis for a more detailed assessment and the development of site-specific guidelines called water quality objectives. Water quality objectives are not legally enforceable, but rather provide environmental "goal-posts" for agencies, industry, and municipalities. Temperatures in the Pend d'Oreille River exceed the British Columbia guidelines, but no objectives have been developed for the Pend d'Oreille River.

Designated Uses: Fisheries

Washington's Water Quality Standards establishes designated uses which are protected by numeric criteria and by narrative standards. The primary use affected by temperature is fisheries, and the most sensitive uses are protected by criteria for "char" (Bull Trout) in many of the tributaries and in the mainstem by criteria for "salmon and trout spawning, noncore rearing, and migration." A variety of other designated uses are protected under the Water Quality Standards, but not by temperature criteria.

Bull trout is listed as a threatened species under the Endangered Species Act. The Bull Trout Draft Recovery Plan designates the Pend Oreille River and its tributaries as the core area of the Northeast Washington Recovery Unit (USFWS, 2002). In April 2004, U.S. Fish and Wildlife Service announced they were beginning a five-year review of the Bull Trout listing. Development of Recovery Plans was suspended for a number of areas including the Pend Oreille River, but development of critical habitat designation is continuing for this area (USFWS, 2004).

In the Draft Recovery Plan, bull trout were identified in the LeClerc Creek Watershed. Other documents report that Bull Trout have also been found in the mainstem at times (Geist, et al., 2004) and in the mouths of other tributaries (Entrix, 2001; Andonaegui, 2003). A draft map of critical habitat was published as part of a proposed rule for the critical habitat designation (Federal Register, 2002). The waterbodies identified as Bull Trout habitat include: mainstem Pend Oreille River, Slate Creek, Sullivan Creek, Cedar Creek, Ruby Creek, LeClerc Creek, Mill Creek, Tacoma Creek, Calispell Creek, and Indian Creek (Table 1).

Bull Trout Habitat Limiting Factors Report (Andonaegui, 2003) provides a broad overview of Bull Trout current and historical conditions in the mainstem Pend Oreille River. The decline in Bull Trout in the river and its tributaries, compared to historical levels, can be attributed to a variety of factors, primarily migration barriers and competition from introduced species, but also including mainstem flows and temperatures.

Bull Trout are believed to have used the river for an adfluvial life stage, migrating into Lake Pend Oreille or into cooler tributaries to avoid high summer water temperatures. Andonaegui (2003) states: "Only holding pools in tributary streams, pockets of cooler water in the vicinity of tributary mouths, and areas of groundwater influence along the shoreline of the mainstem Pend Oreille River could sustain migratory adult bull trout." The report also notes: "The extent to which limited, available, cold-water rearing habitat in the Pend Oreille River system between Albeni Falls Dam and Boundary Dam is a result of natural conditions or exacerbated by human-induced alterations to the environment, is unknown."

Non-native fish are abundant in the watershed including yellow perch, largemouth bass, pumpkinseed, brook trout, brown trout, and rainbow trout (Entrix, 2001). Anadromous salmonids are currently blocked by Chief Joseph and Grand Coulee Dams on the Columbia River, but historical information suggests that Z Canyon and Metaline Falls were natural barriers. Other major game and non-game fish species include cutthroat trout, kokanee, whitefish, and sculpin (Golder Associates, 2004).

Historical Data Review

Ecology collects water quality monitoring data at the following locations in the Pend Oreille River:

- Pend Oreille River @ Metaline Falls, Station 62A090 (1949-50, 1959-62, 1994-95, 1998-present).
- Pend Oreille River @ Newport, Station 62A150 (1959-66, 1968, 1976, 1978-present).

Temperature data from these two sites are illustrated in Figures 3 and 4. High temperatures above the 20°C criterion are generally measured from July through September during the period of lowest flows.

Temperature has been monitored by Pend Oreille PUD at Newport, Box Canyon Dam forebay, and Box Canyon Dam tailrace since 2001 (Pend Oreille PUD, 2001a; 2002; 2003). Figures 5 and 6 show maximum daily temperatures and flow from 2002 and 2003. However, since the primary purpose of this monitoring was for total dissolved gas, data is not available from this monitoring through the summer and fall. Nonetheless, the pattern can be observed of temperatures rising above 20°C as flows drop below 35 kcfs in early July 2002 or below 25 kcfs in late June 2003. The PUD also monitors water temperature hourly year round in the Box Canyon Dam forebay using a data-logging thermistor. Data are available for 1997-98 and 2000-2004.

The U.S. Geological Survey (USGS) has monitored temperature in the Boundary Dam forebay and tailrace since 2000 (Kimbrough et al., 2000; 2001; 2002). Figure 7 shows maximum daily temperatures and flow from October 1999 through September 2002. Here again, temperatures are generally above 20°C in July and August while flows are below 35 kcfs.

The Box Canyon FERC Final License Application (Pend Oreille PUD, 2000) cites and analyzes a large body of temperature data, both historical and collected in support of relicensing. Continuous temperature monitoring in the Pend Oreille River in 1997 and 1998 found temperatures above 20°C from July through mid-September, with peak temperatures exceeding 25°C in late July and early August. Temperatures in tributary slough areas were found to be warmer than mainstem waters in the spring and then slightly cooler than the mainstem in summer.

Tributaries of the Pend Oreille River in Washington have been monitored by many different groups, including Pend Oreille PUD (2000), Pend Oreille CD (Golder Associates, 2004, Pend Oreille CD, 2004), U.S. Forest Service (Wasson, 2004), and the Kalispel Tribe (2004). Tributary temperatures vary, with some tributaries showing temperatures above 20°C, while other tributaries remain relatively cool. Flows can also vary widely in the tributaries, although most make a very small contribution of flow to the mainstem Pend Oreille River.

Table 1 summarizes temperatures and flows in the more significant tributaries. Evaluation of temperature and flows in tributaries is complicated by the fact that many have multiple branches that meet near the mainstem, and measurement of flow may be very inaccurate near the mouth due the flat topography and regulation by pumping into the reservoir. Therefore, the data in Table 1 should be taken as estimates for comparison purposes.

Pend Oreille PUD monitored tributaries during 1997, 1998, 2000, and 2001. Their data showed that temperatures in West Branch LeClerc and Indian Creeks remained at or below 15°C (Pend Oreille PUD, 2000). Studies cited in Andonaegui (2003) reported cool temperatures in Sullivan, Flume, Slate, and Pewee Creeks that can potentially provide thermal refugia to cold-water fish species.

The Kalispel Tribe has conducted temperature monitoring of tributaries since 2001 (Kalispel Tribe, 2004). The coolest tributaries measured were Indian Creek, tributaries of Skookum Creek, Cee Cee Ah, Tacoma, Mill, Middle, LeClerc, and Big and Little Muddy Creeks. Calispel Creek had the warmest temperatures, which is likely caused by warm surface waters from Calispell Lake. Many of the tributaries show warm temperature only near the mouth or only during the hottest part of the summer.

An aerial Thermal Infrared Survey (TIR) was conducted on August 16-17, 2001 (Watershed Sciences, 2001) from Lake Pend Oreille to Box Canyon Dam. A review of the TIR survey is provided in Appendix A. Stratification in Lake Pend Oreille could be observed, with the warmer waters of the lake passing through Albeni Falls Dam into the lower river. Relatively warm areas could be observed in side channels and sloughs, in milfoil beds, and near thermal point sources (a sawmill in Idaho near Newport, the Ione wastewater lagoons, and probably the Ponderay Newsprint plant). Several creeks were observed to be cooler including Indian, Skookum, Cee Cee Ah, LeClerc, and Ruby Creeks.

Flow in the Pend Oreille River is measured by the USGS at three locations:

- Upstream of Newport (Pend Oreille River at Newport Washington, Station Number 12395500).
- Downstream of Box Canyon Dam (Pend Oreille River below Box Canyon near Ione, Washington, Station Number 12396500).
- Downstream of Boundary Dam (Pend Oreille River at International Boundary, Station Number 12398600).

High (95th percentile), low (5th percentile), and median flows for the first two stations are shown in Figures 3 and 4. Several years of flow monitoring data are also available from USGS for Sullivan Creek, ending in 2002.

A detailed study of Box Canyon Dam has found little vertical stratification due to the short residence time and shallow depth (Pend Oreille PUD, 2000). Maximum reservoir residence time is less than three days, and typically is less than two days. The reservoir has a maximum depth of about 110 feet but the average depth of the reservoir is less than 8 feet. Although the main channel is fully mixed, monitoring has indicated that areas outside of the main channel can be significantly warmer (dead-end slough areas and possible milfoil beds) or cooler (near cool tributary mouths).

The Boundary Dam reservoir is also well-mixed, with residence times less than four days and more typically less than two days. The reservoir is over 300 feet deep near the dam but much of the reservoir is very narrow. A temperature survey in 1997 found little temperature difference from surface to bottom.

Sources of Temperature Impairment

The Pend Oreille River Temperature TMDL will be developed for heat, which is considered a pollutant under Section 502(6) of the Clean Water Act. Heat energy processes that control energy transfer to and from a given volume of water include:

- Shortwave solar radiation.
- Longwave radiation exchange between the stream and both the adjacent vegetation and the sky.
- Evaporative exchange between the stream and the air.
- Convective exchange between the stream and the air.
- Conduction transfer between the stream and the streambed.
- Groundwater exchange with the stream.

If the heat energy entering the water from these sources is greater than the heat energy leaving the water, then stream water temperature will rise. Water temperature change, which is an expression of heat energy exchange per unit volume, is most strongly influenced by solar radiation input.

Water temperatures in the Pend Oreille River may be influenced by a variety of factors including:

- Intensity of solar radiation.
- Shading (stream bank vegetation or surrounding hills).
- Meteorological conditions (cloud cover, haze, air temperature, humidity, wind).
- Water depth, volume, and flow.
- Heat exchange with the river bed, air, and atmosphere.
- Upstream temperatures.
- Temperatures of water inputs from tributaries, ground water, and human sources.

Most of these factors are present under natural conditions, but human activities can modify these factors. The principal factors that may increase water temperatures in the Pend Oreille River in Washington are:

- *Changes in upstream water temperatures.* The regulation of Lake Pend Oreille by Albeni Falls Dam and other human activities in the watershed may result in higher temperatures under certain conditions. Idaho has the lead in addressing these issues.
- *Impoundment of the river by Box Canyon and Boundary Dams.* Regulation of flow can result in deeper and slower water flow, greater surface area and volume, and reduced ground water inflows in the impounded reaches. In general, reservoirs often show a “shift” in seasonal temperature pattern--cooler temperatures in the spring and warmer temperatures in the fall, an increase in average temperatures, and a decrease in the range between maximum and minimum temperatures. Also, higher water surface elevations and permanent inundation or diking of riparian areas may alter groundwater-surface water interactions and tributary inflows, which can eliminate local cool-water refugia for aquatic biota. Based on previous studies, the impacts on temperature of the impoundments on the Pend Oreille River may vary from minimal to relatively significant depending on pre-project characteristics and the effects of the project and its operation.
- *Changes in tributary or groundwater inflows and temperatures.* Human activities in the watershed have likely altered hydrology and heat balance, resulting in lower flows and higher water temperatures at times. Although this probably has little effect on average Pend Oreille River temperatures because of the size of the river compared to its tributaries in Washington, it may have biologically significant effects on localized temperatures.
- *Human point source inputs.* Large cooling water discharges have the potential to increase the temperature of a river the size of the Pend Oreille. Ponderay Newsprint Company in Usk is currently the largest point source in the TMDL area that is likely to be of concern. The Teck Cominco Pend Oreille Mine has also recently been issued an NPDES permit with temperature limitations. Newport, Ione, Metaline, and Metaline Falls have year-round discharges of treated municipal wastewater. The wastewater discharges from these facilities are regulated under NPDES permits issued by Ecology.
- **Thermal variability in side-channels and vegetation beds.** Side-channel sloughs and milfoil beds have been found to have higher surface temperatures than the main channel. However, these areas are often stratified, with cooler temperatures near the bottom. In sloughs, shallow water with slow water velocities allows the surface to heat quickly, but cool tributary inflows, if present, will keep to the bottom. Milfoil beds are also affected by shallow water with slower velocities. In addition, heat absorption by vegetation creates warmer water at the surface, while shading by the vegetation may allow deeper water to remain relatively cool.

Box Canyon and Boundary Dams are each covered by a Federal Energy Regulatory Commission license. Pend Oreille PUD has applied for renewal of the Box Canyon Dam license, received a Section 401 certification from Ecology in 2003, and is expected to receive its new license this year. The 401 certification will go into effect once the FERC license is issued. Boundary Dam’s license expires in 2011; therefore, Seattle City Light is just beginning the relicensing process.

TMDL Approach

Resources and Coordination

The proposed TMDL will need to address the cumulative effects of the human activities and natural phenomena described above. To determine loading capacity, pollutant allocations, and evaluate implementation for the TMDL, a combination of monitoring and modeling will be necessary.

The Army Corps of Engineers will monitor temperature during 2004 in Idaho and their downstream station will be at the USGS flow gage just upstream of the Washington/Idaho state line near Newport (Figures 1 and 8). Idaho DEQ is also planning a temperature study to include temperature monitoring and development of a model. If possible they will contract with Portland State University to develop a CE-QUAL-W2 model for the Pend Oreille River from the Lake Pend Oreille outlet to the Washington State line. EPA will be coordinating between temperature studies in Washington and Idaho.

Monitoring for temperature above and below Box Canyon Dam is included with Pend Oreille PUD's routine voluntary monitoring. These monitoring locations are shown in Figures 1 and 9 ("Project TDG Stations"). Monitoring will continue into the summer but may not include the entire study period at TDG monitoring locations. However, year-round, hourly forebay temperatures and air temperature and relative humidity measurements should be available. Multiple years of temperature monitoring were also conducted for FERC relicensing (Pend Oreille PUD, 2000). Pend Oreille PUD is not planning any additional temperature monitoring for the TMDL this year but will support the TMDL study by sharing data and other information and allowing project access.

Temperatures in the Box Canyon Reservoir have been modeled twice. In both cases, existing conditions with the Box Canyon Dam, powerhouse, and reservoir ("with-project") were compared to model scenarios with the dam and reservoir absent ("without-project").

The first effort was by U.S. EPA who used the RBM10 model (Cope, 2002). Modeling results showed a small difference between with- and without-project average temperature conditions, with a maximum temperature increase with-project of 0.7°C over without-project. The second effort was conducted by Framatome ANP DE&S (2002) for Pend Oreille PUD using the CE-QUAL-W2 model. Their model results showed a small decrease in maximum temperatures from without-project to with-project scenarios.

The differences between these two modeling efforts are not necessarily inconsistent. However, understanding of the differences and a better determination of the effect of the reservoir would be a benefit of additional modeling. Also, this modeling was solely for the hydroelectric project effects, and the TMDL should be examining the cumulative effects of multiple sources.

Monitoring for temperature will continue above and below Boundary Dam in 2004 at the stations used for total dissolved gas monitoring. Seattle City Light is planning to install thermistors in

the reservoir and its tributaries. Ecology will coordinate with this effort to ensure that data is comparable for modeling use and to expand the thermistor coverage in the study area.

The Boundary Dam Reservoir has not been modeled for temperature. However, it is highly likely that Seattle City Light will conduct temperature modeling as part of their FERC relicensing and 401 certification process over the next several years. Ecology will also work cooperatively with Seattle City Light on this effort to ensure an efficient use of resources.

The USFS is developing TMDLs for many of the upper tributaries. Monitoring is planned for 2004 and will be incorporated in the study design where the study areas overlap. Most monitoring sites will be well above the mainstem, but a few are expected to be located near the mouths of tributaries (e.g. Sullivan Creek).

Ecology currently has two tributaries on its 1998 303(d) list and has proposed to include ten Pend Oreille River tributaries on its 2002/2004 303d list. Although some of those tributaries may be covered by the USFS TMDLs or by the Forest & Fish process, some of the lower tributaries may still require development of individual TMDLs. TMDLs for the lower tributaries have not been scheduled and may not be for several years.

Ecology is planning its TMDL technical study to complement on-going monitoring with additional monitoring to fill potential data gaps and provide input data for modeling (as described below). This approach will build on previous work and make optimal use of cooperative efforts in order to conduct a comprehensive evaluation of the effects of human impacts on river temperatures.

Project Objectives

The overall objective for the Pend Oreille temperature TMDL project will be to develop a TMDL for temperature impairments in the Pend Oreille River in Washington, in coordination with Idaho, EPA, and the Kalispel Tribe, for submittal to the EPA for their approval.

The TMDL technical study addressed in this QA Project Plan will address the following objectives:

- A primary objective of the study will be to characterize longitudinal water temperatures in the main channel for use in modeling, using thermistors along the thalweg. Water temperatures will be monitored in the mainstem Pend Oreille River during the 2004 summer and fall season. Additional objectives will be to assess water temperatures in biologically significant areas of potential Bull Trout habitat (mouths of significant tributaries), and to replicate monitoring with thermistors deployed by other parties, through monitoring with additional thermistors.

Monitoring is planned by Idaho Department of Environmental Quality for the Pend Oreille River in Idaho, Seattle City Light for Boundary Dam reservoir, and by the Kalispel Tribe for tributaries. The TMDL will try to work cooperatively, as much as possible, to extend monitoring capabilities.

Data collected will be analyzed for data quality and distributed as a final draft data summary for eventual inclusion as an appendix to the TMDL technical report. Recommendations will also be developed for future work.

- A second project objective is to evaluate existing models, and support model development by consultants, project owners, and other agencies, with the goal of incorporating that work into the final TMDL.

Idaho DEQ has funding for CE-QUAL-W2 model development in their section of the river, and will likely contract with consultants for the work. The model will be used to develop a TMDL for temperature 303(d) listings in the Pend Oreille River in Idaho. Idaho DEQ has asked for technical assistance from Ecology to assure that their modeling and TMDL development will meet Washington's water quality standards. Support for Idaho's work will be provided as part of this TMDL project.

Ecology, the Kalispel Tribe, and EPA are exploring whether funds are available to participate in the contract to evaluate the existing CE-QUAL-W2 model of the Pend Oreille River, update the model, and apply the model to 2004 data. This is the preferred approach, since it would allow development of integrated models for the Pend Oreille River from Lake Pend Oreille to Box Canyon Dam. Under this scenario Ecology will provide technical assistance to the consultant, evaluate model results, and make recommendations on a draft TMDL and any additional future work.

If funds cannot be found to fund a consultant to work on the model, Ecology will evaluate the existing CE-QUAL-W2 and RBM-10 models for the Box Canyon Dam reservoir to determine how input parameters were developed and whether either model is suitable for TMDL development. Based on this evaluation and the results of Idaho's model, Ecology will make recommendations on a draft TMDL and any additional future work.

Seattle City Light is looking into developing a model for their reservoir so Ecology will provide a technical support role to that effort. The goal of that support will ensure that the technical analysis is adequate to support TMDL development or other actions to address the 303(d) listing. However, if Seattle City Light's modeling objectives or schedule do not meet Ecology's needs or schedule, then Ecology may need to take a more active role in model development. The resources and schedule for that level of effort would have to be scoped and authorized at a future date.

The overall question of temperature impairments in the Pend Oreille River and tributaries includes a number of additional issues that are outside the scope of this TMDL and QA Project Plan, but which will be evaluated for action in the future:

- Because of 303(d) listings in the tributaries that may not be addressed by USFS TMDLs or the Forest & Fish process, temperature TMDLs for tributaries may need to be developed. These TMDLs will need to be separately scoped in the future. As TMDLs for tributaries are developed, their results may affect the mainstem TMDL. A decision on whether to revise the mainstem TMDL will be made after tributary TMDLs are completed.

- Most of the monitoring and modeling work described in this plan is focused on compliance with standards for water temperatures spatially averaged across the Pend Oreille River. Because of the Bull Trout ESA listings, there are still questions about compliance with temperature standards in biologically significant habitat areas, such as the mouths of tributaries and areas of groundwater influence.

There are several possible ways that compliance with water quality standards for temperatures in local biologically important areas could be assessed. Since models for the mainstem would not evaluate lateral temperature gradients and detailed studies of tributary temperatures and groundwater flow regimes are not planned, additional analysis would be required. Scoping and funding this evaluation will need to be conducted separately in the future.

The state of Washington will issue the temperature TMDL for waters of the state and submit it to the U.S. Environmental Protection Agency (EPA) for their approval. Idaho is also planning to issue a temperature TMDL for the waters of the Pend Oreille under their jurisdiction. EPA will be issuing the TMDL for Tribal waters and will coordinate among Washington, Idaho, Montana, Canada, and the Kalispel Tribe. Washington will develop a TMDL implementation plan jointly with the Kalispel Tribe.

A technical report will be issued at the end of the current phase of the TMDL project described in this QA Project Plan. The decision on when to issue the TMDL, submit it to EPA, and determine the final scope of the TMDL depends on several factors. The different efforts related to the TMDL--Box Canyon Dam reservoir modeling, Boundary Dam reservoir modeling, tributary TMDLs, Bull Trout habitat evaluation--need to be further developed before there is certainty about how they fit into the overall TMDL effort. Also, Idaho, Washington, and the Kalispel Tribe will be evaluating how best to coordinate issuing one or more temperature TMDLs for the Pend Oreille River and tributaries within their jurisdictions. When the technical report is complete from the work described in this TMDL, the other factors can be evaluated and a decision made to issue the TMDL at that time or wait until other work is completed.

Study Design

Monitoring Parameters and Locations

Data collection, compilation, and assessment will be governed by the data set requirements of the computer temperature model. The data will be assembled from local third party studies and Ecology field surveys. Third party studies include investigations by the Kalispel Tribe, Seattle City Light, Pend Oreille PUD, U.S. Army Corps of Engineers Seattle District, the USFS, and Idaho DEQ.

The key elements for temperature monitoring in a reservoir are:

- Water temperatures of the river, tributaries, and groundwater inflows.
- River flows and tributary and groundwater inflows.
- Meteorological conditions (air temperature, relative humidity or dew point temperature, wind speed and direction, and solar radiation or cloud cover).
- River channel location, topography, and bathymetry.

Ecology will collect water temperatures primarily from the mainstem Pend Oreille River in the Box Canyon reservoir. The Army Corps of Engineers and Seattle City Light will also be collecting mainstem temperatures in their project areas. Tributary water temperatures will be monitored by Seattle City Light, the Kalispel Tribe, and the USFS. Ecology will conduct replicate sampling at a few locations to assess data comparability.

A list of tentative sites is provided in Table 2 and shown in Figures 8 through 10. Not all these sites are expected to be monitored. These sites were chosen in consideration of site security, even distribution in the study area, and replication of earlier Pend Oreille PUD monitoring locations. The final location and number of data-logging thermistor sites will depend on field conditions at the thermistor site, including vandalism or deployment problems, with a goal of installing thermistors with even spatial coverage over the mainstem study area, monitoring significant tributaries, and replicate monitoring with other monitoring programs.

Vertical and lateral temperature distributions will be assessed several times during the summer to evaluate representativeness of the thermistor locations. Temperature profiles will be measured at several locations on a lateral transect near the thermistors using a multi-parameter meter. The final locations and number of spot profiles will depend on field conditions and logistics during monitoring surveys, with the primary goal of measuring profiles at each data-logging thermistor site during each site visit and a secondary goal of measuring other profiles as time allows.

Groundwater inflow rates and temperatures will be estimated from the results of this TMDL

study or third-party studies, such as from groundwater dominated tributaries. Specific areas that are most likely to provide the largest groundwater inflows will be identified and assessed for modeling.

Inflow rates and temperatures from NPDES-permitted point sources will be obtained from permittees through Ecology's Eastern Regional Office Water Quality Section.

Table 2. Approximate Locations of Monitoring Sites.

No. Units	Location	Description	Agency
1	POR above Newport - state line	Data-logging and spot profiles	Ecology
1	POR above Marshall Creek	Data-logging and spot profiles	Ecology
1	POR at Marshall Creek mouth	Stream mouth spot profiles	Ecology
1	POR above Indian Island	Data-logging and spot profiles	Ecology
1	POR at Indian Creek mouth	Stream mouth spot profiles	Ecology
1	POR near Dalkena	Data-logging and spot profiles	Ecology
1	POR above Skookum Creek	Data-logging and spot profiles	Ecology
1	POR near Skookum Creek mouth	Stream mouth spot profiles	Ecology
1	POR near Cusick	Data-logging and spot profiles	Ecology
1	Calispel Creek near pumps	Data-logging (paired replicate w/ Kalispel Tribe)	Ecology
1	POR at Calispell Creek mouth	Stream mouth spot profiles	Ecology
1	POR above Tacoma Creek	Data-logging and spot profiles	Ecology
1	POR at Tacoma Creek mouth	Stream mouth spot profiles	Ecology
1	POR at Mill Creek mouth	Stream mouth spot profiles	Ecology
1	POR above LeClerc Creek	Data-logging and spot profiles	Ecology
1	LeClerc Creek near stream gage	Data-logging (paired replicate w/ Kalispel Tribe)	Ecology
1	POR at LeClerc Creek mouth	Stream mouth spot profiles	Ecology
1	POR above Blueslide	Data-logging and spot profiles	Ecology
1	POR at Ruby Creek mouth	Stream mouth spot profiles	Ecology
1	POR above Lost Creek	Data-logging and spot profiles	Ecology
1	POR near Ione	Data-logging and spot profiles	Ecology
1	POR at Cedar Creek mouth	Stream mouth spot profiles	Ecology
1	POR below Ione (exclusion net)	Mid-channel spot profiles	Ecology
1	POR @ Box Canyon Dam forebay	Data-logging	POPUD
1	POR @ Box Canyon Dam - powerhouse draft tube deck	Data-logging (paired replicate w/ SCL)	Ecology/SCL
1	POR near Sullivan Creek	Data-logging	SCL
1	Sullivan Creek – near USGS gage	Data-logging (paired replicate w/ SCL)	Ecology
2	POR near Slate Creek	Data-logging	SCL
3	POR @ Boundary Dam forebay	Data-logging	USGS/SCL
1	POR @ Boundary Dam tailrace	Data-logging	USGS/SCL

Vertical and lateral temperature distributions will be assessed several times during the summer to evaluate representativeness of the thermistor locations. Temperature profiles will be measured at several locations on a lateral transect near the thermistors using a multi-parameter meter.

Meteorological conditions are currently monitored regionally for the National Weather Service at Deer Park and Sandpoint Airports. The Kalispel Tribe monitors meteorological conditions at the Tribal headquarters just east of the Pend Oreille River near Usk. Pend Oreille PUD monitors air

temperature and relative humidity at Box Canyon Dam. Seattle City Light is planning to install one or two meteorological stations in their project area. These third-party stations should provide adequate coverage and data quality for this study.

River channel information is available from Pend Oreille PUD and Seattle City light from their project records. Seattle City Light is also planning on additional bathymetric surveys to evaluate post-project changes. Other location and topography information is available from existing Geographic Information System coverages.

Monitoring Methods

Ecology monitoring will be limited to temperature and possibly flow. Water temperature will be measured with Onset StowAway Tidbits. The temperature data loggers will be installed in a location in the river that is shaded from direct sunlight by vegetation or structures, if possible, or placed within a shaded enclosure. They will be placed in an area which is representative of conditions in the main channel or side channel depending on the location. The water temperature logger will be installed close to, but above the river bottom, where there is obvious water mixing, and at a depth that will not become exposed if the water level drops.

If flow measurements are needed for tributaries not monitored by third parties (e.g. Sullivan Creek), on-site data loggers for flow gaging will be installed and maintained using the standard protocols for the on-site continuous data loggers currently established by Ecology's Surface Hydrology Unit (Ecology, 2000). Estimation of discharge and instantaneous flow measurement will also follow Ecology (2000). Flows will be calculated from continuous stage height records and rating curves developed prior to, and during, the project. Stage height will be measured by a pressure transducer and recorded by a data logger every 15 minutes. Flows for rating curve development will be measured at flow conditions appropriate for measuring a wide range of discharge levels.

Once data loggers are installed, field surveys will be conducted every two to four weeks to check and download data loggers. Spot checks of water temperature vertical profiles will be taken at the thermistor with a digital profiling thermistor (Hydrolab Minisonde). As time allows, vertical temperature profiles will also be measured at the deepest location adjacent to the thermistor to evaluate the representativeness of the site. Data loggers that are unrepresentative, missing, or show signs of tampering or vandalism will be relocated or the site abandoned. Also during the field surveys, flows will be measured to develop the site rating curve if conditions are appropriate.

Modeling Methods

It is anticipated that the CE-QUAL-W2 model will be used for modeling analysis. It is described on the model support website (<http://www.ce.pdx.edu/w2/>):

CE-QUAL-W2 is a water quality and hydrodynamic model in 2-D (longitudinal-vertical) for rivers, estuaries, lakes, reservoirs and river basin systems. W2 models basic eutrophication processes such as temperature-nutrient-algae-dissolved oxygen-organic matter and sediment relationships. This model is supported by Tom Cole at the Corps of Engineers, Waterways Experiments Station, Vicksburg, MS. The current model release enhancements have been developed under research contracts between the Corps and Portland State University under supervision of Dr. Scott Wells.

The model will be calibrated to observed conditions, and then will be used to evaluate existing critical conditions and to estimate natural background conditions. Critical conditions for temperature are characterized by periods of low flow and high water temperatures. However, in determining compliance with water quality standards, the critical period will occur when the largest increase in existing temperatures has occurred as compared to natural conditions. For impoundments, this critical season may actually occur in early fall because during this period the heat storage of impounded waters causes the maximum increase in temperature over natural conditions. Therefore, modeling of critical conditions will include the entire summer and fall season, including both periods of maximum water temperatures and periods of potential maximum water temperature increases above natural conditions.

Natural conditions are characterized by the absence of human impacts on the temperature regime. Modeling of natural conditions typically involves creating a natural background model run corresponding to the existing conditions model run, except that human influences have been removed as much as possible. Generally, this means removing all point sources; setting tributaries to natural flows and temperatures; setting ground water inflow, shading, and sediment load to historic levels; and modeling the river in its original unimpounded river channel at historic flows. Obviously, accurately estimated pre-development conditions may be difficult so reasonable estimation methods will need to be developed or the parameters left unchanged between natural and existing if no information is available to predict pre-development conditions.

The model will be used to develop load and wasteload allocations for heat energy to the stream. If existing conditions are found to meet the standards, than allocations will be set to match those conditions, and allocations may also be set for future growth in heat loading. If load reductions are required to meet standards, one or more alternative scenarios may initially be developed with human impacts reduced. Modeling of allocations will continue interactively with development of an implementation plan until the optimal allocations and implementation approach are found.

To evaluate model performance and the variability of results, sensitivity analysis and error analysis can be used. Multiple model runs can be made with the model variables and input

parameters that are most significant, or most variable adjusted, within the range of their confidence bands. This provides an assessment of which input parameters and variables are most likely to alter model results because of their variability and allows a limited quantification of model accuracy.

Measurement Quality Objectives and Decision Criteria

Monitoring Objectives

Measurement Quality Objectives (MQOs) and methods for the field measurements in this study are summarized in Table 3.

Table 3. Field Measurement Quality Objectives and Methods.

Analysis	Accuracy or Reporting Value	Method
Water Temperature	$\pm 0.2^{\circ}\text{C}$	Thermistor or Alcohol Thermometer
Velocity	± 0.05 f/s	Marsh-McBirney 201 current meter

Accuracy of the thermograph data loggers will be maintained by a two-point comparison between the thermograph, a field digital thermometer, and a certified reference thermometer. The Certified Reference thermometer, manufactured by HB Instrument Co. (Part No. 61099-035, serial No. 2L2087), is certified to meet ISO9000 standards and calibrated against National Institute of Standards and Technology (NIST) traceable equipment.

The field digital thermometer's accuracy will be evaluated by multiple point comparison to a liquid thermometer of comparable or better accuracy. If there is an average temperature difference of the paired values greater than 0.2°C , the field thermometer's temperature readings will be adjusted by the mean difference.

Manufacturer specifications report an accuracy of $\pm 0.2^{\circ}\text{C}$ for the Onset StowAway Tidbit -5°C to $+37^{\circ}\text{C}$ range model and $\pm 0.4^{\circ}\text{C}$ for the Onset StowAway Tidbit -20°C to $+50^{\circ}\text{C}$ range model. If the mean difference between the NIST certified thermometer and the thermal data loggers differs by more than the manufacturer's reported specifications during the pre-study calibration, the thermal data logger will not be used during field work.

Representativeness of the data is achieved by a sampling scheme that accounts for land practices, flow contribution of tributaries, and seasonal variation of instream flow and temperatures in the subbasin. Extra calibrated field thermometers and thermograph data loggers will be taken in the field during site visits and surveys to minimize data loss due to damaged or lost equipment.

Experience at the Department of Ecology has shown that duplicate field thermometer readings consistently show a high level of precision, rarely varying by more than 0.2°C . Therefore, replicate field thermometer readings were not deemed to be necessary and will not be taken.

Modeling Objectives

Specific quality objectives are not being specified for existing data or for modeling results. However, the following acceptance criteria will be applied:

- *Data Reasonableness.* Data quality of existing data will be evaluated where available. Sources within well-established programs will be acceptable based on the data quality standards of the source (such as National Weather Service or USGS data). Data will be reviewed for whether the amount of variability is appropriate, based on statistical measures, expected values, and comparison between data sets. Data with too much or too little variability will not be used.
- *Data Completeness.* Data sets will be used that are reasonably complete during the period of interest. Incomplete data sets will be used if they are considered representative of conditions during the period of interest.
- *Data Representativeness.* Data will be used that are representative of the location or time period under consideration. For example, attention will be paid to the variations in meteorological conditions throughout the TMDL study area, and to differences in seasonal conditions.
- *Model Calibration and Verification.* The primary measure of calibration and verification success will be by comparing observed versus modeled temperatures. Bias will be measured by the average residual of paired values (observed-modeled), and precision by the root mean square error of paired values. The goal of this study will be a bias of less than 0.2°C and precision of less than 1.0°C. A greater precision and bias will be acceptable if the model successfully predicts the average days per year that the river exceeds the water quality criterion, visual inspection of the time series shows good matching of temperature patterns, or if sensitivity analysis shows that the bias and precision of results between paired runs (e.g. natural and current conditions) will be adequate to assess compliance with the water quality standards.

Quality Control Procedures

The Optic Stowaway Tidbits will be pre-study and post-study calibrated in accordance with TFW Stream Temperature Survey protocol to document instrument bias and performance at representative temperatures. A NIST certified reference thermometer will be used for the calibration. At the completion of the monitoring, the raw data will be adjusted for instrument bias, based on the pre- and post-calibration results, if the bias is greater than $\pm 0.2^{\circ}\text{C}$ or $\pm 0.4^{\circ}\text{C}$ depending on the temperature accuracy of the tidbit.

Variation for field sampling of instream temperatures will be addressed with a field check of the data loggers with a digital profiling thermometer at all thermograph sites (thermograph location and location of maximum thalweg depth) upon deployment, download events, and at tidbit removals at the end of the study period. Field variability will be evaluated using the root mean square error of paired results to assess precision, and the average residual of paired results to assess bias. These measures of variability will be compared to MQOs and taken into account in interpreting results and applying them to data analysis.

Data Review, Quality Assessment, and Validation

Data will be downloaded from the data loggers to a spreadsheet and reviewed for outliers and values exceeding MQOs. Outliers and data that exceed the MQOs will be evaluated for the cause of the problem. Slight exceedances will be tolerated, with the data qualified and the poorer precision taken into account in data analysis. Exceedances that can be traced to equipment failure will result in rejection of the data.

Data completeness will be adequate if monitoring is completed with data meeting the MQOs at least 85% of the time (equivalent to about one day per week of lost data). A lower rate of data completeness will be acceptable; all data meeting MQOs will be used.

From the data collected at each monitoring location, the maximum, minimum, and daily average will be determined. The data will be used to characterize the water temperature regime of the basin and to determine periods when the water temperatures are above state numeric water quality standards. Data collected during this TMDL effort will allow the development of a temperature model that is both spatially continuous and which spans full-day lengths (quasi-dynamic, steady-state diel simulations).

A summary of continuous temperature data (daily maximum, average, and minimum) will be entered into Ecology's Environmental Information Management (EIM) system. Data will be verified and data entry will be reviewed for errors.

Data used for model input parameters will be reviewed for their quality specifications. The impact of the data variability on model results will be evaluated and taken into consideration in interpreting and applying the model results.

The results of modeling and other analyses will be evaluated for compliance with acceptance criteria. Any shortcomings in the analyses will be taken into account in the development of a margin of safety for the TMDL. Every effort will be made to complete the TMDL with data collected by this study and existing data. However, if the quality of data or analytical results is sufficiently poor and the margin of safety unreasonably high, completion of the TMDL may be postponed while additional data is collected and analyses conducted.

Project Responsibilities

- *Paul Pickett*. Project manager and principal investigator, responsible for overall project management, preparation of QA Project Plan, supervision and completion of field sampling, analysis of project data, modeling, and overall preparation of technical content of draft and final reports.
- *Dustin Bilhimer*. Environmental Assessment Program, Nonpoint Studies Unit. Responsible for technical support of temperature monitoring and project plan development, including QA Project Plan review.
- *Jim Ross*. Environmental Assessment Program, Eastern Region. Responsible for field support for equipment maintenance, data downloading, and retrieval of monitoring equipment as well as for technical assistance with regard to field logistics.
- *Will Kendra, Karol Erickson, and George Onwumere*. Supervisors of the Watershed Ecology Section, Water Quality Studies Unit, and Freshwater Monitoring Unit, respectively, of the Environmental Assessment Program. Responsible for review and approval of the QA Project Plan and draft final report.
- *Cliff Kirchmer and Stew Lombard*. Responsible for technical assistance on Quality Assurance, including review and approval of the QA Project Plan.
- *Jim Bellatty, David Knight, Jean Parodi, and Paul Turner*. Section manager, Watershed Unit supervisor, hydropower water quality specialist, and project TMDL coordinator, respectively, for the Eastern Region Section of Ecology's Water Quality Program. Responsible for review and approval of the draft QA Project Plan and draft final report.
- *John Gross and Michele Wingert*. Environmental staff for Kalispel Tribe. Responsible for review of the draft QA Project Plan and final report focusing on issues pertaining to Kalispel Tribal waters and fisheries, and for providing limited field support.
- *Helen Rueda*. U.S. Environmental Protection Agency, Portland Oregon. Responsible for review of the draft QA Project Plan and final report, focusing on issues pertaining to Kalispel Tribal waters, interstate waters, and international waters.

Project Schedule

Temperatures in the Pend Oreille River typically rise above 20°C in late June or early July depending on flow levels (flows below 25,000 kcfs in June or below 35,000 kcfs in July). Current forecasts predict flows below 30,000 kcfs by late June and below 25,000 kcfs in early July. Installation of thermistors and flow gages will begin in late June 2004 and will be completed by mid-July when flows drop below 25,000 kcfs. Thermistors will remain in place at least until October 2004; the specific date will depend on river conditions.

Digital archiving of data in the EIM database will be in accordance with EA Program guidelines. Monitoring data will be reported in a data summary, along with a detailed report on the results of the data quality assessment. The data summary will be developed in accordance with program report review guidelines, distributed as a draft first to the project lead entities (Ecology client, Kalispel Tribe, and EPA staff), and then revised and distributed as a draft to stakeholders and interested public.

Final publication of the data summary will be as an appendix to the TMDL Phase 1 technical report. The technical report will also include modeling results and a preliminary evaluation of pollutant loading capacity in the Pend Oreille River from the Idaho state line to Box Canyon Dam. The proposed schedule in Table 4 for the technical report may be revised to take into account coordination with Idaho, the Kalispel Tribe and EPA, and the City of Seattle.

The timing of additional technical work phases for the TMDL (including study of the Boundary Dam Reservoir), development of implementation plans, and submittal of TMDL to EPA will be determined during development of the Phase 1 technical report. The schedule for the TMDL technical report is shown in Table 4.

Table 4. Project Milestones.

Report	Milestone	Due Date
	Data Technical Appendix	
	Draft Internal Review	March 2005
	Draft External Review	April 2005
	EIM Data Entry	July 2005
	TMDL Phase 1 Technical Report	
	Draft Internal Review	March 2006
	Draft External Stakeholder Review	June 2006
	Final Report Published	August 2006

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Figures

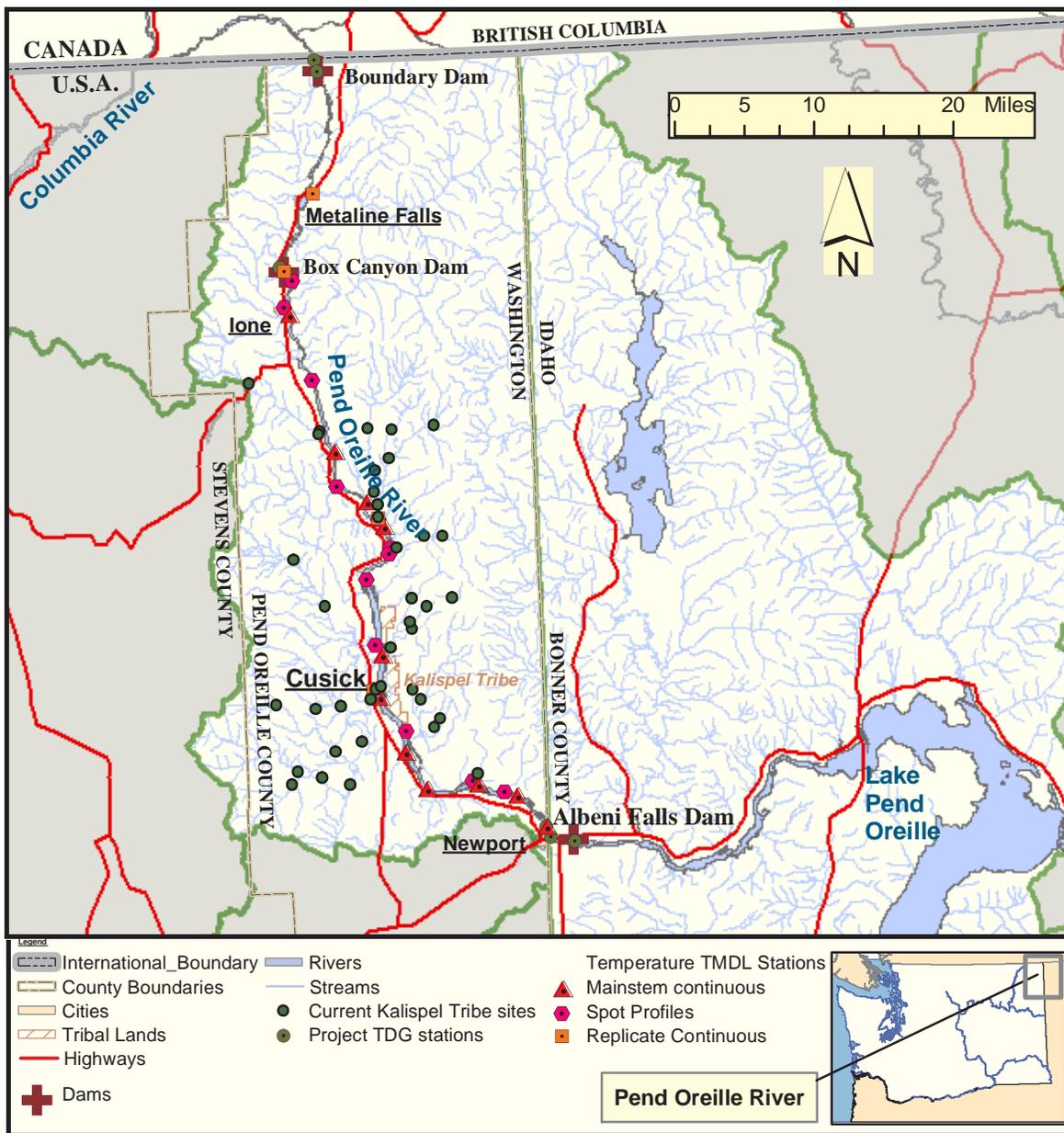


Figure 1. Pend Oreille River Temperature TMDL Study Area (Washington), as well as Upstream (Idaho) and Downstream (British Columbia) Neighboring Areas.

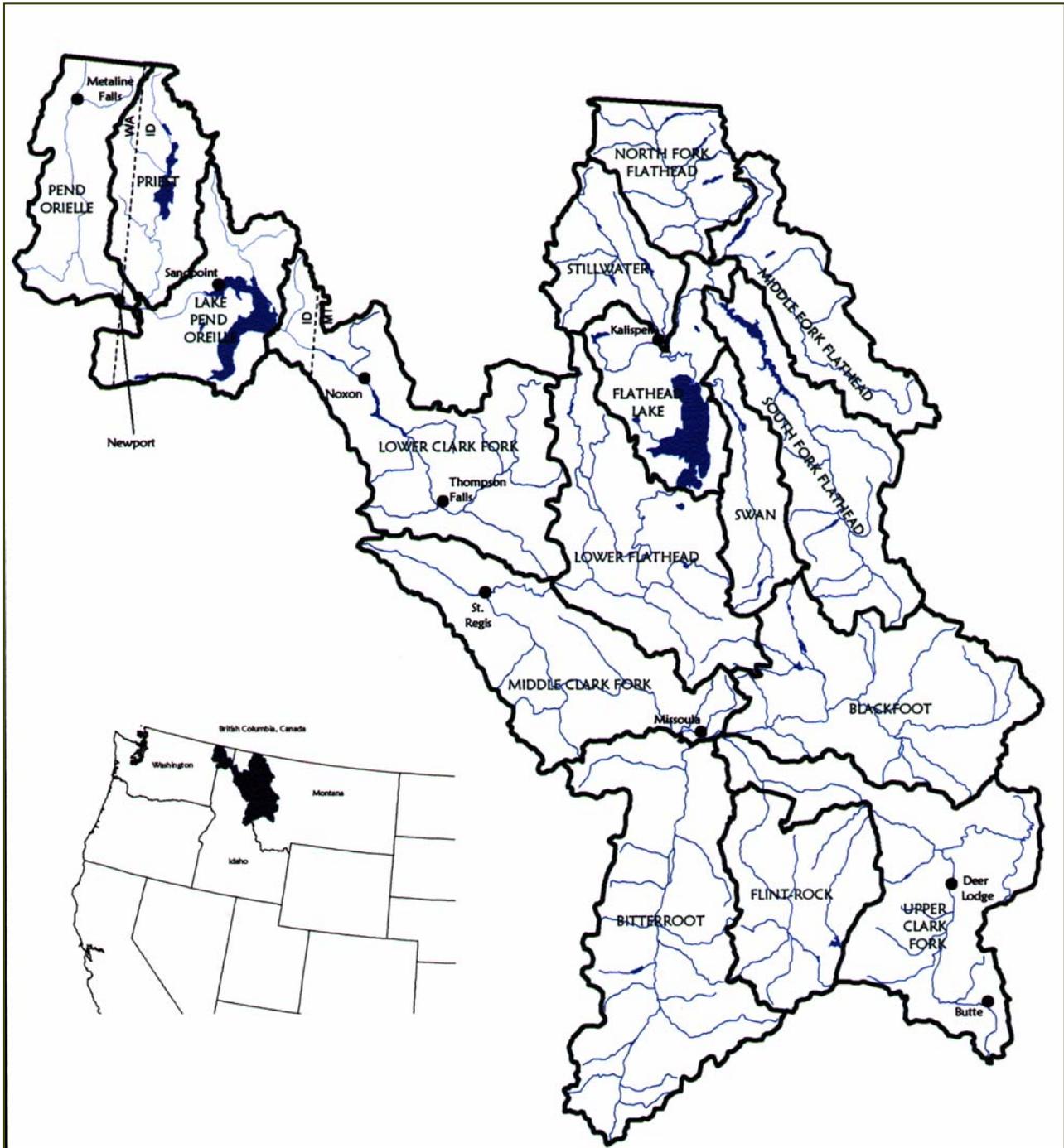


Figure 2. Pend Oreille/Clark Fork Watersheds (Within the United States).

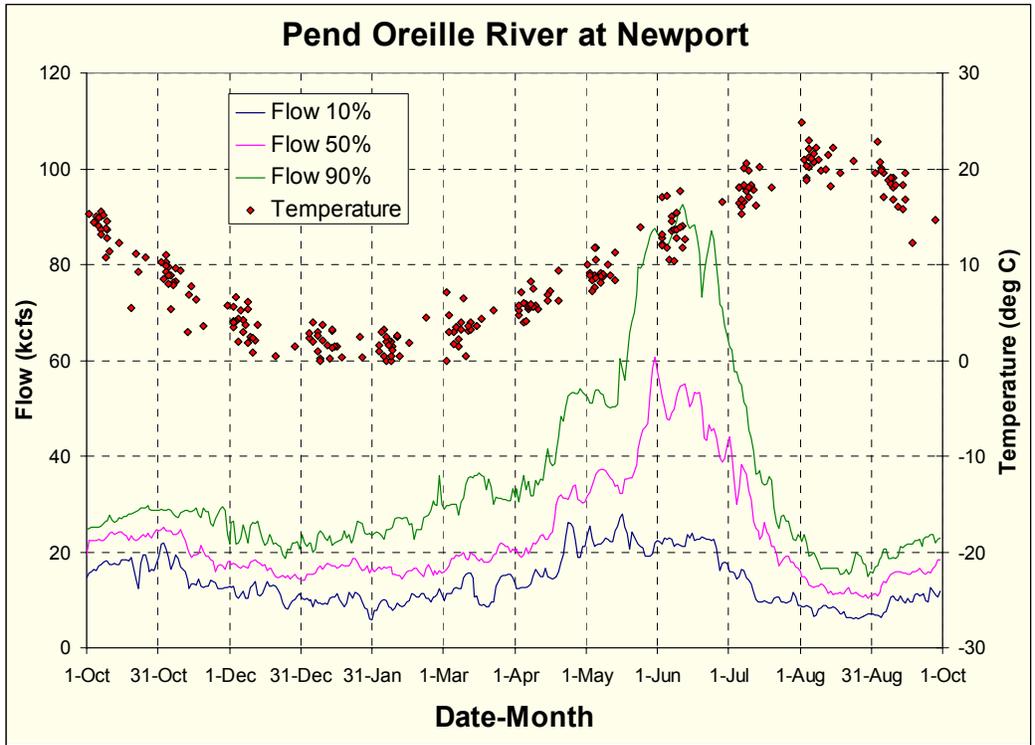


Figure 3. Pend Oreille River Temperatures, and Daily 10th Percentile, Median, and 90th Percentile Flows at Newport (1981- 2002).

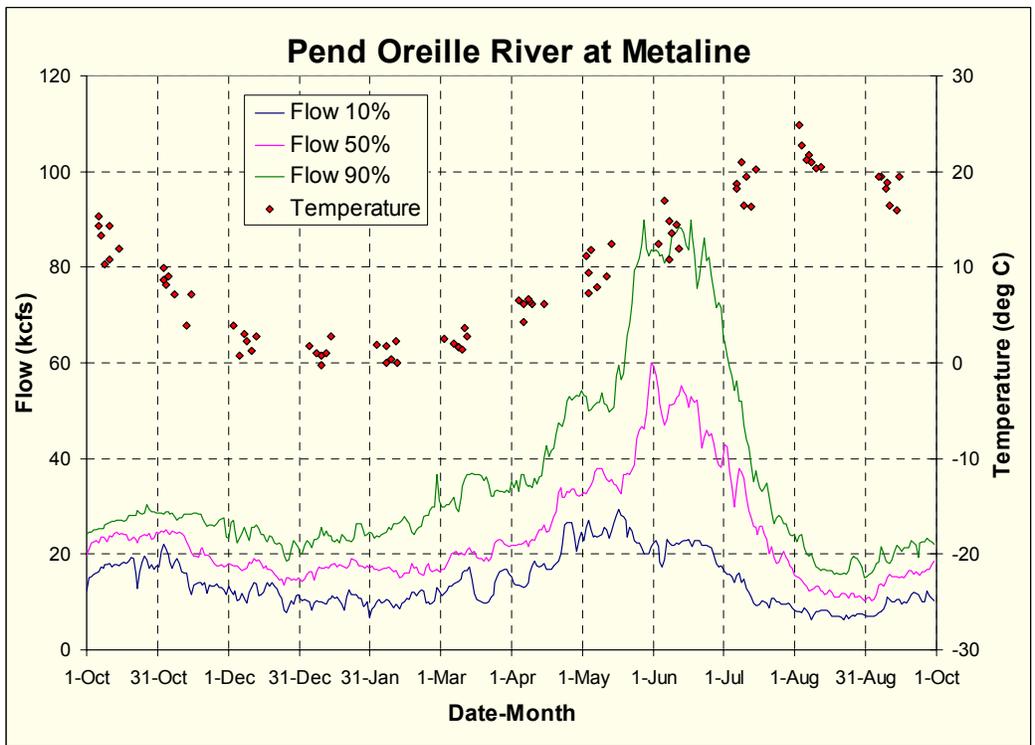


Figure 4. Pend Oreille River Temperatures, and Daily 10th Percentile, Median, and 90th Percentile Flows at Metaline Falls (1981- 2002).

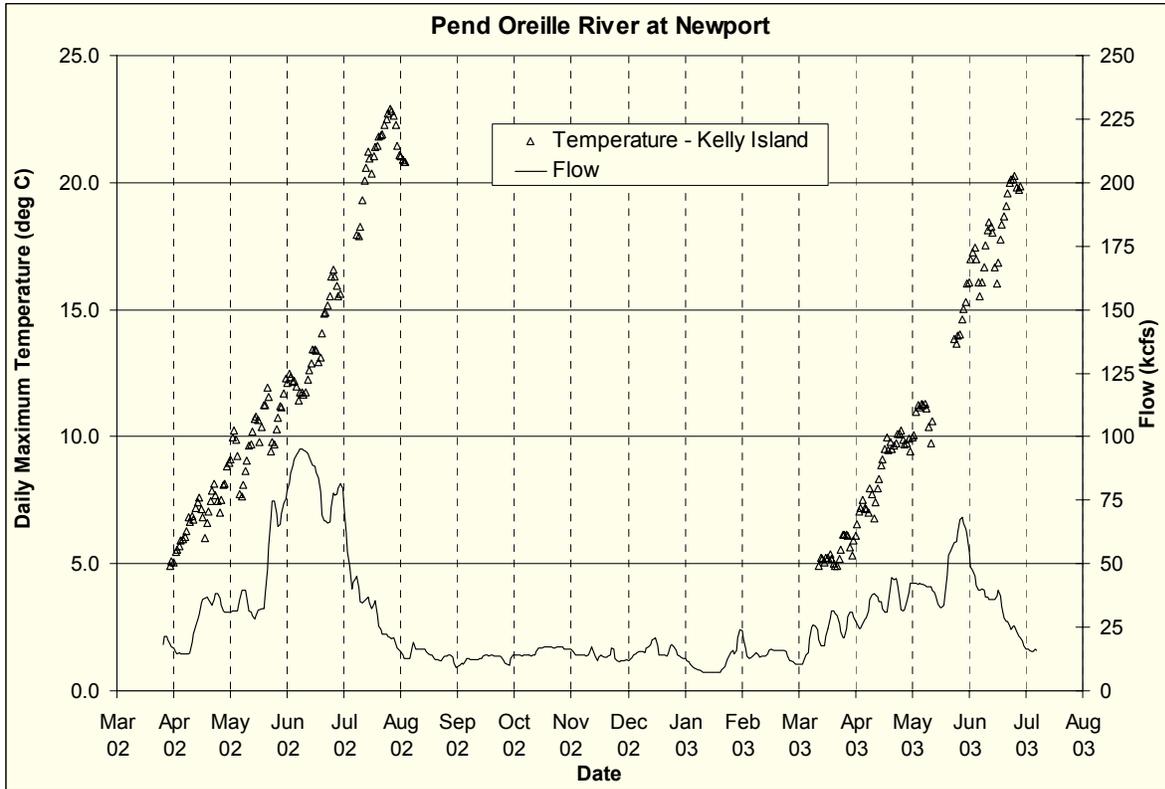


Figure 5. Pend Oreille River Temperatures and Flows at Newport (2002 and 2003).

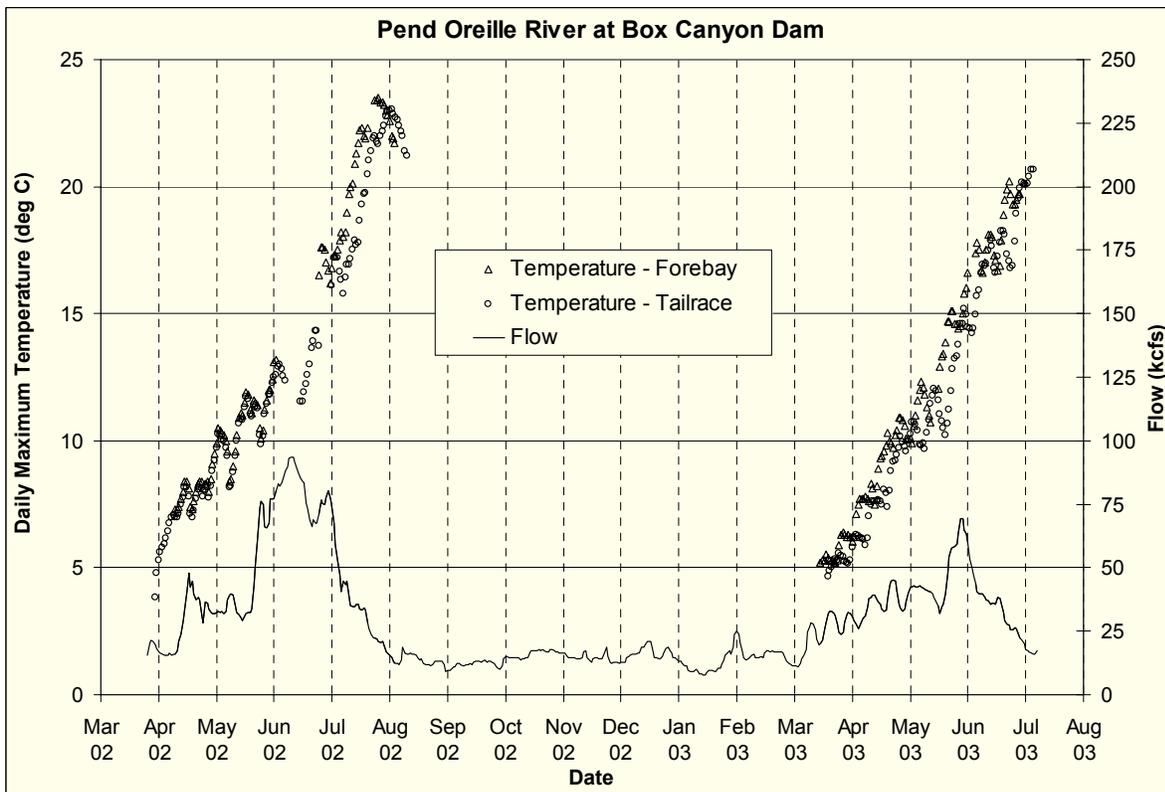


Figure 6. Pend Oreille River Temperatures and Flows at Box Canyon Dam (2002 and 2003).

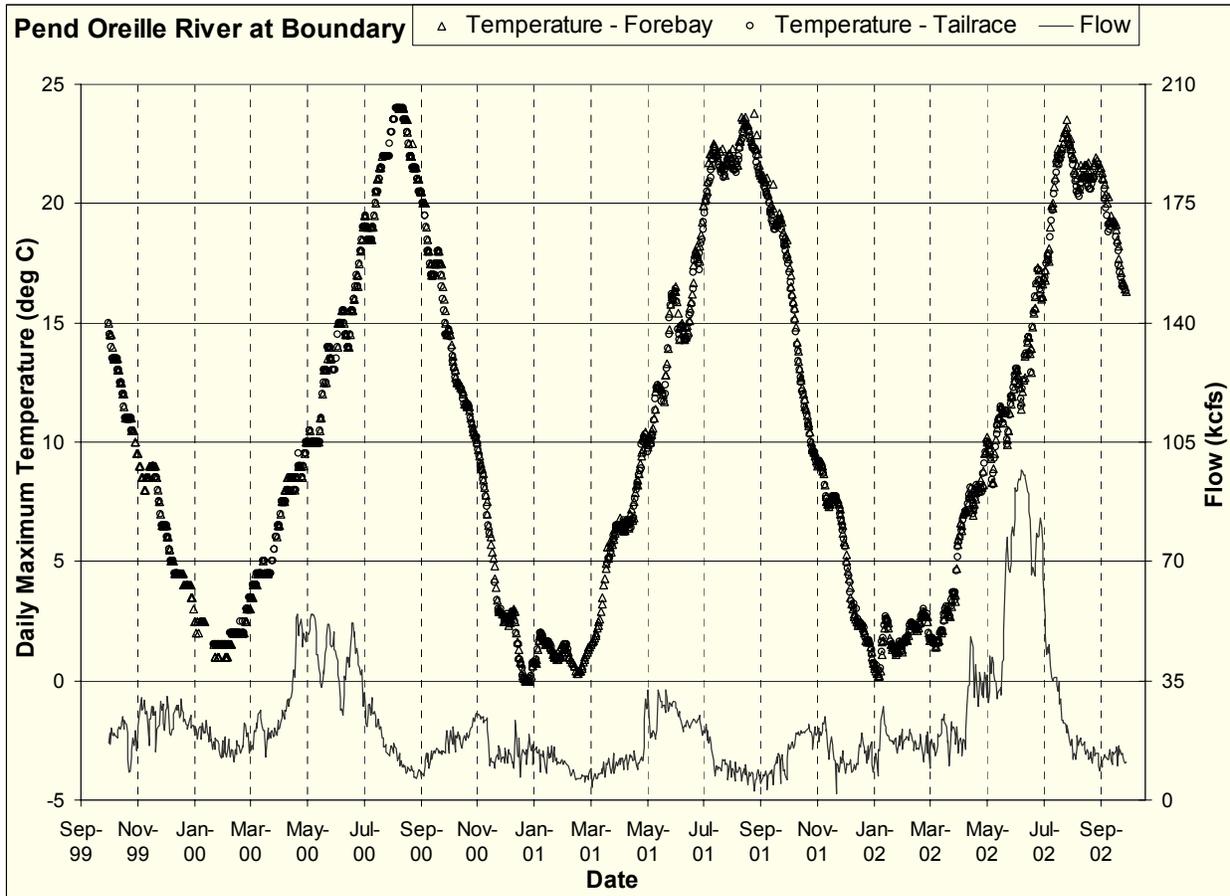


Figure 7. Pend Oreille River Temperatures and Flows at Boundary Dam (1999-2002).

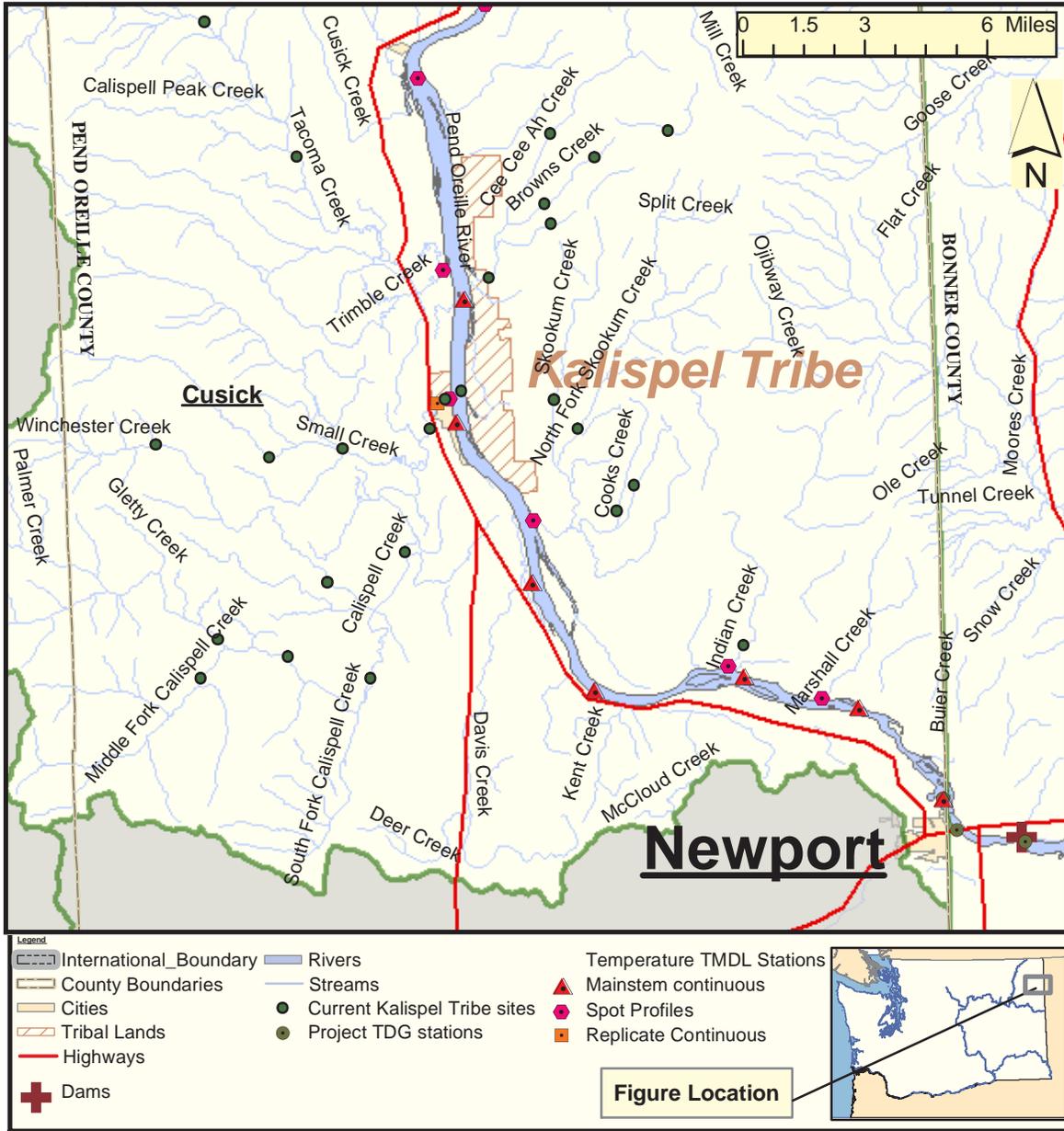


Figure 8. Pend Oreille River Study Area – South Area.

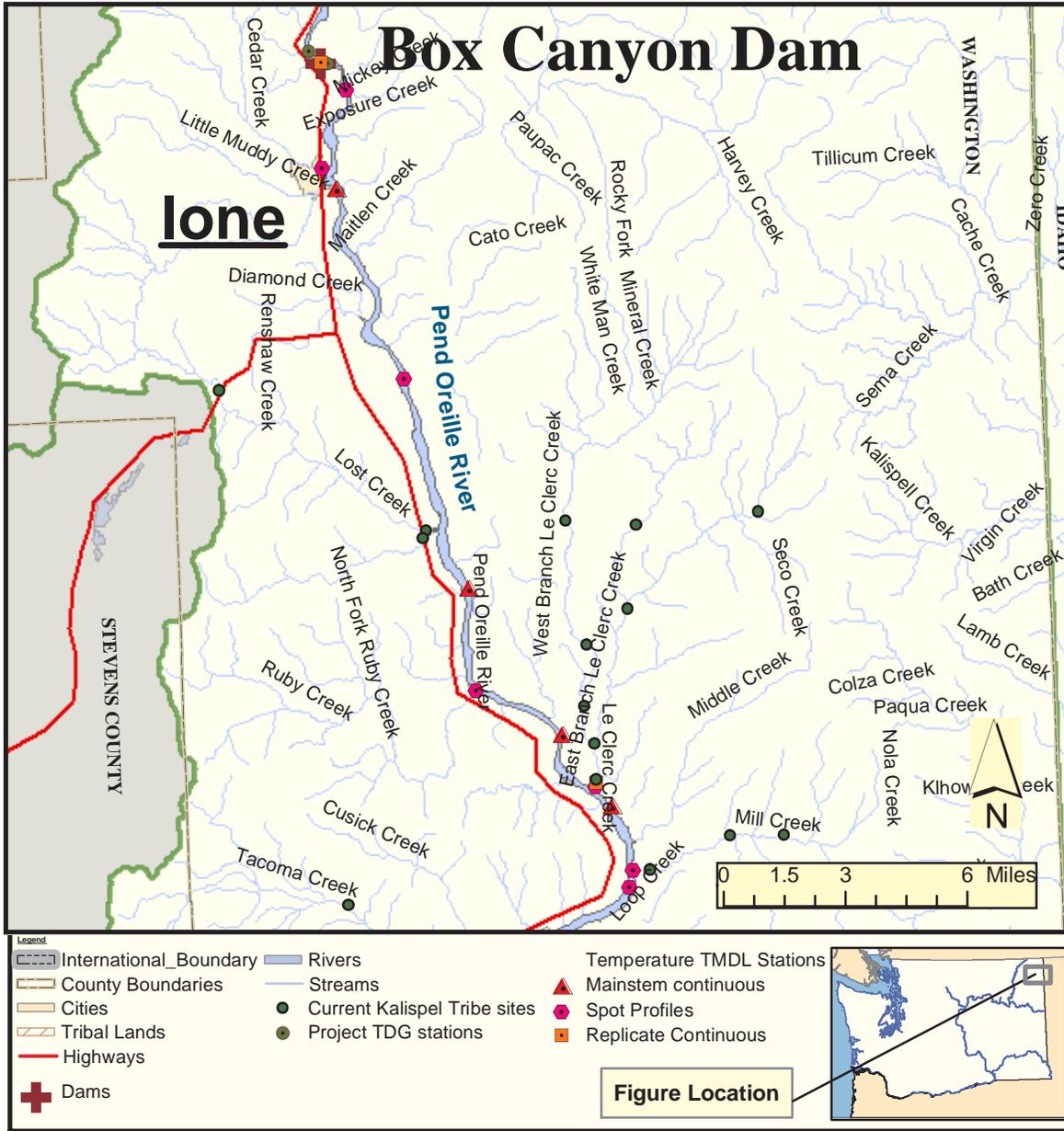


Figure 9. Pend Oreille River Study Area – Middle Area.

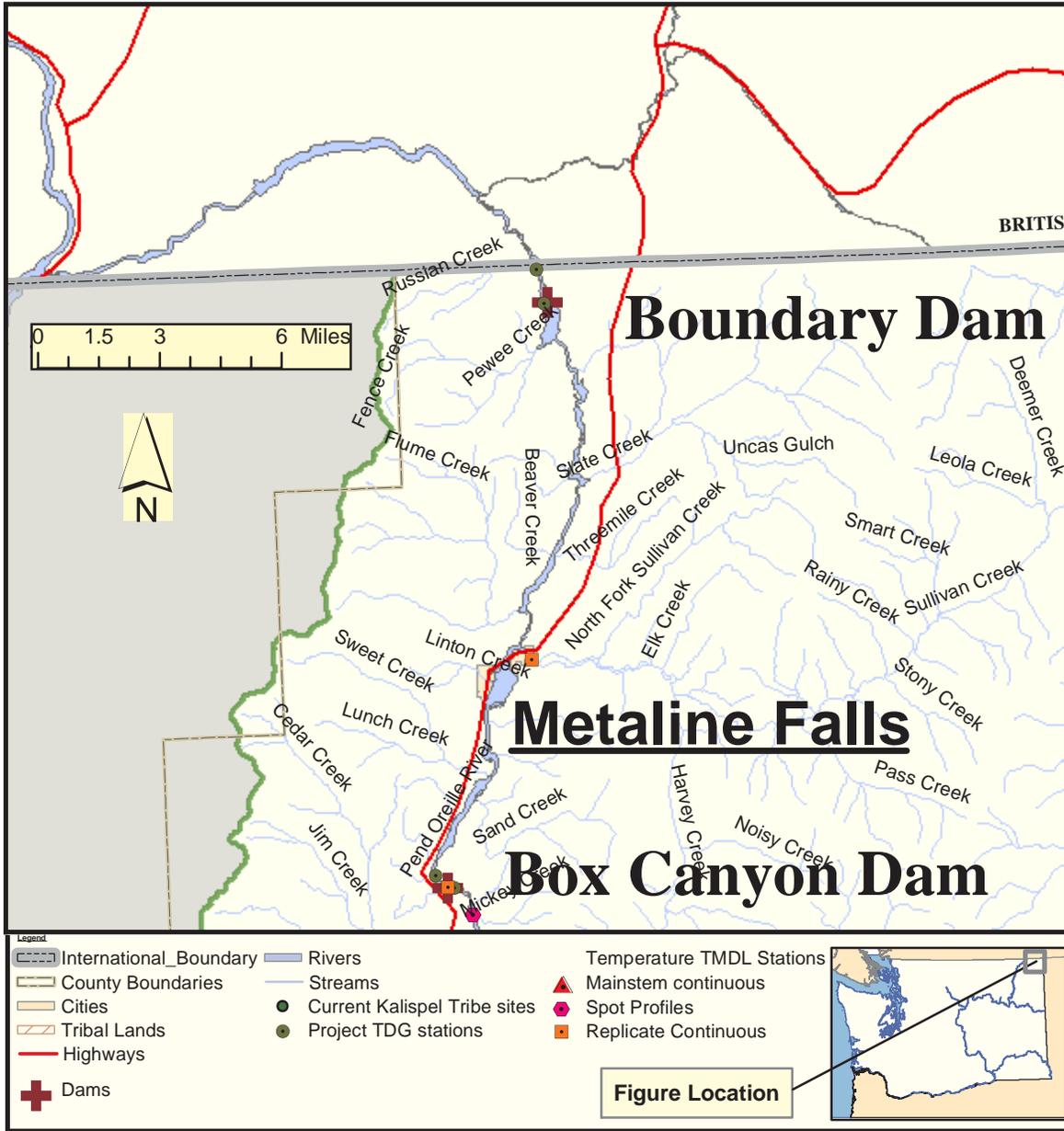


Figure 10. Pend Oreille River Study Area – North Area.

Appendix A

Pend Oreille 2001 TIR Survey Review

Pend Oreille 2001 TIR Survey Review

Dustin Bilhimer

March 2004

I have reviewed the 2001 TIR data for the Pend Oreille River and the lower part of LeClerc Creek. Below are my comments on the data. Below is a bulleted list of sites that seemed significant to me.

- Albeni Falls Dam at river mile 90.3-. The reservoir shows extreme temperature stratification as evidenced by the temperature patterns following boat wakes. The forebay is between 23-24°C and the tailrace raises the water temperature to 25°C immediately following the dam spillway while the area near the powerhouse and downstream of the tailrace appears more mixed and shows lower water temperatures in the 21-22°C range. It seems to me that this cooler water might be a signature from the deeper water in the reservoir moving through the dam system. It is not surprising that the river coming out of Lake Pend Oreille is very warm, the typical heating pattern with lakes would be warm water exiting the lake (usually above standards) and then a cooling trend downstream.
- At river mile 89.29 there is a hotspot on the right bank side upstream of a sawmill (see Figure A-1 below). It is unclear if the higher temperatures result from a point source discharge or are related to the milfoil along the right bank. This may be related to a heating pattern I have noticed throughout the river system where the river edges show higher temperatures in the TIR image than in the main section of flow, and it usually correlates with darker areas of aquatic vegetation seen in the daytime video (DTV) images. I cannot say if the milfoil was floating on the water surface and the TIR picked up their thermal signature or if the milfoil is subsurface and contributed to some local heating effect. The effects of milfoil on stream temperatures may be something to investigate with the 2004 data collection.

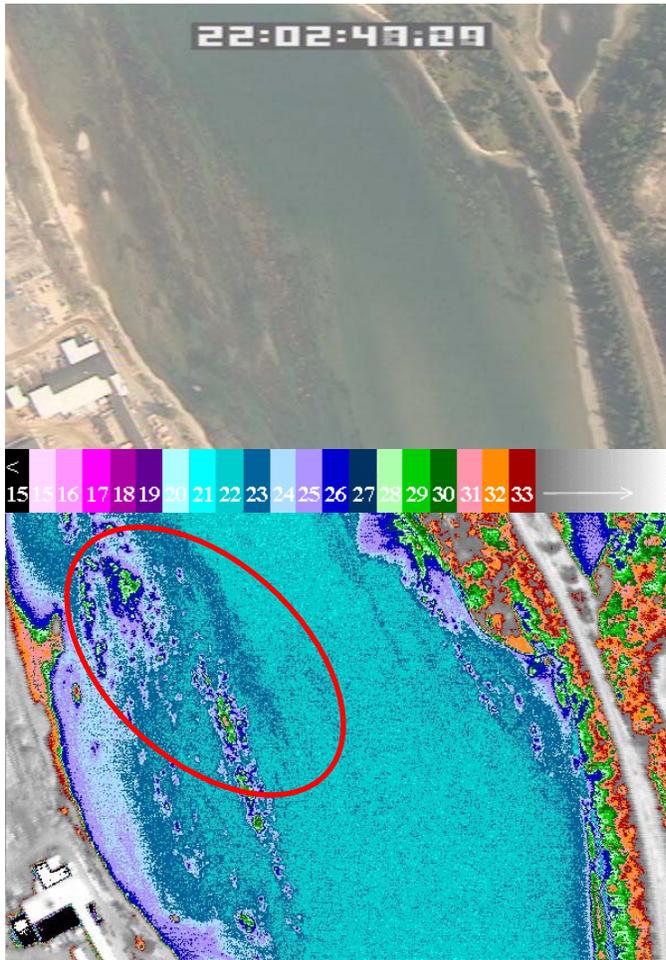


Figure A-1. Thermal Plume near Sawmill (Idaho).

Figure A-2 also shows a similar heating pattern.

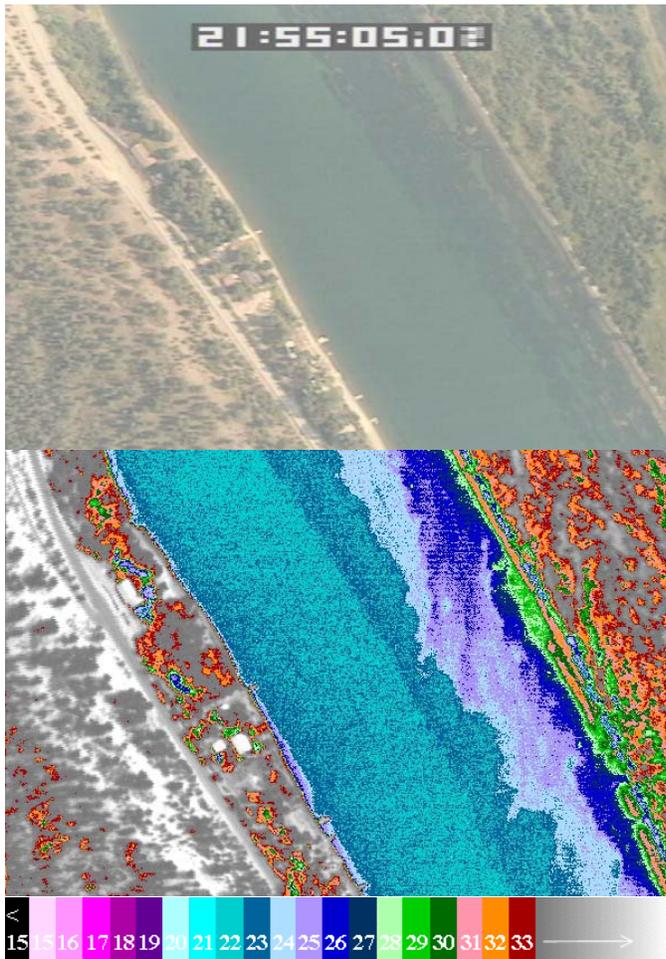


Figure A-2: Elevated Water Temperature and Milfoil on the Right Bank. TIR and DTV Images for RM 81.77 Image poa0648.

- Indian Creek shows water temperatures in the 16-18°C range but does not significantly affect temperatures in the Pend Oreille River.
- The side-channel complex on the right bank of the Pend Oreille between river miles 74.5-76 is a big heat sink. The side channel complex is near the Skookum Community Center (see Figure A-3). In big rivers, side-channels could help provide refugia for fish migrating along the river corridor but most side channels in the Pend Oreille show extremely warm temperatures in the TIR images.

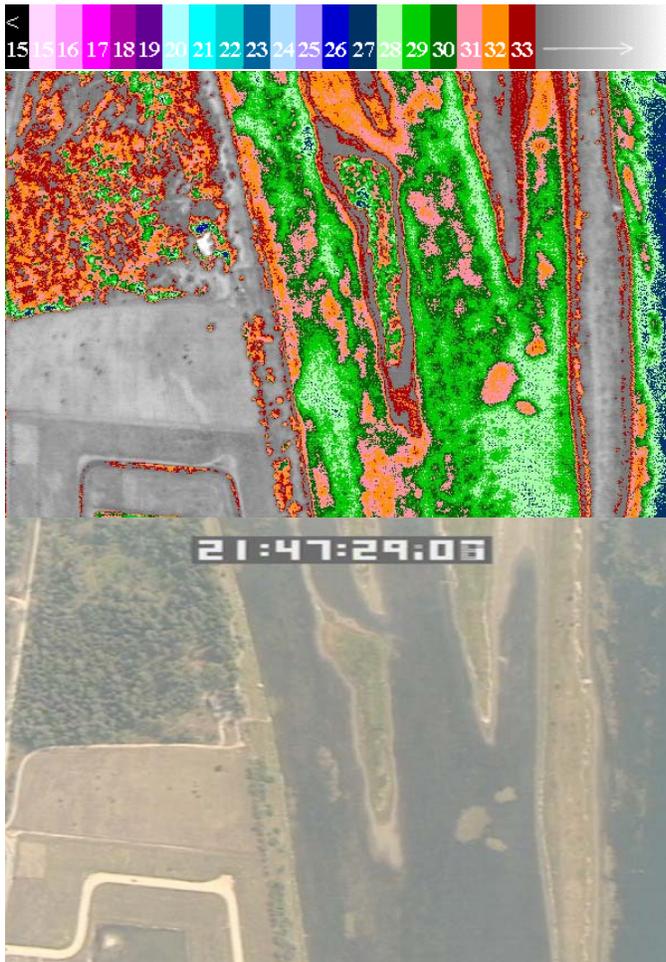


Figure A-3: Side Channel Complex at RM74.5.

- Skookum Creek shows temperatures at its mouth around 20°C which is about 5°C cooler than the Pend Oreille River.
- Cee Cee Ah Creek is cool and has a complex mouth (see Figure A-4).

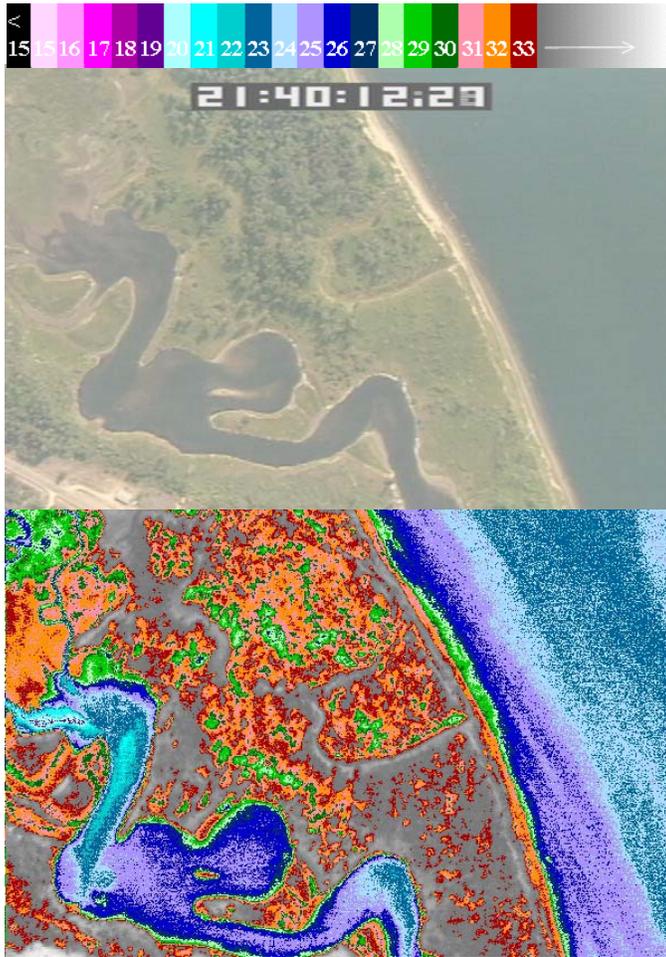


Figure A-4: Mouth of Cee Cee Ah Creek.

- Unmapped stream found near river mile 64.8 on Kalispel tribal lands (see Figure A-5) on the right bank of the Pend Oreille River.

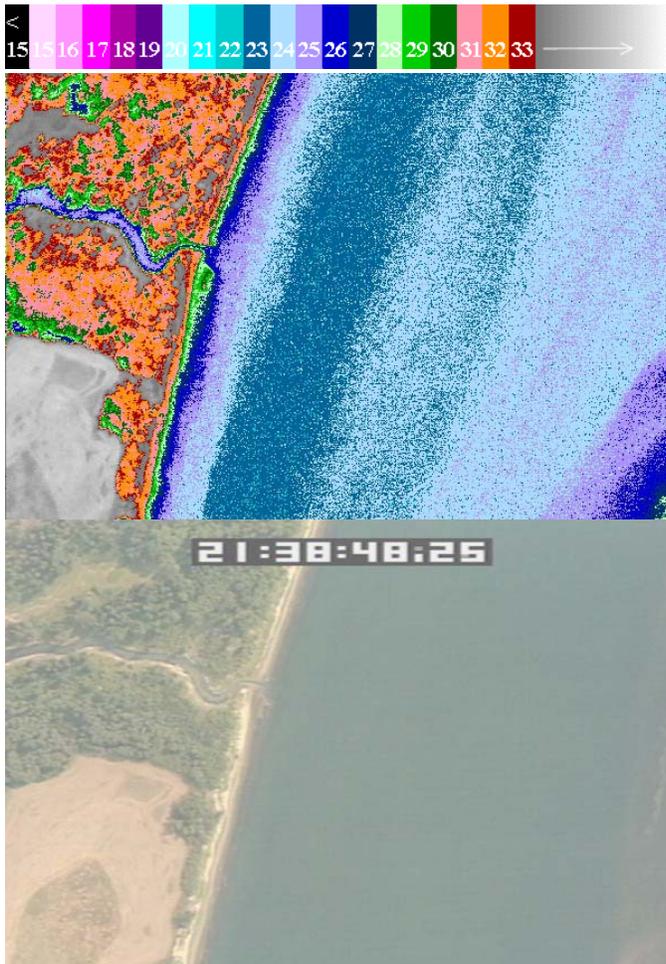


Figure A-5: Unmapped Stream at RM 64.8 Image poa0160.

- LeClerc Creek is a cooler stream with temperatures at its mouth in the 15-16°C range with some spots as cool as 12-15°C. These waters are probably not stratified and the TIR image should fairly represent stream temperatures in LeClerc. West Fork LeClerc Creek is also cool running at 11-13°C.
- There is another interesting hotspot on the left bank of the Pend Oreille River at mile 74.9 and is downstream of the Davis Creek confluence but does not appear (from the TIR image) to be coming from the creek.
- Calispell Creek runs very warm (RM 70) (see Figure A-6).
- Ruby Creek shows cooler water temperatures at the mouth but doesn't show a big impact to cool the Pend Oreille River. The Pend Oreille River in the reach around Ruby Creek does not show thermal stratification patterns like that seen upstream of Albeni Dam.
- The confluence of Lost Creek and Pend Oreille river (river mile 47.6) is a heat sink (see Figure A-7) and the Pend Oreille downstream of Lost Creek exhibits the thermal stratification on the left bank with a boat trail.

- At the town of Ione, there are three lagoons (assumed WWTP related) that look like they may be “leaking” warm water through the ground (see Figure A-8).
- Box Canyon Dam water temperatures don’t specifically show any thermal stratification patterns. The water temperatures upstream and downstream of the dam are similar with the exception of some heating occurring at the spillway and a short distance along the tailrace (see Figure A-9).

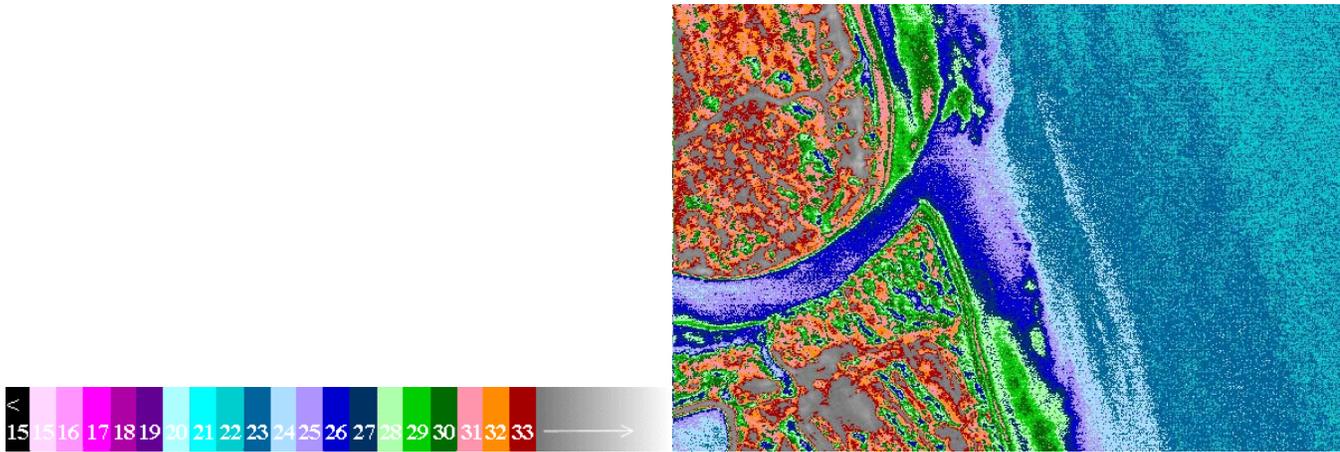


Figure A-6: Calispell Creek Mouth. River Mile 70, Image poa2842.

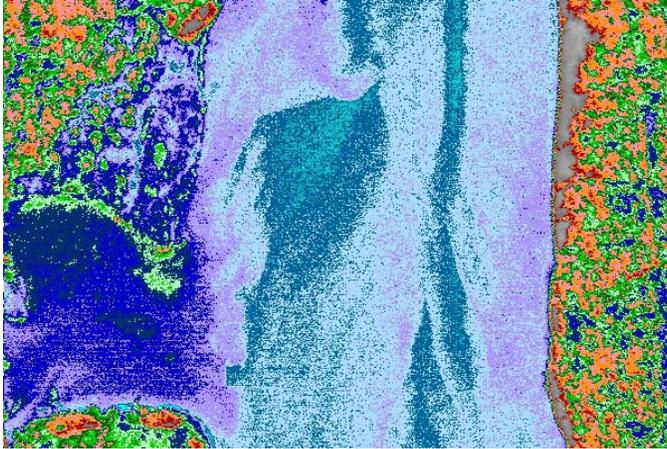


Figure A-7: Lost Creek Confluence. River Mile 47.6, Image poa3443.

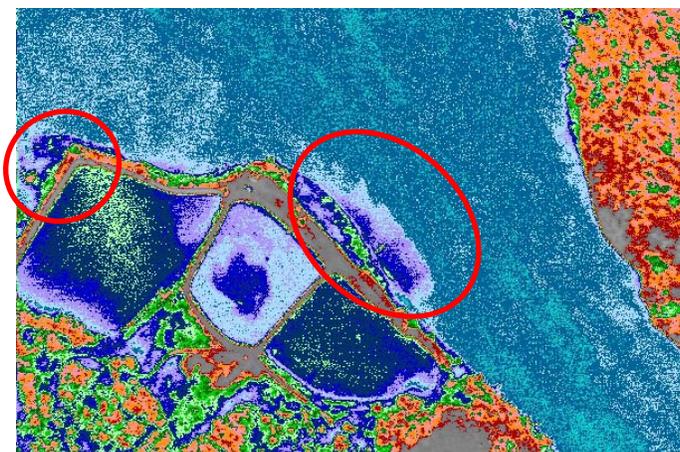


Figure A-8: Ione Lagoons. River Mile 37, Image poa3711.

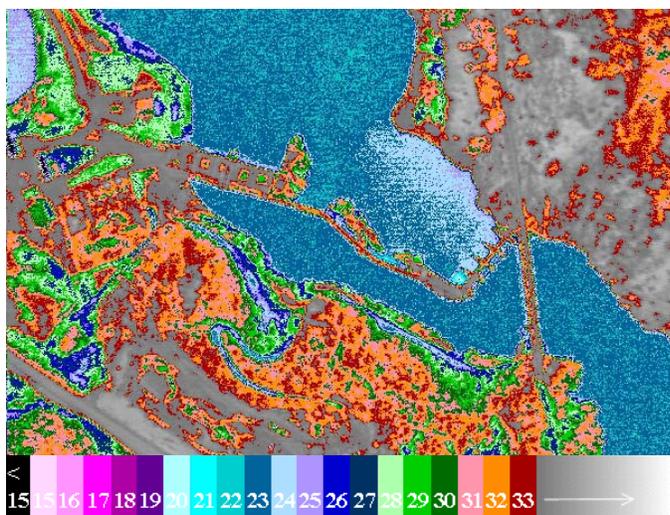


Figure A-9: Box Canyon Dam. River Mile 34.5, Image poa 3773.

In conclusion, there are several goals I would suggest for the 2004 field data collection season.

- Determine the water temperatures below the surface of the Pend Oreille in the thermally stratified reaches of the reservoirs. Is there cold water for fish migration closer to the bottom of the stream? Does the water near the stream bottom meet the standard of 20°C?
- What effect is the milfoil having on stream temperatures? Is the heating effect seen in the TIR images because of milfoil on the water surface fooling the TIR and showing warm milfoil temperatures or is the milfoil submerged and heating the stream below the surface of the water?
- Are the point sources described above real and verified with new data?

- What should be the role of side channel habitats? They are typically much warmer than the river and can act as big heat sinks. The same goes for many of the tributaries with large “bays” at their confluences with the Pend Oreille River. Is there a way to cool them down?
- Which tributaries are important fish habitat for rearing and spawning and what is their temperature condition? Some are running hot and others are fairly cool at their mouths. How can they be protected from further land-use activities that might elevate stream temperatures?
- How can the reservoir be best managed to reduce thermal stratification in their reservoirs?