

Lower Clearwater River Tributaries Water Quality Monitoring Report 2010-2011



Prepared by: Ken Clark, Nez Perce Tribe Water Resources Division
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Acronyms and Abbreviations

BLM	Bureau of Land Management	IDAPA	Idaho Administrative Procedure Act
BMPs	Best Management Practices	mg/L	milligrams per liter
BOR	Bureau of Reclamation	NH₃	Ammonium
C	Celsius	NO₂+NO₃	Nitrate-Nitrite
cfs	Cubic feet per second	NRCS	Natural Resources Conservation Service
cm	centimeter(s)	OP	Ortho Phosphorus
CWA	Clean Water Act	QA/QC	Quality assurance/quality control
CWAL	Cold Water Aquatic Life	SCC	Soil Conservation Commission
DEQ	Idaho Department of Environmental Quality	TDS	Total Dissolved Solids
DO	Dissolved Oxygen	TMDL	Total Maximum Daily Load
EPA	Environmental Protection Agency	TP	Total Phosphorus
GIS	Geographical Information Systems	TSS	Total Suspended Solids
HUC	Hydrologic Unit Code	USFS	United States Forest Service
IASCD	Idaho Association of Soil Conservation Districts	WAG	Watershed Advisory Group

Introduction

The Nez Perce Tribe (Tribe) is a federally recognized Indian Tribe with an aboriginal territory of more than 13 million acres extending from northeastern Oregon and southeastern Washington, through north-central Idaho, to southwestern Montana. The Tribe’s 1855 treaty with the United States acknowledged and guaranteed a variety of retained off-reservation fishing, hunting, and gathering rights. The current Nez Perce Tribal Reservation is approximately 770,483 acres in size, and many tribal members continue to practice a subsistence-based lifestyle to this day. Clean water is valued for its cultural, spiritual, and economic uses, and the Tribe has a vested interest in protecting the quality of water both on Reservation and throughout the Clearwater, Snake, and Columbia River Basins.

The Tribe’s Water Resources Division (WRD) applied for and received Treatment in the Same Manner as a State (TAS) to implement the Clean Water Act §106 Water Quality Monitoring Program in 1990. In 1999, the WRD began collecting water quality data for Reservation water bodies. Table 1 is an Atlas of Tribal Water Resources found within the boundaries of the Reservation of 1863.

Table 1. Atlas of Tribal Water Resources

Topic	Value
Reservation Area (acres)	770,483
Reservation Population	12,256
Number of watersheds within or intersecting the Reservation boundary	19
Total Miles of Rivers and Streams - <i>Miles of perennial streams</i> - <i>Miles of intermittent streams (does not include unnamed streams)</i>	1,590 602* 85*
*the remaining stream miles are unknown for perennial vs. intermittent	
Number of Lakes/Reservoirs/Ponds	8
Acres of Lakes/Reservoirs/Ponds	2,883

The WRD 106 staff collected water quality data from ten previously unassessed tributaries to the lower Clearwater River from October 2010 through September 2011. Each monitoring site was established at or near the mouth of the respective creek. The total sum of stream miles located upstream of the monitoring stations is approximately 79 miles, or five percent of the 1,590 total stream miles located within the Reservation. This monitoring project was initiated to fill data gaps and to collect baseline water quality data, in order to determine if water quality criteria are being met and if beneficial uses are being supported in these waterbodies. Additionally, the Rock Creek (06601A) monitoring site was established approximately 3.5 miles below a wetland/stream restoration project that will be completed in the fall of 2013. This site will help to determine the effectiveness of the restoration project in improving water quality and hydrology in the Rock Creek subwatershed.

This report reviews monitoring results for the following parameters at all monitoring locations:

- Total Phosphorus (TP)
- Orthophosphorus (OP)
- Bacteria (Escherichia coli)
- Nitrogen Components—NO₂+NO₃, TKN, NH₃
- Total Suspended Sediment (TSS)
- Instantaneous Water Temperature
- Turbidity
- Dissolved Oxygen (DO)
- Percent (%) Saturation
- Specific Conductance

The Bureau of Reclamation (BOR) Pacific Northwest Regional Laboratory, in Boise Idaho, conducted all inorganic parameter testing and bacteria analysis. WRD field staff performed all other measurements.

Lower Clearwater River Subbasin

The Lower Clearwater River Subbasin is located in north-central Idaho and encompasses an area of approximately 926 square miles (592,576 acres). This project evaluated water quality in 10 tributaries to the lower Clearwater River, which is contained within the 4th field hydrologic unit code (HUC) # 17060306.

Land Use

The Lower Clearwater River Subbasin is composed of agricultural lands, forest lands, and pasture lands. Land use in the watersheds is primarily agricultural, with 378,870 acres or 49% of the total Reservation area in cropland. Forest covers about 13% of the Reservation, while pasture/meadow is 15%. Logging and grazing are also present throughout the watersheds. These activities have decreased stream riparian vegetative buffers, which provide shade, as well as altered hydrologic regimes and channel morphology.

Winter wheat, spring barley, and spring wheat are the main crops on cultivated land. Other important crops include: spring peas, oats, lentils, rape, and canola. Hay and bluegrass are grown in rotation with small grains. Pasture or forage land comprises 153,280 acres of land within the exterior boundary of the Reservation. Concentrated animal feeding areas are also located throughout the watersheds.

Tribal trust and fee lands are leased for crop production and grazing. The Nez Perce Tribe's Land Services Program manages these lands for the long-term economic and ecological viability of the resources. The program develops Conservation Plans to prescribe management for livestock numbers, crop rotations, weed control, pesticide use, structures/improvements, and residue management.

Climate

Climate in the lower Clearwater River Subbasin is strongly influenced by warm, moist maritime air masses from the Pacific (Bugosh 1999). The area is semi-arid with hot, dry summers and moderately cold winters. There is also a seasonal variability to precipitation patterns in the region, with very little precipitation occurring in the summer months. A general increase in precipitation occurs from west to east across the subbasin, coincident with increasing elevation (Stapp et al. 1984). Mean annual precipitation ranges from 15-20 inches in lower elevations to 50-60 inches in the higher elevations (Figure 1). Due to colder average temperatures, winter precipitation above 4,000 feet falls largely as snow (McClelland et al. 1997). The annual growing season averages from about 84 days in Winchester to 201 days in Lapwai.

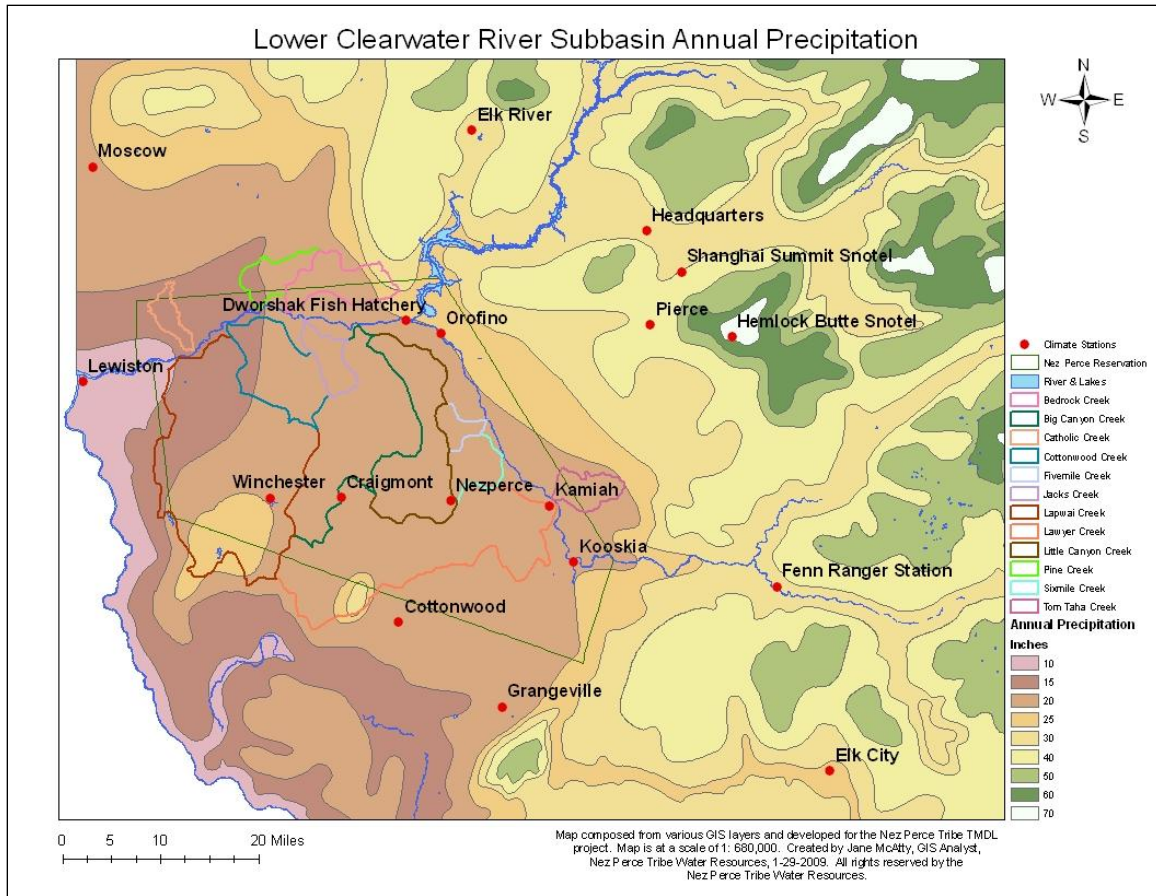


Figure 1. Annual precipitation rates in lower Clearwater River Subbasin.

Fisheries

More than 30 species of fish inhabit the Clearwater River Subbasin, including 19 native species, two of which have been reintroduced.

Table 2 shows general spawning and incubation periods for salmonids species found in the tributaries to the lower Clearwater River.

Table 2. Spawning and incubation periods in lower Clearwater River Tributaries.

Spawning and Incubation Periods in Lower Clearwater Tributaries												
Salmonid Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead/Rainbow Trout		✓	✓	✓	✓	✓						
Spring/summer Chinook	✓	✓	✓	✓				✓	✓	✓	✓	✓
Coho Salmon	✓	✓	✓							✓	✓	✓

Methods and Materials

Water Quality Limited Segments

The Clean Water Act (CWA) requires restoration and maintenance of the chemical, physical, and biological integrity of the nation's water (Public Law 92-500 Federal Water Pollution Control Act Amendments of 1972). Section §303 (d) of the CWA establishes requirements for states and tribes to identify and prioritize waterbodies that are water quality limited (i.e., do not meet water quality standards). A number of streams in this study were placed on the State of Idaho's initial §303 (d) list.

Sampling Protocols

The WRD staff has a Quality Assurance Project Plan (QAPP) which has been reviewed and approved by the US Environmental Protection Agency (EPA). WRD staff follows methods and protocols found in the USGS *National Field Manual for the Collection of Water Quality Data* (TWRI Book 9, 1999-2004) when collecting water quality data in Reservation waters.

Approximately four liters of stream water were collected at each site, using a DH-81 depth-integrating suspended-sediment sampler. The samples were collected and transferred into a 2.5-gallon polyethylene churn splitter. The polyethylene churn splitter was rinsed with ambient water at each location prior to sample collection. The resultant composite sample was thoroughly homogenized before filling the appropriate sample containers. Water samples requiring preservation (NO_2+NO_3 , TKN, NH_3 , and TP) were transferred into preserved (H_2SO_4 pH <2) 500 mL sample containers. Water quality samples (TSS, NO_2+NO_3 , TKN, NH_3 , and TP) were then shipped to Boise, ID overnight to be analyzed at the Bureau of Reclamation (BOR) Pacific Northwest Regional Laboratory.

Bacteriological samples (*E. coli*) were collected directly from the thalweg into sterile sample containers. These samples were also shipped to Boise, ID overnight to be analyzed at the BOR Pacific Northwest Regional Laboratory. Most probable number (MPN) multiple tube fermentation was used to determine *E. coli* levels in the water sample.

A list of parameters, sample sizes, preservation, holding times, and analytical methods is displayed in Table 2. All sample containers were labeled with waterproof markers with the following information: station location, sample identification, date of collection, and time of collection. Samples were placed on ice and shipped to the laboratory the same day as collection. Chain-of-custody forms accompanied each sample shipment.

Table 3. Water Quality Parameters.

Parameters	Sample Size	Preservation	Holding Time	Method
Total Suspended Solids (TSS)	1 qt cubitainer	Store at 4°C	7 days	2540 D
Nitrogen Components: Nitrate+Nitrite (NO ₃ +NO ₂) Ammonia (NH ₃) Total Kjeldahl Nitrogen (TKN)	1 qt cubitainer	Cool 4°C, H ₂ SO ₄ pH < 2	28 Days	EPA 353.2 EPA 350.1 EPA 351.2
Total Phosphorus (TP)	100 mL	Cool 4°C, H ₂ SO ₄ pH < 2	28 Days	EPA 365.4
Ortho-phosphate (OP)	100 mL	Store at 4°C	48 Hours	EPA 365.1-PF
Escherichia coli (<i>E. coli</i>)	100 mL	Cool 4°C	30 Hours	MPN

Field Measurements

At each location, field parameters for dissolved oxygen, specific conductance, pH, temperature and turbidity were measured. Calibration of all field equipment was in accordance with the manufacturer's specifications. Field measurement parameters, equipment, and calibration techniques are shown in Table 4.

Table 4. Field Measurements.

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 556 MPS	Ambient air calibration
Temperature	YSI Model 556 MPS	Centigrade thermometer

Specific Conductance	YSI Model 556 MPS	Specific Conductance (25°C standard)
pH	YSI Model 556 MPS	Standard buffer (7,10) bracketing for linearity
Turbidity	Hach Model 2100P	Formazin Primary Standard

All field measurements were recorded in a field notebook along with pertinent observations about the site, including weather conditions, flow rates, personnel on site, and any problems observed that might affect water quality.

Flow Measurements

Flow measurements were taken at each site using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenths depth method (0.6 of the total depth from the surface of the water surface) was used. A transect line was established at each monitoring station, across the width of the stream at an angle perpendicular to the flow, for the calculation of cross-sectional area. Discharge was computed by summing the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections. Stream discharge was reported as cubic feet per second (cfs).

Quality Assurance and Quality Control (QA/QC)

The BOR Pacific Northwest Regional Laboratory utilizes methods approved and validated by the EPA. A method validation process, including precision and accuracy performance evaluations and method detection limit studies, is an element of the BOR Pacific Northwest Regional Laboratory Standard Methods. Method performance evaluations include quality control samples analyzed with a batch to ensure sample data integrity. Internal laboratory spikes and duplicates are part of the BOR Pacific Northwest Regional Laboratory's quality assurance program. Laboratory QA/QC results generated from this project can be provided upon request.

QA/QC procedures from the field-sampling portion of this project included a duplicate sample and a blank sample (one set per sampling event). The field blanks consisted of laboratory-grade deionized water, transported to the field and poured off into the appropriate sample containers. The blank sample was used to determine the integrity of the field team's handling of samples, the condition of the sample containers and

deionized water supplied by the laboratory, and the accuracy of the laboratory methods. Duplicate samples were obtained by filling two sets of sample containers with homogenized composite water from the same sampling site. The duplicate and blank samples were not identified as such to laboratory personnel to ensure laboratory precision.

Data Handling

All of the field data and analytical data generated from each survey were reviewed in the WRD office by both field staff and the Water Quality Coordinator. These duplicate internal reviews ensure that all necessary observations, measurements, and analytical results were properly recorded. The analytical results were evaluated for completeness and accuracy. Any suspected errors were investigated and resolved, if possible. The data were then stored electronically and made available to interested entities upon request.

Monitoring Site Descriptions

Monthly water quality monitoring was carried out by WRD water quality technicians, from October 2010 to September 2011, on the following streams:

These sites are shown on the map in Figure 2.

Table 5. 2010-2011 Water Quality Monitoring Sites.

Waterbody Name/ID	Watershed	Description
Pickle Canyon (05903A)	Cottonwood Creek (Nez Perce County)	Near confluence with Star Mill Creek
Coyote Creek (01801A)	Cottonwood Creek (Nez Perce County)	Near mouth
Magpie Creek (04901A)	Cottonwood Creek (Nez Perce County)	Near mouth
Louse Creek (04702A)	Bedrock Creek	At prairie/canyon boundary
Louse Creek (04706A)	Bedrock Creek	At Cavendish Rd. crossing
Rock Creek (06601A)	Lapwai Creek	Near mouth

Garden Gulch Creek (02701A)	Lapwai Creek	Near mouth
Leitch Creek (04001A)	Clear Creek	Near mouth
Clear Creek (01001A)	Clear Creek	Near mouth
Maggie Creek (04801A)	Middle Fork Clearwater River	Near mouth
Nikessa Creek (10101A)	Middle Fork Clearwater River	Near mouth

Data Analysis and Assessment

The data were analyzed, and descriptive statistics such as maximum, minimum, median, and mean values for each parameter measured were determined. The number of exceedances was calculated based on the number of sampling events whose respective values exceeded water quality targets or criteria.

The Nez Perce Tribe does not have approved water quality standards, so target criteria for this water quality assessment are based upon a combination of EPA guidelines, literature review, and State of Idaho water quality standards.

The *EPA Ambient Water Quality Criteria Recommendations* set forth nutrient criteria recommendations for rivers and streams by ecoregion. Ecoregions are based on general similarities in geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Three ecoregions are found within the Nez Perce Tribal Reservation boundaries: Northern Rockies, Columbia Plateau, and Blue Mountains. The water quality monitoring sites for this project are found within both the Northern Rockies and Columbia Plateau ecoregion.

The Columbia Plateau ecoregion (10), and more specifically the Nez Perce Prairie sub-ecoregion (10j), is a loess-covered plateau. It is higher, cooler, less hilly, and has shallower soils than the Palouse Hills ecoregion, found on the north side of the Clearwater River divide. Idaho fescue and bluebunch wheatgrass are native. Cropland is now extensive, and farmers grow wheat, barley, peas, and hay. The headwaters of many perennial streams are located in this sub-ecoregion and are impacted by agricultural land use, negatively affecting water quality.

The area of the Reservation that falls within the Northern Rockies ecoregion is broken up into two distinct sub-ecoregions: the Lower Clearwater Canyons and Grassy Potlatch Ridges. The Grassy Potlatch Ridges sub-ecoregion type is a relatively small area on the Reservation and can be found on the north side of the Nez Perce Prairie sub-ecoregion. This area contains many of the headwaters for streams flowing north off the Camas Prairie into the Clearwater River. This sub-ecoregion is underlain by volcanics and

mantled by loess and volcanic ash. Idaho fescue, bluebunch wheatgrass, bluegrass, snowberry, and scattered ponderosa pine occur. Small grain farming, hay operations, and livestock grazing are extensive. The Lower Clearwater Canyons sub-ecoregion is lower in elevation, drier, and warmer than the Grassy Potlatch Ridges sub-ecoregion. Savanna, Douglas-fir/ponderosa pine forest and, in riparian areas, western redcedar/western white pine/grand fir forest occur. Forests are more widespread on canyon bottoms than on slopes (EPA 2000).

Water quality standards and targets address various beneficial uses designated or presumed for specific water bodies, defining the corresponding numeric and narrative physical and chemical limits or criteria needed to support the uses.

All of the waterbodies in this assessment had the designated beneficial uses of:

- Salmonid Spawning (SS)
- Cold Water Aquatic Life (CWAL)
- Primary Contact Recreation (PCR) **The Tribe has designated all water bodies as Primary Contact Recreation (Resolution #NP03-136).*
- Agricultural and industrial water supply
- Wildlife habitat
- Aesthetics

Table 6 shows the first three beneficial uses on the list above, along with some associated numeric criteria used to evaluate the support status of these water bodies.

Table 6. Beneficial use designations and associated criteria.

Parameter	Salmonid Spawning	Cold Water Aquatic Life	Primary Contact Recreation
Bacteria, pH, DO	<p>pH between 6.5 and 9.5</p> <p>Water column: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater</p> <p>Inter-gravel DO: DO exceeds 5 mg/L for a one day minimum and exceeds 6.0</p>	<p>pH between 6.5 and 9.5</p> <p>DO exceeds 6.0 mg/L</p>	<p>Less than 126 <i>E. coli</i> /100 mL as a geomean of five samples over 30 days; no samples greater than 406 <i>E. coli</i>/100 ml</p>

	mg/L for a seven day average		
Temperature	13 °C or less daily maximum; 9 °C less daily average	22 °C or less daily maximum; 19 °C or less daily average	
Turbidity		Turbidity shall not exceed background by more than 50 NTU instantaneously or more than 25 NTU for more than 10 consecutive days	
Ammonia		Ammonia not to exceed calculated concentrations based on pH and temperature	

DO: dissolved oxygen, E. coli: Escherichia coli, NTU: nephelometric turbidity units

All nutrient data gathered during this water quality monitoring project was analyzed using EPA Ecoregion 10 (Columbia Plateau) guidance criteria, as this ecoregion was most reflective of conditions on the ground. Table 7 lists the associated numeric targets.

Table 7. EPA Ambient Water Quality Guidance Criteria.

Ecoregion	Description	Nitrite+Nitrate (NO₂+NO₃ = N mg/L)	Total Phosphorus (mg/L)	TKN (mg/L)
10	Columbia Plateau	0.072	0.03	0.288

Literature suggests that total suspended solids (TSS) levels below 25 mg/L are ideal for the protection of fisheries and at this level there are no harmful effects on fish or fisheries (DFO, 2000). This was the target criterion used in the evaluation of this data.

Table 8 is a summary of all pollutants of concern and the water quality targets used in the evaluation of this data.

Table 8. Pollutant targets used to measure exceedances.

Pollutant of Concern	Pollutant Targets
Temperature	13 °C instantaneous; 9 °C daily average during Salmonid spawning period (August 15 – July 15). 22 °C instantaneous;

	19 °C daily average from July 16 – August 14.
Total Phosphorus	0.03 mg/L
Total Suspended Solids	25 mg/L
NO ₂ +NO ₃	0.072 mg/L
TKN	0.288 mg/L
Dissolved Oxygen	6.0 mg/L
pH	6.5 - 9.0
Bacteria	406 E.coli organisms/100 mL for primary contact recreation

Results and Discussion

Pollutants of Concern and Applicable Criterion/Standards

Dissolved Oxygen

Dissolved Oxygen (DO) is found in microscopic bubbles of oxygen that are mixed in the water and occur between water molecules. DO is a very important indicator of a waterbody's ability to support aquatic life. Fish "breathe" by absorbing dissolved oxygen through their gills. Oxygen enters the water by absorption directly from the atmosphere or via photosynthesis by aquatic plants and algae. Oxygen is removed from the water by respiration and decomposition of organic matter. The State of Idaho standard for DO states that dissolved oxygen must exceed 6.0 mg/L for cold water biota at all times.

Water Temperature

Water temperature is a very important indicator of overall water quality. Many of the physical, biological, and chemical characteristics of a river are directly affected by temperature. For example, temperature influences the following:

- amount of oxygen that can be dissolved in water.
- photosynthetic rate of algae and larger aquatic plants.
- metabolic rates of aquatic organisms.
- sensitivity of organisms to toxic wastes, parasites, and diseases.

Cool water can hold more oxygen than warm water, because gases are more easily dissolved in cool water. The reduction of oxygen solubility at high water temperatures can compound the stress on fish caused by marginal dissolved oxygen concentrations.

The cold water aquatic life (CWAL) criteria for Idaho streams states that water temperatures must be twenty-two degrees Celsius or less with a maximum daily

average of no greater than nineteen degrees Celsius. All of the waterbodies monitored during this project are also listed for Salmonid Spawning (SS), which means that water temperatures must be 13 °C or less with a maximum daily average no greater than 9 °C during salmonid spawning and incubation periods, which is shown in Table 8.

Specific Conductance

Specific Conductance (SC) is a measure of the ability of water to conduct an electrical current. Conductivity increases with increasing concentrations and mobility of dissolved ions. These ions, which come from the breakdown of compounds, conduct electricity because they are negatively or positively charged when dissolved in water. Therefore, SC is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron, and can be used as an indicator of water pollution.

No surface water standards or criteria exist that set limits on SC.

pH

pH represents the effective concentration (activity) of hydrogen ions (H^+) in water. The activity of hydrogen ions can be expressed most conveniently in logarithmic units. pH is defined as the negative logarithm of the activity of H^+ ions:

$pH = -\log [H^+]$,
where $[H^+]$ is the concentration of H^+ ions in moles per liter.

The State of Idaho surface water quality criteria for Aquatic Life Use designations states that Hydrogen Ion Concentration (pH) values must fall within the range of 6.5 and 9.0 (IDAPA 58.01.02.250.01.a).

Total Suspended Solids and Turbidity

Total Suspended Solids (TSS) includes both sediment and organic material suspended in water. Suspended sediment can cause problems for fish by clogging gills. In addition, excessive sediment provides a medium for the accumulation and transport of other constituents such as phosphorus and bacteria. Literature suggests that levels below 25 mg/L are ideal for the protection of fisheries and produce no harmful effects on fish or fisheries (DFO, 2000).

The State of Idaho water quality standard for Turbidity states that measurements shall not exceed background turbidity by more than 50 NTU instantaneously or more than 25 NTU for more than ten consecutive days. The 25th percentile of all turbidity data

collected by EPA over the last decade was 1.45 NTU. So, for the sake of this analysis, any reading over 51.45 NTU will be considered an exceedance over background turbidity levels.

Nitrite+Nitrate (NO₂+NO₃), Total Kjeldahl Nitrogen (TKN), and Ammonia (TAN)

Nitrate (NO₃), Nitrite (NO₂), and Ammonia (NH₃) are considered inorganic forms of nitrogen. Excessive concentrations of nitrate and/or nitrite can be harmful to humans and wildlife. The EPA Ecoregion guidance criterion for NO₂ + NO₃ is 0.072 mg/L.

High concentrations of nitrate and/or nitrite can produce "brown blood disease" in fish. Nitrite enters the bloodstream through the gills and turns the blood a chocolate-brown color. As in humans, nitrite reacts with hemoglobin to form methemoglobin. Brown blood cannot carry sufficient amounts of oxygen, and affected fish can suffocate despite adequate oxygen concentration in the water. This accounts for the gasping behavior often observed in fish with brown blood disease, even when oxygen levels are relatively high (Mississippi State University, 1998).

Ammonia is the least stable form of nitrogen in water. Ammonia concentrations can affect hatching and growth rates of fish; changes in tissues of gills, liver, and kidneys may occur during structural development.

Total Kjeldahl nitrogen (TKN) is the sum of organically bound nitrogen and ammonia in water. High measurements of TKN typically result from sewage and manure discharges to water bodies. The EPA Ecoregion guidance criterion for TKN is 0.288 mg/L.

Phosphorus

In freshwater lakes and rivers, phosphorus is often found to be the growth-limiting nutrient, because it occurs in the least amount relative to the needs of plants. If excessive amounts of phosphorus and nitrogen are added to the water, algae and aquatic plants can be produced in large quantities. When these algae die, bacteria decompose them and use up oxygen. As a result, dissolved oxygen concentrations can drop too low for fish to breathe; leading to fish kills. The loss of oxygen in the bottom waters can free phosphorus previously trapped in the sediments, further increasing the available phosphorus.

Phosphorus sources exist in both inorganic and organic forms. Some important sources of TP include commercial fertilizers and manure, land application of biosolids, wastewater treatment plants (WWTP), livestock grazing, non-agricultural fertilization, and septic systems. Over time, excess phosphorus input causes a phosphorus surplus, which accumulates in soil and is mobilized when erosion occurs.

The EPA Ecoregion guidance criterion for phosphorus is 0.03 mg/L.

Bacteria (*E. coli*)

The coliform bacteria group consists of several genera of bacteria belonging to the family *Enterobacteriaceae*. These mostly harmless bacteria live in soil, water, and the digestive system of animals. *Escherichia coli* (*E. coli*) is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination.

The State of Idaho *E. coli* standard for primary contact is not to exceed 406 organisms/100 mL at any time and not to exceed 576 organisms/100 mL at any time for secondary contact (IDAPA 58.01.02.251.02.a); however, a single exceedance over the criterion does not constitute a violation of water quality standards (IDAPA 58.01.02.080.03). Five samples must be taken within a 30-day period to assess against the geometric mean criterion of 126 cfu/100 ml to determine a violation.

An assessment of the geometric mean criterion was not conducted during this study due to time considerations and limited resources. However, the instantaneous measurements that were collected will allow for identification of streams where follow-up monitoring should occur. All streams on the Nez Perce Reservation will be evaluated using the primary contact recreation criterion of 406 organisms/100mL.

Subwatershed Analysis

Cottonwood Creek Watershed:

Pickle Canyon Creek (05903A), Coyote Creek (01801A), and Magpie Creek (04901A)

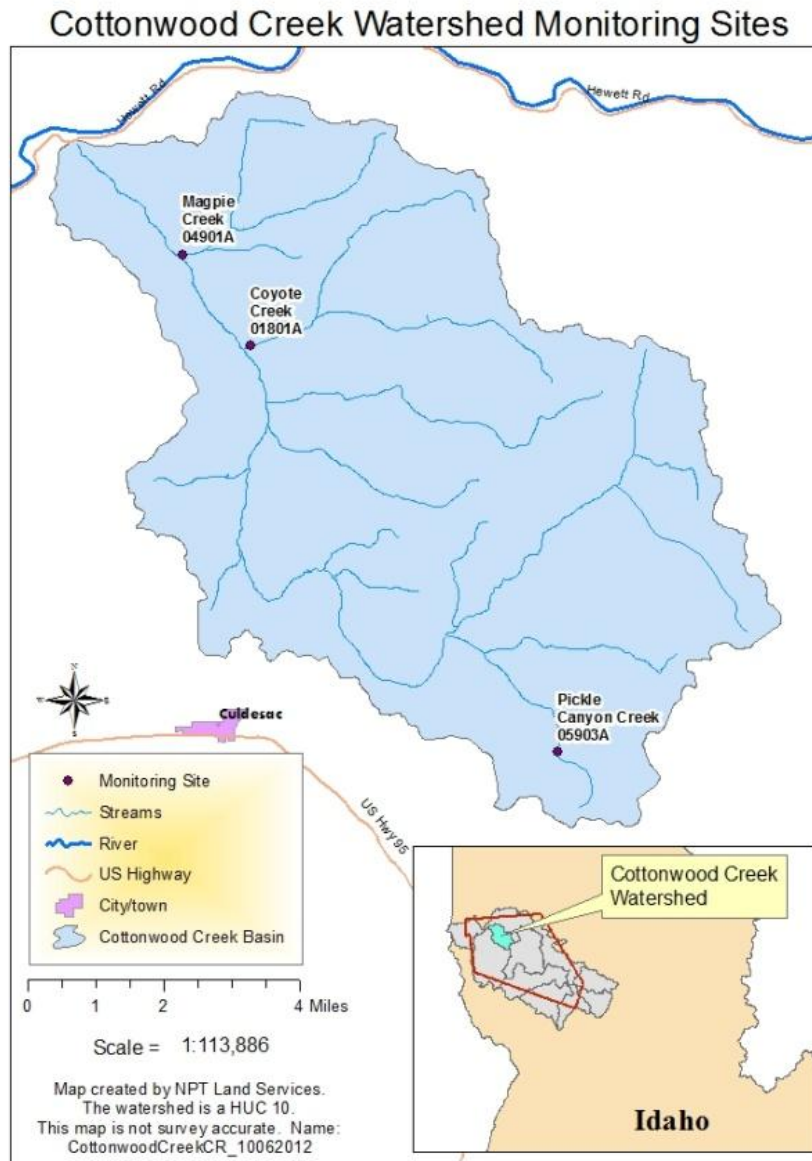


Figure 2. Cottonwood Creek Monitoring Sites, 2010-2011.

The Cottonwood Creek Watershed (42,080 acres) is located in Nez Perce County and is entirely within the Nez Perce Reservation. The creek flows predominantly north for 16 miles before discharging into the Clearwater River near the town of Myrtle. Two perennial tributaries, Magpie Creek and Coyote Creek are located in the lower reaches. The mainstem of Cottonwood Creek flows mostly sub-surface during the hot summer months, beginning at stream mile 4.8, but maintains small stretches of surface water and isolated pools in the canyon areas upstream. The watershed is composed of upland plateau and steep canyon habitat, with elevations ranging from 853 feet at the confluence with the Clearwater River to 3,642 feet in the uplands. Evidence of frequent high flows and flooding are evident from river mile 6 to river mile 9.

The dominant land use in Cottonwood Creek watershed is agriculture (69% cropland), with areas of meadow/pastureland (20%) and coniferous forest lands (5%). The community of Gifford is located in the upper watershed.

The watershed contains steelhead/rainbow trout, Coho salmon, speckled dace, Paiute sculpin, Bridgelip sucker, Northern pike minnow, and Chiselmouth. Kucera (1983) found substantial numbers of steelhead/rainbow trout and sufficient quantities of spawning gravels. In addition, Fuller (1984) noted presence of cutthroat trout, redband shiner, and numerous crayfish. Nez Perce Tribal Fisheries staff has observed Coho salmon as well (Chandler 2012).

Early studies indicate that water quality in Cottonwood Creek is limited by extreme annual stream flow variation, low summer flow, and high in-stream temperatures (Kucera 1983). Cottonwood Creek was listed on the State of Idaho's 1998 303(d) list for bacteria, dissolved oxygen (DO), flow alteration, habitat alteration, ammonia, nutrients, organics, and sediment.

Three monitoring stations were established within the Cottonwood Creek watershed, one near the mouth of Coyote Creek (01801A), one near the mouth of Magpie Creek (04901A), and one on Pickle Canyon Creek (05903A), a small tributary in the headwaters of the watershed.

Tables 9, 10, and 11 present descriptive statistics for Pickle Canyon Creek, Coyote Creek, and Magpie Creek, respectively.

2010-2011 Pickle Canyon Creek (#05903A) Data Summary:



Figure 3. Pickle Canyon Creek monitoring site (05903A), 2010-2011.

Table 9. Descriptive statistics for Pickle Canyon Creek monitoring site #05903A (near confluence with Star Mill Creek), 2010-2011.

Pickle Canyon (05903A)	Temp (°C)	D.O. (mg/L)	pH (H+)	Turbidity (NTU)	E-Coli (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Flow (cfs)
Maximum	7.95	15.33	6.76	23.9	51.2	8.24	0.06	0.13	0.42	2	5.24
Minimum	1.01	9.37	5.36	5.92	2	0.22	0.04	0.06	0.14	0.5	0.01
Mean	4.03	12.46	5.94	17.204	21.4	1.964	0.05	0.09	0.298	1.5	2.035
Median	3.22	12.77	5.88	19.1	11	0.51	0.05	0.09	0.31	2	1.445
# exceedance	0.0	0.0	4.0	0	0	5	5.0	5.00	3	0	
% exceedance	0.0%	0.0%	80.0%	0.0%	0.0%	100.0%	100.0%	100.0%	60.0%	0.0%	
# sampling events	5	5	5	5	3	5	5	5	5	5	4

- Lack of consistent streamflow during summer months and lack of winter access due to heavy snowfall limited monitoring at this site (n=5).
- pH levels were lower than the criteria at this site 80% of the time (<6.5). While there is no definitive explanation for these low readings, site location may have something to do with them. This site was established in a heavily forested canyon, near the mouth of Pickle Canyon Creek. Decomposing pine and fir needles can add to the acidity of soils and potentially influence the acidity of streams.
- Nitrogen levels were very high in this creek, with a maximum nitrate-nitrite reading of 8.24 mg/L, in December 2010. This spike in December was likely due to a rain-on-snow event that washed fertilizer from adjacent farm fields. The

remaining four samples averaged 0.4 mg/L, which also exceeded the 0.072mg/L Ecoregion guidance criterion.

- Total phosphorus exceeded the 0.03 mg/L guidance criteria 100% of the time (n=5). There is no correlation between nutrient levels and flow rates shown in the data.

2010-2011 Coyote Creek (#01801A) Data Summary:



Figure 4. Coyote Creek monitoring site (01801A), 2010-2011.

Table 10. Descriptive statistics for Coyote Creek monitoring site #01801A (near mouth), 2010-2011.

Coyote Creek (01801A)	Temp	D.O.	pH	Turbidity	E-Coli	NO ₂ +NO ₃	OP	TP	TKN	TSS
	(°C)	(mg/L)	(H+)	(NTU)	(coli/100mL)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)
Maximum	16.69	13.51	8.38	180.00	2419.60	11.70	0.14	0.6	1.56	144.00
Minimum	4.07	9.4	7.17	2.11	0.50	0.45	0.08	0.111	0.19	1.00
Mean	9.23	11.492	7.79	37.83	511.63	5.17	0.11	0.2458	0.52	35.33
Median	7.54	11.59	7.86	14.55	38.40	3.74	0.11	0.1905	0.43	11.50
# exceedance	3.0	0	0.0	3.0	3.0	12.0	12.0	12	9.0	3.00
% exceedance	25.0%	0	0.0%	25.0%	27.3%	100.0%	100.0%	100.0%	75.0%	25.0%
# sampling events	12	12	12	12	11.0	12.0	12.0	12	12.0	12.00

- Three exceedances of the temperature criteria occurred in June, August and September of 2011 (n=12) (Figure 2).
- Nitrogen levels were very high in this creek, with a maximum nitrate-nitrite reading of 11.70 mg/L, on January 18, 2011. Levels were elevated throughout

the winter months, with the average being 10.08 mg/L for December through February. This spike in winter nitrogen levels was observed at every site in this watershed, to varying degrees, and is likely the result of fertilizer applied in fall months being delivered to the streams during rain-on-snow events. Every sample collected at this site exceeded the 0.072 mg/L target criterion (n=12).

- Total phosphorus (TP) also exceeded the 0.03mg/L guidance criterion 100% of the time (n=12). Much of the phosphorus in this stream is in the dissolved form (OP), with an average OP to TP ratio of 0.68 during the months of October 2010 – February 2011 and June 2011 – September 2011. During the higher flow periods of March – May 2011, the ratio of OP to TP decreased. This soluble form of phosphorus is more readily available for biological uptake and can lead to excessive algal growth in streams. Figure 3 shows the ratio of OP to TP as it relates to streamflow. Figure 4 graphically illustrates NO₂+NO₃, TP and streamflow for Coyote Creek.
- The 25 mg/L target criterion for sediment was exceeded three times during this study. Two of the exceedances, in January and February, appear to be related to high flow events. One exceedance occurred during a period of relatively low flow, in May, and appears to have been caused by cattle accessing the stream. Elevated levels of *E. coli* were also observed during this period of time, with two of the three *E. coli* exceedances that were documented occurring in May and June 2011.

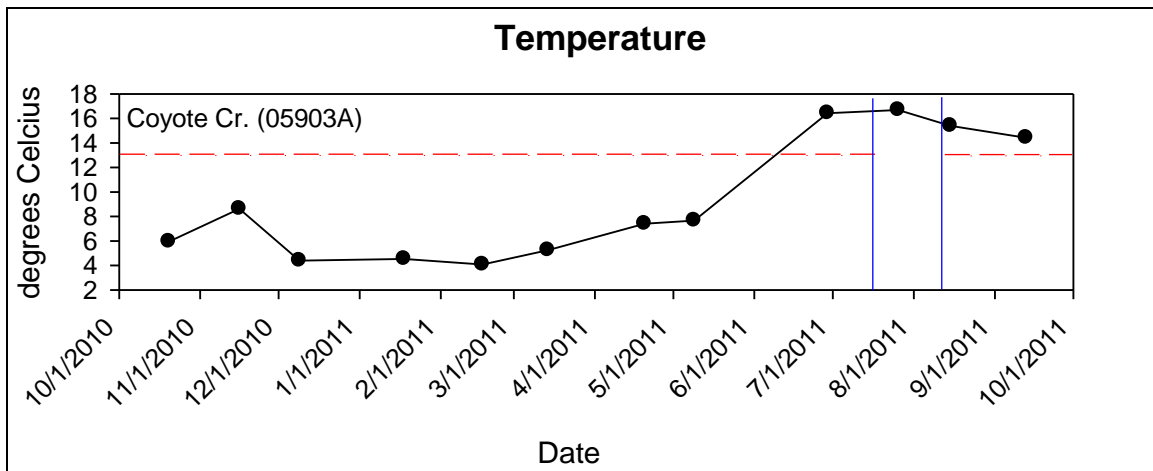


Figure 5. Instantaneous water temperatures @ Coyote Creek (#05903A), 2010-2011. The blue line delineates the period of the year deemed critical to salmonid spawning and incubation (July 16 – Aug. 14). The dashed red lines represent the 13°C and 22°C targets, as they apply.

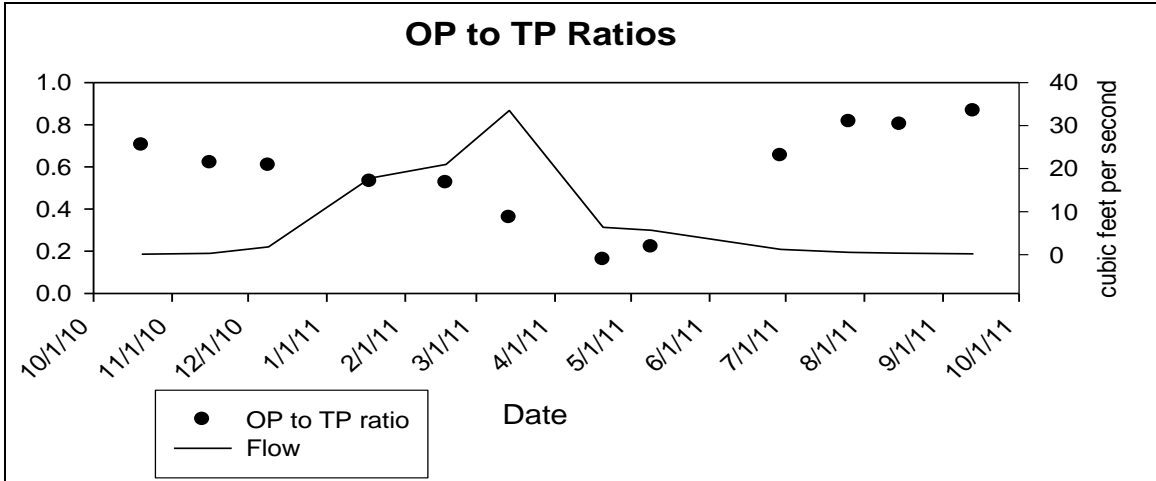


Figure 6. OP to TP ratios as related to streamflow.

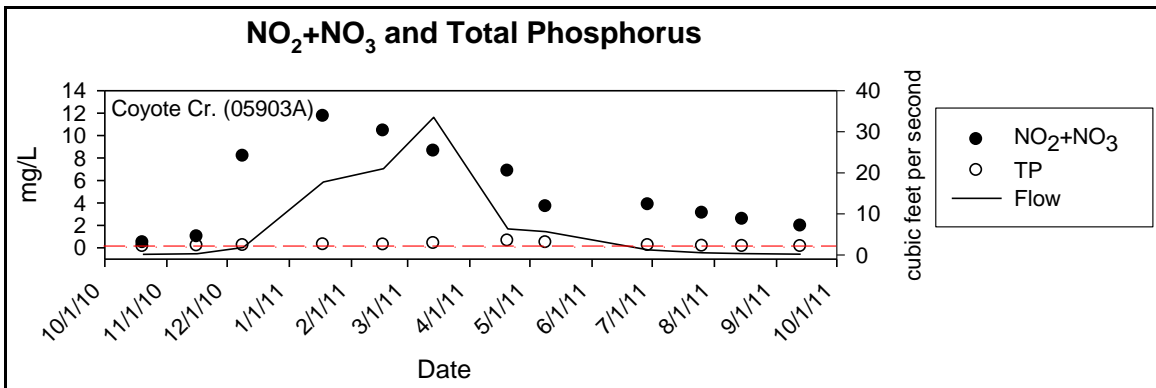


Figure 7. NO₂+NO₃ and TP data collected at Coyote Cr. (05903A), 2010-2011. The dashed red line illustrates the guidance criteria of 0.072 mg/L and 0.03 mg/L for NO₂+NO₃ and TP, respectively.

2010-2011 Magpie Creek (#04901A) Data Summary:



Figure 8. Magpie Creek monitoring site (04901A), 2010-2011.

Table 11. Descriptive statistics for Magpie Creek monitoring site #04901A (near mouth), 2010-2011.

Magpie Creek (04901A)	Temp	D.O.	pH	Turbidity	E-Coli	NO ₂ +NO ₃	OP	TP	TKN	TSS	Flow
	(°C)	(mg/L)	(H+)	(NTU)	(coli/100mL)	(mg/L)	mg/L	(mg/L)	(mg/L)	(mg/L)	(cfs)
Maximum	14.92	13.33	8.06	89.00	1553.10	16.60	0.28	0.45	1.07	185.00	6.37
Minimum	5.08	9.76	7.56	5.87	1.00	3.56	0.15	0.18	0.23	3.00	0.01
Mean	9.35	11.52	7.84	36.41	433.34	9.16	0.20	0.29	0.56	61.67	2.14
Median	8.59	11.44	7.89	28.40	307.60	7.38	0.20	0.29	0.54	51.50	1.09
# exceedance	2.0	0.0	0.0	4.0	4.00	12.0	12.0	12.0	10.0	9.0	
% exceedance	16.7%	0.0%	0.0%	33.3%	36.4%	100.0%	100.0%	100.0%	83.3%	75.0%	
# sampling events	12	11	12	12	11	12	12	12	12	12	12

- Two exceedances of the temperature criteria occurred, in June and August 2011 (n=12).
- Nitrogen levels were very high in this creek, with a maximum nitrate-nitrite reading of 16.6 mg/L, on March 14, 2011. The highest levels were observed from January to May, but every sample was well above the 0.072 guidance criterion (n=12).
- Total phosphorus also exceeded the 0.03mg/L guidance criterion 100% of the time (n=12). Much of the phosphorus in this stream is organic in nature, with an overall OP to TP ratio of 0.72. This was consistent throughout the duration of the monitoring project, with no noticeable seasonal variation. Figure 5 graphically illustrates NO₂+NO₃, Total Phosphorus and streamflow for Magpie Creek.

- The 25 mg/L target criterion for sediment was exceeded nine times during this study. The two highest measurements occurred during the two highest flows measured, but flows were relatively low throughout the monitoring period, with a high flow of 6.37 cfs on 3/14/11. Livestock use is very limited in this drainage, so elevated sediment levels are likely a result of the intensive agricultural practices that are common in the headwaters of this stream.
- Four exceedances of *E. coli* criterion occurred during this study. No seasonal pattern was observed and, due to the lack of livestock use, it seems likely that the elevated bacteria levels are attributable either to wildlife or septic systems from several houses located within this drainage.

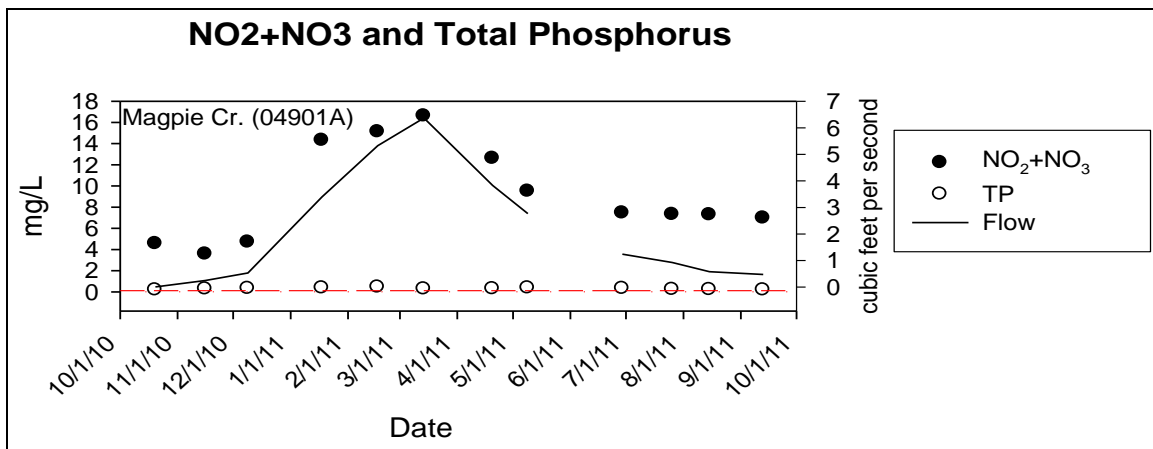


Figure 9. NO₂+NO₃ and TP data collected at Magpie Cr. (04901A), 2010-2011. The dashed red line illustrates the guidance criteria of 0.072 mg/L and 0.03 mg/L for NO₂+NO₃ and TP, respectively.

**Bedrock Creek Watershed:
Louse Creek (04702A & 04706A)**

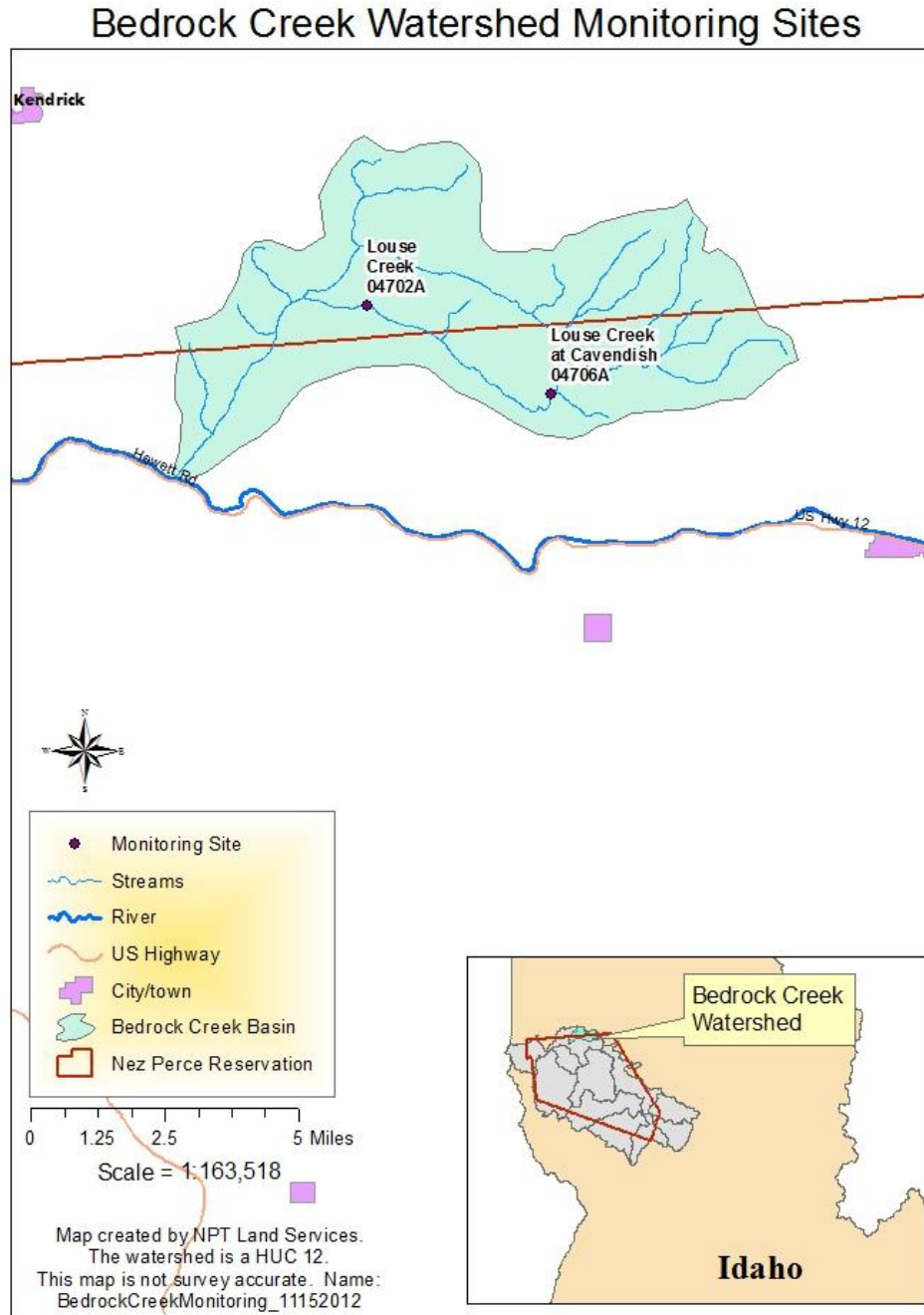


Figure 10. Bedrock Creek Monitoring Sites, 2010-2011.

Bedrock Creek watershed (24,650 acres) is located in Nez Perce and Clearwater counties, with the lower half of the watershed entirely within the Nez Perce Reservation. The stream is a third order tributary to the Clearwater River, flowing south-westerly to the confluence, 10 miles upstream of the junction of State Highway 3 and US Highway 12 (River Mile 20). Bedrock Creek is approximately 12.69 miles in length with the lower three miles located on the Reservation. The watershed contains rolling plateau and steep canyon. Elevations range from 4,140 feet at Teaken Butte to 870 feet at the confluence with the Clearwater River.

Louse Creek (10,479 acre watershed) is 5.2 miles in length and a major tributary to Bedrock Creek. In the upper four miles Louse Creek flows through relatively flat agricultural lands, then it plunges into a steep canyon for approximately one mile, before entering Bedrock Creek. Several other first- and second-order streams, one to three miles in length, drain the plateau and flow into mainstem Bedrock Creek.

Early studies have shown that Bedrock Creek is water quality limited by sediment, nutrients, flow reduction, and high temperatures. High instream temperatures were attributed to the loss of riparian areas and increased suspended sediments. Excess nitrogen and phosphorus were also shown to impact water quality, with the largest loads related to spring runoff (IDHW 1986). Kucera et al. (1983) noted that riparian vegetation in the lower section of Bedrock Creek was sparse, and a lack of instream cover coupled with high annual stream flow variation, and elevated temperatures may be limiting anadromous fish production. The highest temperatures occurred at the mouth.

The dominant land use in Bedrock Creek watershed is crops (63%), with the remaining acres used for timber (26%), and pasture (7%). In Louse Creek, the dominant land use in the upper watershed is dryland farming (approximately 5,600 acres or 70%) with the remaining acres used for range and timber (30%). The small community of Cavendish is located in the upper watershed.

Bedrock Creek has been identified as the second-most important Clearwater River spawning tributary for steelhead, salmon, and trout. Bedrock Creek also supports a wild population of steelhead (USDA 1992).

Bedrock Creek is listed on the 1998 303(d) list for sediment and nutrients from the Reservation boundary to the mouth and bacteria, dissolved oxygen, habitat alteration, flow alteration, ammonia, nutrients, sediment, temperature, and organic/synthetic pollutants from the Reservation boundary to the headwaters.

One monitoring station was established on Louse Creek, at the point where it drops into the steep canyon (04702A). It was quickly ascertained that this site was inaccessible

during inclement weather, so the site was relocated to a more accessible location higher in the watershed (04706A). Since no significant tributaries enter Louse Creek between these two sites, the single data point collected from site #04702A was merged with the remaining data collected from the upstream site (#04706A).

Table 12 presents descriptive statistics for Louse Creek.

2010-2011 Louse Creek (#04706A) Data Summary:



Figure 11. Louse Creek monitoring site (04706A), 2010-2011.

Table 12. Descriptive statistics for Louse Creek monitoring site #04706A, 2010-2011.

Louse Creek (04706A)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	E-Coli (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	15.08	12.96	7.25	38.30	1119.90	5.94	0.09	0.17	0.60	18.00	93.19
Minimum	-0.64	7.68	5.54	1.21	2.00	0.01	0.02	0.05	0.10	1.00	0.05
Mean	6.56	11.14	6.48	19.86	222.87	1.76	0.05	0.09	0.37	7.75	23.81
Median	6.66	11.56	6.56	19.90	62.40	1.13	0.04	0.08	0.37	7.50	7.92
# exceedance	1.0	0.0	2.0	0.0	1.00	7.0	6.0	8.0	5.0	0.0	
% exceedance	12.5%	0.0%	25.0%	0.0%	14.3%	87.5%	75.0%	100.0%	62.5%	0.0%	
# sampling events	8	8	8	9	7	8	8	8	8	8	7

- Lack of consistent streamflow during summer months limited monitoring at this site (n=8). The stream had no surface flow from July until September, 2011, when this monitoring project concluded.
- pH levels were lower than the 6.5 criterion at this site on January 20, 2011 and March 31, 2011. The cause of these low readings is unknown.

- Nitrogen levels were elevated in this creek, with a maximum nitrate-nitrite reading of 5.94 mg/L, in December, 2010. Seven of the eight samples exceeded the 0.072 mg/L guidance criterion.
- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=8). There is no correlation between nutrient levels and flow rates shown in the data.
- Sediment and turbidity levels were quite low at this site, with the highest TSS measurement of 18 mg/L occurring during the highest measured streamflow event of 93.19 cfs.
- *E. coli* levels were quite low at this site, aside from a single sample collected 6/28/11, which had 1,119.9 *E. coli*/100mL. There was very little flow in the creek on this day and large, stagnant pools were observed upstream of the sampling location, which may account for the single *E. coli* exceedance.

**Lapwai Creek Watershed:
Rock Creek (06601A) & Garden Gulch Creek (02701A)**

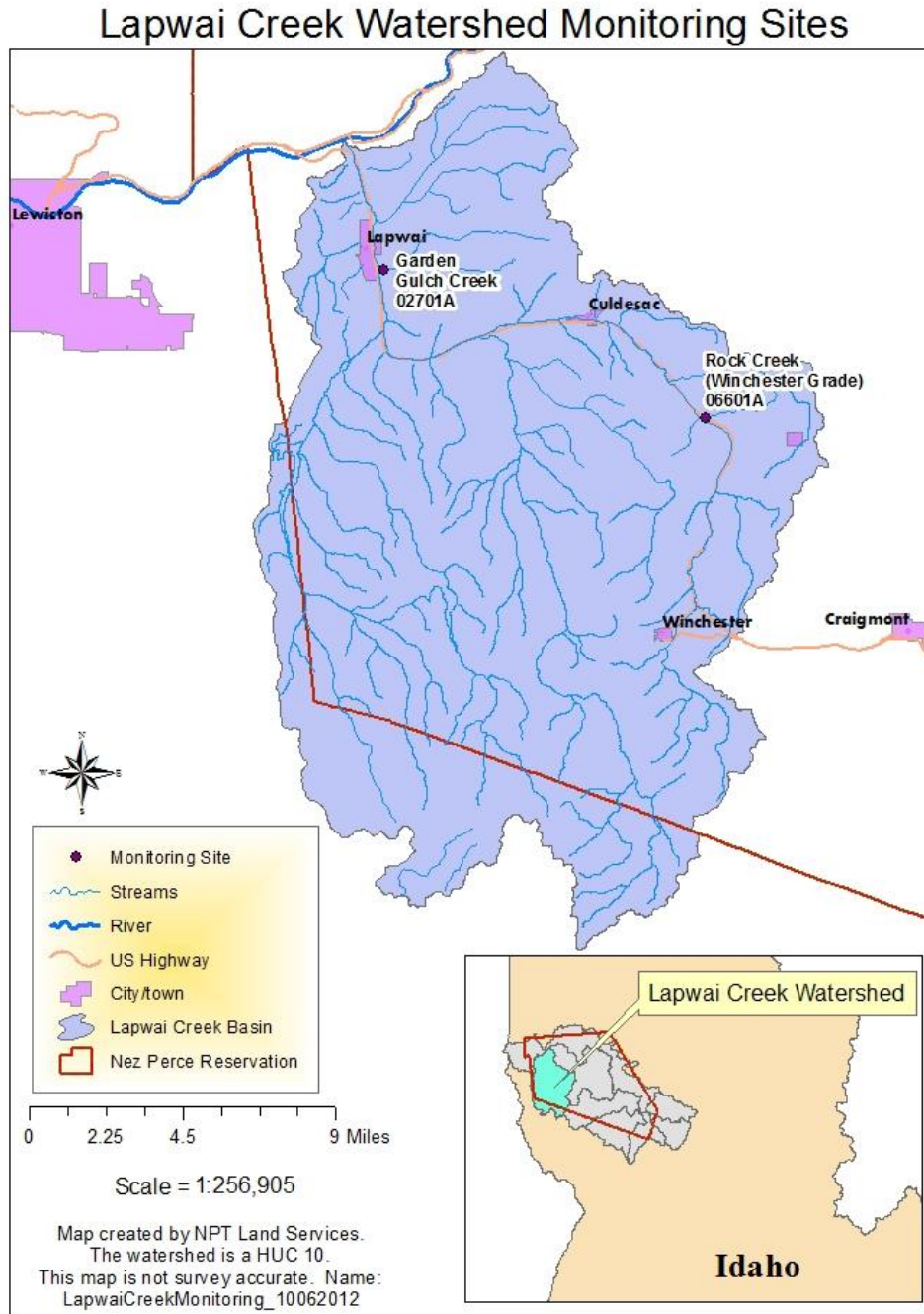


Figure 12. Lapwai Creek monitoring sites, 2010-2011.

Lapwai Creek Watershed (171,000 acres) is located almost entirely within the Nez Perce Reservation and in Nez Perce County, with portions of the headwaters located in Lewis County. Major tributaries include: Tom Beall Creek, Sweetwater Creek, Webb Creek, and Mission Creek. Lapwai Creek is a 4th order tributary, flowing 31 miles in a northwesterly direction to its confluence with the Clearwater River at the town of Spaulding. The headwaters of Lapwai Creek flow approximately 5.5 miles before being impounded in Winchester Lake at the town of Winchester. A TMDL was completed for the upper portion of Lapwai Creek and Winchester Lake in 1999. Elevations within the watershed range from 800 feet near the mouth to 4,800 feet in the headwaters of Sweetwater and Webb Creek. The communities of Spalding, Lapwai, Sweetwater, Culdesac, Winchester, Reubens, and Slickpoo are located in the Lapwai Watershed.

Land use in Lapwai Creek Watershed is approximately 40% non-irrigated crop land; 32% coniferous forest, and 19 % meadow/pastureland. Early studies have shown water quality impacts to Lapwai Creek from sediment, nutrients, bacteria, and high summer water temperatures. Mission Creek, Webb Creek, and Sweetwater Creek had low summer flows, high summer in-stream temperatures, low in-stream cover, and high siltation (Kucera 1983). Kucera also observed that Lapwai Creek provided poor to marginal habitat for anadromous fish. Tom Beall Creek contributed the highest nonpoint source pollutants (sediment and nutrients) relative to its size. In a study conducted by Latham (1986), most sediment and nutrient loading was event related, occurring during thunderstorms and rain-on-snow events. Lapwai Creek hydrology has been altered and floodplain access limited by flood control structures, and highway and railroad prisms. Nonpoint sources of pollutants include agriculture, grazing, forestry activities, and urban impacts (stormwater runoff, failing septic tanks, etc...).

Lapwai Creek is 303(d) listed on the 1998 list for bacteria, dissolved oxygen (DO), flow alteration, habitat alteration, ammonia, oil and grease, nutrients, sediment, and temperature.

For this monitoring effort, two monitoring sites were established at the mouths of previously unassessed streams in the Lapwai Creek watershed. One monitoring station was established on Rock Creek (#06601A), which is a small tributary that enters Lapwai Creek in the steep canyon found immediately below Winchester Lake. A second monitoring site was established at Garden Gulch Creek (#02701A), located near the town of Lapwai, in the lower section of the Lapwai Creek watershed.

Tables 13 and 14 present descriptive statistics for Rock Creek and Garden Gulch Creek, respectively.

2010-2011 Rock Creek (#06601A) Data Summary:



Figure 13. Rock Creek monitoring site (06601A), 2010-2011.

Table 13. Descriptive statistics for Rock Creek monitoring site #06601A, 2010-2011.

Rock Creek (06601A)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	E-Coli (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	12.01	13.95	7.69	85.50	290.90	8.23	0.13	0.29	0.68	67.00	36.08
Minimum	1.03	8.82	4.39	2.80	0.50	0.14	0.07	0.09	0.10	0.05	0.02
Mean	7.19	11.16	6.69	19.25	76.29	2.31	0.09	0.14	0.34	9.34	6.32
Median	7.75	10.94	7.08	10.31	34.50	0.77	0.08	0.12	0.28	4.00	0.39
# exceedance	0.0	0.0	5.0	1.0	0.00	12.0	12.0	12.0	6.0	1.0	
% exceedance	0.0%	0.0%	38.5%	8.3%	0.0%	100.0%	100.0%	100.0%	50.0%	8.3%	
# sampling events	13	11	13	12	11	12	12	12	12	12	11

- Streamflow was consistent year-round, although extensive populations of Reed canarygrass at the monitoring site made flow measurement difficult.
- pH levels were below the 6.5 criterion five times at this site. The low measurements were observed from January to June 2011, with the February measurement being the only one during that period to be within an acceptable range. The cause of these low readings is unknown at this time, and there is no clear correlation with any other parameter.
- Nitrogen levels were elevated in this creek, with a maximum nitrate-nitrite reading of 8.23 mg/L, on January 18, 2011. All 12 samples exceeded the 0.072 mg/L guidance criterion.
- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=12). There was a relatively significant correlation between TP levels and

discharge rates at this site (0.84 Pearson correlation coefficient). This was the only site where a statistically significant correlation between these two parameters was observed.

- Sediment and turbidity levels were quite low at this site, with the highest TSS measurement of 18 mg/L occurring during the highest measured streamflow event of 93.19 cfs. The lower reaches of this subwatershed is heavily forested canyon land, owned by the Tribe. Although sediment levels are known to be elevated in the agriculturally dominated upper reaches of the Rock Creek subwatershed, it appears that much of this sediment drops out of suspension in the canyon reach, before being delivered to Lapwai Creek.
- *E. coli* levels were low at this site, with no exceedances observed (n=11).
- No temperature exceedances were observed at this site.

2010-2011 Garden Gulch Creek (#02701A) Data Summary:



Figure 14. Garden Gulch Creek monitoring site (02701A), 2010-2011.

Table 14. Descriptive statistics for Garden Gulch Creek monitoring site #02701A, 2010-2011.

Garden Gulch Creek (02701A)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	<i>E-Coli</i> (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	18.18	12.43	8.10	677.00	2419.60	16.30	0.31	1.60	6.40	868.00	6.73
Minimum	5.90	8.62	6.74	0.91	2.00	4.33	0.18	0.19	0.10	1.00	0.06
Mean	10.36	10.51	7.60	69.57	303.74	8.32	0.23	0.42	1.14	91.67	2.51
Median	9.69	10.36	7.62	10.09	37.30	6.27	0.23	0.34	0.48	17.50	1.11
# exceedance	1.0	0.0	0.0	1.0	2.00	12.0	12.0	12.0	10.0	5.0	
% exceedance	8.3%	0.0%	0.0%	8.3%	18.2%	100.0%	100.0%	100.0%	83.3%	41.7%	
# sampling events	12	11	12	12	11	12	12	12	12	12	11

- Streamflow was consistent year-round, although extensive populations of Reed canarygrass at the monitoring site made flow measurement difficult.
- pH levels were within acceptable limits.
- Nitrogen levels were elevated in this creek, with a maximum nitrate-nitrite reading of 16.30 mg/L, on March 14, 2011. All 12 samples were well above the 0.072 mg/L guidance criterion. Figure 6 illustrates the seasonal fluctuation of nitrate-nitrite, as well as the correlation with streamflow (0.91 Pearson correlation coefficient).
- TKN levels were also much higher at this monitoring site than at any other. TKN is the organic nitrogen plus ammonia. When added to NO₂+NO₃, this represents total nitrogen (TN). Ammonia levels were very low at this site and were subtracted from the TKN results, so that the organic nitrogen could be assessed independently. The organic number was then divided by the TN number, to give a ratio of organic to total nitrogen. Figure 7 shows this ratio throughout the monitoring year. The spike in the organic portion observed during May and June 2011 may be due to livestock use or septic systems in this subwatershed.
- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=12). There is no correlation between TP and discharge at this site.
- Sediment and turbidity levels were generally low at this site, with the exception of one event on May 9, 2011, when a TSS level of 868 mg/L and a turbidity level of 677 NTU was documented. Streamflow discharge rate was relatively low during this event (4.49 cfs), so it seems likely that these high numbers were either a result of activities occurring immediately upstream of the monitoring site, or from sample contamination by the field crew. Field notes do not indicate any source of the sediment.
- Two exceedances of the *E. coli* criterion occurred in February, 2010 and June, 2011 (n=11). Livestock and septic systems are common in this drainage.

- One exceedance of the 13 °C temperature criterion for Salmonid Spawning was documented on June 29, 2011.

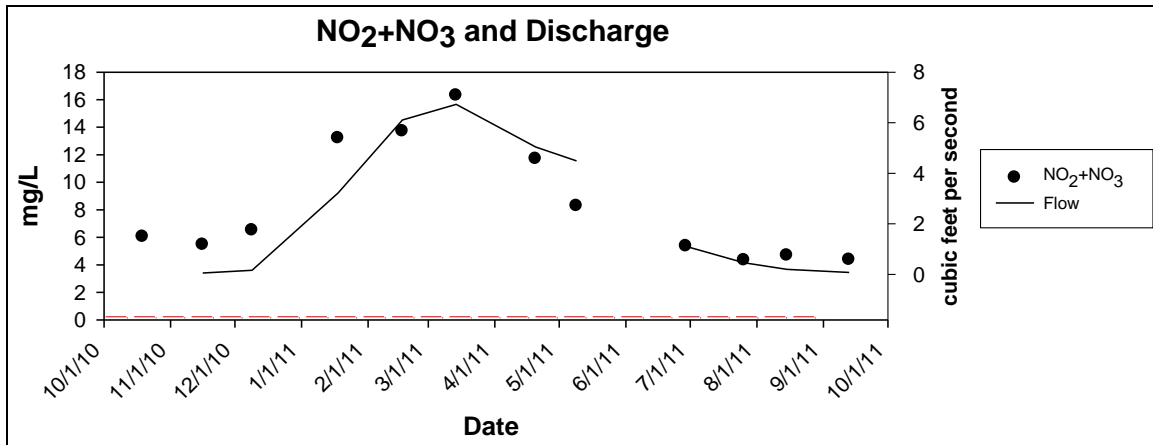


Figure 15. NO₂+NO₃ and Discharge at Garden Gulch Creek monitoring site, 2010-2011. The dashed red line illustrates the guidance criteria of 0.072 mg/L NO₂+NO₃ and TP.

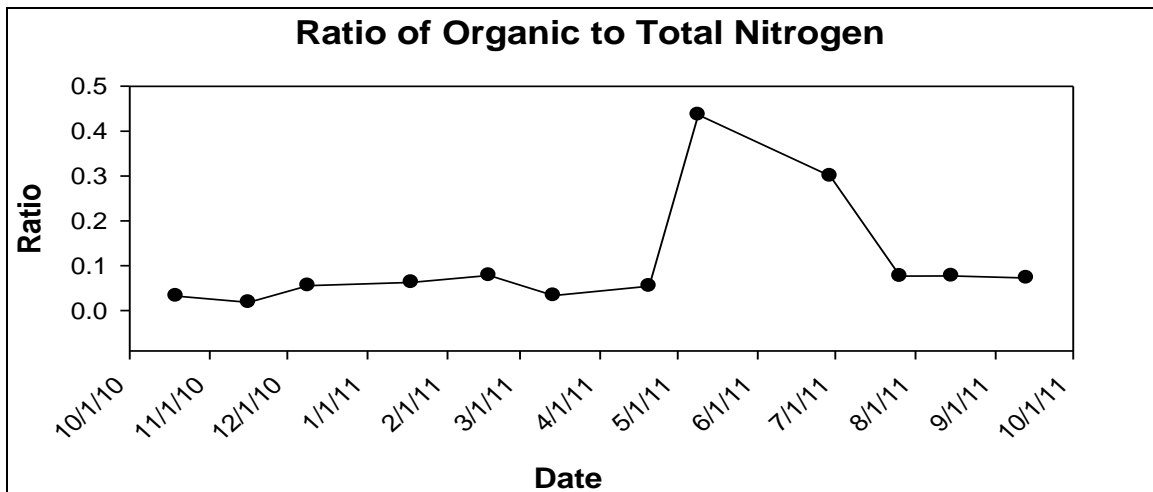


Figure 16. Ratio of organic to total nitrogen. Mouth of Garden Gulch Creek, 2010-2011.

Clear Creek Watershed: Leitch Creek (04001A) & Clear Creek (01001A)

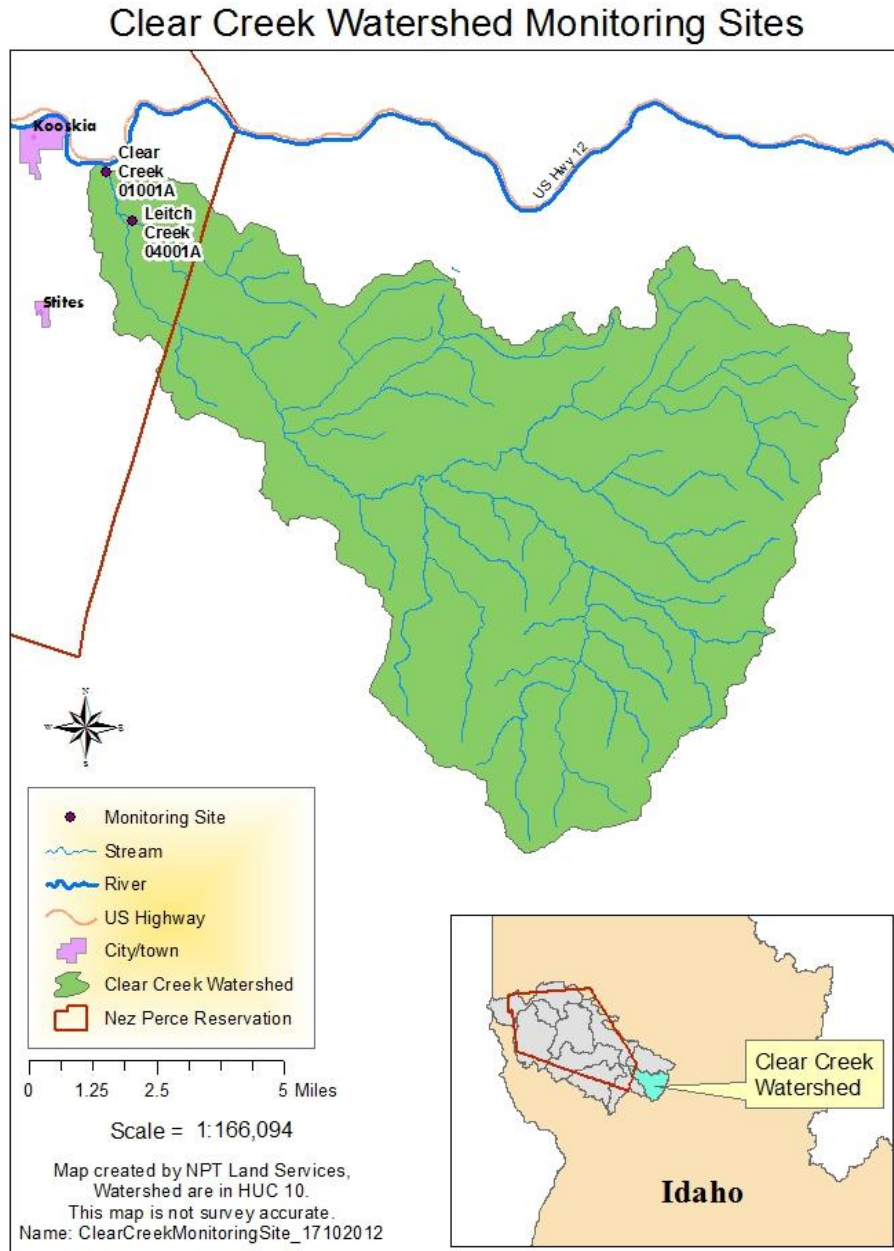


Figure 17. Clear Creek monitoring sites, 2010-2011.

Clear Creek watershed (65,017 acres) is located in Idaho County. Major tributaries include: Leitch Creek, Little Cedar Creek, and Big Cedar Creek, which all flow into the lower eight miles of Clear Creek. Clear Creek flows in a northwesterly direction from its source on Lookout Butte to its confluence with the Middle Fork Clearwater River, just east of the city of Kooskia, ID. The lower four miles of Clear Creek flow through the Nez Perce Reservation. Elevations within the watershed range from 1,260 feet near the mouth to 6,610 feet in the headwaters.

The Clear Creek Watershed is approximately 75% forested, with much of it being very steep, mountainous terrain. Logging and livestock grazing are the primary land uses within the upper part of the drainage, while suburban homesteads and hobby farms are common in the lower reaches. The impacts of overgrazing are evident in much of the lower watershed. A road also parallels the lower eight miles of Clear Creek.

The US Fish and Wildlife Service operates the Kooskia National Fish Hatchery, which rears spring Chinook salmon for release into Clear Creek, and subsequently into the Clearwater River. The impacts of overgrazing are evident in much of the lower watershed. Early studies have shown Clear Creek water quality impacts from sediment, low nitrate levels, and low flows.

Clear Creek is listed in Category 3 of the State of Idaho's 2010 Integrated report as "Unassessed" (IDEQ, 2010).

For this monitoring effort two monitoring sites were established, one near the mouth of Clear Creek (#01001A) and one near the mouth of Leitch Creek (#04001A), a small, previously unassessed tributary that enters Clear Creek approximately one mile from its confluence with the Middle Fork Clearwater River.

Tables 15 and 16 present descriptive statistics for Leitch Creek and Clear Creek, respectively.

2010-2011 Leitch Creek (#04001A) Data Summary:



Figure 18. Leitch Creek monitoring site (04001A), 2010-2011.

Table 15. Descriptive statistics for Leitch Creek monitoring site #04001A, 2010-2011.

Leitch Creek (04001A)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	<i>E-Coli</i> (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	16.06	13.81	7.85	43.20	165.80	1.73	0.09	0.15	0.40	13.00	23.93
Minimum	3.17	9.95	6.66	4.40	4.10	0.04	0.06	0.09	0.14	1.00	0.28
Mean	7.22	11.82	7.23	22.27	35.72	0.87	0.07	0.12	0.27	5.25	9.95
Median	6.54	11.63	7.16	22.65	11.60	0.88	0.07	0.11	0.27	5.00	9.19
# exceedance	1.0	0.0	0.0	0.0	0.00	7.0	8.0	8.0	3.0	0.0	
% exceedance	12.5%	0.0%	0.0%	0.0%	0.0%	87.5%	100.0%	100.0%	37.5%	0.0%	
# sampling events	8	8	8	8	6	8	8	8	8	8	8

- The stream went dry in early July 2011 and no flow returned during the remaining two months of monitoring.
- pH levels were within acceptable limits.
- Nitrogen levels were elevated in this creek, with a maximum nitrate-nitrite reading of 1.73 mg/L, on December 8, 2010. Seven of the eight samples exceeded the 0.072 mg/L guidance criterion. There is fairly extensive agriculture occurring in the upper portions of Leitch Creek, which is a potential source of this nutrient enrichment.
- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=8). There is no correlation between TP and discharge at this site.
- Sediment and turbidity levels were low at this site, with no samples exceeding the target criteria.

- No exceedances of the *E. coli* criterion were observed (n=6).
- One exceedance of the 13 °C temperature criterion for Salmonid Spawning was documented on June 27, 2011.

2010-2011 Clear Creek (#01001A) Data Summary:



Figure 19. Clear Creek monitoring site (01001A), 2010-2011.

Table 16. Descriptive statistics for Clear Creek monitoring site #01001A, 2010-2011.

Clear Creek (01001A)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	<i>E-Coli</i> (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP mg/L	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	17.36	16.69	8.01	20.90	35.00	0.20	0.04	0.08	0.63	36.00	372.26
Minimum	1.06	9.63	6.05	1.19	0.05	0.01	0.01	0.04	0.08	2.00	7.39
Mean	8.33	12.07	6.96	7.77	15.93	0.07	0.03	0.05	0.23	8.00	145.40
Median	6.47	11.61	6.90	3.86	8.05	0.06	0.03	0.05	0.19	5.50	86.47
# exceedance	2.0	0.0	1.0	0.0	0.00	5.0	4.0	12.0	3.0	1.0	
% exceedance	16.7%	0.0%	8.3%	0.0%	0.0%	41.7%	33.3%	100.0%	21.4%	8.3%	
# sampling events	12	12	12	12	10	12	12	12	12	12	11

- The stream had perennial flow, and measured velocities were greater than 200 cfs from January – April 2011. A high flow measurement of 372.26 cfs was taken on January 20, 2011.
- pH levels were mostly within acceptable limits (6.5 – 9.5), with the exception of a single reading on January 20, 2011, which was measured at 6.05.

- Nitrogen levels were fairly low in this creek, with a maximum nitrate-nitrite reading of 1.73 mg/L, on December 8, 2010. The 0.072 mg/L guidance criterion was exceeded 41.7% of the time (n=12).
- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=8). Levels were not extremely high, however, with the maximum TP value measured being 0.08 mg/L.
- Sediment and turbidity levels were quite low at this site, with only one TSS measurement exceeding the 25 mg/L instantaneous target criterion, on May 10, 2011. This was during a flow event that measured >300 cfs.
- No exceedances of the *E. coli* criterion occurred (n=6).
- Two exceedances of the 13 °C temperature criterion for Salmonid Spawning were documented on July 18 and September 14, 2011 (n=12).

**Maggie Creek Watershed:
Maggie Creek mouth (#04801A)**

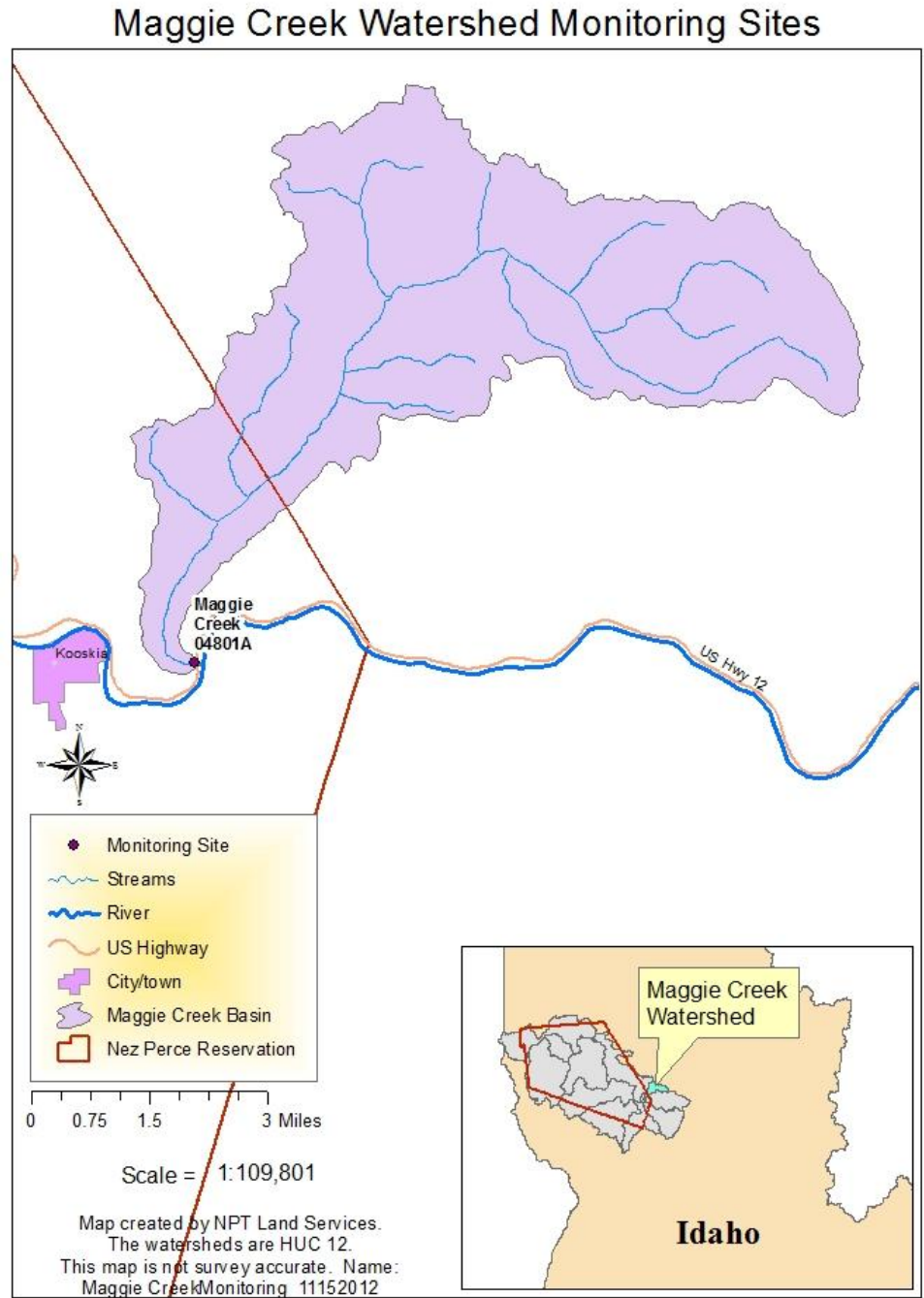


Figure 20. Maggie Creek monitoring site, 2010-2011.

Maggie Creek watershed (16,915 acres) is located in Idaho County. The North Fork Maggie Creek is the only named tributary to the mainstem, although other smaller intermittent tributaries flow into the creek along its length. Maggie Creek flows in a southwesterly direction from its source on Woodrat Mountain to its confluence with the Middle Fork Clearwater River, just east of the city of Kooskia, ID. The lower 3.4 miles of Maggie Creek flow through the Nez Perce Reservation. Elevations within the watershed range from 1,240 feet near the mouth to 4,980 feet in the headwaters.

General problems impacting the lower part of the drainage are low summer stream flows, extreme fluctuation in annual stream flow, high summer stream temperatures, and lack of instream cover (Kucera, et. al 1983).

Maggie Creek is currently listed in Category 2 of the State of Idaho’s 2010 Integrated Report as “Fully Supporting” its designated beneficial uses of Cold Water Aquatic Life and Secondary Contact Recreation from its source to the mouth (IDEQ 2010).

For this monitoring effort, one monitoring site was established near the mouth of Maggie Creek (#04801A). Table 17 presents descriptive statistics for Maggie Creek.

2010-2011 Maggie Creek (#04801A) Data Summary:



Figure 21. Maggie Creek monitoring site (04801A), 2010-2011.

Table 17. Descriptive statistics for Maggie Creek monitoring site #04801A, 2010-2011.

Maggie Creek (04801A)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	<i>E-Coli</i> (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP mg/L	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	18.24	14.97	7.33	36.90	59.10	0.28	0.05	0.11	0.67	9.00	118.16
Minimum	2.27	8.42	6.33	1.01	4.10	0.01	0.02	0.04	0.09	0.05	0.52
Mean	8.65	11.43	6.81	11.97	22.24	0.06	0.03	0.06	0.21	2.51	40.52
Median	6.95	10.87	6.78	8.62	16.05	0.03	0.03	0.06	0.18	2.00	8.52
# exceedance	3.0	0.0	2.0	0.0	0.00	4.0	6.0	12.0	1.0	0.0	
% exceedance	25.0%	0.0%	16.7%	0.0%	0.0%	33.3%	50.0%	100.0%	8.3%	0.0%	
# sampling events	12	12	12	12	10	12	12	12	12	12	12

- The stream had perennial flow, with the highest velocity measured being 118 cfs, on May 10, 2011.
- pH levels fell below the 6.5 criterion twice during this study, in December 2010 and January 2011.
- Nitrogen levels were relatively low in this creek, with a maximum nitrate-nitrite reading of 0.14 mg/L, on March 23, 2011. The 0.072 mg/L guidance criterion was exceeded 33.3% of the time, the lowest of any creek assessed in this study (n=12).
- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=12). Levels were not extremely high, however, with the maximum TP value measured being 0.11 mg/L.
- Sediment and turbidity levels were extremely low at this site, with no TSS measurements exceeding the 25 mg/L instantaneous target criterion.
- No exceedances of the *E. coli* criterion occurred (n=10).
- Three exceedances of the 13 °C temperature criterion for Salmonid Spawning were documented on June 27, July 18 and September 14, 2011 (n=12).

**Nikesa Creek Watershed:
Nikesa Creek mouth (#10101A)**

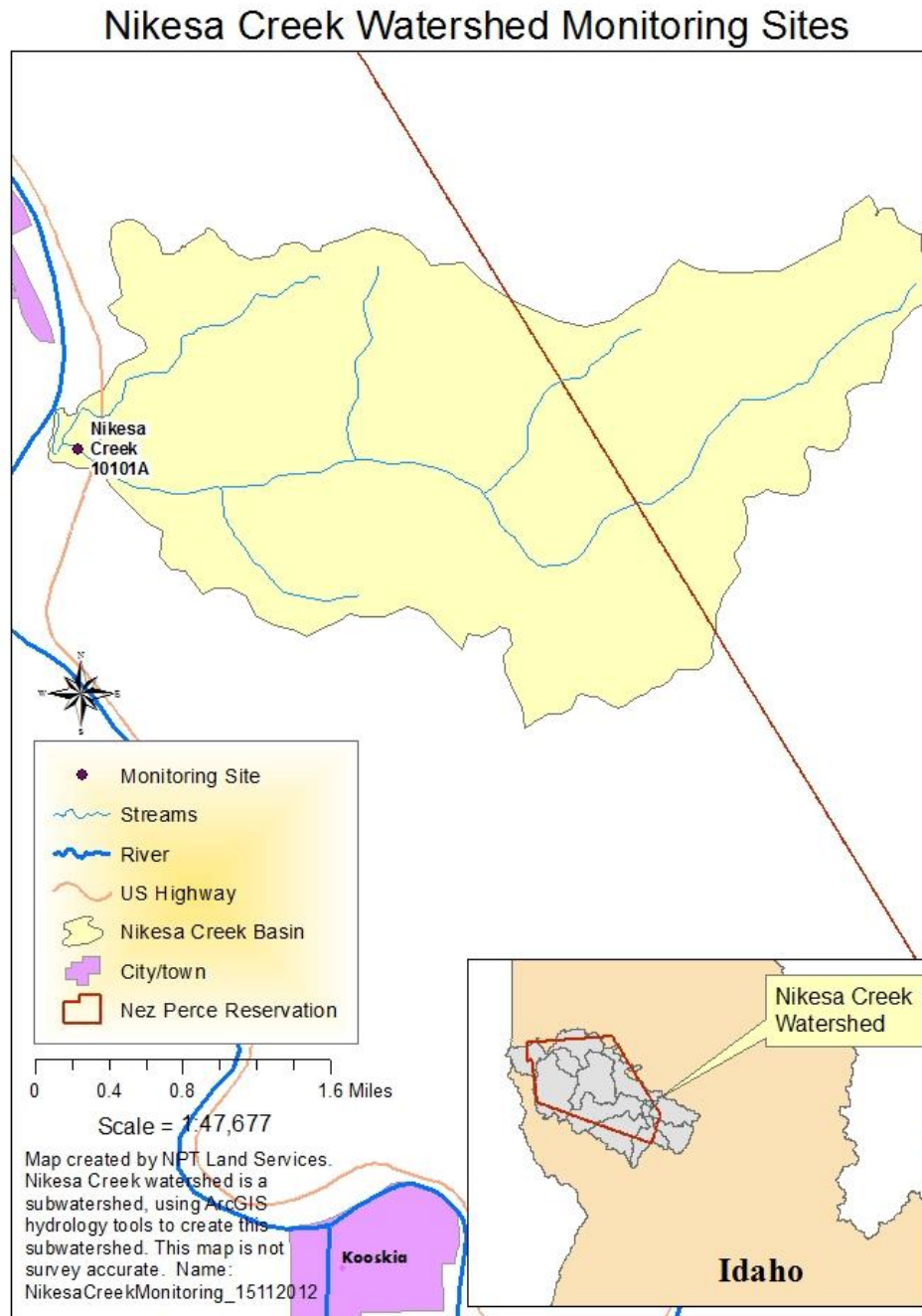


Figure 22. Nikesa Creek monitoring site, 2010-2011.

Nikesa Creek watershed (4,147 acres) is located in Idaho County. Nikesa Creek flows in a southwesterly direction from its source to its confluence with the Middle Fork Clearwater River, just east of the city of Kamiah, ID. The lower four miles of Nikesa Creek flow through the Nez Perce Reservation. Elevations within the watershed range from 1,200 feet near the mouth to 3,460 feet in the headwaters.

For this monitoring effort, one monitoring site was established near the mouth of Nikesa Creek (#10101A). Table 18 presents descriptive statistics for Nikesa Creek.

2010-2011 Nikesa Creek (#10101A) Data Summary:



Figure 23. Nikesa Creek monitoring site (10101A), 2010-2011.

Table 18. Descriptive statistics for Nikesa Creek monitoring site #10101A, 2010-2011.

Nikesa Creek (10101AA)	Temp (°C)	D.O. (mg/L)	pH (H ⁺)	Turbidity (NTU)	E-Coli (coli/100mL)	NO ₂ +NO ₃ (mg/L)	OP (mg/L)	TP (mg/L)	TKN (mg/L)	TSS (mg/L)	Q (cfs)
Maximum	8.55	13.22	6.80	24.80	21.30	0.80	0.09	0.15	1.80	2.00	22.34
Minimum	5.04	8.65	5.75	4.40	1.00	0.07	0.07	0.09	0.12	1.00	0.10
Mean	6.80	11.39	6.25	13.76	7.22	0.27	0.08	0.12	0.42	1.38	8.68
Median	6.74	11.92	6.16	13.55	5.75	0.20	0.08	0.11	0.25	1.00	4.54
# exceedance	0.0	0.0	6.0	0.0	0.00	7.0	8.0	8.0	2.0	0.0	
% exceedance	0.0%	0.0%	75.0%	0.0%	0.0%	87.5%	100.0%	100.0%	25.0%	0.0%	
# sampling events	8	8	8	8	6	8	8	8	8	8	8

- Nikesa Creek went dry in late July 2011.
- pH levels fell below the 6.5 criterion six times during this study. There were no apparent seasonal trends or correlation with any other parameter.
- Nitrogen levels exceeded the 0.072 mg/L criterion 87.5% of the time (n=8).

- Total phosphorus exceeded the 0.03 mg/L guidance criterion 100% of the time (n=8), Levels were not extremely high, however, with the maximum TP value measured being 0.11 mg/L.
- Sediment and turbidity levels were extremely low at this site, with no TSS measurements exceeding the 25 mg/L instantaneous target criterion (n=8).
- No exceedances of the *E. coli* criterion occurred (n=6).
- No exceedances of the temperature criteria were documented at this site.

Conclusions

The monitoring project for these previously unassessed tributaries to the lower Clearwater River was successfully carried out as planned. Protocols were followed, QA/QC standards were met, and specific information per parameter for each sub-watershed was collected. This effort has helped to fill water quality data gaps in the Clearwater River Subbasin, and will help to prioritize implementation of best management practices (BMPs) throughout the subbasin.

Excessive stream temperature is a concern in many of the streams that were monitored. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for their optimal health. Aquatic insects are sensitive to temperature and will move in a stream to find their optimal temperature. Temperature is also critical for fish spawning and embryo development. If stream temperatures are outside of optimal levels for prolonged periods of time, organisms become stressed and may die or be unable to reproduce. With the exception of Pickle Canyon, Rock Creek, and Nikesa Creek, every site exceeded the temperature criteria during the course of this study.

Total phosphorus loading is also a persistent issue at every monitoring location. Every site exceeded the EPA Ecoregion criterion of 0.03 mg/L one-hundred percent of the time during the course of this study. The average ratio of orthophosphorus to total phosphorus was 0.72 in Garden Gulch Creek, 0.66 in Rock Creek, and 0.72 in Magpie Creek, indicating that a sizeable portion of the total phosphorus load is in soluble form and can be readily taken up by aquatic vegetation. This high level of phosphorus is potentially contributing to excessive growth of algae and other aquatic plants that can cause destruction of habitat and depletion of dissolved oxygen, which usually results in the disappearance of intolerant aquatic insect species and fish. However, no violations of the 6.0 mg/L standard for dissolved oxygen were documented at any site during the course of this study.

Nitrogen levels were elevated throughout the study area, with most of the monitoring sites exceeding the 0.073 mg/L ecoregion criterion 100% of the time. Nitrogen levels were somewhat lower as one moved higher up in the Clearwater River Subbasin, with

the lowest number of exceedances being found in Clear Creek (42%) and Maggie Creek (33%). Elevated concentrations of nitrogen can be harmful to humans and wildlife, and can be the cause of excessive plant growth and possible eutrophication. The data suggest that much of the nitrogen could be coming from agricultural fields located on the Camas Prairie. Many agricultural fields have nitrogen fertilizer applied to them in the fall, and seasonal spikes in nitrogen levels are seen in January through March as winter and spring rains wash residual nitrogen off fields and into nearby waterways.

Escherichia coli (*E. coli*) is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination. Bacteria levels were generally low at most monitoring sites, with occasional spikes being observed. Exceedances of the 406 *E.coli*/100mL instantaneous criterion occurred at four of the ten monitoring sites. Magpie Creek, in the Cottonwood Creek watershed, had four exceedances during this project, making it the highest of all sites monitored (n=11). Livestock numbers are extremely low in the Magpie Creek subwatershed, making wildlife and/or septic systems a potential cause of elevated bacteria levels.

Total Suspended Sediment (TSS) includes both sediment and organic material suspended in water. Excessive sediment levels can cause problems for fish by clogging gills and for aquatic plants by limiting growth because of reduced light penetration. In addition, sediment often provides a medium for the accumulation and transport of other constituents such as phosphorus and bacteria. Sediment levels were highest in watersheds that had the largest agricultural component in land use. Magpie Creek and Coyote Creek, both in the Cottonwood Creek watershed, had the highest number of measured exceedances over the 25 mg/L target criterion, with nine (n=12) and three (n=12), respectively. Sediment doesn't appear to be a significant problem in most of the streams that were monitored, however.

All of the waterbodies in this assessment had the same designated beneficial uses. Table 19 shows the support status determinations for these waterbodies, based on evaluation of the water quality monitoring data.

Table 19. Beneficial use support status for monitoring sites, 2010-2011.

Stream Name/ID	Cold Water Aquatic Life	Salmonid Spawning	Primary Contact Recreation
Pickle Canyon Creek (05903A)	NFS	NFS	FS
Coyote Creek (01801A)	NFS	NFS	NFS
Magpie Creek (04901A)	NFS	NFS	NFS
Louse Creek (04702A)	NFS	NFS	NFS
Rock Creek (06601A)	NFS	NFS	FS
Garden Gulch Creek (02701A)	NFS	NFS	NFS
Leitch Creek (04001A)	NFS	NFS	FS
Clear Creek (01001A)	NFS	NFS	FS
Maggie Creek (04801A)	NFS	NFS	FS
Nikesa Creek (10101A)	NFS	NFS	FS

NFS = not fully supporting beneficial uses, FS = fully supporting beneficial uses

Recommendations

Nutrients are the major pollutant in these waterbodies, with every site showing elevated levels of both phosphorus and nitrogen components. Steps should be taken to reduce the overall quantity of nitrogen and phosphorus entering these systems. Nutrient management plans should be developed by landowners in the watersheds, with assistance from the Natural Resource Conservation Service (NRCS) and local soil and water conservation districts, so that producers have a tool to increase net returns while protecting water quality. Producers in this area often apply nitrogen fertilizer as anhydrous ammonia in the fall. Winter and spring rains appear to wash much of this soluble fertilizer into these streams. All nitrogen fertilizers convert to nitrate in the soil, through the process of nitrification. Nitrate is the form of nitrogen that is susceptible to loss. Ammonia converts to nitrate slower than other forms of nitrogen, reducing the risk of loss. The use of additives, such as Agrotain and N-Serve, can further reduce the risk of nitrogen loss by slowing the conversion of ammonia to nitrate. The use of these additives should be explored, if fall application of anhydrous ammonia is determined to be the only feasible application strategy. The preferred strategy to reduce nitrogen loss from agricultural fields is to apply fertilizers as close as possible to the period of rapid crop uptake.

Although TSS levels were generally quite low in the study area, erosion is evident in many areas, both in-stream and in adjacent farmland, and treatment should be applied to areas undergoing the most severe erosion. In particular, priority should be given to

the Magpie Creek subwatershed, where the lack of substantial riparian vegetation in the upper portion of the catchment results in heavy seasonal sediment loads being delivered to the stream channel annually and subsequently flushed down into Cottonwood Creek. The re-vegetation of stream banks along Magpie Creek would help reduce sediment transport, as healthy riparian vegetation is effective in reducing rates of bank erosion. Riparian vegetation will also filter sediment being transported in surface water runoff. Some best management practices (BMPs) that should be explored for this subwatershed are crop rotations, filter strips, grassed waterways, and residue management strategies, such as no till farming practices. In-stream surveys should also be done in Magpie Creek to evaluate the quantity of sediment being generated from erosion of the stream channel banks and bottom.

Excessive stream temperature, especially in late summer months, is a widespread and difficult problem to overcome, and should be addressed by re-establishing natural, full-potential canopy shade along streams. Reducing sediment loads within critical reaches will also assist in reducing stream temperatures, since suspended particles tend to absorb more heat.

Some specific BMPs that would help improve overall water quality in the lower Clearwater River watershed are: tree and shrub plantings, grassed waterways, stream bank stabilization, conservation cropping and tillage practices, protected riparian zones, and detailed nutrient management plans developed by landowners and local conservation districts. In addition, loss of connectivity between many of these streams and their floodplains and associated wetlands has resulted in a loss of both terrestrial and aquatic biodiversity, as well as land and water productivity.

Based on the collected data from this study, the most severely water quality limited streams in this study are: Coyote Creek, Magpie Creek, and Garden Gulch Creek. Two of these sites are located in the Cottonwood Creek watershed. Giving priority to restoration efforts in this watershed would potentially have the greatest positive impact on water quality in the lower Clearwater River itself.

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Glossary

§303(d): Refers to section 303 subsection “d” of the Clean Water Act. 303(d) requires states to develop a list of waterbodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.

Bedload: Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.

Beneficial Use: Any of the various uses of water, including, but not limited to, aquatic biota, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.

Best Management Practices (BMPs): Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Catchment: Land area that contributes runoff (drains) to a given point in a stream or river. Synonymous with watershed and drainage or river basin.

Censored Data: Sample observations for which the complete distribution is not known. Censored data often appear in laboratory reports when the concentration being analyzed is lower than the detection limit or higher than the allowable range for a particular type of laboratory equipment or procedure.

Conductivity: The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.

Criteria: In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria.

Cubic Feet per Second: A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, one cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Discharge: The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen: The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

DFO: Department of Fisheries and Oceans, Canada.

E. coli: Short for *Escherichia Coli*. *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* strains are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.

Exceedance: A violation of the pollutant levels permitted by water quality criteria.

Mean: Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Median: The middle number in a sequence of numbers. If there is an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; and 6 is the median of 1, 2, 5, 7, 9, 11.

Nonpoint Source: A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Nutrient: Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

pH: The negative \log_{10} of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Point Source: A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Riffle: A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Sediments: Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Subbasin: A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions.

Surface Runoff: Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Suspended Sediments: Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Thalweg: The center of a stream's current, where most of the water flows.

Total Suspended Solids (TSS): A measure of the suspended organic and inorganic solids in water.

Tributary: A stream feeding into a larger stream or lake.

Turbidity: A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Water Quality Limited: A label that describes waterbodies for which one or more water quality criterion is not met or beneficial uses are not fully supported.

Water Quality Standards: State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.

Watershed: 1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller “subwatersheds.” 2) The whole geographic region which contributes water to a point of interest in a waterbody