Hangman Creek Watershed Water Quality Sampling Quality Assurance Project Plan

November 2003

Spokane County Conservation District
N. 210 Havana St.
Spokane, WA 99202
509/535-7274

Washington State Department of Ecology
Water Quality Optional Element Grant, HB 2514 Watershed Planning
No. G0300121

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2.0 Table of Contents and Distribution list

Optional – Not included.

3.0 Organization and Schedule

The project planning team consists of:

Rick Noll, Project Coordinator, SCCD
Walt Edelen, Manager, SCCD Water Resources
Charlie Peterson, Lead Field Technician
Dan Ross, Senior Field Technician
Amy Voeller, Field Technician
Jennifer Grimm, Field Technician
Elaine Snouwaert, Ecology Project Manager
Joe Joy, Ecology Environmental Assessment Program
Darren Lantzer, Spokane Tribal Laboratory

Project decision-makers will consists of:

Rick Noll – Environmental and Quality Control sample data
Elaine Snouwaert – Project and sample review
Joe Joy, Ecology Environmental Assessment Program

The stakeholders directly affected by the outcome of the study are:

Hangman Creek HB 2514 Planning committee
Department of Ecology, Water Quality and Environmental Assessment Programs
Watershed residents

Rick Noll (SCCD) will provide overall organization and coordination of the project. Rick Noll, Charlie Peterson, Walt Edelen, Dan Ross, and Amy Voeller (all SCCD) will conduct the field sampling. Darren Lantzer, Spokane Tribal Laboratory will oversee laboratory analysis and laboratory QA/QC. Elaine Snouwaert and Joe Joy of the Department of Ecology will use the data to evaluate reaches of Hangman Creek and its tributaries for inclusion in the development of a TMDL plan.

Table 1: Project Timetable

Activity	Date	Remarks
Reconnaissance/site setup	Nov 17-26	Establish sample sites and TBMs for discharge
Routine field sampling	Monthly	Sampling to start the week of December 8
Event Sampling	As needed	Significant flow events will be sampled on the rising and falling limb (discharge > 2,000 cfs)
Sample delivery	Next day	Within 24 hours of sampling
Data entry into EIM	N/A	Included in final report, end of project
Progress reports	Quarterly	Quarterly report will be supplied to Ecology
End Field Sampling	July 2004	Sampling and data collection completed
Draft Report	Sept. 2004	Review by Ecology & HB 2514 Planning Unit
Final report	October 2004	Final with corrections
Sample disposal	Two weeks	Laboratory will hold samples for two weeks

Notes:
1. Dates approximate, final start is dependent on review of QAPP, weather, and final site setup.
2. TBM is temporary benchmark.
3. N/A is not applicable.

HB 2514 Water Quality Optional Element Budget

Budget by Element	Water Year 2004
Salaries/Benefits	$ 25,000
Travel	1,000
Equipment	1,000
Materials/Supplies	2,150
Laboratory Costs	15,000
Overhead	6,250
Total Budget by Element	**$ 50,400**

Additional Funding as Needed from TMDL Grant Budget

Budget by Element	Water Year 2004
Salaries/Benefits	$ 10,000
Travel	1,000
Equipment	10,000
Materials/Supplies	1,000
Laboratory Costs	10,000
Overhead	2,500
Total Budget by Element	**$ 34,500**

Note:

Funding from the TMDL grant may not be entirely used for this project. Both equipment and laboratory costs include contingency funds if it is determined that the sampling should be expanded.

4.0 Background and Problem Statement

The Department of Ecology (DOE) has identified the Hangman Creek watershed (also known as the Latah Creek watershed) as a water body with quality and quantity issues. Past water quality studies have shown that state standards for fecal coliform, temperature, pH, and dissolved oxygen are often exceeded (SCCD 1994, 1999, 2000; WDOE, 1998). Past and current land uses within the watershed are varied, and contribute to the problem. Issues such as, stormwater runoff, sedimentation, stream bank erosion, water rights, instream flows, spawning habitat (cold water fisheries), urban development, wetland destruction, and agricultural and forestry practices are all major concerns for the area.

A watershed planning unit for Hangman Creek (WRIA 56 was initiated in late 1999. The Planning Unit has committed representation by the City of Spokane, Spokane County, Whitman County, Hangman Hills Water District, Fairfield Triangle Grange, the Department of Ecology (State Caucus), and several residents.

The Planning Unit has chosen to address water quality in the Hangman Creek Watershed. The basin's growth and continued poor land management has led to environmental stresses that have reduced water quality over the years. Hangman Creek was identified on the 1998 303(d) list for not achieving State water quality standards for fecal coliform, dissolved oxygen, pH, and temperature. Recent monitoring has identified several other water quality problems not acknowledged by the 303(d) list (sediment load, turbidity, ammonia, low flows, and total phosphorus). This project will further characterize the extent and severity of these water quality problems within the basin in preparation for a set of total maximum daily load (TMDL) evaluations.

Historical Basis for the Project

The Hangman Creek watershed drains approximately 431,000 acres and spans across two states and four counties (Figure 1). More than 60 percent of the watershed resides in eastern Washington State while the remaining portion, including the headwaters, originates in the western foothills of the Rocky Mountains near Sanders, Idaho. Land use influences, (agriculture, impervious surfaces, timber harvest, roads, etc.) as well as stream channel and flood plain alterations over the last 100-years have contributed to "flashy" flow conditions, unstable stream banks, and substandard water quality.

Hangman Creek is often described as one of the most degraded waterbodies in eastern Washington State. It is designated as a Class A Washington waterway in the Washington Administrative Code (WAC) Chapter 173-201A. However, point and non-point pollution sources continue to be found throughout the watershed.

There are various factors leading to the non-compliance of water quality standards on Hangman Creek. Agriculture is the significant land use within the basin (64 percent). The largest agricultural production areas are located in the upper to middle reaches of the watershed. Most of the cropland is non-irrigated, annual small grain production. Other crops include peas, lentils, canola, and turfgrass seed. The development of agriculture in the watershed led to a significant reduction of riparian vegetation and extensive channel alterations. The removal of native riparian vegetative buffers has reduced the natural filtering function and increased the rate of stream bank erosion.

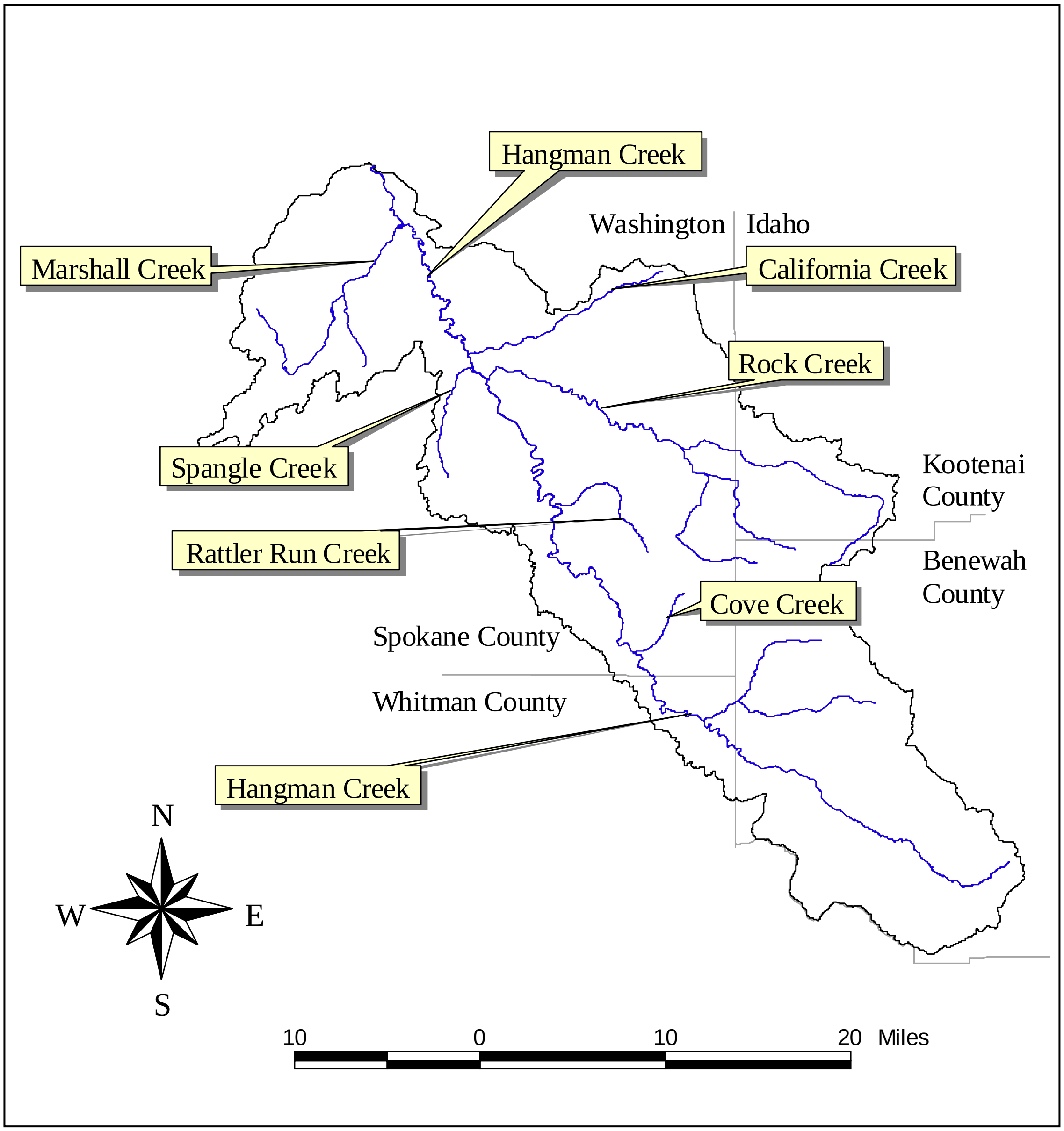

Figure 1: Location Map

The watershed also has an undetermined quantity of livestock that have unrestricted access to small tributaries and the mainstem of Hangman Creek. Over the years, the removal of woody vegetation and continuous trampling by livestock has significantly degraded the riparian areas and stream banks. These issues contribute to fecal coliform, temperature, and dissolved oxygen violations that have been documented throughout the basin.

The basin has many small rural towns and two golf courses (with a third currently being developed) located on major tributaries and the mainstem of Hangman Creek. Several of these towns have wastewater treatment plants that discharge directly into a tributary or the mainstem of Hangman Creek (Table 2). The flows during the summer are often inadequate for effluent inputs and may contribute to low dissolved oxygen levels and other water quality violations.

Table 2: Permitted Surface Water Point Source Discharge Locations

Facility	Permit Number	Discharge Location
Cheney WWTP	WA0020842C	Minnie Creek
Fairfield STP	WA0045489C	Rattler Run Creek
Freeman School District #358	WA0045403C	Little Cottonwood Creek
Rockford STP	WA0044831C	Rock Creek
Spangle STP	WA0045471B	Spangle Creek
Tekoa STP	WA0023141C	Hangman Creek

Notes:
1. WWTP is wastewater treatment plant.
2. STP is sewage treatment plant.
3. There are four permitted ground water discharges within the watershed.

The lower reaches of the watershed are moderately urbanized, but future growth projections by the City of Spokane indicate that the Hangman basin will absorb approximately 50 percent of the city's growth over the next 10 years (SRTC, 1997). Past and current development in these areas has removed riparian vegetation and exacerbated the sediment and nutrient loading problems. Additional stormwater runoff from current and newly urbanized areas may also contribute to these loading problems. The unconsolidated sediments in the lower watershed consist mainly of alluvium and flood deposits that are highly erodible.

Fish habitat and distribution throughout the watershed has radically changed over the last one hundred years. Hangman Creek once had viable populations of native trout and healthy runs of salmon and steelhead (SCCD, 1998). The removal of riparian vegetation, channel alterations, and heavy sedimentation has significantly reduced the spawning and rearing habitat on Hangman Creek. The primary species now found in the stream are adapted to warmer, slower waters and considered undesirable as sport fish. Resident trout populations are severely depressed.

Hangman Creek is suspected to be the largest contributor of bedload and suspended sediment to the Spokane River. The majority of the bedload portion of the sediment load is transported downstream and deposited behind Avista's Nine Mile Dam. The suspended sediments continue through the dam's bypass system and settle out in Lake Spokane.

Although the impacts of sediment to Lake Spokane have not been thoroughly studied, high phosphorus and nutrient levels have been correlated to high suspended sediment values (SCCD, 1999, Joe Joy, Ecology - personal communication, 2003).

Both phosphorus and suspended sediment are known water quality issues for both the Spokane River and Lake Spokane. The Department of Ecology Dissolved Oxygen draft pollutant loading assessment for the Spokane River and Lake Spokane indicates that numerous historic studies have identified phosphorus loading to Lake Spokane to be directly responsible for low dissolved oxygen, excessive phytoplankton populations, and overall poor water quality during the summer period. The studies also indicate that the poor water quality can be directly related to upstream sources. The pollutant loading assessment also identifies higher nutrient concentrations in both Hangman Creek and the Little Spokane River, compared to the Spokane River at the Stateline.

The DOE recognized Hangman Creek as an impaired Washington State waterway and identified it on the 1998 303(d) list. Hangman Creek was listed for exceedences in temperature, low dissolved oxygen, pH values, and fecal coliform bacteria concentrations. These listings only identified two short reaches of the creek, near the mouth and near the town of Tekoa. More recent studies undertaken by the Spokane County Conservation District and others have confirmed that these problems are more widespread, and that other water quality problems are present.

It is not difficult to assess the outcome of the future for water quality in the Hangman Creek watershed if the current situation is not addressed. The lower watershed will be subjected to heavy urban development. Throughout the watershed, agricultural producers will continue to farm to the edges of the creek, livestock will trample the banks and pollute the water, the creek will discharge hundreds of thousands of tons of sediment into the Spokane River, and fish habitat will dwindle until only warm water species thrive. In summary, all beneficial uses will continue to be impaired.

Previous Studies and Work

There are two main sources of water quality data on Hangman Creek. The Department of Ecology maintains a long-term station near the mouth. The Spokane County Conservation District conducted a basin-wide water quality study in the mid-1990's. There are other sources of water quality data, but they are disjunct and limited in scope. Temperature, suspended sediment, turbidity, nutrient, dissolved oxygen, and pH have been the primary parameters measured.

The Washington State Department of Ecology

- Water Quality Monitoring Station # 56A070 Hangman Cr at Mouth. This station is considered a long-term station (1970 – 2003).
- Water Quality Monitoring Station # 56A200 Hangman Creek at Bradshaw Road. This station was only sampled from October 1998 through September 1999.

The Spokane County Conservation District

- Basin-wide water quality study (1994 – 1997) – five different stations (mainstem and tributaries)
- Sediment Study – 1998-1999 – suspended and bedload concentrations
- Paired watershed BMP evaluation data (1997-1998) –on two small sub-watersheds
- Rattler Run farm planning and BMP Implementation Project Data
- Instream Flow Study – temperature, flows (2002)
- Seepage run flow and water quality data, September 2001

Documented Water Quality Exceedences

Temperature: For cold-water biota and trout, the duration of temperature exceedences is as important as the number of exceedences. Hangman Creek has continuously violated this water quality parameter for decades. The fisheries in the basin have suffered and gradually moved towards the dominance of warm water species. The long-term ambient data collected monthly by Ecology and the more recent data collected by the SCCD have shown the temperature problem is widespread and severe.

Instream Flow Recommendation (Water Temperature Monitoring) - The results of continuous water temperature monitoring of several of the stations over a six-month period averages approximately 20 °C, and the average maximums are between 25 and 27 °C.

Seepage Runs – Water quality samples and discharge measurements were taken at 18 sites on a single day along the main stem of Hangman Creek on September 9th 2001. The water samples were taken to evaluate the low flow water quality conditions (See Tables 3 and 4) and to characterize the ground water input to the creek. Seepage runs were also conducted on July 18th and September 4th in 2002.

Other Areas of Concern.

The lower reaches of the watershed are moderately urbanized, but future growth projections by the City of Spokane indicate that the Hangman basin will absorb approximately 50 percent of the city's growth over the next 10 years (STRC 1997). Past and current development in these areas has removed riparian vegetation and exacerbated the sediment and nutrient loading problems. The unconsolidated sediments in the lower watershed consist mainly of alluvium and flood deposits that are highly erodible. Most of the suspended sediment load comes from non-point sources such as roads, annual cropland, and eroding streambanks (SCCD, 1994). A recent sediment sampling study indicated that the total annual sediment load discharged from the mouth of Hangman Creek for 1998 and 1999 was estimated at 52,000 tons and 211,000 tons respectively (SCCD 2000). The average annual flow for 1998 was 166 cfs and for 1999 it was 315 cfs. Field erosion is suspected to be the primary contributor to suspended sediment loads.

The severity of the water quality violations in Hangman Creek has remained high for many decades. Routine water quality samples were taken over a three-year period (1994 – 1997) at five sites, along with selected samples during high flow events to characterize the water quality of the Hangman Creek watershed. Discharge measurements, or discharge values estimated from stage measurements were routinely made along with the water quality sample collection. The five monitored sites were: Hangman Creek at the Idaho state line, Little Hangman Creek, Rattler Run Creek, Hangman Creek at Bradshaw Road, and Rock Creek at Jackson Road. All stations monitored (Table 5) exceeded one or more of either the Washington State Class A Water Quality standards or EPA standards (Table 6).

Table 3: Conservation District Seepage Run Water Temperature Results

Temperature (°C)			
	2001 September 9	2002 July 18	2002 September 4
Stateline	12.6	21.0 e	NM
HC at Tekoa	16.3	26.0 e	NM
HC at Marsh Rd	16.0	29.2 e	NM
Cove Creek	13.1	18.5 e	NM
HC at Roberts Rd	17.6	27.3 e	19.1e
Rattler Run Creek	13.8	17.0	NM
HC at Bradshaw Rd	18.4 e	25.9 e	17.6
HC at Keevy Rd	19.2 e	NM	14.3
HC u/s Rock Ck	20.4 e	23.8 e	15.6
Rock Creek	19.9 e	24.4 e	16.0
HC u/s California Ck	18.8 e	26.6 e	NM
California Ck	16.0	18.0 e	NM
HC at HV Golf Course	20.7 e	28.6 e	16.3
HC at Grunte Home	20.3 e	26.7 e	15.4
HC at Yellowstone	21.2 e	25.1 e	16.4
HC u/s Marshall Ck	20.5 e	22.7 e	14.3
Marshall Ck	17.5	16.0	8.0
USGS Gage site	18.2 e	NM	NM

Notes:
1. e is exceeds Ecology standard.
2. NM is not measured.
3. u/s is upstream.

All sites exceeded the background turbidity values established at Hangman Creek at the Idaho state line. All sites met the fecal coliform geometric mean limit, but exceeded the limit of less than 10 percent of the samples that are allowed to be greater than 200 colonies per 100 ml of sample. Nitrate levels exceeded EPA limits on all the tributaries, but not on Hangman Creek at either the Idaho state line or Bradshaw Road. Nitrite levels exceeded the more restrictive EPA limits for cold water fisheries only on Little Hangman Creek and Rattler Run Creek. The EPA drinking water nitrite limit of 1.0 mg/l was not exceeded at any site. The ammonia criteria was exceeded only at the Rattler Run site. All sites exceeded total phosphorus EPA limits. Most of the total phosphorus exceedences were during the winter, however both Little Hangman Creek and Rattler Run Creek exceeded the limit throughout the year. Rattler Run Creek exceeded the total phosphorus limit on every sample collected. Temperature and dissolved oxygen limits were exceeded at all sites. The pH limits were exceeded at Rattler Run Creek, Hangman Creek at Bradshaw Road, and Rock Creek.

Other parameters measured during the September 6, 2001 seepage run are detailed in Table 4.

Table 4: Seepage Run Parameter Summary

	Discharge (cfs)			Total P (µg/l)	Fecal Coliform (colonies /100ml)	pH (units)	Dissolved O_2 (mg/l)	Temperature (°C)		
	2001 Sept 6	2002 July 18	2002 Sept. 4	2001 Sept 6	2001 Sept 6	2001 Sept 6	2001 Sept 6	2002 July 18	2002 Sept. 4	2001 Sept 6
Stateline	0.23	0.15	0.16	63	59	7.21	7.14 e	12.6	21.0 e	NM
HC at Tekoa	0.29	1.48	0.72	79	28	7.94	11.49	16.3	26.0 e	NM
HC at Marsh Rd	0.55	2.19	1.21	64	46	7.70	10.05	16.0	29.2 e	NM
Cove Creek	0.07	0.18	0.11	100	190	7.65	10.32	13.1	18.5 e	NM
HC at Roberts Rd	0.62	2.99	1.66	77	16	7.86	9.41	17.6	27.3 e	19.1
Rattler Run Creek	0.08	0.23	0.15	256 e	310 e	7.81	9.24	13.8	17.0	NM
HC at Bradshaw Rd	0.59	3.75	1.43	97	16	8.00	7.61 e	18.4 e	25.9 e	17.6
HC at Keevy Rd	0.35	3.32	1.10	58	2	8.64 e	11.55	19.2 e	NM	14.3
HC u/s Rock Ck	1.62	5.62	2.31	72	7	9.23 e	16.64	20.4 e	23.8 e	15.6
Rock Creek	0.41	1.33	0.74	35	790 e	9.15 e	8.37	19.9 e	24.4 e	16.0
HC u/s California Ck	1.77	5.73	2.47	74	4	8.93 e	10.21	18.8 e	26.6 e	NM
California Ck	0.04	0.59	0.12	95	290 e	8.34	10.23	16.0	18.0 e	NM
HC d/s Golf Course	1.43	7.07	3.72	32	19	8.52 e	13.90	20.7 e	28.6 e	16.3
HC at Grunte Home	1.33	8.21	2.80	41	17	8.18	10.86	20.3 e	26.7 e	15.4
HC at Yellowstone	1.33	8.85	2.40	29	3	8.29	10.75	21.2 e	25.1 e	16.4
HC u/s Marshall Ck	1.20	9.76	3.47	32	2	7.83	10.58	20.5 e	22.7 e	14.3
Marshall Ck	.60	0.98	1.74	65	1600 e	7.56	7.56 e	17.5	16.0	8.0
USGS Gage site	4.30	14.0	10.0	22	65	8.17	12.56	18.2 e	NM	NM

Notes:
1. Total Phosphorus is not listed on the 1998 DOE 303(d) list, but exceedences of EPA recommended levels have been documented in previous SCCD sampling within the Hangman Creek watershed.
2. Fecal coliform was considered an exceedence if greater than 200 colonies per 100 ml sample. Not enough samples were obtained to adequately characterize exceedences.
3. HC is Hangman Creek.
4. u/s is upstream.
5. d/s is downstream.
6. e indicates an exceedence of DOE water quality standards, except for total phosphorus which is an EPA recommended limit.
7. There were no exceedences for nitrate, nitrite, or ammonia. Two ammonia samples had corresponding pH values greater than 9.00. The exceedences criteria are dependent on pH, and the pH limit used in the calculation of exceedences is 9.00. For the samples with pH values greater than 9.00, extrapolations were used to estimate the limits.

Project Objectives:

The data collected to date have shown that several water quality parameters do not meet state and federal standards and that beneficial uses are not being met. These data are not yet adequate to fully describe the sources and transport mechanisms necessary to derive TMDLs, and to calculate the various source load reductions required to meet water quality standards.

Table 5: Historic Water Quality Exceedences

Parameter		Hangman Creek at the Idaho State Line	Little Hangman Creek	Rattler Run Creek	Hangman Creek at Bradshaw Road	Rock Creek at Jackson Road
Turbidity Low Flows	Exceedences	NA	7	7	1	6
	Number of Samples	NA	19	41	16	44
Turbidity High Flows	Exceedences	NA	6	6	14	46
	Number of Samples	NA	10	10	23	63
Fecal Coliform	Percent > 200 col/100 ml	16	24	30	15	27
Nitrate NO_3	Exceeds EPA Limit	0	1	14	0	3
	Number of Samples	25	25	57	27	59
Nitrite NO_2	Exceeds EPA Limit	0	1	2	0	0
	Number of Samples	25	25	57	27	59
Ammonia	Exceedences	0	0	4	0	0
	Number of Samples	24	24	47	19	50
Total Phosphorus	Exceeds EPA Limit	10	18	57	14	34
	Number of Samples	25	25	57	29	61
pH	Exceedences	0	0	8	5	3
	Number of Samples	25	25	53	23	58
Dissolved Oxygen	Exceedences	7	8	1	6	7
	Number of Samples	19	20	51	25	57
Temperature	Exceedences	7	5	1	11	14
	Number of Samples	25	30	76	33	88

Notes:

1. NA is not applicable. Turbidity values from Hangman Creek at the Idaho state line were used as background values to establish the limits for the rest of the sample sites.
2. For turbidity, the low flows are less than 100 (10 for Rattler Run Creek) cfs and the high flows are greater than 100 (10 for Rattler Run Creek) cfs.
3. The number of temperature exceedences is for grab samples only. Continuous temperature recorders were installed at some sites, but the exceedences recorded by the continuous temperature recorders are not included here.
4. For Nitrate, Nitrite, and Total Phosphorus, the EPA recommended limits are used. No Washington State Standards for these parameters are presently contained in the Water Quality Standards for Surface Waters of the State of Washington.

5.0 Project Description

Goals

The problems this study is attempting to evaluate are:

1. Characterize fecal coliform, suspended sediment, and phosphorus loading from various parts of the basin.
2. Obtain additional data to assist with 303(d) list determinations and a set of total maximum daily load (TMDL) evaluations on fecal coliform, total phosphorus, and suspended sediment/turbidity.

From these problem evaluations, the following decision statements were developed:

Determine whether the parameter concentration exceeds current Ecology water quality standards and requires the reach to be placed on the 303(d) list and included in the upcoming TMDL cleanup plan.

Determine if certain land uses cause significant increases in monitored parameters and requires the land use to be modified in the upcoming TMDL cleanup plan.

Answers we need from the data:

1. What are the fecal coliform loads from Idaho, selected major tributaries, nonpoint sources, stormwater, and reaches of the main stem?
2. What are the total phosphorus and suspended sediment loads from Idaho, selected major tributaries, municipal wastewater treatment plants, and reaches of the main stem?
3. How do fecal coliform, suspended sediment, and phosphorus loads vary during the winter and spring at flow events greater than 2,000 cfs?
4. What are the severity and geographic scope of other water quality problems that should be addressed in the future?

Project Objectives will reflect the goals and decision statements by:

1. Conducting monthly monitoring from December through July to provide additional data for determining the fecal coliform, total phosphorus, suspended sediment, and associated parameter loads within the Hangman Creek basin.
2. Conducting monitoring during three events when discharge in the creek is greater than 2,000 cfs to determine fecal loading during the rising and falling hydrograph.
3. Coordinating monthly monitoring with municipal treatment plant effluent sampling conducted by treatment plan staff.
4. Coordinating (or expanding) sampling at Spokane CSOs discharging to Hangman Creek during rain events concurrent with routine or event monitoring.
5. Characterizing fecal coliform loading from a livestock grazing area along the creek.

Objectives

The objective of the study is to determine where and under what conditions water quality parameters (fecal coliform, suspended sediment, and total phosphorus) exceed Ecology standards or EPA recommended levels, and if certain land uses are contributing to significant increases in monitored parameters. The target population is the representative stream sample from tributaries and mainstem reaches in the watershed that have not been fully characterized in the past. The sample locations will be sampled over a range of normal flow conditions (higher flows during the winter months and low flows during the spring and summer months) and rapidly changing flow conditions (runoff events where Hangman Creek, as monitored by the USGS gage, is expected to exceed 2,000 cfs).

For each parameter sampled, the statistic used to describe the target population will be the level of exceedence outlined in Table 6. Turbidity and TSS will be evaluated for the possibility of using turbidity as a surrogate for suspended sediment to determine criteria compliance. The listing policy will follow the Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC, amended July 1, 2003. Mean, maximum, and minimum statistics will also be included. Instantaneous and/or seasonal loads will be calculated for each site. The scope of the decisions will include all samples collected through July 2004. The action level is detailed in Table 6, and any sites that have samples that exceed the action level will be recommended for placement on the Ecology 303(d) list and inclusion in the upcoming TMDL cleanup plan. Any alternative courses of action for individual sites or parameters will be outlined in the upcoming TMDL clean up plan.

The decision-rule statement for this project is as follows:

> **If any sample results exceed the limits or guidelines presented in Table 6, the site and parameter will be recommended for placement on the Ecology 303(d) list and inclusion in the upcoming TMDL cleanup plan.**

Table 6: Washington Class A water and EPA Standards for Selected Parameters

Parameter	Washington Class A Waters	EPA
Temperature (°C)	≤ 18	NA
Dissolved Oxygen (mg/l)	>8.0	>5.0
Fecal Coliform (geometric mean of all samples is less than the stated number of colonies/100ml) (less than 10 % of the samples exceed the stated number of colonies/100ml)	100 200	200 400
pH (units)	6.5-8.5	NA
Turbidity Background <50 NTU Turbidity Background >50 NTU	< 5 NTU increase < 10 % increase	Less than 10 % reduction in depth of photosynthetic zone 1.45 NTU
Total Phosphorus (mg/l)	NA	0.030
Nitrate + Nitrite (mg/l)	NA	0.072
Nitrite (mg/l)	NA	0.06 or 1, see Notes
Ammonia (mg/l)	Varies with Temperature and pH [8,9]	Varies with Temperature and pH [8,9]

Notes:

1. NA is not applicable.
2. NTU is Nephelometric Turbidity Units.
3. The EPA criteria for dissolved oxygen, turbidity, and the lower nitrite standard are the recommended limits for cold water fisheries (1976 Criteria).
4. The EPA criteria for fecal coliform is the recommended limit for swimming and bathing (1976 Criteria).
5. The EPA criteria for total phosphorus is the recommended limit to prevent eutrophication.
6. Ecoregion 10 reference conditions for turbidity, total phosphorus and nitrate + Nitrite are based on the 25th percentile for all seasons (USEPA, 2000).
7. The EPA upper nitrite criteria and nitrate criteria are the recommended limits for drinking water.
8. Ammonia acute criteria shall not exceed a 1-hour average concentration once in every three years calculated as: Maximum = 0.52/[(FT)(FPH)(2)]. FT = $10^{[0.03(20\text{-}TCAP)]}$ when TCAP≤ T ≤ 30. TCAP = 20^{o}C when salmonids are present, and 25^{o}C when salmonids are absent. FT = $10^{[0.03(20\text{-}T)]}$ when 0 ≤ T ≤ TCAP. FPH = 1 when 8 ≤ pH ≤ 9. FPH = $(1+10^{7.4\text{-}pH})/1.25$ when 6.5 ≤ pH ≤ 8.
9. Ammonia chronic criteria shall not exceed a four day average concentration once every three years calculated as: Maximum = 0.80/[(FT)(FPH)(RATIO)], where TCAP = 15^{o}C when salmonids are present, and 20^{o}C when salmonids are absent. FT and FPH are as detailed in Note 8, and RATIO = 16 when 7.7 ≤ pH ≤ 9, and RATIO = $[(24)10^{7.7\text{-}pH}]/(1+10^{7.4\text{-}pH})$ when 6.5≤ pH≤7.7.

6.0 Data Quality Objectives

The data quality and measurement quality objectives are outlined in Table 7. For low concentrations, considered to be an order of magnitude greater than the laboratory minimum detection limit, the accuracy limit will be considered three times the detection limit.

Table 7: Data Quality Objectives

Parameter	Accuracy (percent deviation from true value, except pH)	Precision (percent relative standard deviation, except pH)	Bias (percent of true value)	Minimum Detection Limits
pH	0.30 units	0.10 units	0.10 units	NA
Temperature	20	10	NA	NA
Conductivity	20	10	NA	NA
Dissolved Oxygen	20	10	NA	NA
Suspended Solids	40	25	10	2
Turbidity	30	15	10	0.05
Nitrates	30	10	10	0.01
Nitrites	30	10	10	0.01
ammonia as N sample value < 0.1 mg/l	50	40	10	0.01
ammonia as N sample value ≥ 0.1 mg/l	30	20	10	0.01
Phosphorus	30	10	10	0.005
Fecal coliform	NA	25	NA	1

Notes:
1. NA is not applicable.
2. Ammonia RSD are split depending on the sample value because low sample values may have small numerical differences that could be very large percentage differences. For example, a sample result of 0.01 mg/l and a duplicate result of 0.02 mg/l show a small numerical difference (0.01 mg/l) but a large percentage difference (100 percent).

7.0 Sampling Design

This project is designed to evaluate the water quality of tributaries and select reaches of Hangman Creek for determining fecal coliform, total phosphorus, and suspended sediment loads. The tributaries and reaches (Figure 2) were selected based on an evaluation of previous water quality sampling work. Rock Creek, Spangle Creek, Cove Creek, California Creek, and Marshall Creek were selected because they have generally had monitoring limited to a single sample near the mouth. The HB 2514 planning committee identified the sites on Hangman Creek (except for the livestock area) in 2003 as areas needing further evaluation. The sites integrate water quality characteristics from several sources and upstream reaches. The livestock area was selected to specifically evaluate the influence of livestock grazing near the creek on fecal coliform levels for the upcoming TMDL cleanup plan. The upstream livestock sample site is currently awaiting landowner approval. If approval is not obtained, the upstream site will be moved to Keevy Road.

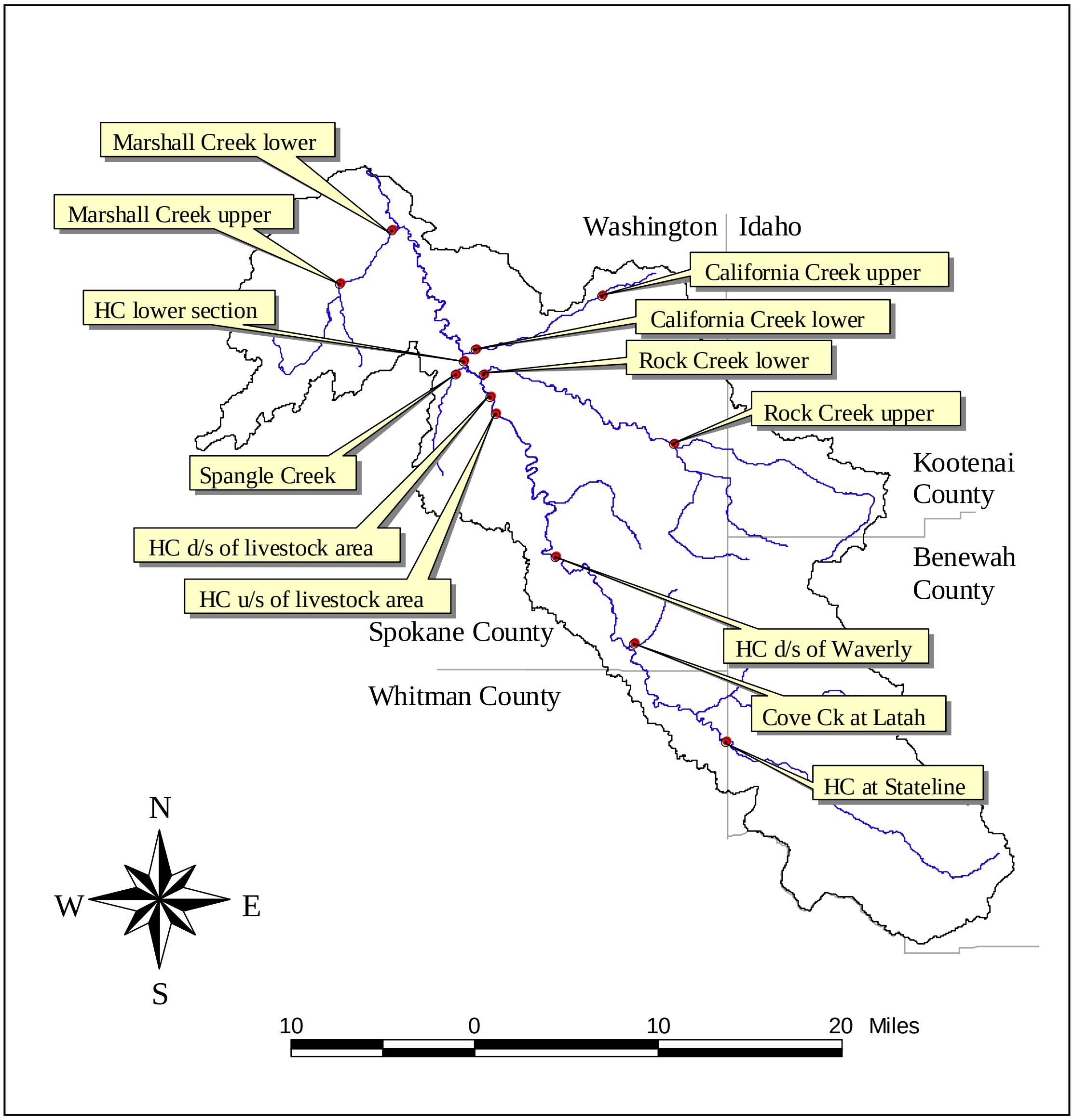

Figure 2: Sample Site Locations

Total phosphorus samples will be collected by municipal WWTP and STP personnel in coordination with project sampling times. Additional fecal coliform samples will be collected from combined sewer overflows (CSO) and Hangman Creek near the mouth (at the USGS gaging site). CSOs only flow during significant storm events, and sampling will be coordinated with current City of Spokane sampling schedules if possible.

Samples will be collected from upstream sites to downstream sites, but will not be timed to sample changes in a single block of water. Two type of samples will be collected, routine and event. Routine samples are samples collected on a regular monthly basis. Routine samples may be collected over two days if flow conditions are stable. Event samples are collected to evaluate the effects of significant flow events on water quality. For event sampling, samples will be collected on the rising limb and falling limb of the hydrograph, if possible. Events are defined as a Hangman Creek flow that is expected to exceed 2,000 cfs at the mouth as measured by the USGS gage. The USGS gage has a web-based monitoring system where the flows are updated and graphed every four hours. Real time data can be obtained by calling the gage house and obtaining the actual stage measurements. The instantaneous stage measurement can then be converted to a stream flow using the current stage-discharge rating.

Stream discharge measurements or estimations will be completed with all samples at all sites. Because of the time involved in sampling and measuring discharge, three sampling teams will be used for each sample run. One sampling team will sample all sites that can be sampled by wading for both the sample collection and the discharge measurements. The second sample team will sample sites that can be sampled by wading, using a boat and a tag line, or a hand line from a bridge. The third team will sample all sites that are only accessible using a bridge crane or truck mounted boom. Water quality samples will generally be collected first, and discharges measured or estimated later. During routine sampling, depending on flow levels, discharge measurements may be done at the time of sampling collection. During event sampling, flows will be measured or estimated after all water quality samples are collected.

The project design calls for the collection of: nutrients (phosphate, nitrate, nitrite, and ammonia), sediment (suspended solids and turbidity), and biological (fecal coliform bacteria). For the CSOs, Hangman Creek near the mouth, and the upper livestock site, these sites will be sampled for fecal coliform bacteria only. The lower livestock sample site will be sampled for all parameters. Waster water treatment plants and sewage treatment plants will collect total phosphorus samples in additional to their normal required parameters. All field sample sites will also measure dissolved oxygen, conductivity, pH, and temperature at the time of sample collection.

8.0 Field Procedures

Field sampling procedures will be completed to minimize disturbance to the stream environment. Samples that will be collected by wading into the stream will be collected upstream from the entry point.

The fecal coliform bacteria samples will be sampled using grab samples. Fecal coliform samples will be placed in autoclaved sample bottles. Nutrients will generally be analyzed from the suspended sample (this provides a channel and vertically integrated sample – see below). For grab samples, the bottle is uncapped, inverted, and submerged to a depth near the streambed without making contact. Sample bottles will be kept away from the streambed to prevent the collection of debris and bed load from the stream bottom. At this point the bottle is slowly turned upright with the mouth angled towards the direction of flow. As the bottle is turned upright, it is raised through the water column at a rate that will allow the container to be filled just before it reaches the water surface. This prevents sampling the water-air interface of the stream. The full bottle is then capped under water without retaining any air. Details on sample containers, preservation, and holding times are located in Table 8. Samples will be stored in the dark and on ice. Samples will be delivered to the Spokane Tribal Laboratory by district vehicle within 24 hours.

Table 8: Field Procedures

Parameter	Sample Size (milliliters)	Container Type	Preservation	Holding Time
Suspended Solids	Various	Glass or Plastic	Hold < 4 °C	48 hours
Turbidity				
Nitrates	500	HPDE Poly	Hold < 4 °C	24 hours
Nitrates				
Ammonia				
Phosphorus				
Fecal coliforms	500	Sterile Poly	Hold < 4 °C	<30 hours

Notes:
1. The sample size for suspended solids and turbidity will vary by the number of verticals. Sample size could be approximately from 0.5 to 3.0 liters.
2. All samples will be turned into the laboratory at the same time; therefore the shortest holding time (24 hours) will be used for all samples.

For nutrients and sediment sampling, the USGS equal width increment (EWI) sample method will be used when possible. The EWI samples will be taken according to U.S. Geological Survey (USGS) techniques in *Field Methods for Measurement of Fluvial Sediment* (Edwards T. K. and Glysson G. D., 1988). Samples obtained by the EWI method require a sample volume proportional to the amount of flow at each of the equally spaced verticals in a cross section. This equal spacing between the verticals yields a gross sample volume proportional to the total streamflow. For streams over five feet wide, a minimum of 10 verticals will be used. For streams under five feet wide, as many verticals as possible will be used spaced at a minimum of three inches.

EWI samples will be obtained using US Geological Survey standard depth-integrated samplers. The samplers use pint or quart glass bottles or three liter plastic bottles for sample collection. Sample bottles will be rinsed three times with deionized water.

For sediment samples during event sampling (and possibly at some routine sample sites), standard box samples will be obtained and a box coefficient calculated. Box samples are samples from a selected single sample point, and are used when time does not permit a complete EWI measurement. A single vertically integrated sample is collected at the point to represent the sample. Later when time is not critical in the sampling run, full EWI samples are collected and compared to box samples collected at the same time and a correction coefficient is estimated (a box coefficient). All box sample results are multiplied by the box coefficient to estimate the true sediment concentration. Box samples are used during the event sampling because of the need to collects samples a quickly as possible because the flow conditions are constantly changing.

Discharge measurements will be completed following standard USGS procedures outlined in *Rantz and others, 1982*. During periods when time does not allow standard discharge measurements (such as during events where water quality samples are being collected rapidly) normal depth calculations will be used. The sample sites will be setup and surveyed to measure cross-section water surface elevation and water surface slope through the cross-section. Several discharge measurements will be completed during non-event times to back calculate the roughness coefficient (Manning's *n* value) for use in the normal depth calculations (Henderson, 1966).

All sample containers will be labeled with:
1. Site identification
2. Sample date and time
3. Samplers initials
4. Sample parameters

For Fecal coliform samples, the laboratory will be notified if the sample is suspected to result in high counts, and the laboratory will do additional dilutions to cover a wider range of possible results. Replicate samples will be labeled to prevent the laboratory from knowing the actual sample site. Artificial site locations and times will be placed on the sample bottles and the actual times and locations noted in the field logbook.

Field notes and activities will be documented on dated field sheets. Changes will be made by drawing a line through the error, initialing the lineout, and writing the correct entry. Notes will include information such as:
1. Site location
2. Personnel
3. Any problems encountered or changes to sampling routine
4. Site and weather conditions
5. Samples collected
6. Field measurement results
7. Quality control samples collected and pseudo-identification used

9.0 Laboratory Procedures

The Spokane Tribal Laboratory was selected to analyze samples for this project. The Spokane Tribal Laboratory is accredited with the Washington Department of Ecology (Accreditation #T004) for all parameters to be analyzed (see Table 9). The Spokane Tribal Laboratory quality assurance plan is included in Appendix A.

Table 9: Laboratory Procedures

Parameter	Sample Matrix	Expected Range of Results (mg/l unless noted)	Laboratory Detection Limits	Analytical Method
Suspended Solids	Surface Water	DL – 2,000	2 mg/l	EPA 160.2
Turbidity	Surface Water	DL – 200 NTU	0.05 NTU	EPA 180-1
Nitrites	Surface Water	DL – 1.00	0.01mg/l	EPA 300.0
Nitrates	Surface Water	DL – 10.0	0.01mg/l	EPA 300.0
Ammonia	Surface Water	DL – 2.00	0.01mg/l	EPA 350.1
Phosphorus	Surface Water	DL – 5.00	0.005mg/l	EPA 365.1
Fecal coliforms	Surface Water	DL –2,000 colonies/100 ml	1 colony/100 ml	Standard Methods 9222D

Notes:
1. DL is detection limit.
2. NTU is Nephelometric Turbidity Units.

10.0 Quality Control

Both quality control and quality assurance are an integral part of this project. Quality assurance consists of the procedures used to control the unmeasurable components of the project. These components consist of such things as sampling at the right placed with the right equipment using the right techniques. The quality assurance aspect of this project has been addressed previously.

The quality control (QC) consists of the data generated to estimate the magnitude of the bias and variability in the processes for obtaining the environmental data. The quality control samples are used to be sure that the sampling process is not influencing the sample results. The data from the QC samples measure errors in the environmental data. The two types of errors measured are bias and variability.

Bias is systematic error inherent in a method or measurement system. The error can be positive (contamination) or negative (loss). Variability is random error in independent measurements as the result of repeated application of the same process under specific conditions.

Data generated from quality control samples are a requisite for evaluating the quality of the sampling and processing techniques. The quality control data also are used to evaluate the samples themselves. Without QC data, environmental sample data cannot be adequately interpreted because the errors associated with the sample data are unknown. The various types of QC samples collected during this project are described below.

<u>Blank Samples</u>

Blank samples are collected and analyzed to ensure that environmental samples have not been contaminated by the overall data-collection process. The blank solution used is a solution that is free of the analytes of interest. Any measured value signal in a blank sample for an analyte that was absent in the blank solution is believed to be due to contamination. Bias in the collection of samples due to contamination will be evaluated using field blanks.

Field blanks consists of a blank solution that is subjected to all aspects of sample collection, field processing, transportation, and laboratory handling as an environmental sample. If contamination is found in the field blank, other blanks, known as topical blanks, will be evaluated to segregate different parts of the overall data-collection process. The other types of topical blanks that could be evaluated on an "as-needed" basis are:

Trip blanks
Equipment blanks
Source solution blanks
Ambient blanks

It is not anticipated that any of the above topical blanks will be required or sampled.

Reference Samples

Reference samples consists of reference solutions prepared by a laboratory whose composition is certified for one or more properties so that they can be used to assess measurement methods. Samples of reference material are submitted for analysis to ensure that an analytical method is accurate for the known properties of the reference material. The selected reference material properties will be similar to the environmental sample properties. No spiked samples are scheduled for this project. Reference samples are scheduled to be included twice during the project.

Replicate Samples

Replicate samples, also referred to as duplicated samples, are a set of environmental samples collected in a manner such that the samples are thought to be essentially identical in composition. Replicate samples are collected and analyzed to establish the amount of variability in the data contributed by some portion of the collection and analytical process. Several types of replicate samples are possible, but the type collected for this project will be predominantly concurrent replicate samples. Concurrent samples are samples collected simultaneously, or by alternating subsamples between two or more collection bottles. In some cases, sequential samples may be collected. Sequential samples are a replicate sample in which the samples are collected one after the other, typically over a short period of time.

Replicate samples for fecal coliform bacteria, nutrients, and sediment will be collected throughout the project during routine sample runs because of the speed required to obtain the event samples during changing flow conditions. For the routine sample runs, 13 sites will be sampled monthly. During these runs, approximately 128 fecal environmental samples are scheduled to be collected, 108 nutrients and sediment environmental samples are scheduled to be collected, and 45 concurrent replicate samples for fecal, sediment and nutrients are scheduled to be collected. Some fecal sampling locations, such as CSOs, will only be samples when flowing.

Along with the replicate samples, six field blanks each for fecal, sediment, and nutrients will be collected. Two reference samples will be submitted for nutrients. The reference samples will be obtained from the USGS Denver laboratory.

Suspended Sediment – special handling

Suspended-sediment concentrations are determined from samples collected by using depth-integrating samplers. Samples usually are obtained at several verticals in the cross-section, or a single sample may be obtained at a fixed point and a coefficient applied to determine the mean concentration in the cross-section.

Sediment samples collected at several verticals usually fill several samples bottles from the depth-integrating samplers. Samples with more than one collection bottle will be combined in the field and a subsample collected for analysis. Three composite samples will be evaluated for variability. Once the complete composite sample is collected, the subsample for analysis and three replicate samples will be collected and analyzed by the laboratory.

Samples obtained from a single sample at a fixed point will be corrected with a coefficient applied to determine the mean concentration in the cross-section. The single sample from a fixed point, along with a complete composite sample from the full set of verticals will be collected simultaneously. Both samples will be submitted to the laboratory for analysis.

11.0 Data Management Procedures

Optional – not included.

12.0 Audits and Reports

Optional – not included.

13.0 Data Review, Verification, and Validation

A data quality assessment will be performed after completing the field and laboratory activities. The field records, including field sample collection forms, will be organized and reviewed for accuracy and completeness.

Analytical data is expected to be received from the laboratory in both hard copy and electronic formats. The data will be logged in, reviewed to ensure that all analytical requests are present, organized in files, and catalogued. A complete set of data files, both hard copy and electronic, will be maintained in the project files. Data review procedures associated with the monitoring samples includes evaluating sample holding times, field duplicate, and laboratory duplicate samples.

Quality Control Procedures

Approximately 45 randomly selected environmental samples will also have duplicate samples collected. The duplicate sampling sites were chosen at random during the sampling design. The laboratory staff will not be informed of the sample identity until all samples from that event are analyzed. Six blanks will be submitted as samples to the laboratory. Blank samples will undergo all the processing a normal field sample receives, including running through the USGS sampler.

The contract laboratory has been certified by the Washington Department of Ecology. The laboratory conducts quality assurance checks that are provided with each sample set data results. The routine laboratory QC procedures used by the Spokane Tribal Laboratory have been approved by the DOE.

Performance and System Audits

System audits will be conducted monthly, once on the field activities and once on the laboratory results. Field activity audits will determine whether procedures are being followed and documented. All fieldwork activities are documented using field water quality monitoring sheets. The field data that will be recorded on the water quality monitoring sheets are listed below.

- Date of sample collection
- Time of sample collection
- Location of sample collection
- Sample numbers (including associated duplicate and split sample numbers)
- Instrument calibration checks, and
- Notes regarding sample collection, instrument operation, water stage conditions, and weather conditions

The field water quality-monitoring sheet is to be completed by the field team leader and provided to the project coordinator. The project coordinator will record the data in the project database after checking the field sheets for completeness and consistency.

Preventive Maintenance

Field instruments and test equipment will be calibrated according to the manufacturers recommended procedures on a regular basis during sampling activities. Instruments will typically be calibrated at the beginning of the day or prior to taking measurements, unless otherwise specified in the instrument manual.

Data Assessment Procedures

Data from the laboratory analysis will be reviewed to ensure the data quality objectives have been achieved. Data quality will be assessed by using pooled estimates of the standard deviations and the relative standard deviation for each parameter.

The pooled estimate of the standard deviation (S) is given by:

$$\text{Pooled } S = \sqrt{(\sum D^2 / 2m)}, \text{ where:}$$

D = sample value – duplicate value, and
m = the number of sample pairs;

(S. M. Lombard, written commun., 1999).

The pooled relative standard deviation is given by the median value of the relative standard deviation estimated for each sample pair.

The relative standard deviation is given by:

$$\text{RSD (in \%)} = \frac{(|\text{sample value} - \text{duplicate value}| / \sqrt{2})}{(\text{sample value} + \text{duplicate value})/2} \ (100);$$

(S. M. Lombard, written commun., 1999).

14.0 Data Quality Assessment

The data quality objectives outlined in Section 6.0 will be assessed at the end of the project. The project data will be used to evaluate environmental sample results against a fixed numerical value, or the regulatory standards that could place a stream reach or tributary on the 303(d) list.

The decision process for determining compliance with the water quality standards will initially assume that there is no bias in the sample results. Initial environmental sample results will be compared to the standards for exceedence.

Duplicate results will be used to estimate the standard deviation associated with the project sampling. Replicate analysis will be used to determine the standard deviation.

$$SD = \sqrt{(C_1-C_2)^2/2}$$

$$RSD = \sqrt{((C_1-C_2)^2/2)/(C_1+C_2)/2}$$

The sample/duplicate variability will be estimated using a piecewise linear model. The replicate data will be split into groups based on the ranges of the mean concentrations. The mean standard deviation or relative standard deviation for each range will be computed. A plot of the computed means as linear estimates of standard deviation versus mean concentration will be completed.

The variability determined using the field replicates is assumed to be the true standard deviation (field variability) for all possible samples. The field variability will be used to estimate the uncertainty of the concentrations measured in a single sample and to estimate the minimum difference in means that can be determined with confidence.

Bias will be evaluated using the results from the field blanks. Because of the nature of the parameters being evaluated (nutrients, fecal coliform, and sediment) sample contamination is not expected to be a significant problem. If consistent contamination is found and is not able to be corrected by the use of topical blanks as described in Section 10.0, the action level will be evaluated to account for the bias. If bias is account for, all laboratory results will be reported as received from the laboratory. Any environmental sample results that account for bias will be clearly noted. Both the laboratory results and any results that need to account for bias will be detailed in the report appendix.

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