Ferndale WWTP Outfall Sediments

Quality Assurance Project Plan

by
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Washington State Department of Ecology
Environmental Assessment Program
Olympia, WA 98504-7710

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Background and Problem Statement

The Nooksack River originates in the Mt. Baker Snoqualmie Wilderness Area where it flows through the national forest and down into the foothills of northwest Washington. Five miles upstream from where the Nooksack River enters Bellingham Bay, it flows through the city of Ferndale (Figure1). Ferndale's Waste Water Treatment Plant (WWTP) is located adjacent to the Nooksack River and discharges its treated effluent into the river through a side bank, single-port outfall (Figure 2). The WWTP treatment system consists of a main mixing lagoon, three auxiliary lagoons, a chlorine contact chamber, and a fabric effluent filter.

The influent for the plant comes from residential homes and small commercial establishments. Recomp of Washington is the only industrial discharger contributing to the influent loads (Hoyle-Dodson, 1998). Recomp is an industrial facility that incinerates and composts municipal solid waste and employs extensive water recovery and pretreatment processes; a small amount of overflow is generated and discharged to Ferndale's WWTP.

Ferndale's WWTP has limits for the maximum amount of cadmium, mercury, lead, and copper that remain in the discharged effluent. In 1999, the National Pollution Discharge Elimination System (NPDES) permit for Ferndale's WWTP was amended to raise limits for copper and lead. The change in permit metal limits is shown by the shaded area of Table 1. The increase in metals limits was rather controversial with local environmental groups; however, the WWTP found it was impractical to decrease the source of metals to their plant and the Department of Ecology found that previous limits were overly stringent (Ecology,1999).

Table 1. Changes in Permit Limits Measured as the Average Monthly Concentration (ug/L)

Permit	Copper	Lead	Cadmium	Mercury
NPDES Permit Limit 1993	11.08	2.29	2.54	0.24
NPDES Permit Limits 1999	19	30	2.54	0.24

To ensure that the increased metals limits are not causing an unacceptable accumulation of metals in sediments from the Lower Nooksack River, an updated evaluation of sediments must ensue. A review of Ecology's sediment database (SEDQUAL) found that historical sediment data in the Lower Nooksack River is limited to two studies. The first was done by Ecology in 1989 (Ruiz,1989). This study screened for 13 different metals including cadmium, copper, lead and mercury. Results of this study found some accumulation of metals without a direct correlation to the WWTP outfall. A portion of the results can be seen in Table 2 compared to freshwater sediment quality guidelines. All historic sampling locations are shown in Figure 2.

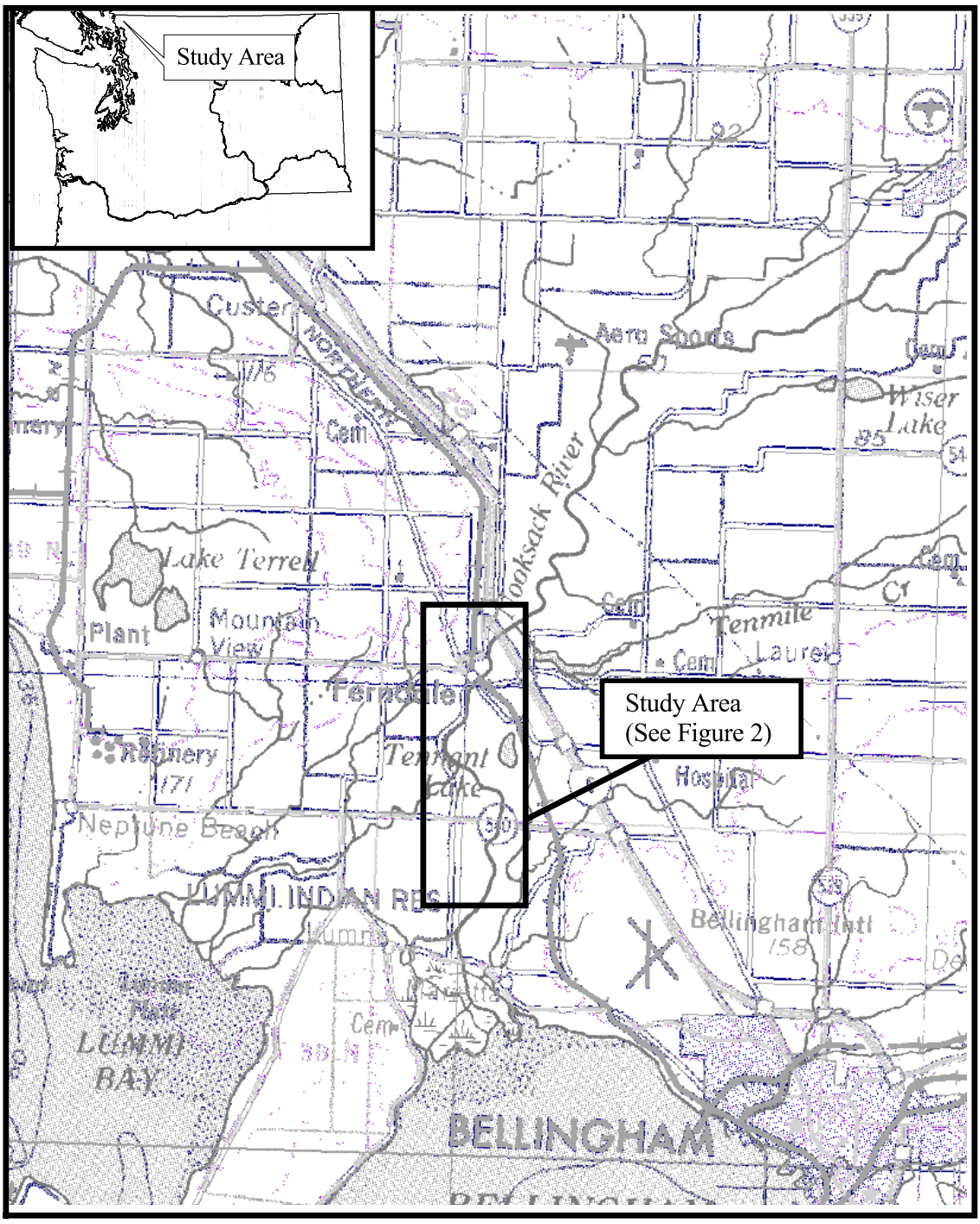

Figure 1: Nooksack River Study Area

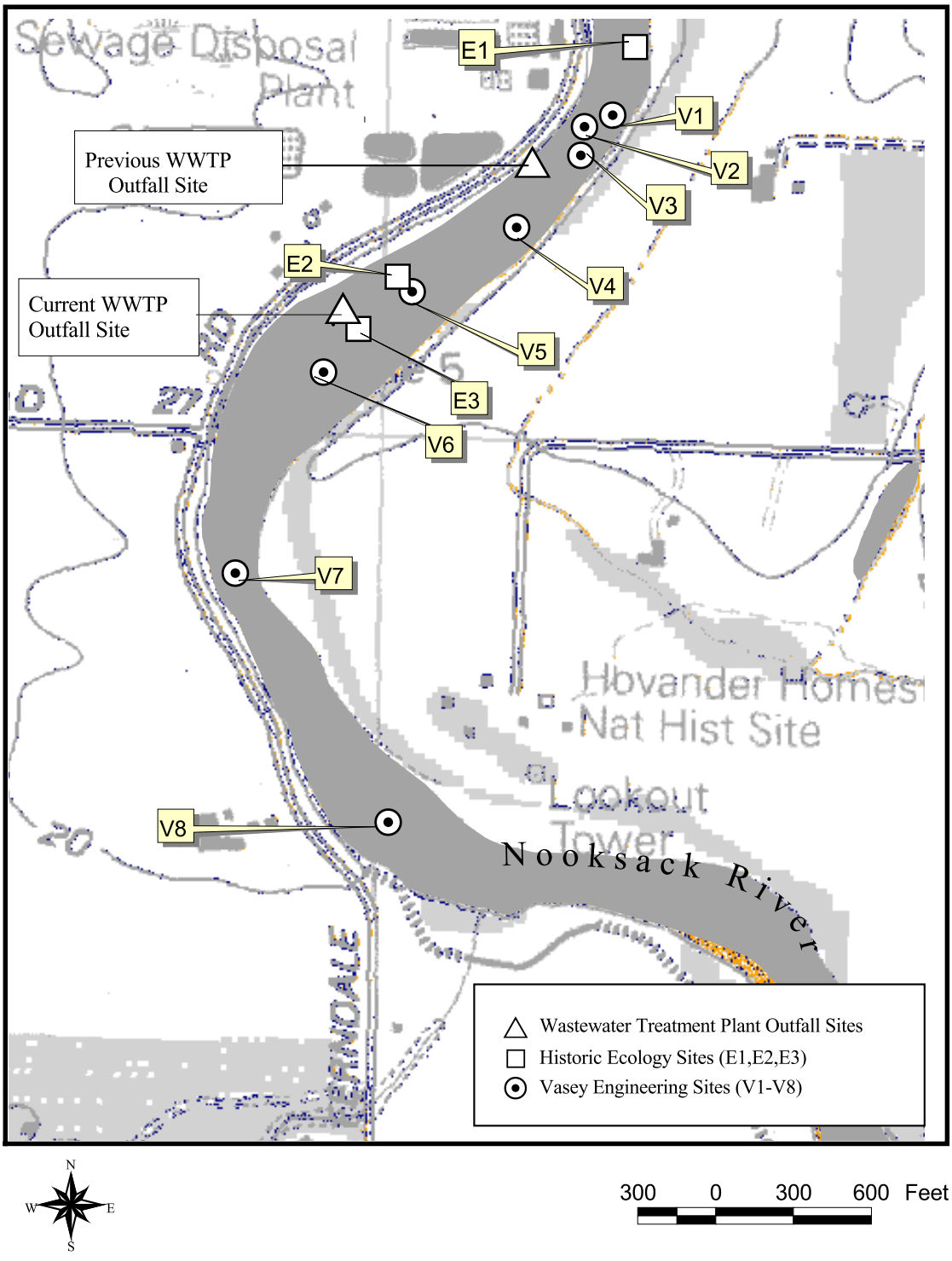

Figure 2: Historic Sediment Study Sites on the Nooksack River

The second study was done in 1997 by Vasey Engineering. This study looked at eight sites just upstream and downstream from the original WWTP outfall which was moved in 1996 to avoid discharging onto a sandbar during low flows (Berryman, 1997). The results shown in Table 2 are an average of the upstream and downstream sites. No correlation was made between the outfall and any accumulation of metals in the river sediments.

Table 2. Existing Sediment Data from 1988 and 1997 (mg/Kg, Dry Weight)

Station	Copper	Lead	Zinc	Cadmium	Mercury
V1-V3 [a] (Upstream of Outfall)	20	2.9	46.1	1.7	NA
E1 [b] (Upstream of Outfall)	26	2.4	62.3	0.5 U	0.016
E2 [b] (Below Outfall)	15.3	2.3	57.2	0.5 U	0.006 U
V4-V8 [a] (Below Outfall)	14.7	3.1	37	1.3	NA
E3 [b] (Below Outfall)	14.6	1.4	51.5	0.5 U	0.006 U
Sediment Guidelines	32[c]	36[c]	121[c]	0.99[c]	0.56[d]

a = Vasey Engineering Monitoring (Berryman, 1997)
b = Ecology Monitoring by Ruiz (1989)
c = Consensus-Based Threshold Effects Concentrations (MacDonald et al., 2000)
d = Lowest Apparent Effects Threshold (Cubbage et al., 1997)
U = Undetected at Value Shown

The 1995 Needs Assessments for the Nooksack/San Juan Watershed recommended a sediment characterization study which would focus on Ferndale's WWTP outfall. A Class II inspection conducted in 1997 focused on performance and operation of the facility and did not include sediment from the river (Carey and Coots, 2000). This area of the Nooksack River will be studied to determine if effluent is having an impact on the sediments.

Project Description

Ecology's Bellingham Field Office has requested a characterization of the sediment upstream, downstream, and at the Ferndale WWTP outfall to determine if metals are accumulating in the sediments of the Nooksack River. The Environmental Assessment Program (EAP) will sample sediments at nine stations in the Nooksack River. Station selection will be determined by historical study locations and WWTP outfalls. Sampling will occur during fall low flow conditions to increase comparability with existing sediment data. Each station will be analyzed for grain size, Total Organic Carbon (TOC), % Solids, and the metals listed in Table 3. Since there are currently no standards for freshwater sediments, the guidelines listed below are meant to aid in determining whether the metals concentrations in the Nooksack represent a threat to the benthic community. The guidelines come from several sources and each is selected on the conservative side. After the samples are analyzed, the results will be compared to each other and these guidelines. If there is an accumulation of metals correlated to the outfall sites, permit limits at the WWTP will have to be re-evaluated and other possible sources investigated.

Table 3. Sediment Quality Guidelines for Adverse Effects Thresholds to Sediment Dwelling Organisms (mg/Kg, Dry Weight)

Cd	Cr	Cu	Ni	Ag	Pb	As	Zn	Se	Tl	Fe	Mn	Ba	Hg	Sb	Be
0.99[b]	43[b]	32[b]	46[a]	4.5[a]	36[b]	0.79[b]	121[b]	5[c]	na	20,000[d]	na	na	0.56[a]	na	na

a=Lowest Apparent Effect Threshold (Cubbage et al.,1997)
b=Consensus-Based Threshold Effect Concentrations (MacDonald et al., 2000)
c=British Columbia Freshwater Sediment Quality Working Guidelines (Nagpal et al., 1995)
d=Lowest Effect Level (Persaud et al., 1993)

Study Objectives

- Provide broader spatial coverage of metals concentrations in the Lower Nooksack River sediments.

- Conduct screening to see if sediments downstream of the WWTP are accumulating priority pollutant metals, iron, manganese, or barium above background concentrations.

- Assess whether metals may be toxic to benthic organisms as measured by comparison to available sediment quality guidelines.

Project Organization

Project Manager and Principal Investigator– Morgan Roose (360/407-6458)

BFO Client – Mark Henderson (360)676-2198

BFO Section Manager – Richard Grout (360)738-6250

Watershed Ecology Section Manager - Will Kendra (360)407-6698

Toxics Studies Unit Supervisor - Dale Norton (360)407-6765

Manchester Laboratory Director - Stuart Magoon (360)871-8801

Quality Assurance Officer - Cliff Kirchmer (360)4076455

Schedule

October 2001	Sediment samples collected and submitted for analysis
November 2001	Laboratory analyses completed and results reported to project lead
December 2001	Data entered into EIM and SEDQUAL
December 2001	Draft report to client
January 2001	Final report

Data Quality Objectives

PSEP procedures (EPA, 1996) for collection, preservation, transportation, and storage of sediment samples will be followed in an effort to limit sources of bias. Archived samples will be held in the event that samples need to be re-analyzed.

The measurement quality objectives (MQOs) in this study are shown below in Table 4. Data collected will be compared to the sediment quality guidelines shown in Table 3 to determine if follow-up work is warranted or permit limits need to be modified.

Table 4. Measurement Quality Objectives

Parameter	Accuracy	Precision	Bias	Required Reporting Limit
	% Deviation from True Value	% Relative Standard Deviation	% of True Value	mg/Kg Dry Weight
Cadmium	40	15	10	0.99
Chromium, Copper, Nickel, Lead	40	15	10	32
Thallium, Mangenese, Barium, Beryllium, Antimony	40	15	10	10
Iron	40	15	10	20 g/Kg, dw
Mercury	40	15	10	1
Zinc	40	15	10	121
Arsenic	40	15	10	9
Silver, Sellenium	40	15	10	4
TOC	40	15	10	

Study Design

Samples from nine stations in the Nooksack River will be screened for Priority Pollutant metals. Stations will be selected to compare with existing sediment data and to bracket the WWTP outfall, I-5 corridor, and the city of Ferndale. Proposed sampling sites are shown in Figure 3 and described in Table 5. Several sites will be selected upstream from the outfall to bracket potential sources of metals contamination from storm-water drain outfall sites and to obtain unbiased background levels of metals in the Nooksack River sediment. The storm-water drain outfall locations were provided by the city of Ferndale (Sperry, 2001). All sites will be selected for areas where flow is low enough for fine grain particulates to accumulate. Estimated analytical costs for this study are shown in Table 6.

Table 5. Proposed Nooksack River Station Location and Purpose (See Figure 3)

Station Name	Location	Purpose
F1	300 ft. upstream from I-5	Background
F2	300 ft. downstream from I-5	Freeway Impacts
F3	200 ft. upstream from railroad crossing	Above City of Ferndale
F4	200 ft. downstream from Cherry Street	Below City of Ferndale
F5	100 ft. upstream from outfall	Above Outfall
F6	10-20 ft. downstream from outfall	Outfall Impacts
F7	500 ft. downstream from Ulrick Rd.	Outfall Impacts
F8	1/2 mile downstream from outfall	Outfall Impacts
F9	approx 1 mile downstream from outfall	Outfall Impacts

Table 6. Cost Estimate for Analyzing Ferndale WWTP Sediment Samples

Analysis	Number of Samples	Matrix Spikes	Blind Field Duplicate	Total Analyses	Cost/ Analysis	Cost Subtotals
Chemistry:						
Metals	9	2	1	12	$218	$2616
TOC	9	0	1	10	$33	$330
% Solids	9	0	1	10	$9	$90
Grain Size	9	0	1	10	$90	$900
						$3936

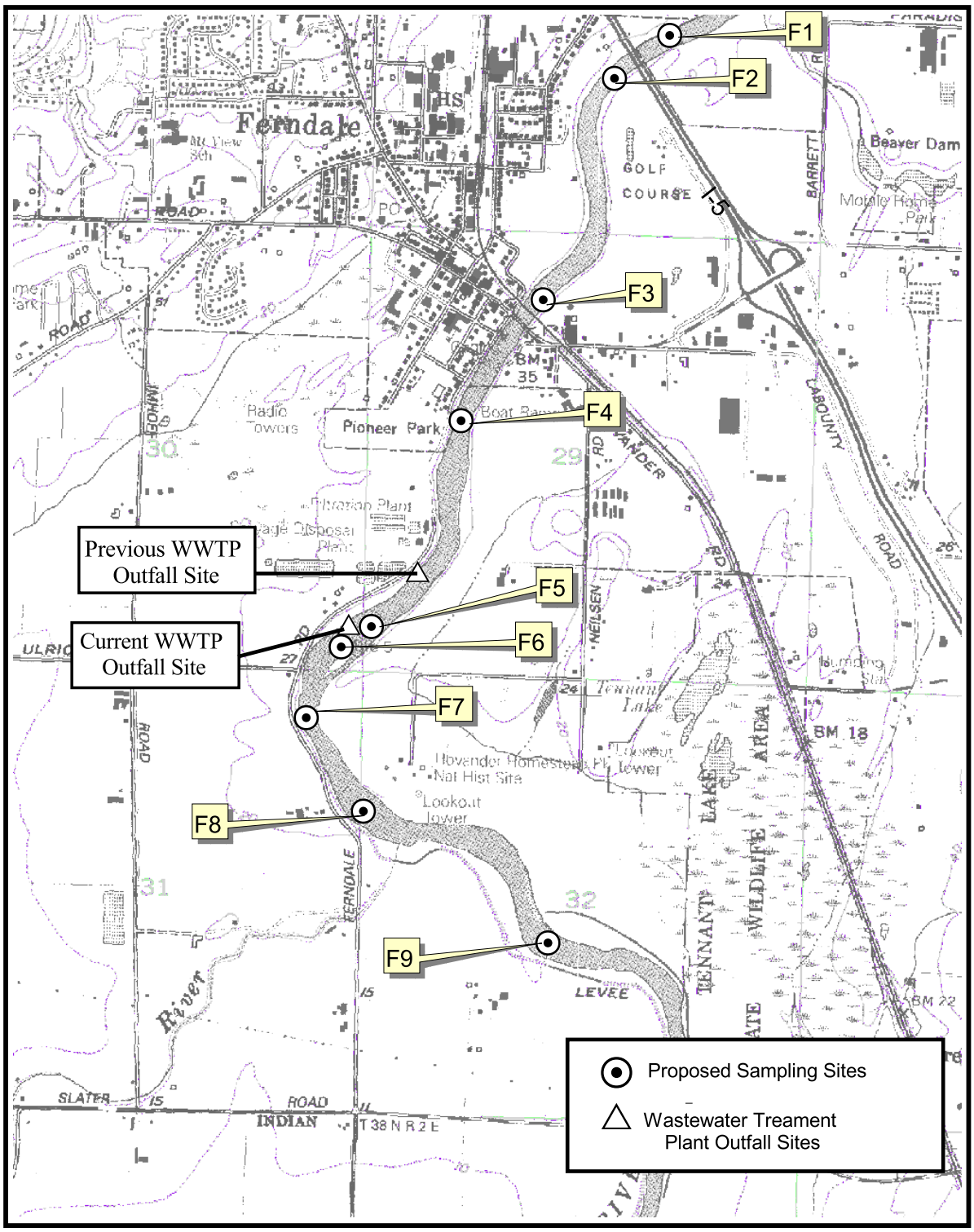

Figure 3: Proposed Sampling Sites

Representativeness

The objective is to obtain samples which are representative of bottom sediments at the locations targeted. Composite samples will be collected in an effort to obtain data representative of each sampling site.

Completeness

The objective of obtaining 100% useable data will be maximized by careful planning of field work, packaging, and transport of samples. Excess sample will be collected and stored at the Manchester Laboratory for 60 days (at 4^{o} C) from the time the data is sent to the project lead to allow time for QA review.

Comparability

Results obtained from this study should be comparable to other EAP studies and those conducted in the Nooksack River. Sampling methods will be consistent with PSEP protocols (EPA, 1996) and requirements of the Sediment Management Standards (Ecology, 1995a,b). Each composite sample will be taken from the top 10 cm of each grab. Station positions will be recorded using global positioning system (GPS) to allow comparison with previous sampling locations.

Field Procedures

Samples from the sites will be collected from Ecology's Jet Sled using a 0.02 m^2 stainless steel Petite Ponar grab and a .05 m^2 stainless steel Ponar grab. Sampling sites will be located and positions recorded using GPS and landmarks. A grab will be considered acceptable if not over-filled with sediment, overlying water is present and not excessively turbid, the sediment surface is relatively flat, and desired depth penetration has been achieved. A field log will be maintained during sampling. After siphoning off overlying water, the top 10 cm of each grab will be removed with stainless steel scoops, placed in a stainless steel bowl, and homogenized by stirring. Material touching the sidewalls of the grab will not be taken. Each sample will consist of a homogenized composite of three individual grabs, all taken within the same 10' x 10' area.

The homogenized sediment will be placed in glass jars with Teflon lid liners cleaned to EPA QA/QC specifications (EPA, 1990). Sample containers, preservation, and holding times are shown in Table 6. Excess samples will be retained from each station and stored frozen in the event that additional analysis is required.

Stainless steel implements used to collect and manipulate the sediments will be cleaned by washing with Liquinox detergent and followed by sequential rinses with tap water, 10% nitric acid, and deionized water. The equipment will be air-dried and wrapped in aluminum foil. Between-sample cleaning of the grab will consist of thorough brushing with on-site water.

Sediment samples will be placed on ice immediately after collection and transported to Manchester Laboratory within one-to-two days. Chain-of-custody will be maintained. Back-up sampling equipment, sample containers, positioning instruments, and spare parts will be carried during field sampling as preventative maintenance.

Table 7. Sample Containers, Preservation, and Holding Times

Analysis	Container	Preservation	Holding Time
Metals	8 oz glass; TFE-lined lid	4 deg C in the dark	6 months
TOC	4 oz glass; TFE-lined lid	4 deg C in the dark	28 days (1 year frozen)
% Solids	4 oz glass; TFE-lined lid (analyzed from metals jar)	4 deg C in the dark	7 days
Grain size	8 oz glass; TFE-lined lid	4 deg C in the dark	6 months

Laboratory Procedures

The holding time for metals is six months at 4^{o} C (EPA, 2000). The samples will be analyzed well before their holding times expire.

Table 8 lists each parameter, its expected method detection limit, and the method that will be used by the laboratory. The methods selected meet the accuracy requirements listed in Table 4.

Table 8. Analytical Methods, Method Detection Limits, and Laboratories

Analysis	Method Detection Limit (dry weight)	Method	Laboratory
Chemistry:			
Thallium, Lead, Antimony	0.1 mg/Kg	ICP-MS EPA 3050/6010B	Manchester
Arsenic	0.2 mg/Kg	ICP-MS EPA 3050/6010B	Manchester
Cadmium	0.3 mg/Kg	ICP– EPA3050/6010B	Manchester
Copper, Zinc, Chromium	0.5 mg/Kg	ICP – EPA3050/6010B	Manchester
Beryllium	0.1 mg/Kg	ICP/AES – EPA3050/6010B	Manchester
Nickel, Silver	1 mg/Kg	ICP/AES – EPA3050/6010B	Manchester
Barium, Manganese	0.2 mg/Kg	ICP– EPA3050/6010B	Manchester
Iron	2 mg/Kg	ICP– EPA3050/6010B	Manchester
Mercury	.00003 mg/Kg	CVAA - EPA245.5	Manchester
TOC	0.1%	Combustion/CO2 - EPA (1996)	Manchester
% Solids	0.1%	Gravimetric - EPA (1996)	Manchester
Grain Size (clay, silt & sand)	0.1%	Sieve & Pipet - EPA (1996)	Contract

Quality Control

The QC procedures routinely followed by Manchester Laboratory for the metals analysis will include a laboratory duplicate, method blank, one matrix spike, a blind field duplicate and one matrix spike duplicate. The matrix spikes will be taken at one of the Background Stations and the Blind Field Duplicate will be taken below the outfall. All QC samples will be analyzed from the same batch as the test samples. QC samples for Total Organic Carbon (TOC) and percent solids will include a laboratory duplicate and a Laboratory Control Sample (TOC only). A laboratory triplicate analysis will be conducted for grain size.

Table 9 shows the quality control analysis requirements for this project. Matrix spikes provide an indication of bias due to interference from the sample matrix. The laboratory control sample (metals and TOC) recoveries will provide an estimate of accuracy for the entire analytical procedure. Overall precision of the chemical data will be estimated from the results of duplicate analyses and matrix spike/matrix spike duplicates. The Relative Standard Deviation (RSD) for lab duplicates will give an indication of overall data precision.

Table 9. Quality Control Analysis Requirements

	TOC	Grain Size	Metals
Matrix Spikes	NA	NA	75-125% recovery
Matrix Spike Duplicates	NA	NA	≤ 25% RPD
Laboratory Control Samples	NA	NA	70-130% recovery
Laboratory Duplicates	≤ 20% RPD	≤ 20% RPD	≤ 20% RPD
Blind Field Duplicate	≤ 20% RPD	≤ 20% RPD	≤ 20% RPD

NA=Not Applicable RPD=Relative Percent Difference

Data Management Procedures

Station data and field data will be written in field notebooks and will then be entered into Ecology's Environmental Information System (EIM) and Sediment Database (SEDQUAL). After the laboratory data is reviewed, it will also be entered into EIM and SEDQUAL. All of the data will be entered in EIM and SEDQUAL before the final report is complete.

Data Review, Verification and Validation

Manchester's standard operating procedure (SOP) for reduction, review, and reporting of the chemical data will meet the needs of this project. Each laboratory unit assembles data packages consisting of raw data from the analyses of the samples, copies of the pertinent logbook sheets, QA/QC data, and final reports of data entered into LIMS. These data packages are subjected to a data verification and quality assurance review by another analyst familiar with the procedure. Reviewers use *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* February 1994 and *U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, October 1999.

On receipt of the chemical data, the project lead will review the results for completeness, reasonableness, usability, and comparison to QAPP specified targets. The chemical data and case narratives will be reviewed to assure that quality control procedures meet frequency requirements and control limits.

The project lead will provide a draft report of the study results to the clients in December 2001. At a minimum, the final report will contain the following:

- A map of the study area showing sampling sites.
- Latitude/longitude and other location information for each sampling site.
- Descriptions of field and laboratory methods.
- A discussion of data quality and the significance of any problems encountered in the analyses.
- Summary tables of the chemical data.
- An evaluation of significant findings.
- Recommendations for follow-up work.

A final report will be prepared after receiving review comments from the BFO client and internal comments from EAP. The goal is to have the revised final report completed by January 2001. The data will be entered into Ecology's Environmental Information Management (EIM) system and made available electronically for entry into SEDQUAL.

Data Quality Assessment

The data will be reviewed to make sure the data satisfactorily meets the data quality objectives (DQOs) specified in this QAPP and will be noted in the final report. Once the data is determined to be satisfactory, it will be compared to the freshwater sediment guidelines, previous sediment data, and the upstream and downstream data will be compared.

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