Appendix A

Additional Quality Assurance Information For Water Quality Monitoring

STILLAGUAMISH SUB-BASIN RESTORATION AND MONITORING

WATERSHED ANALYSIS
QUALITY ASSURANCE PROJECT PLAN

This document was prepared in partial fulfillment of
the contract requirements of
Centennial Clean Water Fund No. G96000292

Prepared by:

Kathy Thornburgh
Snohomish County Department of Public Works
Surface Water Management Division
2930 Wetmore Avenue, Suite 101
Everett, WA 98201-4044
206-388-3464

July, 1996

Approved by:

____

Bill Hashim
Project Manager
Department of Ecology

____

Kathy Thornburgh
Project Manager
Snohomish County Surface Water Management

TABLE OF CONTENTS

Project Description

Introduction

Tributary 30 is a small, 2000 acre watershed, which drains into the lower Stillaguamish River. Tributary 30 has been identified as a source of bacterial loading in the lower Stillaguamish River and is also an important stream for fish habitat. This project will directly improve water quality and salmon habitat by identifying specific nonpoint sources, designing measures to correct specific problems, implementing improvement projects, and evaluation of the effects of these improvements. We will analyze nonpoint problems and implement solutions throughout a small watershed as an effective way to reduce nonpoint pollution in a larger river system. Small watersheds have a more rapid response to change than larger watersheds and improvements in water quality should be measurable more quickly. We will continue monitoring for one year after implementation to evaluate the effectiveness of the project.

Project Purpose and Goals

The purpose of this project is to correct specific nonpoint pollution sources in an important tributary of the Stillaguamish River that currently contributes to pollution in the mainstem river and in Port Susan. This project will directly improve water quality and salmon habitat in Tributary 30 by identifying specific nonpoint pollution sources, implementing improvement projects, and evaluating the effects of the improvements. Improvement projects in this watershed may include installing fences to limit animal access to streams, establishing riparian vegetation, or instream structural modifications to improve fish habitat.

The goal of this project is to improve water quality and restore fish habitat throughout Tributary 30 of the Stillaguamish River. The objectives of this project include:

- assessment of the watershed and prioritization of nonpoint pollution problems;
- monitoring of index sites and reaches before and after implementation of projects;
- development of farm plans and other measures to address nonpoint problems;
- implementation of best management practices using local funds on private property;
- participation and education for farmers, landowners, schools, and community groups; and
- a continuation of community involvement and tracking of water quality problems by the watershed steward after the end of the project.

Project Organization

The project manager, Kathy Thornburgh, is responsible for managing all phases of monitoring and evaluation under the terms of the Centennial grant contract, including performance or supervision of the following activities:

- site selection and sampling design,
- sample collection and handling,
- field data collection,
- review of laboratory data packages,
- data analysis,
- project report writing,
- verification of compliance with all Quality Assurance Plan requirements,
- administrative and financial duties related to the Centennial grant contract, and
- communication and coordination with other monitoring projects in the lower Stillaguamish watershed.

North Creek Analytical, Inc., will perform all water analyses indicated in this document. The SWM Project Manager will notify Ecology if a different laboratory is used. All laboratories used in this project will be accredited by Ecology for any analyses conducted.

Project Elements

Watershed Assessment - Field Data Collection and Analysis

To accomplish the goal of improving water quality in the watershed, SWM will assess the entire area and prioritize nonpoint pollution problems. Watershed assessment will include compiling baseline information about the watershed, using established assessment methodologies, and adding information to the County's Geographical Information System (GIS). Watershed assessment will include establishment of reference sites and chemical, temperature, invertebrate, and fish habitat monitoring. Assessment procedures are discussed in detail in the following section on Watershed Analysis Experimental Design.

Public Involvement and Education

SWM will develop a brochure describing the project which will be mailed to watershed residents. Staff will initiate direct contact with streamside residents to encourage participation in watershed protection and restoration. We will work with the Stillaguamish Clean Water District board members to develop private partnerships and funding sources for implementing best management practices on private property. We will also provide opportunities for farmers, landowners, schools, and community groups to participate in workshops, fencing and revegetation projects, bank stabilization, and monitoring. SWM will attempt to work with established community groups who will continue stewardship activities in the watershed after the completion of the project.

Watershed Restoration - Project Development and Implementation

SWM will contract with the Snohomish Conservation District to develop farm plans with cooperating landowners and implement fencing and stream restoration projects. Agricultural best management practices and restoration projects will be prioritized so that those implemented will provide the greatest protection for water quality. SWM will solicit cooperation from school and community groups for volunteer labor in restoration and enhancement projects. Technical assistance for agriculture activities provided will be consistent with the current U.S. Natural Resources Conservation Service standards.

Project Evaluation

SWM will continue to monitor reference and restoration sites throughout the life of the project. SWM will evaluate changes in water quality, physical condition of the stream channel, and biological populations in the stream which may occur a result of restoration projects. SWM will review the program and evaluate the effectiveness of the elements of monitoring and restoration as a model for reducing nonpoint pollution in similar watersheds. A detailed analysis will be presented in project annual reports and the final report.

Planning Area Description

Tributary 30 drains approximately three square miles, flowing into the mainstem Stillaguamish River from the south and to the west of Portage Creek. A number of non-commercial farms are located in the upper watershed with several commercial operations in the lowlands. Several miles of the stream provide fish habitat, and the Tulalip Tribes have identified the stream as important for salmon production.

Review of Previous Investigations

The Tulalip Tribes monitored the water quality at a site near the mouth of Tributary 30 from 1991-1994. In 1994, SWM began monthly monitoring at the same site as part of the Ambient Water Quality Monitoring Program. The Tribes and SWM have found numerous violations of the state water quality standard for fecal coliform bacteria, occasional violations of the turbidity standard, and nitrate levels that indicate contamination form nonpoint pollution (Thornburgh 1995). The geometric mean of fecal coliform bacteria from 1991 through 1994 was 280 col/100 ml with levels recorded as high as 5000 col/100 ml. The mean nitrate-nitrite level from this time period was greater than 1.5 mg/l and turbidities as high as 50 NTU were measured. SWM conducted a reconnaissance survey of fourteen road crossings of streams in the watershed in 1994 and found eight locations of animal access and four locations of confirmed nonpoint pollution, as well as garbage or trash deposited in the stream. Several miles of the stream provide fish habitat and the Tribes have identified the stream as important for salmon production.

The Snohomish Conservation District combined the Hat Slough and Valley Creek areas with Tributary 30 in their farm inventory (Steinbarger 1995). In the combined area, they found that almost all the farms were non-commercial and that over 30% of these farms had serious and moderately serious water quality problems.

Watershed Analysis Experimental Design

Overview

This project will utilize a coordinated approach to assess the health of the watershed both before and after implementation of restoration projects. The watershed assessment will help prioritize nonpoint pollution and habitat problems and to evaluate changes in water quality after implementation of best management practices. Since animal access and lack of vegetation have been identified as problems, an intensive temperature monitoring study will identify the stream reaches where temperatures violate water quality standards and will evaluate the effects of restoration projects. We will establish stream channel reference sites to evaluate problems related to bank instability and sedimentation. The limiting factors analysis is designed to identify potential physical limitations to fish production that may be moderated or removed by habitat rehabilitation or enhancement programs. Bioassessment techniques will allow us to assess benthic invertebrates, including freshwater mussels, as indicators of water quality. Finally, water quality monitoring data will allow us to estimate pollutant loads in sub-basins of the watershed before and after implementation of best management practices.

Temperature Study

Temperature is an important physical parameter for aquatic life. Changes in land use in a watershed and loss of riparian buffer are reflected by increases in stream temperature. Ambient monitoring programs measure a single temperature at the time of sampling and not the range of temperatures to which aquatic organisms are exposed. This study will monitor temperature continuously to establish the temperature regime in different reaches of the stream system. The study will use StowAway temperature loggers and will record temperature at two hour intervals. During the summer and fall of 1996, at least four temperature loggers will be deployed on both vegetated and open reaches of the stream to establish ambient conditions. During the summer and fall of 1997, the loggers may be placed upstream and downstream of rehabilitated reaches. The temperature data will be summarized to determine the number of violations of state temperature standards and the duration of time that these temperature were maintained both daily and cumulatively.

Stream Channel Reference Sites

We will establish permanent reference sites within the watershed to document long-term changes in the physical and biological character of the stream. We will establish and monitor sites using U.S. Forest Service protocols described by Harrelson et al (1994). These protocols include installing a staff gage and measuring channel cross section, discharge, stream bed composition, and stream bank composition. These sites will be established in the first year of the project and surveyed annually.

One objective in establishing reference sites is to document changes in channel morphology as land use changes or as best management practices are implemented. Other objectives include identifying sensitive areas for protection, documenting changes in the quality and quantity of habitat related to land use, and to gain information on the variability within the basin of stream morphology.

Criteria in choosing reference sites include long-term access, land use, and reaches of known and potential fish use. Reaches with a potential response to land use change based on gradient, soil type, substrate, channel type, wetlands or lakes may also be chosen. Reference sites may also include sensitive areas, which have known problems of stream instability, flooding, bank erosion, or property damage.

Limiting Factors Analysis

The limiting factors analysis is designed to identify potential physical limitations to fish production that may be moderated or removed by habitat rehabilitation or enhancement programs. We will follow U.S. Forest Service methods outlined by Reeves et al. (1989). The methods are coho habitat surveys which generate estimates of the amount of habitat use by coho salmon in a basin. The methods estimate the total amount of habitat present in the basin and the amount of usable habitat. Besides physical habitat data, the method incorporates summer and winter water temperature data and any available information on smolt output or adult escapement. Temperature data will be available from the temperature loggers. Salmon presence, absence, and abundance will be noted on stream surveys and any available data from the Tulalip or Stillaguamish Tribes will be used.

We will choose index reaches for the limiting factors analysis based on accessibility, gradient, land use, soil type, and vegetation. We will attempt to find reaches in gradient categories of less than 1%, 1-3%, 3-6%, and greater than 6%. We will choose reaches along the mainstem, in each major tributary, in the floodplain, and in confined or entrenched channels. Reaches will be surveyed during the low flow season of 1996. Data will be analyzed consistently with a similar study in the entire Stillaguamish basin, which is being conducted by the Tulalip Tribes under contract with SWM.

Invertebrate Monitoring

We will use instream biological assessment monitoring protocols developed by DOE (Plotnikoff 1994). We will choose representative reference sites for biological monitoring as a subset of the stream channel reference sites. The sites will be monitored annually, during the time period from August through October. At the time of invertebrate sampling, the water temperature, dissolved oxygen, conductivity, and pH will be measured. At each site, riffle and depositional areas will be identified. Four samples will be collected from each of these two area types and the samples from each type will be composited. The composited samples will be subsampled and identified according to DOE protocols.

Freshwater Mussel Survey

Freshwater mussels can be used as environmental indicators in a watershed analysis. Mussel larvae are parasitic and require the presence of certain species of trout or salmon. Development impacts, such as increased siltation, reduced riparian cover, or loss of year-round stream flow can also reduce mussel populations. Mussel beds are present in Tributary 30. This survey will map the extent of the beds. A healthy mussel population is reproducing and this can be inferred by the presence of multiple age classes. We will sample the mussels in selected locations to determine whether or not multiple age classes are present.

Sampling will follow methodology established by Dr. Terry Frest of Deixis Consultants. Mussels are sampled in 0.25 m squares with approximately 20 squares sampled in an area. All mussels are removed in each square and length, width, and depth recorded to the nearest 0.1 cm. Mussels are kept damp and returned to their original location. Data is analyzed by plotting length versus width and length versus depth. Clusters of data points indicate different age classes.

Water Quality Monitoring

Sampling Site Determination

A goal of the water quality monitoring is to estimate pollutant loads from various sub-basins in the watershed before and after implementation of best management practices. Sampling sites will be chosen so that sub-basins or specific reaches of the stream can be isolated. On reaches where pollutant sources have been identified, sampling sites will be located upstream and downstream of the specific area. On short tributaries, sampling sites will be located as close as possible to the confluence so that the pollutant load from that tributary can be estimated. One sampling site on the mainstem of Trib 30 has been sampled monthly since October, 1991, by the Tulalip Tribes and SWM. Monthly monitoring will continue at this site throughout the project to determine long-term trends in water quality.

Water Sampling and Analysis Schedule

The sampling schedule will consist of low flow and high flow surveys with discharge measured on each sampling occasion. Three sets of low flow samples will be collected at all project sites with sufficient flow during the low flow period in 1996, or approximately from August through October. The low flow survey will be less extensive than the high flow survey because many reaches in the upper watershed are dry during the summer. The high flow survey will include from six to ten sets of samples and will include sites in the upper watershed. SWM staff will attempt to sample during several periods of extreme runoff, including the first storm in the fall which produces significant runoff. Estimates of pollutant loading during storms will give a range of peak pollutant loads contributed to the Stillaguamish River from the Trib 30 watershed. The high flow survey sampling will be conducted from October, 1996 through March, 1997. In the low flow season of 1997, approximately six sets of samples will be collected from June through October. The high flow survey will be repeated during the 1997-1998 wet season.

Sampling Procedures

Water samples shall be collected at a point chosen to ensure that a well mixed and representative sample is taken. Water samples will be collected either directly into appropriate sample containers provided by the laboratory, or into a primary container from which subsamples will be transferred into sample containers. Table 1 lists the parameters, analytical methods and detection limits. Samples will be handled and stored in accordance with contract laboratory requirements as described in this table. The sampler will label each sample container with site name, date and time of collection, and analyses to be performed. Sample containers will be kept closed and in a cooler until reaching the lab.

Table 1. Water quality parameters

Parameter	Method	Detection Limit	Storage / Preservation / Holding Requirements
Temperature	meter - YSI model 50B	0.1 degree C.	
Dissolved Oxygen	EPA 360.1/2 meter - YSI model 50B	0.1 mg/l	
Conductivity	EPA 120.1 meter - VWR model 604	1 umhos/cm	
Velocity	meter - Swoffer model 2100	0.01 ft/sec	
pH	meter - Orion model SA250	0.05 pH unit	
Fecal Coliform Bacteria	membrane filter	1 col/100 ml	Glass/4^{0}C / 6 hours
Nitrate-nitrite	EPA 351.2 cadmium reduction	10 ug/l	Plastic,Glass/ 4^{0}C/ H2SO4/28 days
Total Phosphorus	EPA 365.1 ascorbic acid	3 ug/l	Plastic,Glass/ 4^{0}C/ H2SO4/28 days
Total Suspended Solids	EPA 160.1 gravimetric	1 mg/l	Plastic,Glass/ 4^{0}C/7 days
Turbidity	meter - LaMotte model 2008	1 NTU	

Following sample collection, containers will be immediately placed in a cooler, packed with ice, and delivered to the laboratory within the appropriate holding time. Chain of custody forms provided by the laboratory shall be used in this project. Upon receipt of the samples at the laboratory or by the laboratory's courier, the condition of the samples will be recorded by the receiver. Chain of custody records will be included in the analytical report prepared by the laboratory.

The stream discharge will be measured at each site on each sampling occasion. We will measure velocity and depth along a cross section of the stream at the sampling site. The stream velocity will be measured at intervals above the stream bed at 60% total depth below the surface with a Swoffer model 2100 horizontal-axis current meter. The velocity meter will be held stationary relative to the bed and the axis of rotation of the propeller shall be perpendicular to the flow. Stream discharge will be calculated as the summation of the products of the subsection areas of the stream cross section and the corresponding average velocities (Rantz et al. 1982).

Quality Control Procedures

Field Duplicate Samples

A minimum of one field duplicate water sample will be collected for every ten field water samples collected for each analytical parameter. The duplicate pairs shall consist of two full volume samples, one collected immediately after the other. These samples will be labeled in such a manner that the laboratory will not know that the samples are replicates. The field duplicate analyses will be used to determine whether experimental precision is adequate.

Laboratory Duplicate Analyses

The laboratory shall be directed to randomly select one water sample from each batch of up to twenty samples, thoroughly mix and split this sample, and perform all required analyses on both samples. The laboratory shall use these data to determine internal quality control and take any corrective action required, and shall report all data to the County.

Field Blank Samples and Blind Reference Samples

A minimum of one field blank water sample will be prepared for every twenty field water samples collected for each analytical parameter. The field blank sample will be prepared by filling the sample container with distilled water. These data shall be used to evaluate the compound effects of imprecision plus bias.

At the Project Manager's discretion, blind reference samples of known concentrations shall be sent to the laboratory. These data shall be used to evaluate the combined effects of imprecision plus bias.

Performance Evaluation Samples

The laboratory shall report to the County the results of all external performance evaluation analyses for parameters in this project, including all evaluation samples submitted by the US Environmental Protection Agency or Ecology. These data shall be used to evaluate overall accuracy.

Data Quality Objectives

Precision

Field duplicate analyses and laboratory duplicate analyses shall be used to evaluate precision. Field duplicate analyses will indicate the degree of imprecision due to the combined effects of heterogeneity of the stream, variation in sample collection methods, and imprecision of analytical methods. Laboratory duplicate analyses will indicate the degree of imprecision due to the combined effects of sample splitting in the laboratory, and imprecision of analytical methods.

For each type of duplicate analysis, overall method precision shall be considered acceptable if the relative percent difference (RPD) does not exceed 20%. The RPD is defined as

|measurement 1 - measurement 2| * 100 / duplicate mean.

This is approximately equal to accepting the precision if the highest value in a set of duplicate measurements is not greater than 1.2 times the lowest value. The analytical laboratory under contract with SWM defines their acceptable analytical precision in the latter manner.

Bias

The project goal for maximum systematic bias is 10%. Problems with systematic bias will be suspected in the following two cases:

- if the RPD between the measured and expected values of a blind reference sample in a batch exceeds 20%, while similar comparisons between analyses for precision are acceptable; or
- if the measured value of a parameter in a field blank sample exceeds the reporting limit.

Representativeness

The primary considerations regarding representativeness in this study are homogeneity of the stream, variations in analyte values due to stochastic factors such as flow variation and weather, and the choice of sample site. The standard procedures used to collect field data and water samples help ensure that the samples collected are representative of the streams at the time of collection.

Completeness

Completeness is defined as the percentage of valid analytical determinations with respect to the total number of determinations. A reasonable completeness goal is 90%. Typical field problems such as sample container contamination or equipment failure may result in completeness of less than 100%. Another factor which may reduce completeness is the identification of nonstandard field conditions following data or sample collection. Completeness will be evaluated and documented throughout the project, and corrective action taken as warranted on a case by case basis.

Comparability

The sampling methods, analytical procedures, and data analysis methods proposed for this project are standard and similar to comparable projects.

Data Handing and Analysis

Data packages from a completed set of samples will be sent to SWM by the laboratory within 30 days of the sampling date. Data reports from the analytical laboratory will be reviewed for completeness by the Project Manager. Potential errors and omissions will be reported to the responsible laboratory personnel. Acceptable laboratory reports will be stored in project notebooks. Laboratory results will be entered into a database. Based on the distributions and statistical characteristics of the data, various statistical and probabilistic methods may be used to compare and analyze the data. The statistical methodologies and assumptions used in the assessment of water quality data will be discussed in the annual and final project reports.

References

American Public Health Association/American Water Woks Association/Water Pollution Control Federation (1989). Standard Methods for the Examination of Water and Wastewater, 17th Edition. Washington, D.C.

Harrelson, Cheryl C., C.L. Rawlins, John P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. U.S. Department of Agriculture, Forest Service. General Technical Report RM-245. Fort Collins, CO. 61 pp.

Plotnikoff, R.W. 1994. Instream Biological Assessment Monitoring Protocols: Benthic Macroinvertebrates. Washington State Department of Ecology, Environmental Investigations and Laboratory Services, Ambient Monitoring Section. Publication # 94-113. 27 pp.

Rantz, S.E. et al. 1982. Measurement and Computation of Streamflow: Volume 1, Measurement of Stage and Discharge. Geological Survey Water-Supply Paper 2175. Washington, D.C.

Reeves, Gordon H., Fred H. Everest, Thomas E. Nickelson. 1989. Identification of Physical Habitats Limiting the Production of Coho Salmon in Western Oregon and Washington. U.S. Department of Agriculture, Forest Service. General Technical Report PNW-GTR-245. Pacific Northwest Research Station, Corvallis OR. 18 pp.

Steinbarger, Douglas M. 1995. Inventory and Evaluation of Livestock Operations and the Potential for Non-Point Pollution in the Stillaguamish Clean Water District. Final Report. Snohomish Conservation District. 26 pp.

Thornburgh, Kathy. 1995. Water Quality Monitoring in the Stillaguamish Clean Water District. Results of Surface Water Management Monitoring 1994-1995. Snohomish County Department of Public Works, Surface Water Management. Everett, WA. 27 pp.

USEPA (1983). Methods for Chemical Analysis of Water and Wastes. EPA-600/4-82-029. Environmental Monitoring and Support Laboratory, Cincinnati, OH.