Colville River Fecal Coliform
Total Maximum Daily Load Study

Final Quality Assurance Project Plan

by
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March 22, 2000

Washington State Department of Ecology
Environmental Assessment Program
Watershed Ecology Section

Approvals:

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Project Description

Introduction

Located in northeastern Washington, the Colville River originates at the confluence of Sheep Creek and Deer Creek in southern Stevens County. Flowing northerly for 53 miles, the river passes through the towns of Chewelah and Colville, eventually discharging to Lake Roosevelt, an impoundment of the Columbia River behind Grand Coulee Dam, near Kettle Falls (Figure A1). The Colville River watershed accounts for an entire Water Resource Inventory Area (WRIA 59).

The Colville River drains a 1015 square mile basin. Only eight and a half square miles of the basin, along the northeastern divide, is outside of Stevens County, in Pend Oreille County to the east. The Colville River basin drains 41% of the land area in Stevens County - a rural county with 1997 population of 37,400 (OFM, 1997). Land-use in the watershed is urban/residential near the population centers of Chewelah, Colville, Kettle Falls, Springdale, and along portions of the highway corridors. The sub-basins are rural/residential with agriculture the predominant land-use along the valleys and on some terraces higher up. The uplands are dominated by evergreen forest making-up almost 75% of the land cover in the Colville River watershed.

In 1994, the Washington Department of Ecology (Ecology) conducted a study to determine the capacity of the Colville River to assimilate pollutant loads (Pelletier, 1997). A Total Maximum Daily Load (TMDL) for dissolved oxygen was developed as a result of that study. The study also found pollution by fecal coliform (fc) bacteria was a significant problem. Portions of the river and tributaries are listed under section 303(d) of the federal Clean Water Act as not meeting water quality standards for fecal coliform (Figure A2). Section 303(d) requires Washington State and the United States Environmental Protection Agency (USEPA) to establish TMDLs for all waterbodies not meeting water quality standards.

A TMDL includes problem identification, technical analysis to determine the loading capacity of the waterbody to assimilate the pollutant, establishing allocations of pollutant loads to sources, public participation, and an implementation plan for the TMDL. This project plan addresses the problem identification, loading capacity, and load allocation elements of the TMDL process. The Eastern Regional Office will be responsible for the public participation and implementation plan.

Project Objectives

The major objectives of the study are to:

* Characterize fecal coliform bacteria density and loads in the Colville River and tributaries;

* Identify relative contributions of fecal coliform loading from near-shore and tributaries to the Colville River; and

* Establish load allocations from nonpoint sources to support a TMDL as required under section 303(d) of the federal Clean Water Act.

Study Design

The objectives of the project will be met through a combination of water quality and discharge data collection, modeling the fate and transport of fecal coliform, and the analysis of loading scenarios and resulting water quality. The monitoring is designed to evaluate spatial and temporal patterns in loads coming from tributaries and along the Colville River.

Fecal coliform surveys are planned bi-weekly from March 2000 through March 2001 to meet project objectives. Stevens County Conservation District (SCCD) personnel will be collecting the water quality samples and discharge data as cooperators in the project. The schedule for proposed field surveys is listed below in Table 1 under Sampling Schedule. Sample sites are identified with an alphanumeric label (Figure A1). A total of 10 mainstem and 15 tributary sites will be sampled for water quality parameters. Descriptions of site locations and land cover in the sub-drainage areas proposed for monitoring are presented in Appendix A. These sites have been sampled in previous studies completed by the SCCD and Ecology (SCCD, 1993; Pelletier, 1997).

Synoptic surveys will be conducted once in July and again in September by Ecology staff. These times were selected to coincide with the period of greatest biological activity and lowest stream flows. Sample sites will be the same for the synoptic surveys as the fecal coliform surveys. Additional water quality parameters are included in synoptic studies at the request of the regional office and the water quality program. Results from synoptic survey samples will be available to compare to results from earlier studies and provide data for possible expansion of the project scope in the next fiscal year to include additional parameters.

Currently, the Colville River at Kettle Falls has the only USGS flow station (station 12409000) in the basin. In an effort to get current discharge information for sub-basins, Ecology personnel will establish gaging stations at key locations in the basin. A total of five flow monitoring stations will be developed. Stage height will be recorded hourly by pressure transducers and data loggers during the project. Icing conditions may require removal of pressure transducers during the winter to prevent damage. Flow will be measured at these stations over the range of discharge for developing rating curves. At other stations, stage height will be measured from installed staff gages or tape downs from bridges by survey personnel during the sampling events. Flow rating of ungaged sub-basins will be accomplished by developing relationships between instantaneous measurements with continuous measurements at other locations. Locations for the installation of the continuous recorders will be determined through consultation with the SCCD and site review from a reconnaissance survey. In addition, Ecology personnel will deploy weather stations, and water and air temperature probes in the basin. Weather stations will be located at Colville and Chewelah wastewater treatment plants for recording climatic data. Two sites are proposed for installing weather stations, to account for north to south differences in weather patterns within the basin. Data from weather stations will be used for modeling exercises. Water and air temperatures will be recorded by data loggers from June through October at up to eight sites. Locations of temperature probes will be determined during the

course of the study to allow possible future expansion of the project scope to include temperature modeling of the mainstem Colville River.

Project Organization and Responsibility

The following individuals and organizations will be involved in the project:

Carl Nuechterlein and David Knight (Ecology): Client section manager and staff contact for the Eastern Regional Office Water Quality Program. Responsible for reviewing the quality assurance project plan (QAPP), draft study report and coordinating basin planning activities. (509/456-2926)

Greg Pelletier (Ecology): Project manager, responsible for overall project management. Develops the project objectives, scope, and design. Responsible for water quality model development and the write-up of model results. Reviews the project QAPP and final report and is responsible for primary contact with the client and stakeholders. (360/407-6000)

Randy Coots (Ecology): Principle investigator, assists in developing the objectives, scope, and study design. Responsible for preparation of the QAPP, coordinating sample analysis and shipment of sample containers to project cooperators, collecting and analyzing data, installation of remote sensing equipment, and report writing. (360/407-6000)

Charlie Kessler (Stevens County Conservation District): Project cooperator responsible for sample collection and shipping, and providing discharge information to Ecology principal investigator. (509/685-0937)

Stuart Magoon and Manchester Environmental Laboratory (MEL) Personnel (Ecology): Responsible for review of the QAPP pertaining to laboratory analyses, the analysis and reporting of project data to principal investigators for samples submitted to the Ecology MEL, and contracting Jim Sweet of Portland, Oregon for the phytoplankton ID/biovolume analysis. (360/871-8860)

Dale Norton(Ecology): Contaminant Studies Unit Supervisor. Responsible for review of the project QAPP and final report. (360/407-6765)

Cliff Kirchmer (Ecology): Quality Assurance Officer responsible for the review of the project QAPP. (360/895-4649)

Data Quality Objectives

The data from the laboratory's standard quality control procedures and replicate field samples will provide information to determine if data quality objectives have been met. The lab routinely runs two split samples per survey batch and two blanks, one before and one after the run, to check dilution water quality.

Precision and Bias

Standard protocols for data and sample collection will be followed throughout the study to limit sources of bias. Sources of bias from sampling procedures and sample handling will be minimized by adherence to standard operating procedures listed in the WAS protocol manual (WAS, 1993). Results from bacteria samples will be considered acceptable when lab split sample pairs and field replicate pairs are within an order of magnitude. If sample pair data differ by greater than an order of magnitude, a judgement will be made to either flag the data or not use it. Measurement accuracy will be optimized by following manufacturers recommendations for proper calibration and maintenance of field meters and equipment which include; dissolved oxygen meters, velocity meters, pressure transducers and data recorders, staff gages, thermometers, and measuring tapes.

Representativeness

The sampling design was developed to ensure that the data are representative. All study stations will be sampled on 26 occasions to cover the range of flow/runoff events. To assess the total variability of the data (field variability plus laboratory variability) a minimum of 10% of the stations per survey day will be sampled in replicate (defined as one sample or measurement taken immediately following the first) for all parameters. The relative percent difference (RPD) will be calculated for replicate pairs to determine total variability.

Completeness

The amount of usable data obtained by this study will be maximized by careful planning of field surveys and employing standardized protocols for sample collection and analysis. All personnel involved with sample collection will be familiar with the WAS field sampling and measurement protocol manual (WAS, 1993). Any needed training would be provided by the Ecology principal investigator.

Two sample sites have potential access problems during the wet season. The Huckleberry Creek at the mouth station (site HUC7) could be difficult to access because of snow and mud. The location of an alternate sample site will be upstream at the culvert crossing on Farm to Market Road over Huckleberry Creek. The Stensgar Creek station (site STEN14) could also be difficult to access due to snow. If snow prevents access to the Stensgar Creek site, an alternative sample location will be upstream at the Zimmer Road crossing over Stensgar Creek.

Comparability

Data comparability between this study and earlier studies in the Colville River basin will be assured by use of standard operating procedures for sample collection and handling listed in the WAS protocol manual (WAS, 1993) and adherence to comparable bacterial and chemical analytical methods.

Analytical Procedures

The analytical methods and sensitivity or reporting limits for laboratory and field measurements of conventional and biological parameters for the study are listed in Table B1. The E.coli analysis has been included in the project in the event the state water quality standard for bacteria are changed during the course of the project. Field sampling and measurement techniques will adhere to protocols described in the WAS protocol manual (WAS, 1993).

Sampling Procedures

Sample collection and handling, and measurement procedures for the study will follow those described in WAS protocols (WAS, 1993). Grab samples, except for dissolved oxygen, will be collected directly into pre-cleaned containers supplied by MEL and described in the *Manchester Environmental Laboratory Users Manual* (MEL, 1994). Dissolved oxygen samples will be collected in bottles prepared by WAS staff and analyzed according to WAS protocols for the modified Winkler method (WAS, 1993). All meters will be calibrated and post-calibrated in accordance with the manufacturer's recommendations.

Gaging stations will be developed based on procedures described in the WAS protocol manual (WAS, 1993). Discharge will be calculated based on procedures described in the WAS protocol manual and *Open-Channel Hydraulics* (Chow, 1959). Continuous data from weather stations and stage height probes will be recorded by Unidata dataloggers. Unidata and Design Analysis pressure transducers will be used for measuring and logging stage height.

Quality Control Procedures

Total variation for field sampling and laboratory analysis will be assessed through collection of field replicates. A minimum of 10% of the laboratory samples and field measurements per parameter will be replicated each survey day. The laboratory will follow standard operating procedures for quality control as described in the *Manchester Environmental Laboratory Users Manual* (MEL, 1994).

All laboratory analysis listed in Table B1 will be performed in accordance with the *Manchester Environmental Laboratory Users Manual* (MEL, 1994). Field sampling and measurement protocols will follow those described in the WAS protocols manual (WAS, 1993). All meters will be calibrated and post-calibrated per manufacturer's instructions. Samples for laboratory analysis will be preserved on ice as specified by the *Manchester Environmental Laboratory Users Manual* (MEL, 1994) and delivered to the lab within 24 hours of collection.

Data Assessment Procedures

The data reduction, review and reporting will follow the procedures outlined in the *Manchester Environmental Laboratory Users Manual* (MEL, 1994). Data will be transferred to the principal investigators electronically from MEL through the Ecology environmental information management (EIM) system to avoid transcription errors. Before entering data into a final project

database, 100% of the data will be reviewed for missing or improbable values. Sample holding times will be reviewed to assure results are properly flagged. Total variability for field replicates and laboratory variability for lab splits will be quantified by calculating the RPD for sample pairs. At the conclusion of the study, all quality assured project data will be archived into the Ecology EIM database.

Modeling and Data Analysis

Project data will be entered into Excel spreadsheets. Statistics will be calculated using the spreadsheets and importing the data into other statistical software like SYSTAT (Wilkinson, 1988) or WQHYDRO (Aroner, 1992). Water quality models will be reviewed during the sampling phase of the project. The choice of a water quality model will be made after an evaluation for the most current and applicable to the project goals. Spreadsheet models will also be used during the project.

Data from the USGS and SCCD will also be used to meet project objectives. The USGS data will be obtained from their web-site as text files for their Kettle Falls gaging station (station 12409000) and analyzed in Excel spreadsheets or WQHYDRO. The SCCD data will be imported into project spreadsheets and analyzed using Excel software.

Sampling Schedule

Sampling dates for the Colville River TMDL are listed below in Table 1. Twenty-six sample surveys for bacteria and conventional parameters will be conducted bi-weekly between March 2000 and March 2001. Two synoptic surveys for nutrients and conventional parameters will also be conducted, one in July and one in September 2000. The size of the basin and logistical constraints preclude sampling all 25 sites in one day. The northern basin sites will be sampled on Mondays of the sampling week and the southern basin sites will be sampled on Tuesdays. The dates of the proposed surveys are as follows:

Table 1. Sample dates for the Colville River TMDL study.

Bi-weeklySurveys		
March 13-14	July 31-August 1	December 18-19
March 27-28	August 14-15	January 8-9
April 10-11	August 28-29	January 22-23
April 24-25	September 11-12	February 5-6
May 8-9	September 25-26	February 19-20
May 22-23	October 9-10	March 5-6
June 5-6	October 23-24	March 19-20
June 19-20	November 6-7	***Synoptic Surveys***
No Survey the week of July 3	November 20-21	July 25-26
July 17-18	December 4-5	September 19-20

Project Schedule and Laboratory Budget

The schedule of the proposed project is as follows:

Draft QAPP to Signature list for review	January 7, 2000
Final QAPP	March 7, 2000
Field Surveys	March 2000 – March 2001
Draft Report to Unit Supervisor	February 28, 2002
Draft report to Client and External Reviewers	March 31, 2002
Final Report	May 31, 2002
EIM Data Entry Completion	July 30, 2002

The laboratory budget is presented in Table B2 in Appendix B. The total laboratory expense for the project is estimated to be $36,500 ($9000 for the FY00 period and $27,500 for the FY01 period).

Reporting

A draft report will be provided to the client program in the Eastern Regional Office by March 31, 2002. The report will include:

- an Executive Summary
- an introduction with project background and a problem statement
- a study area map including sample sites and significant features in the watershed
- descriptions of the laboratory and field methods
- a discussion of data quality
- summary tables of sample results and field measurements
- summary tables of model results
- discussion of significant findings and water quality standards exceedances
- loading estimates and TMDL load allocations
- recommendations for follow-up work as needed
- sample site descriptions including land cover percentages of sub-drainages as an appendix
- the complete survey set of bacteria, chemical, and physical data as an appendix

A final report will be completed after review comments are received from the Eastern Regional Office client, the SCCD, and EAP peer reviews. The final report is scheduled for completion by June 1, 2002. A copy of the project data set will be electronically forwarded to the SCCD after completion of a QA review.

References

Aroner, E.R., 1992. *WQHYDRO: Water Quality Hydrology Graphics/Analysis System.* June, 1992. P.O. Box 18149. Portland, OR.

Chow, V., 1959. *Open-Channel Hydraulics.* McGraw-Hill Book Company, New York, New York. 680 pages.

MEL, 1994. *Manchester Environmental Laboratory Users Manual, Fourth Edition.* Washington State Department of Ecology, Olympia, WA.

OFM, 1997. *State of Washington 1997 Data Book.* State of Washington, Office of Financial Management, Olympia, WA.

Pelletier, G., 1997. *Colville River Water Quality: Pollutant Loading Capacity and Recommendations for Total Maximum Daily Loads.* Washington State Department of Ecology. Environmental Assessment Program. Olympia, WA.

SCCD, 1993. *Water Quality Summary for Colville River Watershed Ranking and Planning.* Stevens County Conservation District. Colville, WA.

WAS, 1993. *Field Sampling and Measurement Protocols for the Watershed Assessments Section.* Washington State Department of Ecology. Environmental Assessment Program. Olympia, WA

Wilkinson, Leland. *SYSTAT: The System for Statistics.* Evanston, IL: SYSTAT, Inc. 1988.

Appendix A

Site Locations and Descriptions
(Sample site descriptions were largely excerpted from the SCCD (1993) report: *Water Quality Summary for Colville River Watershed Ranking and Planning.*)

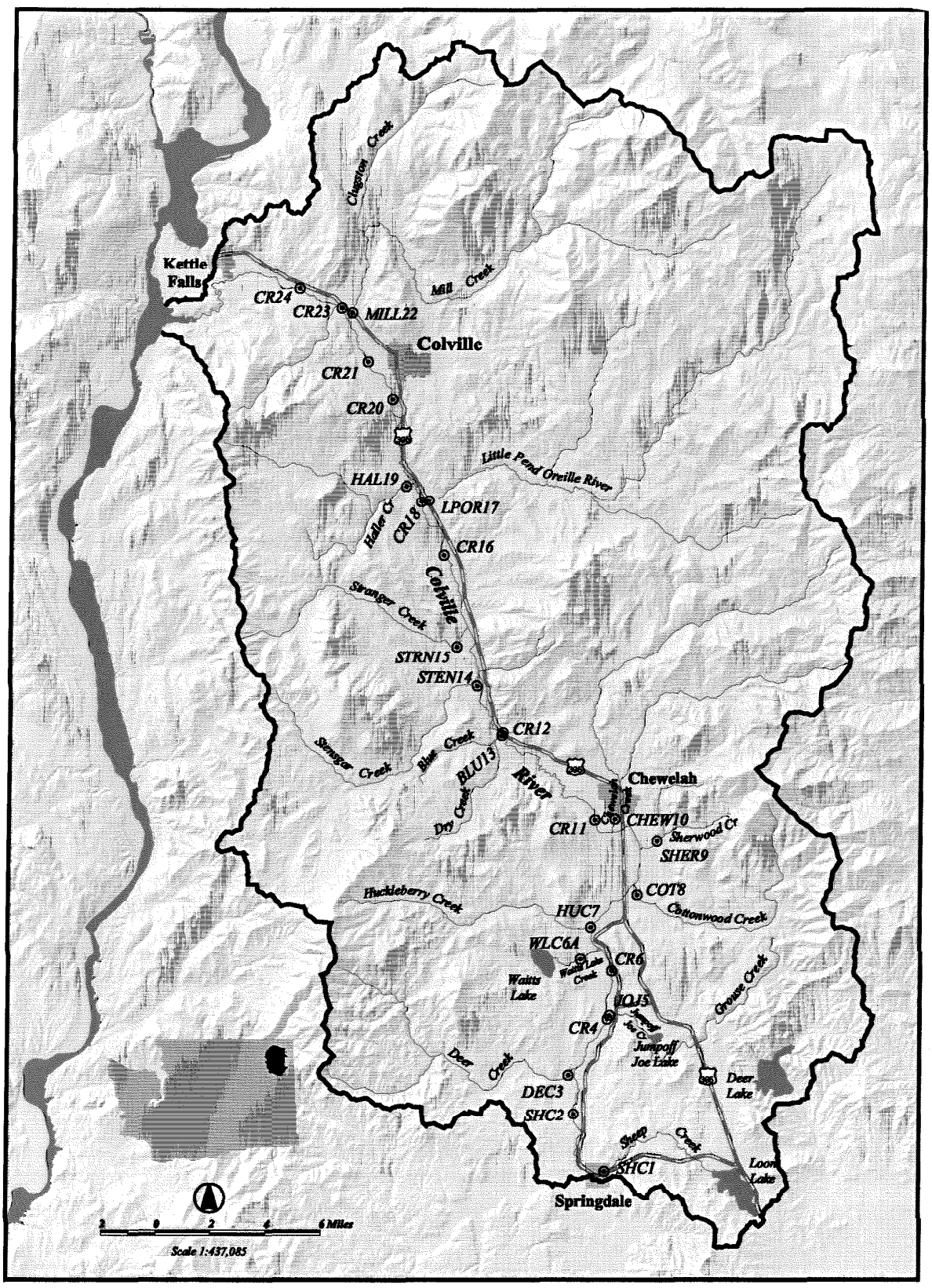

Figure A1. Study area map showing the Colville River Watershed and sampling stations.

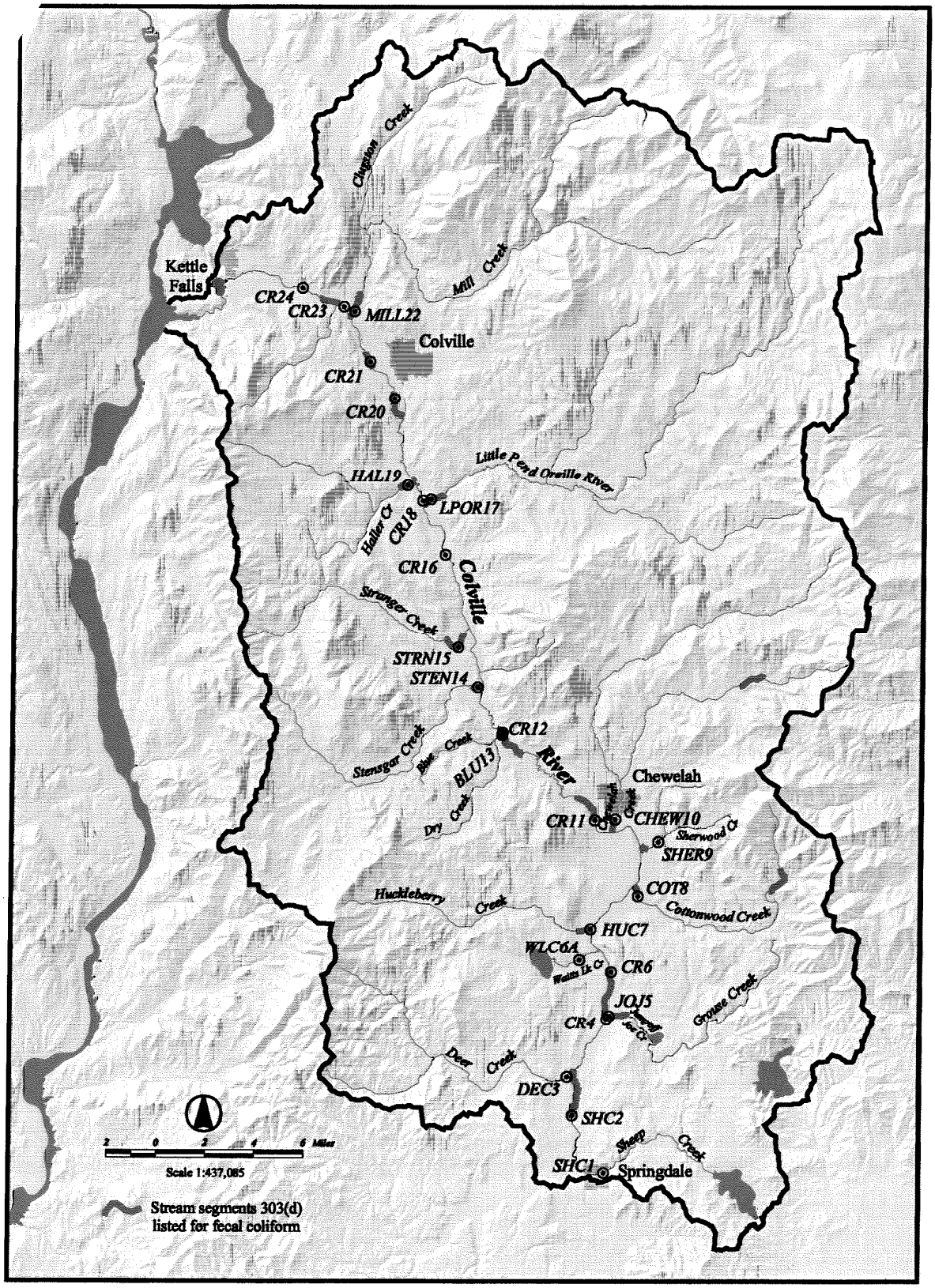

Figure A2. Colville River waterbody segments on the 1998 303(d) list for fecal coliform.

Sampling Sites

SCH 1: Sheep Creek in Springdale, Washington

The most upstream sample site for study is located in the town of Springdale. Samples are collected downstream of a culvert below a large sandy fill under Main Street North. Substrate materials around the sampling area consisted of numerous large rocks. Flowing northwest through Springdale the creek has a uniform profile, following a series of steps from the uplands. Upstream of the sample site is generally undeveloped with an established riparian zone.

The majority of the sub-basin is forested with much of the open land in agriculture. Highway 292 runs east to west through the southern portion of the sub-basin and Highway 231 runs north to south through the middle.

Fifty-four square miles of land drain to the Sheep Creek in Springdale site. This accounts for about 5.3% of the Colville River watershed. Evergreen forest (73%) is the predominant land-cover in the sub-basin, followed by open water (6.9%), transitional areas (4.8%), and grasslands (3.9%).

SCH 2: Sheep Creek at Long Prairie Road

The sample site is downstream of a large arched culvert under Long Prairie Road, just east of the junction with Forest Center Road. The creek discharges to a large pool just below the culvert. Leaving the pool the creek meanders downstream. Samples are collected from the meandering portion of the creek.

Areas adjacent to the creek, both upstream and downstream of the sample site, are used for livestock grazing and crop production. Cattle have access to the creek upstream and around the sample site.

Sixty-one square miles of land drain to the Sheep Creek at Long Prairie Road site. This accounts for about 6.0% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by open water (6.2%), transitional areas (4.4%), and grasslands (4.3%).

DEC 3: Deer Creek at Deer Creek Road

The sample site is located upstream of the large arched culvert under Deer Creek Road, between Highway 231 and Long Prairie Road. The immediate area is characterized by a well-established riparian zone, although the creek flows adjacent to the gravel surfaced Deer Creek Road for about one mile upstream. An irrigation diversion splits Deer Creek upstream of the sample site. Just downstream of the sample site Deer Creek and Sheep Creek flows combine to form the Colville River.

The substrate materials around the sampling area are comprised of cobble with boulders. There is recruitment of woody debris from the riparian zone.

Forty-two square miles of land drain to the Deer Creek at Deer Creek Road site. This accounts for about 4.1% of the Colville River watershed. Evergreen forest (80%) is the predominant land-

cover in the sub-basin, followed by transitional areas (9.7%), mixed forest (3.6%), and hay/pasture (1.4%).

CR 4: Colville River at Betteridge Road, RM 50

The most upstream sample site on the Colville River is located above the town of Valley and the Lane Mountain plant. Upstream of the station is an aggregate plant, but previous investigations have not shown significant contributions from the plant to the river. Access to the sample site is from the bridge on Betteridge Road – a gravel road running east to west across the valley floor. Agricultural lands border the river upstream and downstream of the site. Much of the land is grazed because it is too wet to consistently raise grain crops.

Previous surveys found the river at this site often had a milky appearance. Continued investigation found that during early morning the river water was less milky than later morning. The source of the milky color is still open to debate.

The Colville River at Betteridge Road site drains 123 square miles of land. This accounts for about 12% of the Colville River watershed. Evergreen forest (73%) is the predominant land-cover in the sub-watershed, followed by transitional areas (5.8%), mixed forest (4.1%), and pasture/hay (3.8%).

JOJ 5: Jump-Off-Joe Creek at the Mouth

This sampling site is adjacent to sampling site 4, with the creek running along the north side of Betteridge Road, before entering the river downstream of the bridge. Jump-Off-Joe Creek is the outflow of Jump-Off-Joe Lake and descends through a canyon before flowing through an old mill site, under Highway 231, through a livestock holding area, and on to the Colville River. The creek flows along the base of a road fill for approximately a quarter mile before discharge to the river.

The upland area of the sub-basin is drained by Grouse Creek, which discharges to Jump-Off-Joe Lake. Development around the lake is increasing.

Sixteen square miles of land drain to the Jump-Off-Joe Creek site. This accounts for about 1.5% of the Colville River watershed. Evergreen forest (77%) is the predominant land-cover in the sub-basin, followed by transitional areas (9.6%), pasture/hay (3.0%), and open water (2.7%).

CR 6: Colville River at Waitts Lake Road, RM 48

This sampling site is just downstream of the town of Valley. Agricultural lands border the river along this reach, both upstream and downstream. Much of the land is grazed because it is too wet to consistently raise grain crops. Less than one-mile upstream, Lane Mountain has a series of holding ponds adjacent to the river.

Substrate around the site has very little coarse materials and a high organic content. A dense aquatic plant growth is present in the river, while grass covers the riverbanks.

A discharge pipe coming from the river's east bank was found in a previous investigation. Elevated levels of fecal coliform, ammonia, nitrate-nitrite, and total phosphorus were measured

in samples. A sewer system was installed for Valley/Waitts Lake in 1998 that should help control the discharge.

The Waitts Lake Road is paved and receives heavy truck use from material hauling to the Lane Mountain company. It is also a well-traveled road for accessing the western Colville River Valley.

The Colville River at Waitts Lake Road site drains 165 square miles of land. This is about 16% of the Colville River watershed area. Evergreen forest (72%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.1%), pasture/hay (4.8%), and mixed forest (3.9%).

WLC 6A: Waitts Lake Creek at Farm to Market Road

This site is located upstream of the culvert under the Farm to Market Road. Downstream of the culvert, a seasonal pond is created by a board dam. The site is far enough upstream to avoid backwater effects of the pond. During the low flow period, water movement is non-existent at the site.

Forest and agricultural land surround Waitts Lake. A resort and numerous residences are present around the lake. Residences in the sub-basin use on-site sewage disposal systems.

The creek flows out of Waitts Lake and along Waitts Lake Road southeast before crossing under the road and dropping down to the valley floor.

Thirteen square miles of land drain to the Waitts Lake Creek at Farm to Market Road site. This accounts for about 1.2% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by open water (6.7%), pasture/hay (6.1%), and transitional areas (4.8%).

HUC 7: Huckleberry Creek at the Mouth

Access to the Huckleberry Creek site is from the Newton Road bridge, south about one half mile across private property, along the west bank of the Colville River. Winter and spring access could be limited due to snow and mud. If conditions prevent access to the primary site, the location of an alternate sample site will be upstream at the bridge crossing on Farm to Market Road over Huckleberry Creek.

Land adjacent to the sample site is cropland. Upstream of the site is a sediment basin behind a rock gabion dam. The dam was constructed to alleviate sediment build-up in the Colville River downstream of the confluence with Huckleberry Creek.

Forty-one square miles of land drain to the Huckleberry Creek site. This accounts for about 4.1% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-basin, followed by transitional areas (15%), mixed forest (3.6%), and pasture/hay (1.6%).

COT 8: Cottonwood Creek at the Mouth

Access to this site is through private property, where Farm to Market Road ends east of Highway 395. The creek flows through cropland and grazing areas for approximately one half mile before discharging to the Colville River. The area around the sampling site has been heavily grazed. Water quality samples are collected above a cattle wallow.

The lower portions of the sub-basin contain fertile farmland used for production of hay and grains as well as grazing cattle. Uplands contain a significant amount of Forest Service land.

Thirty-four square miles of land drain to the Cottonwood Creek site. This accounts for about 3.3% of the Colville River watershed. Evergreen forest (80%) is the predominant land-cover in the sub-basin, followed by transitional areas (8.1%), pasture/hay (4.2%), and grasslands (1.6%).

SHER 9: Sherwood Creek at Cottonwood Creek Road

The sample site is located downstream of the culvert under Cottonwood Creek Road. The uplands above the sample site have a few houses, while downstream the creek borders agricultural lands until discharge to the Colville River. Well upstream of the sample site, an earthen dam, which contained Horseshoe Lake, failed in 1974. The resulting debris torrent created a large canyon and deposited gravel and fine sediment throughout the lower reaches of Sherwood Creek. This material is evident downstream of the sample site, piled on either bank as the result of previous dredging activities.

Cottonwood Creek Road is a paved, north to south oriented road, located on the east side of the Colville River valley. Horseshoe Lake Road is graveled, and runs adjacent to portions of the creek upstream of the sampling site.

Twelve square miles of land drain to the Sherwood Creek site. This accounts for about 1.1% of the Colville River watershed. Forest Service land makes up a large portion of the sub-basin, while farmland is found along the Colville River in the western portion of the drainage and on terraces higher up. Evergreen forest (91%) is the predominant land-cover in the sub-basin, followed by transitional areas (7.1%) and pasture/hay (0.94%).

CHEW 10: Chewelah Creek at Alm Lane

This site is located downstream of the City of Chewelah. The creek flows through a city park, business, and residential areas, before discharge to the Colville River south of the sample site. The creek is used for recreation and flows under a major highway and several city streets upstream of the site.

The portion of the creek that flows through the city and on to the river falls under the Shorelines Protection Act because its average discharge is greater than 20 cubic feet per second. The City of Chewelah is developing a Shorelines Management Plan. Stevens County already has such a plan for the portions of the creek under their jurisdiction.

Ninety-three square miles of land drain to the Chewelah Creek site, which includes the City of Chewelah with a population of about 2000. The road network in the drainage makes many portions of the creek readily accessible to the public. The Chewelah Creek sub-basin accounts for about 9.2% of the Colville River watershed. Evergreen forest (81%) is the predominant land-cover, followed by transitional areas (10.5%), pasture/hay (3.0%), and grasslands (1.5%).

CR 11: Colville River at Alm Lane, RM 39

The sampling site is located upstream of the City of Chewelah sewage lagoons on the west side of the valley. Alm Lane crosses the river at this point. It is a paved road and a major access to the west side of the valley.

The land adjacent to the river upstream and downstream of the sampling site is used for agricultural purposes. A horse ranch is located downstream and the horses are restricted to selected access points but this has not been consistent. Samples are collected upstream of the horse access points.

River substrate material at this site is predominantly sandy. There are aquatic plants along the banks and in the center of the channel in some areas.

The Colville River at Alm Lane drains 390 square miles of land. This accounts for about 38% of the Colville River watershed. Evergreen forest (74%) is the predominant land-cover in the sub-watershed, followed by transitional areas (8.1%), pasture/hay (5.1%), and grasslands (2.8%).

CR 12: Colville River at Blue Creek, RM 32

Located downstream of the City of Chewelah, this site is affected by flows from the community of Bluecreek. Bluecreek is a small community with many residences along Blue Creek, a stream flowing into the Colville River above the sample site.

Flows at this site have higher velocities than other Colville River sites. The river is shallow through the reach and substrate is composed of large cobble and gravel. The bottom appears to be well armored for all but the higher flows. Highway 395 parallels the river at this site and Blue Creek Road crosses the river via a paved surface bridge.

Draining 427 square miles of land the Colville River at Blue Creek site accounts for about 42% of the watershed. Evergreen forest (73%) is the predominant land-cover in the sub-watershed, followed by transitional areas (8.1%), pasture/hay (5.3%), and grasslands (3.0%).

BLU 13: Blue Creek in the Community of Bluecreek

Blue Creek watershed is made up of Blue Creek and Dry Creek – an intermittent stream. The sample site is located just upstream of the culvert under Blue Creek Road and below the railroad crossing.

Blue Creek flows through agricultural lands before passing through the community of Bluecreek. There are many residences along the creek. All of these residences have on-site sewage disposal systems. Upstream of the community are two livestock holding areas, one on Blue Creek and the other on Dry Creek, above its confluence with Blue Creek.

Sixteen square miles of land drain to the Blue Creek site. The Blue Creek sub-basin accounts for about 1.6% of the Colville River watershed. Evergreen forest (78%) is the predominant land-cover in the sub-basin, followed by transitional areas (9.7%), mixed forest (4.0%), and pasture/hay (3.2%).

STEN 14: Stensgar Creek at the Mouth

Access to the site is through private property off Zimmer Road via a two-track grass road. Snow could impact access to the site. If snow prevents access an alternative sample location will be upstream at the Zimmer Road crossing over Stensgar Creek.

The Stensgar Creek sub-basin is rural and contains some dairies. The creek flows through agricultural lands for a significant distance above the sample point. Some of the land is cropland and some is used to graze dairy and beef cattle.

During a previous investigation, the creek did not flow to the river for a portion of the dry season. It was assumed irrigation extractions upstream, in addition to it being a dry year, were the cause.

Fifty-six square miles of land drain to the Stensgar Creek site. The Stensgar Creek sub-basin accounts for about 5.5% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by pasture/hay (9.8%), transitional areas (5.7%), and grasslands (2.1%).

STRN 15: Stranger Creek at Marble Valley Basin Road

Upstream of the culvert under Marble Valley Basin Road, this site is near the Northwest Alloy Magnesium Plant in Addy. The stream reach immediately above the sampling point flows along the toe of the fillslope for Marble Valley Basin Road. The fill is well vegetated with grass. The Marble Valley Basin Road receives a great deal of heavy truck traffic due to gravel hauling from the Northwest Alloy plant.

The Stranger Creek sub-basin is diversified with agricultural land along the river and creek, forests on the side hills and mountains, and a major industrial complex, Northwest Alloy, near Addy.

Forty-three square miles of land drain to the Stranger Creek site. This accounts for about 4.2% of the Colville River watershed. Evergreen forest (72%) is the predominant land-cover in the sub-basin, followed by pasture/hay (7.7%), transitional areas (6.8%), and grasslands (3.2%).

CR 16: Colville River at 12 Mile Road, RM 25

The sample site is located downstream of Addy and the Northwest Alloy Magnesium Plant. The Burlington Northern right-of-way runs along the east bank of the river. There is evidence of debris from railroad maintenance operations being cast into the river. Trucks hauling gravel from Northwest Alloy heavily use the 12 Mile Road bridge.

The land adjacent to the river upstream and downstream of the sampling site is primarily used for agricultural purposes. Most of the land is used for hay and grain production but there is some livestock grazing.

The substrate material along the west bank is soft with aquatic plant growth present. The remainder of the substrate is primarily fine material with scattered coarse particles.

The Colville River at 12 Mile Road drains 558 square miles of land. This accounts for about 55% of the Colville River watershed. Evergreen forest (73%) is the predominant land-cover in the sub-watershed, followed by transitional areas (7.4%), pasture/hay (6.1%), and grassland (3.0%).

LPOR 17: Little Pend Oreille River at Highway 395

This sample site is located downstream of the Highway 395 bridge and upstream of the Burlington Northern railroad bridge. Upstream of the site, the river flows through a residential area, Arden. Downstream of the site is the Stimson Lumber Company mill.

Highway 395 is a major north-south route from Canada and northeastern Washington, to Spokane and locations farther south. There is a great deal of heavy truck traffic across the bridge.

The substrate materials at this site are composed of cobble and large gravel. The river gradient keeps flows moving well through the reach.

The U.S. Fish and Wildlife Service administers a large portion of the sub-basin as the Little Pend Oreille Wildlife Refuge. The headwaters of the river are in the Little Pend Oreille Lakes area, a popular recreational destination.

The Little Pend Oreille River sub-basin is the largest in the Colville River watershed. One hundred and eighty-seven square miles of land drain to the Little Pend Oreille River site. This accounts for about 18.5% of the Colville River watershed. Evergreen forest (84%) is the predominant land-cover in the sub-basin, followed by transitional areas (5.0%), pasture/hay (3.5%), and grasslands (2.2%).

CR 18: Colville River at Arden Hill Road, RM 21

The sample site is located upstream of the Arden Hill Road bridge on the west side of the Colville River Valley and downstream of the Stimson Lumber Company mill. Water is pumped

from the river by the timber mill to wet log decks. A detention pond is used to prevent runoff water from direct return to the river.

River substrate in the reach is a mixture of course and fine material. Just upstream of the site is a large gravel bar formed by the higher energy flow of the Little Pend Oreille River meeting the lower energy flow of the Colville River. The Colville River is braided around the bar and vegetation is growing on it.

The land adjacent to the river upstream and downstream of the site supports industrial, residential, and agricultural land-uses. Arden Hill Road climbs away from the river at a steep grade and is heavily sanded in the winter.

The Colville River at Arden Hill Road drains 751 square miles of land. This accounts for about 74% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.7%), pasture/hay (5.6%), and grasslands (2.8%).

HAL 19: Haller Creek off Skidmore Road

Access to the sample site is from the 90-degree corner on Skidmore Road, through private property. The area immediately upstream of the site has residences and is used for agricultural purposes. A historic gaging station was located upstream of the sample site where Skidmore Road crosses the creek. The gaging station was active from August 1959 to September 1970.

There has been significant construction of new homes in the watershed. A subdivision of larger homes was developed in the 1980's along Haller Creek Road. Numerous small animal keeping operations characterize the watershed.

Thirty-eight square miles of land drains to the Haller Creek site off Skidmore Road. This accounts for about 3.7% of the Colville River watershed. Evergreen forest (80%) is the predominant land-cover in the sub-basin, followed by transitional areas (6.1%), pasture/hay (4.9%), and grasslands (3.1%).

CR 20: Colville River at Mantz-Rickey Road, RM 16

Upstream of the City of Colville the riparian zone around the sample site contains large, older cottonwood trees. Many of these trees have fallen into the channel both upstream and downstream of the site. Altered flow at the site from debris has caused areas of sediment deposition throughout the channel.

The substrate material is primarily sand, with muck occurring along the west bank in the shadow of large woody debris. Velocities and gradient through the reach are such that deposition of fine materials is occurring.

The land-use immediately upstream and downstream of the sample site is agriculture. Hay and grain crops are raised in the area. The Mantz-Rickey Road, running east west across the valley, is not a heavily used road.

The Colville River at Mantz-Rickey Road drains 800 square miles of land. This accounts for about 79% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.6%), pasture/hay (5.7%), and grasslands (2.9%).

CR 21: Colville River at Oakshot Road, RM 14

This sample site is located downstream of the City of Colville's sewage lagoons. Treated wastewater from the lagoons is discharged to the Colville River. The substrate materials are predominantly sand, with some gravel along the west bank. Deposition at the site is apparent by the development of sand mounds. The banks are well covered with grasses but undercutting is evident.

The land-use adjacent to the sampling site is agriculture. Hay and grains are raised and cattle are grazed in the area. Cattle occupy the fields on either side of the site but do not have access to the river.

The Colville River at Oakshot Road drains 817 square miles of land. This accounts for about 81% of the Colville River watershed. Evergreen forest (74%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.5%), pasture/hay (6.0%), and grasslands (3.0%).

MILL 22: Mill Creek at Highway 395

This sample site is located between the Highway 395 bridge and the Burlington Northern railroad bridge. The channel has changed alignment beneath the bridge, over the years. During periods with multiple channels, samples will be collected upstream of the highway bridge to catch the flow before splitting.

The substrate materials are composed primarily of gravel and cobble. The banks upstream have been stabilized with riprap for a number of years. Some of the large riprap materials are probably native to the site. Velocities in the creek through the sample reach are such that a large amount of material is moved during higher flows.

The Mill Creek drainage contains two very distinct streams, Mill Creek and its tributary, Clugston Creek. Clugston Creek flows into Mill Creek approximately four miles upstream of the confluence of Mill Creek and the Colville River.

The land-use upstream of the sample site include agriculture and residential. Hay and grain, and livestock keeping, characterize the agricultural activities.

The Mill Creek sub-basin is the second largest in the Colville River watershed. One hundred and forty-one square miles of land drain to the Mill Creek at Highway 395 site. This accounts for about 14% of the Colville River watershed. Evergreen forest (82%) is the predominant land-cover in the sub-basin, followed by pasture/hay (4.5%), transitional areas (4.1%), and grasslands (3.4%).

CR 23: Colville River at Gold Creek Road, RM 11

The sample site is located adjacent to the Gold Creek Road/Valley Westside Road bridge. The channel is wider at this site. Deeper water is along the riverbanks while deposition has created shallower water mid-channel. Gravel is predominant in the middle of the channel, while boulders are found along the margins.

This site is downstream of the City of Colville and the Vaagen Brothers Lumber Mill. Most of the area between Colville and the sample site is used for agriculture. Hay and grain crops are raised in the area and cattle are grazed along much of the land adjacent to the river.

Downstream of the site is a heavy equipment yard and a deposition site for mining residue. The exact nature of the residue is not known.

The Colville River at Gold Creek Road drains 973 square miles of land. This accounts for about 96% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.1%), pasture/hay (5.9%), and grasslands (3.2%).

CR 24: Colville River at Greenwood Loop Road, RM 9

The most downstream sample site for the project is approximately two miles upstream of the backwater effect of the dam at Meyers Falls. The riparian zone in this section of the river contains a substantial amount of large woody vegetation. There is large woody debris upstream and downstream of the sample site but flow does not appear to be affected

Substrate materials are comprised of mixed sand, gravel, and cobble. Flow velocity through the reach is generally high enough to flush much of the fine material out.

The Burlington Northern railroad right-of-way is adjacent to the river at the sample point. The Greenwood Loop Road is paved but not heavily traveled.

The Colville River at Greenwood Loop Road drains 986 square miles of land. This accounts for about 97% of the Colville River watershed. Evergreen forest (75%) is the predominant land-cover in the sub-watershed, followed by transitional areas (6.1%), pasture/hay (5.9%), and grasslands (3.2%).

Appendix B

Analytical Methods and Estimated Costs

Table B1. Summary of field and laboratory measurements, target detection limits, and methods.

	Parameter	Target Sensitivity or Reporting Limit	Method*
	Field Measurements		
	Dissolved Oxygen	± 0.06 mg/L	Gas Probe/Winkler Titration
	pH	± 0.1 standard units	Field Meter/Electrode
	Temperature	+ 0.2 ° C	Alcohol Thermometer
	Velocity	± 0.05 f/s	Marsh-McBurney Current Meter
	Stage Height	± 0.02 feet	Staff Gage
	Stage Height Continuous	± 0.01 feet	Pressure Transducer
General Chemistry/Microbiology			
	Specific Conductivity	1 *u*mhos/cm at 25° C	SM 18, 2510
	Fecal Coliform	2 cfu/100 mL	SM 18 Membrane Filter 9222D
	E. coli	2 cfu/100 mL	EPA 1105
	Ammonia Nitrogen	0.01 mg/L	EPA 350.1
	Nitrate + Nitrite	0.01 mg/L	EPA 353.2
	Total Persulfate Nitrogen	0.01 mg/L	SM 18 4500 NO_3-F Modified
	Orthophosphate	0.01 mg/L	EPA 365.3
	Total Phosphorus	0.01 mg/L	EPA 365.3
	Total Organic Carbon	1 mg/L	EPA 415.1
	5-Day BOD	2 mg/L	EPA 405.1
	Ultimate Carbonaceous BOD	2 mg/L	NCASI (1987)
	Phytoplankton ID/Biovolume	--	SM 18 10200F; Sweet (1987)
	Chlorophyll *a*	0.05 *u*g/L	SM 18 10200H(3), fluorometer

* SM = Standard methods for the examination of water and wastewater. Eighteenth edition (1992). American Public Health Association, American Water Works Association, and Water Environment Federation. Washington D.C.

EPA = Methods for the chemical analysis of water and wastes. Environmental Monitoring Supply Laboratory U.S. Environmental Protection Agency. Cincinnati, OH. EPA-600/4-74-020. 1983.

NCASI = A procedure for the estimation of ultimate oxygen demand (biochemical). National Council of the Paper Industry for Air and Stream Improvement, Inc. Special Report No.87-06. May 1987.

Sweet (1987) = Phytoplankton of selected northwest lakes and rivers. Final report prepared for the Environmental Protection Agency Region X, Seattle, WA. Project Officer: Dave Terpening. Prepared by J.W. Sweet. June 1987.

Table B2. Laboratory budget for the proposed Colville River fecal coliform study.

Laboratory Parameter	Unit Cost	Samples/ Survey	Number of Surveys	sample Total	Total Cost
Primary Surveys					
Fecal Coliform (MF)	$20	30	26	780	$15,600
E. coli (MF)	$10	30	26	780	$7,800
Synoptic Surveys					
Specific Conductance	$7	30	2	60	$420
Total Persulfate Nitrogen	$16	30	2	60	$960
Nutrients 5	$53	30	2	60	$3,180
Alkalinity	$14	30	2	60	$840
Total Organic Carbon	$29	30	2	60	$1,740
5-day Biochemical Oxygen Demand	$46	4	2	8	$368
Ultimate Carbonacous Biochemical Oxygen Demand**	$304	4	2	8	$2,432
Chlorophyll *a*	$46	30	2	60	$2,760
Phytoplankton ID/Biovolume	$56	3	2	6	$336
Grand Total:					$36,436

** Ultimate UCBOD with combined NO_2 and NO_3 - N (9 measurements during incubation)