Quality Assurance Project Plan

Phase 2 Water Quality Monitoring Program

Long Tom Watershed Council

July 2004 – June 2006

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Introduction

The Council received funding from the Oregon Watershed Enhancement Board (OWEB) and the Oregon Department of Environmental Quality (EPA 319 Funds) to implement a Phase 2 water quality monitoring program. There are several significant differences between Phase 1 (from September 1999 – June 2003) and Phase 2 (July 2004 – June 2006). First, Phase 2 expands the number of sites for nutrients and *E. coli* in some areas and decreases them in others. For example, we added four sites in the Ferguson Creek sub-watershed between our two original sites because this tributary shows impairment for *E. coli*, nitrate, and total phosphorus. However, we stopped collecting these parameters at the original, upstream-most site on Ferguson Creek (FC2) because this location did not show impairment for any of these parameters. Second, in order to conserve time and money, we collect nutrient and bacteria samples every other month. Third, we stopped measuring dissolved oxygen between December and March because data from the past four years indicate that low dissolved oxygen is not a problem in the winter. Fourth, we focused our continuous temperature monitoring on identifying tributaries that meet state temperature standards in the summer. Fifth, we added a macroinvertebrate monitoring program, which will characterize the health of stream biota at a sub-watershed scale. One similarity between Phase 1 and 2 is that we are continuing monthly field monitoring at our 18 baseline sites.

In overview, this program includes:

I. Monthly monitoring of water temperature, turbidity and conductivity at 18 baseline sites.
II. Monthly monitoring of dissolved oxygen from April through November at 18 baseline sites.
III. Continuous temperature monitoring at up to 34 sites.
IV. Grab samples for *E. coli*, nitrate, and/or total phosphorus on a bi-monthly basis at 33 sites.
V. Macroinvertebrate sampling at 100 randomly selected sites in each sub-watershed.

This Quality Assurance Project Plan describes the Program's objectives, study design, methods, and quality control/assurance procedures.

Watershed Overview

The Long Tom River Watershed drains 410 square miles of land at the southern end of the Willamette Valley. The headwaters of the Upper Long Tom originate on the eastern side of the Coast Range and flow south through forested hills and small farms until reaching Noti where the river veers east near its confluence with Elk and Noti Creek. Coyote Creek, which drains the southern portion of the basin, and Amazon Creek, which drains the eastern portion, both merge with the Upper Long Tom near what is now Fern Ridge Reservoir. The Lower Long Tom spills out the north end of the reservoir and flows approximately 25 miles before joining the Willamette River.

The Watershed contains four ecoregions, which will each require somewhat different water quality goals and management strategies. The Mid-Coastal Sedimentary and Valley Foothills ecoregions cover the steeper upland areas of the watershed. Near headwaters, stream channels are confined within steep, narrow valleys, becoming more sinuous downstream where the valleys widen. The underlying geology is mostly sedimentary with some basalt in the Valley Foothills region. The combination of soft sedimentary rock and relatively high precipitation rates in these regions contributes to higher erosion rates. Natural vegetation includes western hemlock, western red cedar, Douglas fir, and red alder.

The Prairie Terrace ecoregion covers most of the low gradient valley lands except for a small portion along the Lower Long Tom River, which is part of the Willamette River and Tributaries Gallery Forest ecoregion. Unmodified streams in these regions cut a sinuous path across the valley floor. Many streams have been channelized in order to protect farms, homes and businesses from flooding. In either case streams are often deeply entrenched in the thick sedimentary clay soils deposited by the Missoula floods thousands of years ago. The natural vegetation within the Prairie Terraces region is Oregon white oak, Oregon ash, Douglas fir and prairie, whereas the Willamette River Gallery Forest contains large stands of cottonwood, alder, Oregon ash, bigleaf maple and Douglas fir.

The Long Tom Watershed is home to a variety of fish, amphibians, birds and invertebrates that rely on the network of streams, lakes and wetlands in the Basin. Native fish species include White sturgeon, Cutthroat trout, Mountain whitefish, Pacific lamprey, Western brook lamprey, Chiselmouth, Peamouth, Longnose dace, Leopard dace, Speckled dace, Mountain sucker, Sand roller, Northern pikeminnow, Redside shiner, Largescale sucker, Threespine stickleback and a variety of sculpin.

Currently, no fish that spawn in the Long Tom Watershed are on the federal list of Threatened and Endangered Species. However, Spring Chinook use portions of the lower Long Tom River for winter rearing habitat. Historically, Oregon Chub inhabited the Watershed, and this species is currently listed on the Threatened and Endangered Species List.

The water quality of streams and lakes is a significant issue in the Long Tom Watershed. It affects fish and wildlife, such as cutthroat trout and red legged frog, and has an impact on human health through activities such as swimming and fishing in Fern Ridge Reservoir and the Long Tom River. The Long Tom and several of its tributaries are listed on the Department of Environmental Quality's 303(d) list for a variety of parameters, including bacteria, dissolved oxygen, turbidity, temperature, heavy metals, and toxic organic compounds (see **Appendix A**). The water quality of the Long Tom also has a significant effect on the Willamette River. A 1995 Tetra Tech study identified the Long Tom as one of the five most polluting tributaries to the Willamette (Tetra Tech 1995). Recent listings of upper Willamette River salmon and steelhead populations highlight a need to understand and improve all watersheds influencing these populations.

Table 1 shows the distribution of land ownership and **Table 2**shows the proportion of land use and acreage in each sub-watershed[1]. The watershed's population in 1990 was estimated to be 92,000.[2] The greatest concentration of people is located in the urban portions of the watershed, chiefly Eugene, Veneta and Monroe. Farming, ranching, logging and rural residential development are other significant land uses.

Table 1. Long Tom Watershed Ownership

Ownership	Acres	Percentage
Private	242,131	92
BLM	295	<1
O & C Lands	20,355	8
State Lands	66	<1

[1] Land use acreage was determined from state-wide zoning maps.
[2] This calculation was based on digitized census block information from the 1990 U.S. Census.

Table 2. Sub-basin Land Use

Sub-basin	Agri-culture	Forestry	Urban	Rural Resident	Parks & Rec.	Rural Indust	Other	Total Acres
Upper Long Tom R.	8%	80%	<1%	10%	2%	<1%	0%	35,605
Elk Cr.	9%	88%	0%	1%	0%	1%	0%	27,709
Coyote Cr.	31%	64%	0%	4%	2%	0%	0%	45,185
Spencer Cr.	22%	49%	1%	27%	<1%	0%	0%	21,320
Upper Amazon Cr.	6%	6%	80%	7%	<1%	0%	0%	19,710
Lower Amazon Cr.	62%	0%	21%	6%	<1%	0%	11%	19,292
Fern Ridge	25%	20%	5%	20%	5%	0%	25%	32,209
Bear Cr.	33%	57%	0%	10%	<1%	0%	0%	17,701
Ferguson Cr.	40%	59%	0%	<1%	0%	0%	0%	16,357
Lower Long Tom R.	81%	7%	1%	8%	2%	0%	<1%	27,784
Watershed Total	**31%**	**46%**	**8%**	**9%**	**1%**	**1%**	**4%**	**262,872**

Summary of Results from Phase 1 Monitoring

Results from our water quality monitoring program from September 1999 through June 2003 indicate a number of water quality issues in the basin (Thieman 2003). The most striking data are the high *E. coli* levels in several sub-watersheds. As shown in earlier studies, Amazon and Coyote Creek have chronic *E. coli* problems (City of Eugene 1999, Army Corps of Engineers 1999, Lane Council of Governments 1983). In addition, very high levels have been found in Bear Creek, Ferguson Creek and at the outlet of Fern Ridge Reservoir.

Data for dissolved oxygen and water temperature indicate problems at all downstream sites during the summer months. Both nitrate and phosphorus are a concern in the upper and lower Amazon sub-watersheds and the lower Long Tom River. The upper Amazon sub-watershed drains the City of Eugene and the lower sub-watershed and the lower Long Tom River drain high-density, irrigated cropland. We suspect that phosphorus is the primary limiting nutrient in Long Tom Watershed streams and lakes, and the high levels we are seeing may be a significant factor influencing algal growth, biological oxygen demand and in turn dissolved oxygen levels. However, it is possible that nitrogen may become a limiting nutrient in the Amazon sub-watersheds during the summer when algal photosynthesis is at a high point.

Conductivity and pH data follow predictable trends. Conductivity levels are higher in the summer, especially at downstream sites, and lower in the winter. Because there is no state standard for this parameter it is difficult to say whether conductivity levels are a problem. At our urban and agricultural sites there are distinct spikes in conductivity during the summer months. This may relate to fertilizer and other chemical uses, in addition to slower flows, which concentrate salts in the water. pH is lower in the winter and higher in the summer, especially in the afternoons when photosynthetic rates are highest. pH does not appear to be a significant problem in our basin when compared with the state standard.

Turbidity data show spikes associated with winter storm events. At certain sites, turbidity levels have exceeded 50 NTU during the winter. We will re-evaluate our turbidity data when the new turbidity standard becomes finalized.

Objectives

The Long Tom Watershed Council will use the Phase 2 water quality monitoring results to:

- Support implementation of the Upper Willamette TMDL
- Identify tributaries that are contributing to bacteria and nutrient problems in sub-watersheds where one or more of these parameters have been identified as consistently not meeting state standards
- Initiate cooperative problem solving through the Council's Sub-Watershed Enhancement Program by discussing results with streamside landowners
- Continue to monitor watershed conditions and verify that data we have collected over the last three years accurately reflects the ecological condition of the Watershed
- Evaluate stream health based on the macroinvertebrate community
- Monitor effectiveness of restoration and enhancement activities at a sub-watershed scale
- Educate and involve landowners, residents and high-school age youth in water quality monitoring and analysis

Monitoring Questions

1) For sub-watersheds where *E. coli* consistently does not meet state standards, do selected tributaries contribute a significant proportion of the bacteria loading or is the loading distributed across the sub-watershed?
2) For sub-watersheds where phosphorus or nitrates consistently do not meet state standards, do certain tributaries contribute a significant proportion of the nutrient loading or is the loading distributed across the sub-watershed?
3) Are correlations between water quality trends and land use consistent with what we've seen over the past four years?
4) Have water quality conditions improved or worsened at a sub-watershed and watershed scale over the past 6 years?
5) Based on macroinvertebrate assemblages, what percentage of stream miles are in good, fair, or poor condition?

Study Design

Monthly Field Monitoring and Summer-time Temperature Monitoring

Monthly surface water measurements of temperature, conductivity and turbidity will continue to be collected at 18 baseline sites within the Watershed. Monthly monitoring of dissolved oxygen will occur from April through November at 18 the baseline sites. Additional observations that will be documented during each site visit may include recent rainfall, weather, water color, vegetation changes, wildlife, and recent events in the Watershed that may influence water quality at that site.

The locations of these original 18 sites were selected with three objectives in mind:

1) To characterize water quality in each of the Watershed's sub-basins
2) To investigate correlations between water quality and land-use.
3) To investigate spatial variation of water quality in the Basin (i.e. up to downstream differences).

To accomplish these objectives we selected sampling sites at the mouths of each sub-basin, at junctures between different land uses, and that were distributed in the upper, middle and lower portions of the Watershed. In addition, all 18 sites are monitored once a month in a three-day period between 8:00 and 11:00. This helps minimize differences due to time of day or changes in stream conditions.

Continuous temperature monitoring will be conducted from June through September of 2004 and 2005 using Vemco data loggers. The monitoring coordinator and Technical Advisory Committee will determine locations for continuous temperature monitoring. **Table 3** summarizes the sampling frequency, data collector, and general method for each parameter.

Table 3. Summary of Baseline Field Monitoring and Continuous Temperature

# of Sites	Parameters	Sampling Frequency	Data collection responsibility	Method
18	Temperature	Monthly	Monitoring team	Portable field meter
Up to 34	Temperature	Continuous June - September	Staff	Vemco dataloggers
18	Turbidity	Monthly	Monitoring team	Portable field meter
18	Bridge height (for flow rating curve)	Monthly April - November	Monitoring team	Measure to water surface from fixed point on bridge.
18	Dissolved Oxygen	Monthly	Monitoring team	Winkler titration kit
18	Conductivity	Monthly	Monitoring team	Portable field meter

Nutrient and Bacteria Sampling

In our Phase 1 program we collected nitrate, total phosphorus, and *E. coli* at the 18 baseline sites once/month. After evaluating results from four years of data, we concluded that we needed better spatial resolution for bacteria and nutrient concentrations in some areas and that we could stop sampling for some or all of these parameters in other areas. As a result, we now have 33 sites where we collect nitrate, total phosphorus, and/or *E. coli*. This will allow us to better determine the source of these pollutants and develop solutions with willing landowners.

Table 4 lists the monitoring sites where we collect monthly field data (i.e., D.O., conductivity, turbidity, temperature) and bi-monthly grab samples for nitrate (NO_3), total phosphorus (TP), and/or *E. coli*.

Table 4. Site Descriptions, Parameters, and Locations

Sub-WS	Site Description	Site ID[3]	Parameters	Predominant Upstream Land Use	River Mile	Lat	Long
Bear Creek	Bear Creek @ Templeton Rd.	**BC2**	D.O., Cond, Turb, Temp	Forestry, livestock, rural residential	10.1	44.1824	-123.3799
	Bear Creek @ Territorial Rd.	**BC1**	D.O., Cond, Turb, Temp, NO_3, TP, *E. coli*	Forestry, livestock, rural residential	1.2	44.2143	-123.2897
	Bear Creek @ Hall Rd.	BCA	NO_3, TP, *E. coli*	Forestry, livestock, rural residential	4.6	44.1852	-123.3184
	Owens Creek @ Smythe Rd.	BCT1	NO_3, TP, *E. coli*	Forestry, livestock	1.4	44.2014	-123.3312
	Jones Creek @ Hall Rd.	BCT2	NO_3, TP, *E. coli*	Forestry, livestock, rural residential	0.6	44.1852	-123.3224
	Battle Creek at Battle Creek Rd.	BatCr@ BatCrRd	TP, *E. coli*	Forestry, rural residential	0.1	43.9685	-123.3206
Coyote Cr	Coyote Creek @ Powell Rd.	**CC2**	D.O., Cond, Turb, Temp, *E. coli*	Forestry, livestock, rural residential	16.4	43.9245	-123.2706
	Tributary of Coyote Creek	**CC4**	D.O., Cond, Turb, Temp, NO_3, TP	Forestry	Not avail.	43.9200	-123.2923
	Coyote Creek @ Petzold Rd.	**CC1**	D.O., Cond, Turb, Temp, TP, *E. coli*	Forestry, livestock, agriculture, rural residential	6.35	44.0043	-123.2694
	Coyote Creek at Battle Creek Rd.	CC@Bat CrRd	TP, *E. coli*	Forestry, livestock, rural residential	11.3	43.9697	-123.3189
Elk Cr	Cedar Creek @ Bishop Rd. (off Hwy. 126)	**EC2**	D.O., Cond, Turb, Temp, NO_3	Forestry	0.6	44.0679	-123.5338
	Elk Creek @ Vaughan Rd.	**EC1**	D.O., Cond, Turb, Temp, NO_3, *E. coli*	Forestry, livestock, agriculture, rural residential	0.1	44.0558	-123.4515
	Noti Creek @ Vaughn Rd.	NCT1	NO_3, *E. coli*	Forestry, livestock, agriculture, rural residential	0.6	44.0558	-123.4518
	Poodle Creek @ Hwy126	PCT1	NO_3, *E. coli*	Forestry, livestock, agriculture, rural residential	0.9	44.0671	-123.4569

[3] Site ID's in bold are baseline sites

Ferguson Creek	Ferguson Creek @ Fergsuon Rd. (~MP 9)	**FC2**	D.O., Cond, Turb, Temp	Forestry	6.2	44.2509	-123.3717
	Ferguson Creek @ Territorial Rd.	**FC1**	D.O., Cond, Turb, Temp, NO_3, TP, *E. coli*	Forestry, livestock, agriculture, rural residential	1.4	44.2474	-123.2880
	Ferguson Creek (bridge on private land)	FCA	*E. coli*	Forestry, livestock, agriculture, rural residential	2.8	44.2403	-123.3148
	Ferguson Creek @ Turnbow Rd.	FCB	NO_3, TP, *E. coli*	Forestry, livestock, rural residential	4.6	44.2438	-123.3464
	Ferguson Creek @ Ferguson Rd.	FCC	NO_3, TP, *E. coli*	Forestry, livestock, rural residential	6.2	44.2518	-123.3725
	South Fork Ferguson Cr. (bridge on private land)	FCD	NO3, TP, *E. coli*	Forestry, livestock, rural residential	0.6	44.2454	-123.3800
Lower Long Tom	Lower Long Tom @ Bundy Bridge	**LL1**	D.O., Cond, Turb, Temp, NO3, TP, *E. coli*	Forestry, agriculture, livestock, urban, rural residential	0.8	44.3799	-123.2486
	Lower Long Tom @ Hwy. 36	**LL2**	D.O., Cond, Turb, Temp, NO3, TP, *E. coli*	Forestry, agriculture, livestock, urban, rural residential	18.2	44.1904	-123.2787
	Lower Long Tom @ Clear Lake Rd.	**LL3**	D.O., Cond, Turb, Temp, NO3, TP, *E. coli*	Forestry, agriculture, livestock, urban, rural residential	24	44.1214	-123.3090
	Lower Long Tom @ Monroe/Hwy 99	LLA	NO3	Forestry, agriculture, livestock, urban, rural residential	7.6	44.3129	-123.2959
	Lower Long Tom @ Cox Butte Rd.	LLB	NO3	Forestry, agriculture, livestock, urban, rural residential	14.3	44.2372	-123.2648
Lower Amazon	Lower Amazon @ High Pass Rd.	**LA1**	D.O., Cond, Turb, Temp, NO3, TP, *E. coli*	Agriculture, urban	1.4	44.2147	-123.2504
	Lower Amazon @ Alvadore	LAA	NO3, TP	Agriculture, urban	3.5	44.1875	-123.2476
	Lower Amazon @ Bodenhammer Rd.	LAC	NO3, TP	Agriculture, urban	10.8	44.0920	-123.2149
	Lower Amazon @ Meadowview Rd.	LAB	NO3, TP, *E. coli*	Agriculture, urban	6.2	44.1499	-123.2402

Spencer Creek	Tributary to Spencer Creek @ Summerville Rd.	**SC2**	D.O., Cond, Turb, Temp, *E. coli*	Livestock, rural residential	0.5	43.9790	-123.2079
	Spencer Creek @ Pine Grove Rd.	**SC1**	D.O., Cond, Turb, Temp, TP	Forestry, livestock, rural residential	2.0	43.9924	-123.2376
	Spencer Creek @ Lorane Hwy	SCA	TP	Forestry, livestock, rural residential	0.7	44.0001	-123.2559
Upper Amazon	Upper Amazon @ Danebo Ave.	**UA1**	D.O., Cond, Turb, Temp, NO3, TP, *E. coli*	Urban	14.6	44.0493	-123.1777
Upper Long Tom	Upper Long Tom @ Hwy. 126 near Veneta	**UL1**	D.O., Cond, Turb, Temp, NO3	Forestry, livestock, agriculture, rural residential	35	44.0520	-123.3712
	Upper Long Tom @ Alderwood State Park	**UL2**	D.O., Cond, Turb, Temp, NO3, *E. coli*	Forestry, livestock, rural residential	51	44.1544	-123.4239

Macroinvertebrate and Physical Stream Habitat Monitoring
A significant addition to our monitoring program is the collection of macroinvertebrates and stream habitat data at 100 randomly selected sites. Each of the sub-watersheds will have approximately 10 randomly selected sites located within them. This sampling strategy will enable us to assess the biological conditions of each sub-watershed as well as differences between forestland, agricultural/rural residential zones, and urban areas. These data will also provide us with an important baseline of information, which will allow us to establish long-term biological monitoring. The survey design and generation of randomly selected sites was provided by Tony Olsen in the Environmental Statistics Section at the Corvallis Branch of the Environmental Protection Agency. Please see **Appendix G** for a complete description of the sampling design.

Macroinvertebrates will be collected during the summers of 2004 and 2005 between June and September. Upon recommendation of Rick Hafele, Oregon DEQ, five duplicate samples will be taken in 2005 to assess any annual differences between 2004 and 2005 samples. In addition, five duplicate samples will be taken in September 2005 to assess seasonal differences between June and September 2005 samples. (All samples in 2004 were collected in August and September. Because of this relatively narrow sampling window, we determined seasonal differences would not be an issue in 2004.) An outside lab will identify 500 insects to genus level from each of the composited macroinvertebrate samples. These results will be analyzed using a predictive model of stream health (i.e., RIVPAC) developed by the DEQ.

Physical habitat measurements may not be made at all sites, due to the time-consuming nature of collecting this type of data. Our first priority is to collect macroinvertebrates at all 100 sites and duplicates at 10 sites. After reviewing the results from the macroinvertebrate analysis, we will determine the sites for which physical habitat data is most needed to aid in our assessment of these sub-watersheds.

Methods

Monthly Field Monitoring
A DEQ led training session on equipment and methods was held in August of 1999. Attendees were given hands-on experience in collecting field measurements and collecting samples for dissolved oxygen, pH, conductivity, turbidity and water temperature. Several subsequent training sessions were conducted in August and September by the monitoring coordinator for volunteers who were not able to attend the DEQ led training. The Monitoring Coordinator will train any new volunteers. In addition, volunteers receive regular feedback on results and technical support from the monitoring coordinator throughout the project period.

Field monitoring will be conducted using the standard protocols described in the OWEB Water Quality Monitoring Guidebook for stream temperature, turbidity, conductivity, and dissolved oxygen. Please see **Appendix B** for sampling order, duplicate sampling instructions, and equipment instruction sheets that are used by the monitoring team in the field. **Table 5** lists the equipment specifications and holding times for each parameter.

Volunteers will record a correlate for streamflow by measuring the distance from a fixed point above the stream (e.g. usually fixed point on bridge) to the surface of the water. Stream flow values will then be estimated by correlating actual stream flow data with these measurements for each site. The monitoring coordinator will collect the stream flow data using standard USGS flow measuring devices. At least 4 measurements will be taken at each site at different stream levels to determine the relationship between stream flow and stream height.

Field measurements will be recorded immediately after the sample is collected, both on the data sheet and in each volunteer's personal logbook. The only exception is for titration of the dissolved oxygen sample. Once all three powder reagents have been added to the sample, it can be stored in the refrigerator for up to 8 hours before titrating. However, this should only be done when absolutely necessary. Volunteers will dispose of liquid waste from the dissolved oxygen titration in a liquid waste container included with the field equipment kit. The monitoring coordinator will then dispose of the liquid waste by putting it down the sink drain at the Council office. While pouring the waste down the drain, the faucet will be turned on to dilute the concentration of the titrating chemicals.

Continuous Temperature Monitoring

The monitoring coordinator and program assistant will audit, deploy and retrieve continuous temperature probes. Continuous temperature loggers will be checked for accuracy before and after field deployment according to the procedures outlined in Chapter 6 of the OWEB Water Quality Monitoring Guidebook. In addition, the field installation procedures described in Chapter 6 will be followed. Loggers will be set to record a data point once an hour. At the time of logger deployment and removal, the monitoring coordinator will record stream temperature using a NIST traceable thermometer. Additional stream temperature audits may be collected throughout the summer. The procedure for conducting a field audit on continuous temperature loggers is described in the section "Field Checking Instrument Performance" of Chapter 6 of the OWEB Monitoring Guidebook. An accuracy and audit form will be maintained for each logger for recording the results of the accuracy checks and field audits and submitted to DEQ along with the temperature data (see **Appendix F**).

Nutrient and Bacteria Sampling

The monitoring coordinator and program assistant will collect the nutrient and bacteria samples. Surface water samples for *E. coli* and nutrient analysis will be collected within a 24-hour period and kept on ice during transport. As described in the monthly field monitoring methods, samples will be collected by wading or from a bridge using a bucket. They will be taken to Delta Environmental Laboratories within 24 hours of collection and each sample will be marked with the sample ID number and time and date of collection. A chain of custody record will be submitted to Delta Environmental upon delivery of samples (see **Appendix K** for example). Delta Environmental will send a copy of the chain of custody and results to the Watershed Council approximately one month after the sampling date. The analytical methods and specifications for nitrate, total phosphorus, and *E. coli* are listed in **Table 5** below.

Table 5. Specifications for Monitoring Equipment and Analytical Methods

Parameter	Equipment/Method	Container	Preservation	Holding Time
Water Temperature: *single*	NIST Traceable Thermometer	Instream or bucket	none	immediately
Water Temperature: *continuous*	Vemco data logger	Instream	none	N/A
Dissolved Oxygen	HACH OX-DT Kit	300 ml BOD btl	Winkler Titration	8 hr.
Conductivity	YSI Model 30 Meter	Instream or sampling bucket	none	immediately
Turbidity	HACH 2100P Meter	Screw top bottle	none	immediately
Total Phosphorus	EPA 365.3	125 mL plastic bottle	Acidified to pH <2; stored < 4° C	28 days
Nitrate-Nitrite-N	EPA 353.3	125 mL plastic bottle	Acidified to pH <2; stored < 4° C	28 days
E. coli	Colilert QT (IDEXX laboratories)	120 mL plastic bottle	none	24 hours

Macroinvertebrate and Physical Stream Habitat Monitoring

The macroinvertebrate program also relies on volunteers to collect macroinvertebrate samples and collect physical habitat data at each site. Trainings will be held each summer for new and returning volunteers. In addition, the monitoring coordinator or program assistant will review each team's technique at their first site for the season.

The monitoring coordinator will identify and contact the landowner for each randomly selected "x" site. If permission is granted, volunteers are given driving directions and any special instructions to reach the site, a topographic map of the area, an aerial photo, GPS coordinates of the "x" site, and landowner contact information. Volunteers will use the maps and aerial photos to reach the general location of the site and locate the "x" site using a handheld GPS. In the event that landowner permission is not granted or the site is unsampleable because it is dry, unsafe to access, etc., a new site will be selected from the Oversample List (see **Appendix G**).

Volunteers will collect macroinvertebrates according to the Oregon DEQ Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams detailed in **Appendix I**. Measures of physical habitat were adapted from the EPA Western Pilot Field Operations Manual. These adapted methods and datasheet are shown in **Appendices H and J**, respectively. Volunteers will return macroinvertebrate samples and datasheets to the monitoring coordinator at the end of each sampling day and the monitoring coordinator will deliver the preserved samples to the taxonomist at the end of the sampling season.

Safety Precautions
Monthly to bi-monthly sampling will be the normal monitoring schedule, unless weather or other environmental conditions create unsafe conditions for field staff. If conditions do prevent the field staff from conducting a sampling event, they should notify the monitoring coordinator as soon as possible, record the current conditions in the project notebook, and re-schedule the sampling event for the earliest possible date.

Table 6. Potential Safety Hazards and Precautions

Potential Risks	Precautions
1) Sampling during high stream flows	Sample from bridge using bucket on end of rope
2) Slipping on rocks or other slick surfaces in or near stream	Use footwear with felt soles and a stick/surveying rod to stabilize yourself
3) Sampling from roadways with heavy traffic	Wear bright, orange safety vest provided. Once you have collected the sample, do your testing off of the bridge, preferably on a side road or driveway (with owners permission).
4) Spilling chemicals on clothing, skin or eyes	Use rubber gloves (in equipment box) and glasses/safety goggles when handling powder reagents from dissolved oxygen kit and pH 10 buffer. Avoid opening and pouring powders in direct wind. When shaking containers, hold the container down at your side, away from your eyes. If chemicals do get on skin or eyes, wash them off with water immediately (squirt bottle in equip. box); contact an eye doctor if chemicals in get in eyes.
5) Accidentally ingesting chemicals	Call Poison Control Center: 1-800-452-7165
6) Surface water contaminated with toxins or fecal coliform bacteria	Wear rubber gloves and/or wash hands (soap in equipment box) after completing measurements and before eating.
7) Getting lost while finding/leaving macroinvertebrate sites.	Bring map, compass, and GPS unit to site and be comfortable with their use. If not comfortable with orienteering, notify the monitoring coordinator who will assign you sites that are near a road and easy to find. Unless you are leaving to get help for your injured partner, stick together while going to and from the site.
8) Getting injured while traveling to and from macroinvertebrate sites	Where protective clothing and proper footwear for hiking in and out of sites. Bring first aid kit along that is included with monitoring equipment. Always go out to the site with your partner, and unless you are leaving to get help for your injured partner, stick together while going to and from the site.

Quality Assurance and Quality Control Procedures

Measurement Quality Objectives
All data will be gathered and handled in accordance with the Oregon Plan for Salmon and Watersheds (OPSW) Water Quality Monitoring Guidebook. The DEQ Data Quality Matrix is shown in **Appendix C** for reference. The type of equipment and methods used in this study are

sufficient to achieve "Level A" data. The target precision and accuracy levels for "A" data are listed in **Table 7**, along with measurement range. Quality Control Procedures for Delta Environmental are included in a separate document and will be provided to the DEQ Volunteer Monitoring Coordinator.

Table 7. Precision and Accuracy Targets

Parameter	Precision	Accuracy	Measurement Range
Water Temperature	± 1.5 ° C	± 0.5 ° C	-5 to 35 ° C
Conductivity	± 10%	± 7% of Std. Value	0 to 4999 m S/cm
Turbidity	± 5%	± 5% of Std. Value	0 to 1000 NTU
Dissolved Oxygen	± 0.3 mg/L	No calibration done	1 to 20 mg/l
Total phosphorus	Delta Environmental: ±10% Watershed Council duplicates: ±0.1 mg/L or ± 20%	Delta Environmental Laboratories: +/- 10% of NIST traceable standards and spiked samples	0.02 to 50 mg/L
Nitrate-Nitrite-N	[4]Delta Environmental: ±10% Watershed Council duplicates: ±0.1 mg/L or ± 20%	Delta Environmental Laboratories: +/- 10% of NIST traceable standards and spiked samples	0.02 to 50 mg/L
E. coli	Delta Environmental: ±10% Watershed Council duplicates: ± 0.5 log	Delta Environmental Laboratories: check that container volume is within 10% of acceptable range and check medium for growth of correct bacteria	0 to 2419 cells

Representativeness: Samples for dissolved oxygen, conductivity and turbidity will be collected at or near the center of the stream channel where the water is well-mixed and most representative of the ambient conditions. Continuous temperature data loggers will be placed in a location that is well mixed and represents the average thermal condition of the stream.

Comparability: This monitoring program will ensure comparability with similar projects in other watersheds by following the standardized sampling protocols and procedures developed by state agencies. These protocols are described in detail in the OPSW Water Quality Monitoring Guidebook.

[4] Delta Environmental performs duplicates on one out of 20 samples or one in each batch of samples if smaller than 20.

Completeness: It is anticipated that samples will be collected from at least 90% of selected sites during all sampling events unless unanticipated weather-related events or safety issues prevent sampling.

Measurements outside range: Any data or sample values outside of the expected range for the parameter being measured will be rechecked for validity in the field by the monitoring team member, and if necessary, he/she will re-sample. Data that continue to be outside expected values will be noted on the field data sheet so that the monitoring coordinator can check the equipment and procedures.

Duplicate Samples

Duplicate quality assurance (QA) samples for all measurements will be made for at least 10% of sites during each sampling period. See **Appendix D** for the duplicate sampling schedules for field monitoring July 2004-June 2006.

The monitoring coordinator will check the continuous temperature loggers for accuracy before and after each field deployment and field audit the probes at the time of deployment and removal. If time permits, we will field audit the probes during the monitoring season.

Instrument/Equipment Testing, Inspection, and Maintenance Requirements

All field monitoring equipment will be tested for accuracy and /or calibrated in accordance with the procedures outlined in the appropriate chapters of the OPSW Water Quality Monitoring Guidebook and the manufacturer user manuals. The NIST Traceable Thermometer will be returned to the manufacturer for an annual accuracy check. The manufacturer will complete the accuracy check and re-certify the thermometer to NIST standards. All equipment has been loaned to the Long Tom Watershed Council by the Oregon DEQ or purchased with funding from Oregon Watershed Enhancement Board. The Council will be responsible for maintaining the equipment and restocking all field supplies when necessary.

Instrument Calibration and Accuracy Checks:

- The conductivity meter will be calibrated every 3 – 4 months following the procedure outlined in the user manual.
- The conductivity meter will be checked for accuracy with secondary standard each day prior to use.
- The turbidimeter will be re-calibrated with formazin standards quarterly.
- The turbidimeter will be checked for accuracy with secondary standards each day prior to use.
- There is no calibration for the dissolved oxygen titration. However, split samples will be performed periodically with DEQ staff to check the accuracy of the field kit.
- The NIST Traceable Digital Thermometer is calibrated at the factory and will be returned to the DEQ for an accuracy check and re-certification once a year.
- Continuous temperature loggers are factory-calibrated and they will be checked for accuracy by the field monitoring team before and after each field deployment.
- Results of accuracy checks and calibration will be recorded in the appropriate data book for each piece of equipment.

Documentation and Records

Document or Record Name and Description	Storage Location	Storage Time
Quality Assurance Project Plan	Council office/DEQ	10 years
OWEB's Oregon Plan for Salmon and Watersheds Water Quality Monitoring Guidebook- methods manual	Council library	10 years
Completed Field Data Sheets for Monthly Monitoring and Stream Physical Habitat (See Appendix E and J for sample data sheets)	Council office	5 years
Field Data Notebooks: back-up record of field data sheets	Volunteer's homes while monitoring; Council office when complete	5 years
Equipment Notebooks: records of calibration and accuracy checks	Council office (w/ equipment)	5 years
Continuous Temperature Audit Forms (See **Appendix F** for example data sheet)	Council office	5 years
Laboratory Reports from Delta Environmental	Council office	5 years
Macroinvertebrate taxonomic report: submitted by contracted taxonomist	Council office	10 years
Final Reports: Two-year summary of results	Council office	10 years

Data Management

The monitoring coordinator will check all field data sheets for completeness and accuracy at the end of each sampling period. Errors will be corrected prior to entering the data into the comprehensive database. Unusual results or data recording errors will be noted in the coordinator's logbook so that she can either find an explanation for the results or help the person collecting the data avoid similar mistakes in the future.

The laboratory technician and Quality Control Director at Delta Environmental will review nutrient and *E. coli* results before mailing results to the monitoring coordinator. The monitoring coordinator will also check lab results for completeness and to flag any outliers.

The data generated from this project will be entered and stored in a computerized database established by the watershed council. The database will be compatible with hardware and software used by state water quality agencies. Data are available to the public and will be shared with all agencies/groups upon request.

Once the data has been entered in the project database, the monitoring coordinator will print a paper copy of the data and proofread it against the original field data sheets. Errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review or be discarded. Data quality problems will be discussed by the monitoring coordinator and technical advisory committee as they occur and in the final report to data users. The paper copy of this data check will be kept on file for at least five years at the Watershed Council office.

After each sampling event, determinations of precision, completeness, and accuracy will be made. If data quality does not meet the project's objectives, we will determine whether the cause was equipment failure, failure to correctly follow methods, or other possible factors. If the cause is found to be equipment failure, steps will be taken to re-calibrate and/or repair the equipment. If the problem is found to be sampling team error, the monitoring team coordinator will review the team's monitoring techniques and ask them to complete another duplicate sample the following month. Any limitations on data use will be detailed in both interim and final reports and other documentation as needed.

The monitoring coordinator and Technical Advisory Committee will review all data resulting from this project to determine if it meets the QA Plan objectives. Decisions to accept, qualify or reject data will be made by the monitoring coordinator, Technical Advisory Committee and DEQ Volunteer Monitoring Coordinator. Once data is approved for public release by the monitoring coordinator and Technical Advisory Committee, the monitoring coordinator will send an electronic version of the data to the Department of Environmental Quality Lab as part of the equipment loan agreement.

Project Oversight

The monitoring coordinator and the Technical Advisory Committee will be responsible for reviewing the entire monitoring project on a bi-annual basis. The monitoring coordinator will also receive guidance and advice from state agencies. The monitoring coordinator will train all new volunteers before any monitoring activities are done, and schedule refresher training sessions as needed.

All field activities may be reviewed by state agency QA staff at the request of the monitoring coordinator. The DEQ Volunteer Water Quality Monitoring Coordinator will perform data quality audits once a year and any/all identified procedural problems will be corrected based on his or her recommendations.

QAPP Updates and Monitoring Reports

The Monitoring Coordinator will submit any revisions or updates to the Council's QAPP to the DEQ Volunteer Monitoring Coordinator and Quality Assurance Officer state agencies for review and/or approval. This will occur if there are any changes to the monitoring program or procedures.

Annual presentations of results will be given at Council meetings. The monitoring coordinator will be responsible for a final written report due by September 30, 2006. These reports will be submitted to the Council, Cascade Pacific Resource Conservation and Development, Oregon Watershed Enhancement Board, DEQ, City of Eugene and other interested agencies. Reports will include results, analysis and interpretation as well as pertinent field observations and QA/QC assessments.

References

Army Corps of Engineers. 1999. Unpublished water quality monitoring data.

City of Eugene. 1999. Unpublished water quality monitoring data.

Lane Council of Governments. 1983. Fern Ridge Clean Lakes Study. Unpublished report.

Tetra Tech Inc. 1995. Willamette River Basin Water Quality Study: A Summary of Recent Scientific Reports on the Willamette River. Report prepared for the Oregon Department of Environmental Quality.

Thieman. 2003. Water Quality in the Long Tom River Watershed: 1999-2003. Report prepared for the Long Tom Watershed Council

Appendix A: 2002 303(d) List of Water Quality Limited Streams in Long Tom Watershed

River or Stream	Characteristic	Data Source (sampling period)	Season
Amazon Creek (RM 0 – 22.6)	Arsenic	City of Eugene (sampling period not specified)	Year round
Amazon Creek (RM 0 – 22.6)	Lead	City of Eugene (sampling period not specified)	Year round
Amazon Creek (RM 0 – 22.6)	*E .coli*	City of Eugene (sampling period not specified)	Year round
A-3 Channel	dichloroethylenes	DEQ (sampling period not specified)	Year round
A-3 Channel	tetrachloroethylene	DEQ (sampling period not specified)	Year round
A-3 Channel	Arsenic	DEQ (sampling period not specified)	Year round
A-3 Channel	Lead	City of Eugene (sampling period not specified)	Year round
A-3 Channel	Mercury	City of Eugene (sampling period not specified)	Year round
A-3 Channel	*E. coli*	City of Eugene (sampling period not specified)	Year round
Amazon Diversion Channel (RM 0 – 1.8)	Fecal coliform	LCOG (1981-82)	Year round
Amazon Diversion Channel (RM 0 – 1.8)	Dissolved oxygen	LCOG (1981-84)	Spr/Sum/Fall
Ferguson Creek (RM 0 – 10)	Temperature	DEQ (2000)	Summer
Fern Ridge Reservoir	Turbidity	LCOG (1981-82)	None specified
Fern Ridge Reservoir	Bacteria	LCOG (1981-82)	Fall/Wint/Spr
Coyote Creek (RM 0 – 26.2)	Dissolved oxygen	LCOG (1981-84)	Spr/Sum/Fall
Coyote Creek (RM 0 – 26.2)	Bacteria	LCOG (1981-82)	Year around
Willow Creek (RM 0 – 2.8)	Arsenic	City of Eugene (sampling period not specified)	None specified
Lower Long Tom	Temperature	DEQ (1986-95)	Summer
Lower Long Tom	Bacteria	DEQ (1986-95)	Fall/Wint/Spr

Appendix B. Sampling Order & Equipment Instruction Sheets

Sampling order

1) If possible, before going out in the field you should complete your accuracy checks on the conductivity and turbidity meters. (See instructions for each on the respective equipment instruction sheets.) If you are not the first person using the equipment that day then you only need to do an accuracy check on the turbidity meter.
2) Collect sample in blue bucket from bridge or directly from stream if too shallow for bucket. To use the bucket lower it near the center of the channel (where the water is well mixed) to about 3' below the surface of the water. If stream depth is less than 6' (estimate) then lower bucket about ½ way between the surface and bottom of stream. **Make sure you rinse the bucket with stream water before filling the bucket.** If stream depth is too shallow to use the bucket, then measure conductivity and temperature directly in the stream and fill the glass DO bottle and turbidity vial from the stream. **Also, be sure and rinse with stream water before filling these bottles**. If you wade into the stream to collect the samples, be sure to hold the containers upstream of you so the bottom sediment that you stir up doesn't get into the sample.
3) After water has been collected immediately measure **water temperature** (with conductivity meter) and **conductivity**. Measure in the blue bucket or directly in stream if flow is too low for bucket.
4) Rinse, submerge and fill glass DO bottle from blue bucket (or stream). (**Important**: don't pour water into bottle because this will aerate the sample and give an artificially high DO reading.)
5) Start DO measurement process.
6) Measure air temperature.
7) Measure turbidity.
8) Measure bridge to water surface.

Note: The most important thing is that water temperature and DO are measured immediately after collecting the stream sample because these parameters change rather quickly once the water is taken out of the stream.

Instructions for duplicate sampling:

- On the **Monitoring Dates** sheet, your name will be listed next to the date you should do a duplicate. You only need to do a duplicate at one site.
- For dissolved oxygen fill both bottles at the same time, either from the same bucketful of water or from the stream. Add the first two powders to one of the bottles and shake as directed. Then add the first two powders to the other bottle and shake as directed. Continue the process, doing each progressive step on one bottle, then the other.
- Also fill two vials for the turbidity duplicate sample at the same time and measure one right after the other.
- For conductivity and temperature, measure once (from the bucket or stream) and record results, then measure again and record results.
- **Are your duplicate results: +/- 0.5 mg/L for dissolved oxygen? +/- 2% for conductivity? +/- 5% for turbidity?** This is what each of these parameters needs to be to get an "A" grade. If your duplicate result for any of the parameters does not meet the above standard, try again.

Equipment List

- Dissolved oxygen kit (contains powder pillows, glass DO bottle with stopper, graduated cylinder for measuring out sample, scissors, titrator, sodium thiosulfide cartridge, delivery tubes, starch, and 500 ml Erlenmeyer flask)
- Rubber gloves
- Liquid waste container
- Distilled water
- Safety vest
- Turbidimeter (contains meter, sample vials, standards, oil, black cloth, drying cloth, logbook)
- Conductivity meter and logbook
- Conductivity standard
- Hand sanitizer
- Data sheets (in plastic folder in box)
- 2 packs of AA batteries & 9 V battery
- Measuring tape
- Blue sampling bucket
- Extra D.O. bottle for duplicates
- 1 extra liter of distilled water
- thermometer

Dissolved Oxygen- Winkler titration

1. Thoroughly rinse glass DO bottle with stream sample water. Then fill the DO bottle by either placing it in the collection bucket or submerging into the stream by hand (when stream depth is too shallow for bucket). Fill the bottle until it overflows and make sure that no air bubbles are trapped in the bottle. Insert stopper. Don't let the bottle sit around! Do the next steps right away or the DO may change.
2. It is recommended that you put gloves on at this point. **Also, avoid getting reagents on your skin or clothing.**
3. Add powder 1 (manganous sulfate) & then powder 2 (alkaline azide)
4. Shake bottle vigorously for 30 seconds.
5. Wait until the particulates settle ½ way down bottle
6. **Again**, shake bottle vigorously for 30 seconds. Make sure there are no large, undissolved chunks of reagent left.
7. Wait until the particulates settle ½ way down bottle.
8. Add powder 3 (sulfamic acid). Be sure to avoid getting this on your clothes.
9. Shake until sample is clear amber.
10. Rinse both the graduated cylinder and flask first with distilled water and then with a little of the amber sample before measuring and pouring into flask.
11. Measure out 200 ml of sample in graduated cylinder and pour it into the 250 or 500 ml flask (whichever is in your kit).
12. Load black titrator with sodium thiosulfide cartridge by sliding it all the way into the slot and twisting 90°. Lower the plunger (push button in and down) on the titrator until it contacts the cartridge.
13. Take cap off cartridge, rinse a delivery tube with distilled water and insert into cartridge.
14. Turn the black dial on top of the titrator clockwise and allow a little of the sodium thiosulfide to come out. Just enough to remove air bubbles from the line.
15. Zero titrator by turning dial next to counter.
16. Slowly add sodium thiosulfide to sample by submerging the delivery tube into the sample. Swirl flask while you do this to mix.
17. When the sample turns pale yellow add 1 ml of starch (1 dropperful) to the sample; swirl to mix; the sample will turn blue/black. If the sample is pale yellow to begin with you can add the starch before you add any sodium thiosulfide.
18. Continue adding sodium thiosulfide with digital titrator, swirling as you add it, until sample is clear. **Go very slowly when the sample becomes pale so you don't overshoot the mark!**
19. Enter the number on the titrator onto the ***data sheet***.
20. Put cap back on sodium thiosulfide cartridge, pull back plunger and remove cartridge from titrator.
21. Rinse all test containers with distilled water and replace in case.

Turbidity meter

Note: if you are storing the equipment overnight be sure to keep it indoors so it does not get cold. A cold turbidity meter gives erroneous readings. If it has accidentally gotten cold, let the machine warm up in your car or house before using it.

1. Place the meter on a flat, stable surface or leave in blue box.
2. Turn meter on (I/O button). Make sure the machine is in auto range ("auto rng" is indicated in lower left corner). If it's not then push the range button until it shows this.
3. **Do an accuracy check using the bottles with numbered labels on top. If you have more than one site you only need to do the accuracy check at your first site**.
   Here's how to do an accuracy check
   a. Place a drop of oil on bottle of 1st standard (around 5) and wipe off with the black cloth.
   b. Insert it into the slot in the meter so that the white diamond on the bottle aligns with the mark at the front of the bottle slot on the meter.
   c. Close lid and press the read button. Record results in the **logbook**.
   d. **Follow the same procedure for the other two numbered vials** (one is around 50, the other around 500).
4. Rinse sample bottle with stream sample water 2 – 3 times. **If sample has been sitting then gently shake it before filling sample vial.**
5. Pour stream sample into the rinsed sample vial.
6. Wipe off vial with a soft, absorbent cloth.
7. Place vial in meter, being sure to align mark on vial with mark on meter.
8. Close lid, push the read button and record reading on ***data sheet***.
9. When finished turn machine off, clean the sample vial with distilled water and return it to the box.

Conductivity & Water Temperature

1. **If you are the first person using the meter today you need to do an accuracy check.** If one has already been completed that day skip to 2. Accuracy check instructions:
   a. After thoroughly rinsing probe and shaking off excess water place it in the container labeled "conductivity standard".
   b. Turn machine on and **make sure it is in temperature compensating mode**. This is indicated when the Celsius symbol (C°) on the bottom right is flashing. If it isn't, push the mode button until you see this feature. Conductivity units are microsiemens per centimeter (µS/cm) and temperature is in C°
   c. Stir probe slowly in the standard solution without touching the sides or bottom of the container. **Make sure the hole on the side of the probe is submerged and doesn't have an air bubble trapped in it.**
   d. When the reading has stabilized enter the conductivity and temperature reading in the **conductivity logbook**.
   e. Put cover back on conductivity standard; **do not discard**.
   f. Skip to 4.
2. Turn machine on. **Make sure it is in temperature compensating mode**. This is indicated when the Celsius symbol (C°) on the bottom right is flashing. If it isn't, push the mode button until you see this feature. Conductivity units are microsiemens per centimeter (µS/cm) and temperature is in C°
3. Thoroughly rinse probe with distilled water and shake off excess water.
4. Measure water temperature and conductivity by placing probe into the blue bucket or the stream, being sure not to let the probe touch the sides of the container or bottom of stream. **Make sure the hole on the side of the probe is submerged and doesn't have an air bubble trapped in it.**

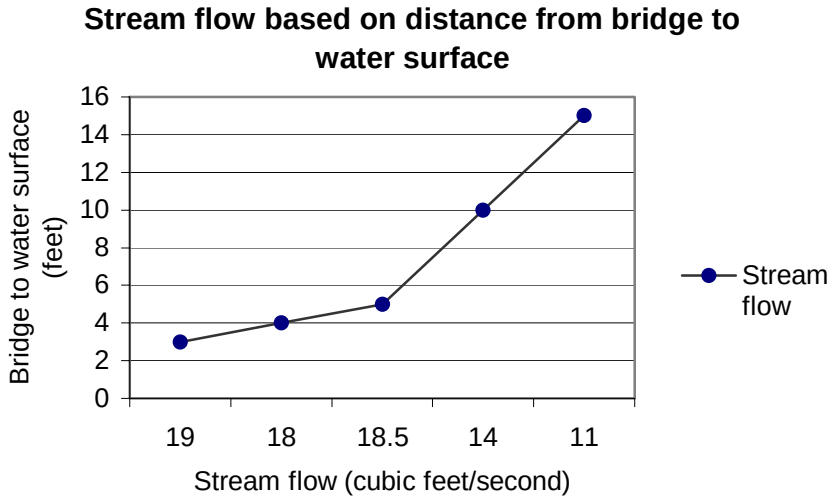
5. When reading has stabilized record water temperature and conductivity on ***data sheet***. (It's ok if the last unit for the conductivity reading fluctuates. For example, if it goes back and forth between 104.5, 104.6 and 104.7, just pick the middle value.)
6. Rinse conductivity probe with distilled water before replacing it in the meter slot.
7. Turn machine off and return to bag, leaving the cord outside of the bag. Make sure the machine doesn't accidentally turn on when you push it into its bag.

Height from Bridge to Stream Surface

This measurement will allow us to estimate stream flow. The way it works is that you record the height from a fixed point on the bridge to the surface of the water. If the weight on the tape is hanging below the end, then measure from the end of the weight. If the weight hangs above the end of the tape, then measure from the end of the tape. Be very precise and be sure to take it from the same point every month. Record on your ***datasheet*** in feet and 10^{th} of feet (e.g. 16.72 ft.)

Sometimes you might have trouble with the tape flapping in the breeze. If this happens try using the bucket to measure the distance. Lower it down until the bottom is at the stream surface (you can even fill it with a little water if necessary). Clamp your fingers on the rope where it hits the point on the bridge (i.e. white paint mark), and then pull the bucket up. Use the measuring tape to measure from the end of the bucket to the point on the rope that you have marked with your fingers. Record on ***data sheet***.

Several times during the year I will go out to these sites and measure stream flow and also the height from stream surface to bridge. This will allow me to develop a graph like the one below. By developing a graph like this we can later calculate what the stream flow was when monitoring occurred.



Appendix C. DEQ Data Quality Matrix

Available at: http://www.deq.state.or.us/lab/qa/DEQ04-LAB-0003-GD.pdf

Appendix D. Sampling Schedule and Duplicates

Sampling Dates	People Doing Duplicates
2004	
July 6,7,8	Erik Osborn & Jack Detweiler; Dave Turner
August 10,11,12	Rolf Anderson; Brian Greene/John Dillard
September 7,8,9	Bob Hager; Len Gillette; Cathy Glaudin & Paul Atkinson
October 12,13,14	Erik Osborn & Jack Detweiler; Carl DiPaolo; Paul Reed
November 7,8,9	Rolf Anderson; Brian Greene/John Dillard ;Dave Turner
December 7,8,9	Bob Hager; Len Gillette
2005	
January 11, 12, 13	
February 8, 9,10	Rolf Anderson; Erik Osborn & Jack Detweiler; Brian Greene
March 8, 9,10	Bob Hager; Cathy Glaudin & Paul Atkinson; Carl DiPaolo
April 5, 6, 7	Len Gillette; Paul Reed; Dave Turner
May 10, 11, 12	Rolf Anderson; Erik Osborn & Jack Detweiler; Brian Greene
June 7, 8, 9	Bob Hager; Cathy Glaudin & Paul Atkinson; Carl DiPaolo
July 5, 6, 7	Len Gillette; Paul Reed; Dave Turner
August 9,10,11	Rolf Anderson; Erik Osborn & Jack Detweiler; Brian Greene
September 6, 7, 8	Bob Hager; Cathy Glaudin & Paul Atkinson; Carl DiPaolo
October 11, 12, 13	Len Gillette; Paul Reed; Dave Turner
November 8, 9, 10	Rolf Anderson; Erik Osborn & Jack Detweiler; Brian Greene
December 6, 7, 8	Bob Hager; Cathy Glaudin & Paul Atkinson; Carl DiPaolo
2006	
January 10, 11, 12	Len Gillette; Paul Reed; Dave Turner
February 7, 8, 9	Rolf Anderson; Erik Osborn & Jack Detweiler; Brian Greene
March 7, 8, 9	Bob Hager; Cathy Glaudin & Paul Atkinson;Carl DiPaolo
April 10, 11, 12	Len Gillette; Paul Reed; Dave Turner
May 8, 9, 10	Rolf Anderson; Erik Osborn & Jack Detweiler; Brian Greene
June 6, 7, 8	Bob Hager; Cathy Glaudin & Paul Atkinson; Carl DiPaolo

Appendix E. Field Data Sheet

Site ID_____

Sampler's name	Date	Time	Air temp. (˚F)	Water temp. (°C)	Conductivity (µS/cm)	Number on D.O. titrator	Turbidity (NTU)	Bridge to water surface (ft./tenths of feet)

Observations: (Weather, water color, flow, wildlife, changes to stream or riparian zone, upstream events over the past month, etc.)

Post-sampling check list:	Yes/No
1. Have you double-checked that all meters are off?	
2. Did you do an accuracy check for the conductivity meter (only need to if you are the first one to use meter that day)?	
3. Did you do an accuracy check for the turbidity meter at your first site?	
4. Did you measure water temperature and DO immediately after collecting sample?	
5. Have sampling containers been rinsed and put away?	
6. Did you enter results in your personal logbook?	
7. Are all equipment and accessories in box (see equipment list)?	

Any problems with equipment or sampling?

Appendix F. QA/QC Sheet for Temperature Dataloggers

Project Name: _____

Site Name: _____

USGS Quad Names and Numbers: _____

LASAR#: _____ **Site Description:** _____

Site Latitude: _____

Site Longitude: _____

Elevation: _____

Temperature Logger ID: _____

Date of Battery Installation: _____

Data File Name: _____

Pre- Deployment Temperature Check

Thermometer ID: _____ Date: _____ Thermometer ID: _____ Date: _____

Low Temp TIME	TEMP MASTER	TEMP UNIT	Difference	STATUS	High Temp TIME	TEMP MASTER	TEMP UNIT	Difference	STATUS
	-	-	-	-		-	-	-	-

AUDIT VALUES

AUDIT VALUES		Water Temperature		Air Temperature		Audit Thermometer ID		
Date	**Time**	**Audit**	**Logger**	**Audit**	**Logger**		**Comments**	**STATUS**
							<--Comments Line	
							<--Comments Line	
							<--Comments Line	
							<--Comments Line	
	Date Downloaded:		**Time:** (Computer)		**Time:** (Unit)		**Time Shift Grade:**	

Post- Deployment Temperature Check

Thermometer ID: _____ Date: _____ Thermometer ID: _____ Date: _____

Low Temp TIME	TEMP MASTER	TEMP UNIT	Difference	STATUS	High Temp TIME	TEMP MASTER	TEMP UNIT	Difference	STATUS
	-	-	-	-		-	-	-	-

COMMENTS: _____

Appendix G. Macroinvertebrate Monitoring Survey Design

Description of Sample Design

Target population: All streams/rivers in the Long Tom watershed. Watershed boundaries as defined in Long Tom boundary coverage.

Sample Frame: RF3 (alpha version with Strahler order). Restricted to Long Tom Watershed boundary and excluding streams in Willamette and Fern Ridge Reservoir subbasins. Subbasins are identified in the NAME attribute.

Survey Design: A Generalized Random Tessellation Stratified (GRTS) survey design for a linear stream resource was used. The GRTS design includes reverse hierarchical ordering of the selected sites.

Multi-density categories: 10 subbasins within the Long Tom

Stratification: None

Panels: 6 panels. Annual panel may be visited once every year. Rotating panels Year1 to Year5 are to be visited once every 5 years.

Expected sample size: 10 in each subbasin over the five years for a total of 100 sites.

Oversample: 200% (200) for a total of 300 sites

Site Use: The base design has 25 sites for each panel. If it is necessary for a site to be replaced, then the lowest ordered SiteID that is part of the oversample of sites (identified by "OverSamp" in variable "Panel") must be used. Subsequent replacement sites continue to be used in the same way.

Sample Frame Summary

The total stream length in the sampling frame 611.1922 km. The length by subbasin is

Bear Creek	Coyote Creek	Elk Creek	Ferguson Creek
49.59577	116.52424	69.28891	43.59273
Fern Ridge	**Lower Amazon**	**Lower Long Tom (S)**	**Spencer Creek**
25.99268	51.08396	87.24958	51.18467
Upper Amazon	**Upper Long Tom**		
32.47687	84.20281		

Length by Strahler Order

0	1	2	3	4	5
25.79639	362.11215	74.76637	88.90017	22.23291	37.38424

Length by subbasin and Strahler order

	0	1	2	3	4	5
Bear Creek	NA	39.13466	4.2838470	6.1772580	NA	NA
Coyote Creek	NA	62.17770	24.4372231	23.1726771	6.73663794	NA
Elk Creek	NA	37.98250	13.3630709	17.1953916	0.74794950	NA
Ferguson Creek	8.3651662	25.15761	10.0699470	NA	NA	NA
Fern Ridge	NA	24.39850	0.3853058	NA	1.20887275	NA
Fern Ridge Reservoir	NA	NA	NA	NA	NA	NA
Lower Amazon	5.0864867	23.10276	6.7859163	16.0577302	NA	0.05107026
Lower Long Tom (S)	5.7957390	43.78448	0.1131816	0.2230060	NA	37.33316647

Spencer Creek	0.9514458	38.70643	4.9903732	6.4880552	0.04836915	NA
Upper Amazon	5.5975515	21.99732	4.8820052	NA	NA	NA
Upper Long Tom	NA	45.67018	5.4554959	19.5860540	13.49108103	NA
Willamette	NA	NA	NA	NA	NA	NA

Site Selection Summary

Number of sites by subbasin and Panel

	Annual	OverSamp	Year1	Year2	Year3	Year4	Year5
Bear Creek	2	18	2	2	3	2	2
Coyote Creek	4	16	1	4	1	3	1
Elk Creek	3	14	2	3	2	3	4
Ferguson Creek	2	15	2	3	1	3	3
Fern Ridge	1	15	4	1	1	3	2
Lower Amazon	3	20	1	2	1	2	2
Lower Long Tom (S)	1	14	4	2	5	2	2
Spencer Creek	4	11	3	2	4	1	5
Upper Amazon	3	13	3	3	3	2	3
Upper Long Tom	2	14	3	3	4	4	1

Description of Sample Design Output:

To achieve an expected sample size of sites in the target population, an appropriate sample size was selected for the study area. A Base set of sites and an Oversample of sites are included in the output. The oversample sites should be added, as needed, in numerical SiteID order. Oversample sites are identified in the "panel" data column as Oversamp. Note that sites may be used in order beginning at the first SiteID number and continuing until desired sample size is reached. If do not want to use the annual panel, then use panels Year1 to Year5. Can combine two panels together if want to visit double the number of sites within a year.

A map of the stream network and the selected sites is given in the accompanying pdf file.

The tab-delimited, ASCII file (BullTroutSites.tab) has the following variable definitions:

Variable Name	Description
SiteID	Unique site identification (character)
arcid	Internal identification number
x	Albers x-coordinate
y	Albers y-coordinate
LonDD	Longitude, decimal degrees NAD27
LatDD	Latitude, decimal degrees NAD27
mdcaty	Multi-density categories used for unequal probability selection
weight	Weight (in meters), inverse of inclusion probability, to be used in statistical analyses
stratum	Strata used in the survey design
panel	Identifies base sample by panel name and Oversample by OverSamp
auxiliary variables	Remaining columns are from the sample frame provided

Projection Information
Albers projection used
Datum: NAD 27
Spheroid: Clarke1866
Units: meters
Center longitude (decimal degrees): -96
Origin latitude (decimal degrees): 23

Standard parallel 1 (decimal degrees): 29.5
Standard parallel 2 (decimal degrees): 45.5
Evaluation Process
The survey design weights that are given in the design file assume that the survey design is implemented as designed. That is, only the sites that are in the base sample (not in the over sample) are used, and all of the base sites are used. This may not occur due to (1) sites not being a member of the target population, (2) landowners deny access to a site, (3) a site is physically inaccessible (safety reasons), or (4) site not sampled for other reasons. Typically, users prefer to replace sites that can not be sampled with other sites to achieve the sample size planned. The site replacement process is described above. When sites are replaced, the survey design weights are no longer correct and must be adjusted. The weight adjustment requires knowing what happened to each site in the base design and the over sample sites. EvalStatus is initially set to "NotEval" to indicate that the site has yet to be evaluated for sampling. When a site is evaluated for sampling, then the EvalStatus for the site must be changed. Recommended codes are:

EvalStatus Code	Name	Meaning
TS	Target Sampled	site is a member of the target population and was sampled
LD	Landowner Denial	landowner denied access to the site
PB	Physical Barrier	physical barrier prevented access to the site
NT	Non-Target	site is not a member of the target population
NN	Not Needed	site is a member of the over sample and was not evaluated for sampling
Other codes		Many times useful to have other codes. For example, rather than use NT, may use specific codes indicating why the site was non-target.

Statistical Analysis
Any statistical analysis of data must incorporate information about the monitoring survey design. In particular, when estimates of characteristics for the entire target population are computed, the statistical analysis must account for any stratification or unequal probability selection in the design. Procedures for doing this are available from the Aquatic Resource Monitoring web page given in the bibliography. A statistical analysis library of functions is available from the web page to do common population estimates in the statistical software environment R.

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Web Page: http://www.epa.gov/nheerl/arm

Appendix H. Sequence of Measurements for Collecting Macroinvertebrates and Physical Habitat Data

1. Locate x-site using GPS, aerial photo, and map.
2. Scout the area to make sure you won't run into a stream order change upstream of the x-site, or other condition that would make the stream unsampleable (e.g., stream changes to a marsh, goes into an underground pipe, etc.). If one of these situations occurs, you'll need to start the reach far enough downstream of x-site to avoid this.
3. Take several wetted width measurements up and downstream of the x-site to determine your average wetted width. Record. Notice whether this stream seems to have a lot of riffles or few to none so that you can plan your bug sample sites accordingly.
4. Multiply your average wetted width by 40 to determine reach length. Record. Remember: minimum reach length is 150 m.
5. Starting about 50 feet downstream of the x-site and walking upstream on the bank (or whatever path is quickest), pace off the reach length and either flag or otherwise note where the reach will end. Since we are not going to flag transects or macroinvertebrate sites ahead of time, this is so you don't collect bug samples outside of the reach.
6. Walk about 50 feet downstream of x-site (don't need to measure, just estimate) and clip Transect A flag to nearest branch or set on bank. Begin collecting your insect samples as you move up through the reach. If you feel it's necessary, you can walk up and downstream to identify where you want to collect insect samples. Remember, if there's only one good riffle or fastest moving section, then you can collect all eight samples from this location. If there are more than this, spread your samples throughout the reach.
7. Collect eight 1-square foot samples as described in DEQ protocol and place each one in the bucket.
   When finished:
   - Sieve contents of bucket (Rinse and discard any large sticks or rocks. Make sure there are no insects clinging to them before discarding)
   - Spoon sediment, leaves, insects, etc. from sieve into plastic Nalgene container(s). Only fill the bottle ¼ - ½ full. Use more than one plastic container if necessary to avoid exceeding the ¼ - ½ full guideline.
   - Top off with alcohol.
   - Place label(s) inside jar and tape to outside. USE PENCIL ONLY for writing on labels, as alcohol dissolves ink.

8. Measure water temperature and take several photos that are representative of the reach. (You can do these two things at any time. Just don't forget!)
9. Go back to Transect A and begin physical habitat survey. Divide total reach length by 10 to determine distance between transects.
10. At each transect make 5 substrate and depth measurements: left bank edge, ¼ across, ½-way across, ¾ across, right bank edge. *Estimate* ¼, ½, and ¾ of the way across. You do not need to estimate % embeddedness.
11. At each transect make estimates for riparian vegetation and shade.
12. As you walk up the stream between transects:
    - Measure thalweg depth
    - Record stream habitat type (riffle/cascade/run/glide or pool)
    - Tally large wood
13. The last steps are to fill out the human disturbance inventory form for the reach and do a written assessment of stream condition (can do this one driving to next site or on your way back)

Appendix I. Oregon DEQ Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams

Benthic Macroinvertebrate Protocol for Wadeable Rivers and Streams

Revised July 18, 2003

Background

Evaluating the biological community of a stream through an assessment of the macroinvertebrates provides a sensitive and cost effective means of determining stream condition. The goal of the protocol described in this section is to collect an unbiased, representative sample of benthic macroinvertebrates in wadeable streams and rivers. At each stream reach, samples are collected by compositing eight D-Frame Net kick samples from a selected habitat unit (e.g. riffles, fastest flowing water). Samples are preserved in the field with ethanol.

Field Collection Methods

Equipment and Supplies

- 500 um mesh D-Frame kick net
- 5-gallon bucket
- Scrub brush
- forceps
- Long-sleeved rubber gloves
- Nalgene containers
- Sample labels
- Waders with slip-resistant soles

Targeted habitat sampling

1. Beginning at the downstream end of the reach, select the first riffle or pool habitat unit (riffles at all sites, pools only if no riffles present). Collect one kick sample from each riffle or pool unless fewer than eight are present within reach. In that case evenly spread the eight samples across the number of riffles or pools within the reach. EXCLUDE margin habitats (area within 5% of channel margins).

   Vissualize a 3x3 grid over each riffle (or habitat unit) to be sampled (see figure 1). For the first habitat unit, select the lower-left square; for the second habitat unit, select the lower-center; the third, the lower-right; for the fourth, select the middle-left; for the fifth select the middle-center; for the sixth select the middle-right; for the seventh select the upper-left; for the eigth select the upper-center. Collect the kick sample in the center of each grid square.

7	8	9
4	5	6
1	2	3

Figure 1. Visualize a grid overlay to select kick sites at each habitat unit (riffle or pool).

2. After locating the random sample location, place the net into the stream with the flat part of the hoop resting on the bottom and perpendicular to the stream flow. As much as possible, make sure to remove any substrate that prevents the flat part of the kicknet from sitting flush with the bottom. It may also be useful to remove large substrate particles downstream of the flat portion of the loop that may affect the flow entering the net. Collect the macroinvertebrate sample by disturbing a 30 by 30 centimeter area (1ft x 1ft).

1

3. Inspect the benthos in a 1 ft X 1ft area (approximately as wide as the kick net) of stream bottom directly in front of the net for any large organisms such as mussels. Pick these and place in the sieve bucket.

4. Carefully rub by hand all substrate larger than five centimeters (golf ball size and larger) in front of the net to dislodge any clinging macroinvertebrates. Then, with a small scrub brush dislodge organisms still clinging to the larger substrate particles. After rubbing, place the substrate outside of the sample plot. (Hand scrubbing is recommended prior to using the brush to prevent damage from occurring to fragile macroinvertebrate specimens. Also, be gentle with the brush, so as not to chew up the macroinvertebrates.)

5. Thoroughly disturb the remaining substrate in the 1ft * 1ft area with your hands or feet for 1 min to a depth of five to ten centimeters.

*(**NOTE:** Collecting a sample in slow moving water is a little more difficult. It may involve pulling the net through the water as the substrate is disturbed to capture suspended organisms.)*

6. After the sample is collected and the net removed, return the large substrate to the sample plot.

7. The contents of the net are placed in a bucket and the sampling procedure is repeated for that habitat type. Always sample downstream to upstream.

8. All kick samples for the same reach are composited in the bucket. Large organic material and rocks are rinsed, carefully inspected for clinging macroinvertebrates, and removed. As much fine sediment as possible should be washed away. Leaf packs from pool samples may require considerable rinsing and removal of debris before preserving the composite sample.

9. When finished sampling all 8 ft^2, sieve sample through 8" brass sieve. Place all insects or material that may have insects on it into Nalgene bottles. Do no fill bottles up more than 25% by volume with organic matter. Place a label (**Rite in the Rain paper**) written in **pencil** containing site and habitat unit information **inside the container**. Label the outside container with a **pencil written on a label, then tape the label to the outside of the jar. Do not use markers as most inks are soluble in alcohol**. Then pour enough ethanol to cover sample until you get back to the car. When you get back to the car, fill bottles up with ethanol to completely preserve them.

10. Fill out Targeted Riffle Benthos section in the Sample Collection Form. **In the comments section describe the habitat types you sampled from** (e.g., all riffles, 1 riffle/3 pools, etc.)

Appendix J. Physical Habitat Data Sheet

Physical Habitat Inventory			**Site ID:**		**Date: __ __/__ __/__ __**		**Transect:**	
Substrate Cross-Section Information				Note: if reach is 150 m, measure thalweg depth every meter; if greater than 150 m, measure thalweg at 10 evenly spaced intervals between transects.	**Station**	**Thalweg Depth (cm)**	**Stream Habitat Type**	**Flag**
	Depth (cm)	Size Class	Flag		0			
Left Bank					1			
One-quarter					2			
Half-way					3			
Three-quarters					4			
Right Bank					**5**			
Total wetted width	__ __.__m				6			
Substrate Size Class Codes					8			
RS= Bedrock (smooth) - (Larger than a car)					9			
RR= Bedrock (rough)-(Larger than a car)					10			
RC= Concrete/Asphalt					11			
XB= Large boulder (meterstick to car)					12			
SB= Small boulder (basketball to meterstick)					13			
CB= Cobble (tennisball to basketball)					14			
GC= Coarse gravel (marble to tennisball)								
GF= Fine gravel (ladybug to marble)								
SA= Sand (gritty to ladybug)								
FN= Silt/clay/muck (not gritty)								
HP= Hardpan (firm, consolidated fine substrate)								
WD= Wood								
OT= Other (flag and describe)								

Stream Habitat Types

ER= riffle, glide, cascade, rapid, or waterfall
DE= pool

Substrate Only	Stn (5 or 7)	LFT	LCTR	CTR

% Shade Covering Channel (30' upstr./30' dwnstr.)		
<40%	40% - 70%	>70%

Riparian Zone: 30' X 30' plot from edge of stream		
	Left Bank	Right Bank
Trees > 15' tall	D C M N	D C M N
# conifers >1' dbh		
Understory	None Spar Mod Den	None Spar Mod Den
Ground cover	None Spar Mod Den	None Spar Mod Den

D= >70% deciduous, C= >70% conifer, M= mixed, N= No trees

Spar= sparse, Den= dense, Mod= moderate

Ground cover: none= bare dirt/duff, sparse= some bare dirt/duff

dbh= diameter at breast height

Tally of Large Wood in Stream at & between Transects	
# pieces 1' - 2' dia. @ large end:	
# pieces > 2' dia. @ large end:	

Invasive Plant Species (circle all present)

blackberry Eng. ivy reed canarygrass none

Comments

Appendix K. Sample Chain of Custody Form: Delta Environmental Laboratories

Delta Environmental Services, Inc.	**36 Irving Rd. Eugene Oregon 97404**	**Phone 541-689-3177 FAX 541-689-5104**	**Chain of Custody Record**

Report Attention:	**Project ID**: _____
Company Name:	
Address:_____ _____	**P.O. Number**: _____
Phone: (___)___-_____ **FAX**: (___)-____-_____	For Lab Use Only **Project Number**: _____
Report Instructions:	**ANALYSES TO BE PERFORMED**

Sample I.D.	**Collection**		**Sample**		***E. coli***	**Nitrate**	**Total P**				
	Date	**Time**	**Grab**	**Composite**							
Sample Comments:											
Sampled by: (print)			**Relinquished by: (sign)**		**Date**	**Time**	**Received by (sign):**			**Date**	**Time**
Remarks:											