Volunteer Monitoring of Suspended Sediment Concentrations and Turbidity in Humboldt, Mendocino and Trinity Counties, California

Quality Assurance Project Plan
Version 2, March 2001

Salmon Forever
Watershed Watch

Project Director:	______________________	Date:	______________________
Field Manager:	______________________	Date:	______________________
Laboratory Manager:	______________________	Date:	______________________
QA Manager:	______________________	Date:	______________________

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3. USEPA - Janet Parrish, Chris Heppe, Mark Kutnink, Palma Reisner
4. North Coast Regional Water Quality Review Board - Ranjit Gill, Fred Blatt
5. Redwood Sciences Laboratory USFS - Rand Eads, Leslie Reid
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Introduction

This Quality Assurance Project Plan (QAPP) covers volunteer monitoring conducted by Salmon Forever in North Coast California watersheds. Salmon Forever has been conducting volunteer monitoring in these basins since 1998. Salmon Forever promotes the continued development of volunteer monitoring and cooperation between research activities and state agency monitoring efforts to develop an understanding and record of sediment loading and transport and the turbidity responses to land use activity in North Coast watersheds.

Project Management

Project Organization

Salmon Forever is the lead organization implementing this study. Salmon Forever is responsible for purchasing equipment, training volunteers, processing and analyzing collected samples and producing reports. The US Forest Service's Redwood Sciences Laboratory (RSL) has provided technical evaluation of grab sampling methods, assistance in installation and operation of sampling instruments, and data analysis. Redwood Sciences Lab, Humboldt State University (HSU), US Environmental Protection Agency (USEPA), North Coast Regional Water Quality Control Board (NCRWQB) and National Marine Fisheries Service (NMFS) act as technical advisors to this study. Principal data users include Salmon Forever, U.S. Forest Service, USEPA, the Trinity River Advisory Committee, NCRWQCB, HSU, RSL and NMFS.

The positions described below are responsible for oversight of the important project tasks:

- Project Director- Jesse Noell / Salmon Forever
- Field Manager- Jesse Noell / Salmon Forever
- Laboratory Manager - Clark Fenton / Salmon Forever
- Interim Quality Assurance (QA) Managers (2001 only) Dr. Margaret Lang and Dr. Eileen Cashman, Humboldt State University
- Data Processing Manager- Clark Fenton / Salmon Forever.
- Watershed Coordinators – Long-term, committed volunteers within each watershed

The Project Director is responsible for question formulation, parameter selection and developing the sampling design with RSL consultants. The Project Director and Quality Assurance Manager review all field and laboratory data for QAPP objectives and reject or qualify data. The Project Director is responsible for report production and distribution and will use the results of reports to implement any necessary changes to the study for subsequent sampling seasons.

The Field Manager conducts creek reconnaissance and selects and documents station locations. The Field Manager also provides field training, re-training and on call technical support; collects and checks completeness of field samples; and verifies the accuracy of field data.

The Lab Manager supervises and trains all volunteers processing lab samples, checks and copies field data, is responsible for lab and field equipment supplies and service, keeps all equipment calibration records, trains lab technicians, provides on call technical support and maintains field and lab QA proficiency checklists.

The Field and Lab Managers share responsibility for maintenance, operation and documentation for the continuous, turbidity-controlled ISCO automatic sampling stations.

The Quality Assurance Manager conducts lab and field certification, documents lab and field volunteer proficiency through proficiency checklists and conducts periodic visits to observe lab and field technique. The QA Manager analyzes Quality Control checks (approximately 10% of data collected in the study), reviews all field and lab data for QAPP objectives and corrects any failures in the analytical system. The QA Manager also analyzes QC field and lab tests performed by the Field Manager and Lab Manager, respectively. Results of these analyses and corrective actions are reported to the Project Director.

The Data Processing Manager proofreads data entered into databases against the original data sheets, verifies re-testing, clarifies ambiguous issues with field operators and reviews all field and lab data for QAPP objectives. The Data Processing Manager also assists the Field Manager and Lab Manager in presentations for data users and presentations for field operators.

Problem Background

Many North Coast streams and rivers have been identified as impaired due to sediment under the Clean Water Act, Section 303d (CSWRCB, 1998). Total Maximum Daily Loads (TMDLs) have or are being developed to identify and mitigate the impacts of sediment and to provide for attainment of Basin Plan water quality objectives. In addition, these watersheds are identified as key watersheds for salmonid production by the Northwest Forest Plan (USDA, 1997). Anadromous fish stocks on the North Coast of California have declined well below historical levels (Brown et al., 1994). Increased sediment delivery to stream channels is thought to be a significant contributor to the decline of fish populations. Sediment can contribute to the decline of fish populations through several mechanisms including, but not limited to: clogging spawning gravel (Chapman, 1988), impacting feeding ability and growth rates (Newcombe and MacDonald, 1991), and simplifying habitat by filling in pools and low gradient reaches (Frissel, 1992). Extensive efforts to restore the fishery are planned. The effectiveness of these efforts will benefit from monitoring turbidity and suspended sediment concentration (SSC) and duration of exposures to assess whether restoration has reduced sediment transport within the channel and whether the turbidities and SSCs present will allow recovery of the fishery.

The project goals are:

- To provide information necessary to adapt management practices to better meet the objectives of the Northwest Forest Plan by quantifying the association between management activities and downstream turbidity and SSC levels.

- To provide information useful for implementing TMDLs by identifying background and current turbidity and SSC regimes.

- To provide information necessary for planning fisheries restoration by determining whether salmonids are likely to be exposed to harmful levels of turbidity and suspended sediment.

- To facilitate education, involvement and empowerment of watershed residents by organizing a community-based volunteer program for monitoring.

- To develop approaches to monitoring and impact evaluation that can be applied to other watersheds.

Project Description

Salmon Forever primarily collects grab samples for turbidity and SSC determination. To supplement the grab sampling, Depth Integrated Sampling (DIS) is conducted in larger streams to measure turbidity and suspended sediment variation with position along a stream cross-section. DIS results are compared to grab sampling results collected at the same time to identify differences or biases between the two sampling methods. Salmon Forever anticipates collecting more than 1,600 grab samples, and that more than 400 of these samples will be processed to determine the suspended sediment concentrations.

Salmon Forever also operates a continuous, turbidity-controlled sampling station (Lewis, 1996) to develop relationships between turbidity and SSC. This station includes a continuous turbidity probe, stage recorder, and an ISCO automatic sampler capable of collecting 24 samples. Sample collection is controlled by the rate of change of turbidity and stage.

Additional measurements needed to evaluate the impacts of turbidity and SSC are also collected. These measurements include stream discharge or stage at sites where a rating curve has been or is being established. Either a direct (discharge) or indirect (stage) measurement must be recorded at the time water samples are collected. When possible position on the storm hydrograph (rising, peak, or falling limb) is also noted.

Salmon Forever maintains their Sunnybrae Sediment Lab for turbidity and SSC determination. If sampling sites are added that are too far to deliver samples to the laboratory within the required time period, a field laboratory will be set up to allow timely sample analysis. The Quality Assurance protocol developed by Salmon Forever requires rapid processing of samples to prevent algae growth.

Data is entered into a computerized management system and checked by the data processing team prior to analysis. Regular analysis of data with review by appropriate Salmon Forever Technical Advisory Panel members will facilitate timely detection of error or need for modification of protocols. Analysis is conducted when data processing is completed.

Data Quality Objectives for Measurement Data

Data quality objectives (DQOs) are "quantitative and qualitative statements of the overall level of uncertainty that a decision-maker is willing to accept in results or in decisions derived from environmental data (USEPA, 1996)." The overall level of uncertainty is based on estimates of measurement error, sampling error, and site variability.

The data collected is intended to inform TMDL development and implementation and watershed analyses by providing monitoring data that can be compared to action levels for turbidity and suspended sediment concentrations found in applicable regulations and guidelines. Water quality objectives in the North Coast Basin Plan provide action levels for turbidity (turbidity shall not be increased more than 20% above naturally occurring background levels) and suspended sediment (the suspended sediment load and suspended sediment rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial use) (NCRWQCB, 1993).

It is difficult to state DQOs for the parameters measured in this study in terms of quantitative data quality measures because specific estimates of variability are site and measurement range dependent. The primary mechanism used to ensure data quality is strict adherence to accepted sample collection and analysis methods described in the Standard Operating Procedures (SOPs). Also incorporated into the monitoring are efforts to quantify the variability and reliability of the data collected such as: developing the relationship between depth-integrated turbidity, turbidity sensor readings and volunteer grab samples; and comparing discharges determined using the current meter to those from float velocities. The experiments and analyses being conducted to evaluate data quality and assist in defining DQOs are presented in the annual QA report and will be used to update project DQOs.

Accuracy, Precision, and Measurement Range Objectives

Accuracy is the degree to which a measured value agrees with an accepted known or true value. For instruments, accuracy is specified by the manufacturer and assured by proper calibration and maintenance of the instruments. Volunteer accuracy is measured by observing sampling with checklists and comparing grab sampling with ISCO and depth-integrated sampling. Laboratory instrument accuracy is evaluated using check weights, filter re-weighs, field splits, filter blanks and other standard QA methods. Accuracy will be estimated for depth, velocity, and cross-section surveys by repeating the measurement and comparing results. Accuracy will be expressed as percent agreement or percent difference.

Precision is the measure of variation among repeated independent observations of the same property under controlled similar conditions. The goal of training and initial calibration is to train volunteers so their estimate of subjective parameters meets the DQO's. Additionally, mid-season comparison of volunteer measurements will be used to assess their precision.

Volunteer precision is estimated for stage, velocity, and grab sampling. Comparison of individual measurements of the same parameter is used to analyze the statistical precision of volunteer measurements. Laboratory precision is determined from analysis of repeated weighing of the balance check weight.

Table 1 summarizes the accuracy, precision, and measurement range estimated for the parameters of interest for the study. Values are derived from knowledge of measurement device characteristics and accuracy and also accounting for expected field and laboratory conditions.

Table 1. Precision, accuracy and measurement range for study parameters

Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
Water	Turbidity	Grab	± 5.0%	± 2.0%[1]	0-2000 NTU
Water	Turbidity	Probe	± 5.0%	± 2.0%[1]	0-2000 NTU
Water	Suspended Sediment	Grab	± 5.0 %	± 2.0%[1]	0.00001-2.0 g/L
		DIS	-	-	-
		ISCO	-	-	-
Water	Velocity	Float	± 8.0%	1.0 ft/sec.	0-10 ft/sec
	Velocity	Meter	± 8.0%	± 8.0%[1]	0.25 - 8.0 ft/sec
Water	Depth	Staff Plate	± 5.0%	0.1 ft	0-20 feet
	Depth	Pressure Transducer	–	0.05 ft	0 - 10 feet

[1] The accuracy for these parameters is a function of the magnitude of the measurement value.

Comparability

Comparability, a measure of the degree to which different methods and data sets can be represented as similar, will be assessed in terms of accuracy and precision for most site measurements. Comparability of the suspended sediment concentration data will be evaluated using audit samples and laboratory and field split samples.

To ensure comparability all monitoring activities will follow protocols established and approved by the EPA and Redwood Sciences Laboratory. See the SOP's in Appendix 1 for sampling and laboratory protocols.

Completeness

Completeness is the ratio or percentage of the amount of valid data obtained compared to the planned amount. Our completeness goal is to sample turbidity and suspended sediment concentration during all major storm events in study tributaries. Lack of volunteers, breakdown of equipment, frequency of major storms, etc. may hamper completeness.

At the end of the season the number of samples collected will be compared to the planned number and the completeness will be presented as a percent for each parameter. Reasons for not meeting the completeness objective will be recorded. It is expected that samples will be collected from at least 90% of the sites unless unanticipated weather conditions prevent sampling.

At the end of each field season, completeness will be assessed as the amount of data (and samples) actually collected compared to the planned amount and will be calculated using the following formulas:

$$\text{\% Completeness (samples)} = \frac{\text{samples collected}}{\text{planned samples collected}} \times 100$$

Following data entry, the amount of validated data will be compared to the number of samples collected, using a formula similar to that above. The measurement quality objective is 100% completeness.

Representativeness

Representativeness is the degree to which data truly characterize a population or environmental condition. Sampling methods are designed to be as representative as possible and experiments are included to compare different methods of measuring the same parameter to quantify the representativeness of the sampling and analysis methods. Descriptions of experiments designed to assess representativeness are listed below and additional experiments will be identified and incorporated into the study when needed.

Where stream discharge is sufficiently energetic to transport large particles (such as sand) in the lower water column, depth integrated sampling (DIS) will be conducted at a range of flows representative of the hydrograph to provide a correlation to grab sampling.

Stream velocity, in streams large enough to permit use of a current meter, will be measured with a current meter at a range of flows representative of the hydrograph to provide a correlation to the float velocity method of estimating discharge.

Previous monitoring conducted by Redwood Sciences Laboratory and Salmon Forever has shown that the highest levels of suspended sediment transport occur on the rising limb of the hydrograph during large storms. Therefore, samples must be collected on the rising limb, at peak discharge, and on the falling limb to truly characterize the sediment transport during a storm. Fifteen or more samples may be needed at each monitoring site to establish a suspended sediment concentration correlation that characterizes the full range of stream discharge response. The actual timing of sampling activities cannot be predicted with much accuracy by more than a few hours in advance. Thus, it may be difficult to ensure volunteer availability throughout each storm event. The sampling protocol assumes that frequent sampling of many storms will capture the turbidity and SSC behavior at each sampling site.

Study design also addresses representativeness to the extent possible by site selection using a gradation of watershed sizes and geology. Adjacent watershed basins as small as 100 acres and as large as 2000 acres will be chosen where feasible. Constraints on access to sites due to winter snow conditions, closed roads and private lands may limit representativeness to subsets of a given litho-topo type. However access is sufficient to permit representative sampling of a substantial fraction of the litho-topo types. Additional details of site selection are provided in the project monitoring plan.

Data Quality Ratings

A variety of methods are used in the field to obtain measurements and each method has inherent limitations in the accuracy of the estimate obtained. To account for different data quality obtained by different methods, a rating is assigned to each data point based on the criteria shown in Table 2. Rating values are defined for the turbidity and SSC measurement method and for the discharge measurement method. The total data point rating is the sum of these two intermediate rating values. For example, if a grab sample is collected on a small stream and the discharge is determined by timing a floating object, the rating for that data point is 1 + 2 = 3. Lower rating numbers indicate more accurate measurements with 2 being the best rating value for a sample data point. Data point rating values are initially recorded on the field forms and follow the data into all other databases.

Table 2. Field Measurement Rating Values

Discharge Method	Rating Value	Sample Collection Method	Rating Value
Direct Measurement using Price AA	1	Grab sample (small stream)	1
Stage reading w/rating curve derived from Direct Measurements	1	Grab sample (large stream)	2
Floating Object Velocity (FOV)	2		
Stage reading w/rating curve derived from FOV	2		
No discharge estimate	3		

Training and Certification

All volunteers collecting or analyzing samples receive consistent training and are observed and certified for performance of the SOPs specific to their tasks by the QA Manager. The goal of training is to educate volunteers so that their estimates of subjective parameters meet the Data Quality Objectives (DQOs). As the study progresses experienced volunteers will become proficient to train and certify others. Field training takes place at established sampling sites. Laboratory training is conducted at the Sunnybrae Sediment Lab.

Training topics include:

- Safety
- Data Recording
- Locating sample locations
- Grab Sampling methods
- Stage measurement
- Velocity measurement
- Cross-section measurements
- Depth Integrated Sampling
- ISCO Automatic Sampler use
- USGS Type AA/Pygmy Current Meter use
- Laboratory Protocols/ Suspended Sediment Processing/ Filter Weighing Procedures

Proficiency checklists (Appendix 3), listing the sequence of sampling and data collection tasks and notes on their proper execution, have been prepared for evaluating the performance of individual and teams of volunteers. The Field Manager, Lab Manager, QA Manager or Watershed Coordinators use these checklists during training to document volunteer proficiency.

The Field Manager, QA Manager or Watershed Coordinators conduct all field training. Volunteers are also assembled once during the field season, for "calibration" in the collection of depth, velocity, cross-section and grab sampling measurements.

Safety procedures for sampling in stormy or hazardous conditions are explained at every training session. High stream flows during storm events present the main hazard that volunteers encounter and sampling points are selected for safety. Under no circumstances is anyone to risk injury for data.

Requirements for volunteers include good physical health, the ability to consistently repeat sampling procedures and time to devote to sampling and analyzing data. Most of the procedures are not physically demanding.

Documentation and Records

The Project Director will ensure that the most current QAPP version is available to all sponsoring and co-operating organizations involved in this study. The organizations in the Distribution List will, if necessary, receive revised copies of the QAPP at the beginning of each sampling season. Current versions of the QAPP are available to any individual or organization requesting one.

Field data are initially recorded on the appropriate data sheets (Appendix 2 contains examples of all data sheets). Most volunteers also maintain field books where they record the information that they collect. All field data sheets and notebooks are Rite-in-the-Rain, waterproof paper to withstand the field conditions.

Laboratory data documentation and recording varies with the analyses being performed. Grab samples are analyzed for turbidity with a HACH 2100P Turbidimeter and then processed for suspended sediment concentrations. Sample sign-in, turbidity determination, and suspended sediment concentration data is recorded in pen on all appropriate data sheets. Suspended sediment calculations are performed and maintained in an Excel spreadsheet and are also written on paper worksheets.

ISCO samples are first analyzed using the HACH 2100P Turbidimeter then processed for suspended sediment concentration. The ISCO station also collects continuous turbidity and stage (using a pressure transducer). This data is recorded electronically with a Campbell CR10X Datalogger and post-processed by RSL using software developed by RSL scientists.

All data summaries and databases developed from raw parameter measurements are in Word and Excel software formats. Paper copies are on 8-1/2 by 11 or 8-1/2 by 14 paper. All data sheets include the Hydrologic Year, initials of the person entering data, the date of data entry and the date of copying. Sign-in sheets and filter tare sheets are numbered sequentially as they are filled out. Laboratory data sheets are filed chronologically and given sequential numbers at the end of each Hydrologic Year. Data presentation will be in a format acceptable to EPA, RSL and NCRWQCB.

Originals of all field and laboratory data sheets, QA/QC analyses, and computer databases will be kept in the Sunnybrae Sediment lab. Copies of field and laboratory data sheets, QA/QC analyses, and computer back-up disks will be kept in the Salmon Forever office. Salmon Forever will maintain hard copies of all data sets and computer back-up disks for at least 10 years. Original ISCO Automatic Sampler field sheets will be stored for 10 years at the Sunnybrae Sediment Lab. Copies of these documents will also be given to RSL.

A QA report will be prepared for each hydrologic year with a tentative deliverable date of August 1st. An annual project report will be completed by September 1st of each year.

Final reports will include raw data, field data sheets, suspended sediment data sheets, equipment calibration data sheets, laboratory data sheets and QA/QC results.

Measurement/Data Acquisition

Procedures for sampling methods, sample handling and custody, and analytical methods are all described in detail in Standard Operating Procedures (SOPs) developed for each method needed in the study. The SOPs are attached as Appendix 1, which includes SOPs for the following methods and procedures:

- Field Grab Sample collection
- Turbidity Measurement using the Hach 2100P Turbidimeter
- ISCO 2100 Automatic Sampler Sampling
- Continuous turbidity measurements using the OBS-3 Continuous Turbidimeter
- Stage measurement using the DRUCK 1830 Stage/Pressure Transducer
- Depth Integrated Sampling – Crane (DH-48) and wading (DH-49)
- Discharge measurements – Crane and wading with the Price AA current meter
- Suspended sediment concentration laboratory measurement

The monitoring plan [under development – will be referenced here] details the sampling design and site selection. A brief summary of the sampling process design is included here.

Sampling Process Design

The monitoring plan [Reference] discusses sampling process design in detail. As a general overview, sampling sites are chosen to meet the following project goals:

- To develop predictive relationships between turbidity and suspended sediment concentrations in North Coast watersheds,
- To measure conditions in relatively undisturbed sites to define "background" conditions, and
- To identify the effects of land use activities in the watershed by sampling above and below select locations within a watershed.

The intentions of this project are to operate a scientifically and statistically valid monitoring program. However, limited access to sampling sites on private property and limitations of volunteer time commitments may not allow perfect adherence to ideal spatial and temporal distribution of sampling. With these limitations, sampling is necessarily directed but opportunistic.

Sampling Methods Requirements

The SOPs, attached to this document as Appendix 1, contain detailed information on the methods used for sample collection and analysis. The sampling processes used in this monitoring effort were selected or developed to ensure accurate measurement of turbidity, SSC and the ancillary measurements (i.e. discharge, stage, etc.) necessary to evaluate the impacts of turbidity and SSC.

Three methods are used to collect samples: turbidity-controlled suspended sediment collection using an ISCO automatic sampler (Lewis 1996), depth integrated sampling (DIS) using a DH-48 on a sampling crane or a hand-held DH-49, and surface grab sampling. Turbidity and SSC values determined from simultaneous sampling by two or more different sample collection methods are used to quantify data accuracy and precision.

Methods used to measure stage, discharge, cross-section and other channel characteristics needed to analyze the significance, impacts, or transport rates of the turbidity or SSC are adopted from USGS or USDA Forest Service (Harrellson, C. C. et al., 1994) protocols.

Sample Handling and Custody Requirements

All sample handling and custody requirements are described in detail in the SOPs (Appendix 1).

Samples are identified using unique stickers attached to bottles and bottle caps. At the beginning of the hydrologic year all bottles (ISCO bottles, DIS bottles, HACH cells and other grab sample bottles) used in sampling are assigned a waterproof sticker with a unique ID number. The Lab Manager procures these stickers, keeps a logbook of the ID numbers, and labels all sample bottles before they are used in the field. Circular stickers are used for the HACH cell samples so they do not interfere with turbidity determinations. All other sample containers will receive a sticker on the side of the bottle. After turbidity and SSC processing the sticker are taken off the sample bottle and replaced with a new sticker.

The numbering system for the stickers is a 7 letter alphanumeric code described in Table 3.

Table 3. Description of code used for sample containers.

ID number examples	00G1234, 01D1234, 9911234
Code description	
1st two digits	Hydrologic year (e.g. 00, 01, 99)
Letter indicating sample method type	G – grab sample I – ISCO sample D – depth integrated sample
Last 4 digits	Unique, sequential number for each sample within the hydrologic year

All ISCO, DIS and grab sample bottles are further labeled in the field with the pertinent data (volunteer, site, time, date, stage, etc.) and logged onto the sign-in sheets when delivered to the lab. ISCO sample bottles are labeled when removed from the sampler. The sample ID # is also written on the field form at the time of sampling.

The chain-of-custody for samples is:

- Volunteers are responsible for samples until they are brought to the Lab or until they are picked up and measurements recorded by the Field Manager or Watershed Coordinator.
- The Field Manager or Watershed Coordinator is responsible for samples until they are checked into the lab. The Field Manager or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data.
- The Lab Manager is responsible for storing and processing samples. The date and time of arrival at the Sediment Lab is recorded on the Lab Sign In sheet by whoever brings the sample into the lab.

Samples at the lab are stored in a cool dark place until processing.

Analytical Methods Requirements

Analytical procedures follow Redwood Science Lab (RSL, 2001), EPA and Standard Methods for the Examination of Water and Wastewater (AWWA, 1990) where appropriate. Analytical procedures are detailed in the SOPs (Appendix 1).

Redwood Sciences Lab performs SSC determination on QC split samples taken during the sampling season. Salmon Forever will perform all other turbidity and SSC determinations.

Volunteer grab samples are analyzed for turbidity with a HACH 2100P Turbidimeter and then processed for suspended sediment concentrations through tared 1.0-micron filters on a vacuum assembly. ISCO samples are analyzed using the HACH Turbidimeter and are processed for suspended sediment concentration until a sufficient range of samples are analyzed to develop a turbidity vs. suspended sediment correlation.

The Lab Manager and QA Manager are responsible for correcting any failures in the analytical system. Detailed information on the corrective actions and any samples affected shall be kept in the lab records.

Quality Control Requirements

The Quality Assurance Manager is responsible for implementing, recording and analyzing the quality control measures undertaken to ensure data quality objectives are met. Quality Control measures for each sampling procedure are detailed in its SOP. In general, quality control will total 10% of the data collected in this study. Results of quality control analyses and corrective actions is reported to the Project Director and described in the annual report.

Instrument/Equipment Testing, Inspection and Maintenance Requirements

A list of all equipment used for the monitoring is included in Table 4 below. All equipment is inspected and maintained to EPA and manufacturer specifications. Records of maintenance and calibration are kept for all appropriate equipment. The Laboratory Manager maintains these records to track scheduled maintenance on all equipment. All records and laboratory equipment will be kept at the Sediment Lab. All spare parts are stored at the Sunnybrae Sediment Lab. Adequate replacement parts will be kept at the lab and are the responsibility of the Lab Manager. If equipment does not meet specifications or is not working properly, it shall not be used until inspected by the QA Manager and acceptance, repair or replacement has been documented. Table 5 summarizes the inspection frequency and performance assessments used to identify equipment malfunctions.

Table 4. List of analytical equipment used.

Instrument	Number Owned	Serial Numbers
ISCO 2100 Automatic Sampler	1	A 2586-50
OBS-3 Turbidity Probe	1	S/N 430
CR10X Campbell Data Logger	1	S/N X14856
Druck 1830 Pressure Transducer	1	S/N 1088275
HACH 2100P Turbidimeter	4	S/N 960100009614; S/N 990800022423; S/N 990800022431; # S/N 990800022441
USGS Type AA current meter	2	
USGS Pygmy current meter	1	
DH-48 Depth Integrated Samplers	3	
DH-49 Depth Integrated Samplers	1	
Mettler H20T Analytical Balance	1	S/N 418151
AND FY 3000 scale	1	S/N 5608313
Grieve Laboratory Oven LR270C	1	
Welch/Thomas Vacuum Apparatus	1	Model # 2522B-01 S/N 040000000715

Table 5. Equipment inspection and performance assessment measures.

Equipment	Inspection Frequency	Type of Inspection or Assessment	Inspector
Balances	Each use	Weigh check weights	Lab manager or responsible volunteer
Hach 2100 turbidimeters	Each use	Proper operation	Lab or field manager
ISCO samplers	Each bottle change	Proper operation	Lab or field manager
Data loggers	Each data download	Check computer operation	Lab or field manager
Pressure transducer	Weekly	Check computer operation and compare to staff plate	Lab or field manager
DH-48 and DH-49 samples	Each use	Visual inspection	Field Manager or responsible volunteer
Price AA	Each use	Visual inspection and spin test	Field Manager or responsible volunteer

Instrument Calibration

Calibration frequency and descriptions are found in the appropriate SOP's (Appendix 1). All equipment calibration records are kept by the Laboratory Manager and are available upon request. Each piece of equipment has an identifying number that is linked to calibration records. Table 6 summarizes the instrument calibration schedule.

Table 6. Instrument calibration schedule.

Instrument	Calibration Frequency	Type of Calibration	Conducting Party
Balances	Annual	Woolard & Sons Standard Wts No. 349-B traceable to NIST Standard Weights	Woolard and Sons PO Box 3438 Salem Or 97302
Hach turbidimeters	Quarterly	Stablcal Calibration	Laboratory Manager
Pressure transducers	Beginning/mid-season	RSL protocol	Lab or Field Manager
Continuous turbidimeter	Beginning/mid-season	RSL protocol	Lab or Field Manager

Data Acquisition Requirements

Volunteers associated with Salmon Forever collect most of the data required to analyze the turbidity response and sediment transport. At a few sites, HSU or RSL scientists are also conducting monitoring projects, primarily continuous stage measurements and rating curve generation. Where continuous records of discharge are recorded and determined by others, Salmon Forever requests copies of the data and to use in their analyses. Redwood Sciences Laboratory and HSU scientists cooperate in this monitoring effort and provide access to their data.

Additionally, Salmon Forever also maintains a collection of maps and aerial photographs of sampling sites and target watersheds. These materials are acquired from the USGS and other appropriate agencies.

Data Management

Sample information and data are all recorded on standardized field and laboratory data forms (Appendix 2). The Field and Laboratory Managers are responsible for checking and copying Field Data sheets and delivering them to the Project Director. The Laboratory Manager is responsible for checking and copying lab data sheets and delivering them to the Project Director. Original laboratory data sheets are kept in the Sunnybrae Sediment Lab. Reports and data are transferred to Excel spreadsheets and Word documents and copies kept at the Sunnybrae Sediment Lab and Salmon Forever Offices.

All data are examined and rated on the basis of field and laboratory codes pertaining to the quality of data (Table 1). Outliers or nonsensical data will be detected during calculations and transfer to electronic spreadsheet and documented by the QA Manager.

Data handling equipment includes data sheets, data loggers, RSL spreadsheets and programs, hand calculators, Excel spreadsheets and Microsoft Word documents. Data collected at the ISCO station will be entered directly into RSL's analysis programs. Data will be presented in a format acceptable to EPA, RSL and NCRWQCB.

Data used to produce annual reports and is kept on paper copies and as electronic copies of Word documents and Excel spreadsheets. Data and calculations are checked at the time of transfer from paper to spreadsheets.

Assessment and Oversight

Quality Assessment/Assurance (QA) refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance is the shared responsibility of all project managers (Field, Lab and Database) and the Watershed Coordinators with oversight and evaluation of these activities provided by the QA Manager. QA activities include evaluating data quality, accuracy and precision; staff training; documentation and development of methods and standard operating procedures; and appropriate handling, processing, and tracking of all data and samples collected. Most of these topics have been thoroughly covered in either the Appendices (SOPs–Appendix 1, Proficiency Check Lists for Volunteer Certification–Appendix 3) or other sections of this document. This section describes additional QA activities and how the responsibilities for these activities are divided among project managers.

Assessment and Response Actions

Watershed Coordinator QA Responsibility

Watershed Coordinators meet every 2 months to compare progress, to discuss and resolve problems that they may have encountered, and to address any issues brought to their attention by the results of internal QA checks. These meetings are extremely important for identifying problems with sampling procedures or logistics in the field. Watershed coordinators will discuss difficulties encountered in specific situations, adopt corrective actions (after consultation with project managers), and implement appropriate modifications for standardizing methods between volunteers.

Field Manager QA Responsibility

The Field Manager, QA Officer or Watershed Coordinator shall observe each volunteer at the beginning of the project and again at least once a year conducting sampling. Proficiency checklists (Appendix 3) will be used to provide a written record and evaluation of volunteer performance. All volunteers are required to pass proficiency evaluations during training. If volunteers do not meet the proficiency criteria, they will receive additional training until they are proficient or they will not be utilized in this study. Volunteers are required to perform all sampling procedures correctly before their data is included in any databases or used for analyses.

During training, any methods that the volunteers find confusing will be noted, and modifications to the method, the training or the checklist will be adopted as needed.

Laboratory Manager QA Responsibility

Laboratory QA procedures are detailed in each SOP (Appendix 1). Either the QA or Laboratory Manager conducts QA laboratory procedures. The Laboratory Manager trains lab technicians before they begin conducting sample processing and observes their proficiency on the job until they are certified to work independently. Technicians work under direct supervision for a minimum of 2 sessions. Certification using the proficiency checklists for turbidity and SSC determination and filter weighing are conducted for all lab technicians at the beginning of each sampling season and once more during the sampling season. The Lab Manager reviews technician data for errors and incomplete data entry. The Lab Manager is responsible for implementing these assessments, correcting technician deficiencies and keeping the checklists on file in the lab. Results of assessments and certifications are reported to the Project Director.

Performance and System Audits

Technical system audits provide an external review of the research and QA activities. External personnel from EPA, NCRWQCB, RSL or HSU may audit this project during the field season. Findings will be discussed with the volunteers and summarized in audit reports submitted to EPA, NCRWQCB, RSL and HSU.

The objectives of field visits by EPA, RSL, or NCRWQCB assessors are to:

- observe implementation of field methods by the field crews;
- assess personnel performance, equipment, and procedures;
- evaluate Salmon Forever training methods;
- assess consistency of volunteers in implementing field methods;
- answer questions arising about sampling design or methods; and
- determining whether DQOs are being met from review of quality assurance data

If deficiencies or problems are identified, agency assessors will make recommendations to the Field and Lab Managers and Watershed Coordinators. Any identified deficiencies or problems will be summarized in an audit report.

Reports

An annual report will be produced and distributed in August of each year. The Project Director is responsible for report production and distribution. Reports will be forwarded to the county, state, and regional agencies, and other members of the Advisory Panel. Reports will contain data analysis for the previous year's sampling, an update on project status and findings to date, volunteer highlights, results of quality assessment audits and internal assessments, and identify any significant QA problems and their recommended solutions. The Project Director will incorporate the recommendations in this report by implementing any needed changes to the study for the next sampling season.

In addition to the annual project report, an annual QA report is also be prepared by the QA Manager. The QA Report summarizes the outcome of all quality assurance efforts undertaken for the sampling season and make recommendations for improving activities for the next year. The QA Report specifically addresses data quality and information management by:

- evaluating all QA data and sampling;
- summarizing data entry errors and describing any difficulties with data;
- evaluating data entry completeness;
- documenting data management activities, including the content and location of project notebooks (field, laboratory, data management) and data sheets.

The QA Report also summarizes the results of quality assurance activities including identifying the greatest sources of error and evaluating of SOPs, DQOS, and training effectiveness.

Data Validation and Usability

Data Review, Validation and Verification Requirements

The Project Director, QA Manager and the Data Processing Manager review all field and laboratory data to determine if the data meets the QAPP objectives. In addition, personnel from the EPA and RSL and HSU who are not directly connected to the project may also review data. Decisions to reject or qualify data are made by the Project Director and the QA Manager.

All data will be rated by several methods to rank usefulness. Final results are ranked poor, fair or good based on field sampling ratings (Table 2) and Lab and Turbidity codes (see Lab and Turbidity Codes in the appropriate SOP's in Appendix 1).

Validation and Verification Methods

Once data has been entered into the database, the Data Processing Manager proofreads it against the original data sheets. Errors in data entry are corrected. Outliers and inconsistencies are flagged for further review or discarded. Problems with data quality will be discussed in the annual report to data users.

Following processing and checking by the Data Processing Manager, the QA Manager evaluates all project data using appropriate techniques such as graphical comparisons and statistical analysis. Results of the QA Mangers findings are reported in the annual QA report.

Reconciliation with Data Quality Objectives

Calculations of precision, accuracy, representativeness, and completeness will be made and included in the annual report. If data quality indicators show that sampling methods are not meeting the project's specifications the cause of failure will be evaluated and corrective action implemented. If the cause is found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is found to be sampling error, volunteers will be retrained. Any limitations on data use will be detailed in the final report and other documentation as needed.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the RSL, EPA and NCRWQCB quality assurance officers for approval. Limitations on the use of data will be reported in the annual QA report.

Appendices

Appendix 1: Standard Operating Procedures (SOP)

Field / Grab Sampling SOP
Turbidity Determination SOP
SSC / TSS Laboratory Procedure SOP
DIS Sampling / Crane & Wading SOP
Discharge Current Meter Crane & Wading SOP
ISCO 2100 Automatic Sampler SOP
OBS-3 Continuous Turbidimeter SOP
DRUCK 1830 Stage/Pressure Transducer SOP

Appendix 2: Data Forms

Sample Sign-In Sheet
Field Sampling Data Sheet
Field DI Sampling Data Sheet
Turbidity Dilution Data Sheet
Grab Sampling SSC Data Sheet
TTS (ISCO) Sampling SSC Data Sheet
Depth Integrated (DI) Sampling SSC Data Sheet
SSC Calculations Data Sheet
Discharge/ AA Current Meter/ Crane & Wading Data Sheet
Automatic (ISCO) Sampler Sheet: (RSL Field Form)
Cross Section Measurement Data Sheet
Equipment Calibration forms
Training Sign-in
Instrument Sheet

Appendix 3: Proficiency Checklists

Field:
1. Grab Sampling
3. ISCO Sampling
4. DIS DII-48 / DII-49 / Crane & Wading Measurement
5. Discharge - Current Meter / Crane & Wading Measurement
7. OBS-3 Continuous Turbidimeter Measurement
8. Druck 1830 Pressure Transducer / Stage Measurement

Laboratory:
1. Suspended Sediment Sample Processing
2. HACH 2100P Turbidity Measurement
3. Filter Weighing Process

References

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http://www.epa.gov/OWOW/monitoring/volunteer/qapp/vol_qapp.pdf
September 1996

USEPA:
Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995
EPA QA/G-4 Guidance for the Data Quality Objectives Process
EPA QA/G-5 Guidance for Quality Assurance Project Plans
EPA QA/G-6 Guidance for the Preparation of Standard Operating Procedures (SOP's) for Quality Related Documents
EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations

USGS:
Techniques of Water-Resources Investigations of the USGS:
Stage Measurements at Gaging Stations Book 3 Chapter A7
Discharge Measurements at Gaging Stations Book 3 Chapter A8
Laboratory Theory and Methods for Sediment Analysis Chapter C1 Book 5
Field Methods for Measurement of Fluvial Sediment Chapter C2 Book 3
Surface Water Techniques:
Discharge Ratings at Gaging Stations - Hydraulic Measurement and Computation Book 1 Chapter 12 1965

Volunteer Monitoring of
Suspended Sediment Concentrations and Turbidity
Humboldt, Mendocino and Trinity Counties,
California

By

Salmon Forever / Watershed Watch
Jesse Noell and Clark Fenton

QUALITY ASSURANCE PROJECT PLANS
Hydrologic Year 2001

Final Draft
9-18-00

Project Manager	________________________	Date	____________
Project QA Manager	________________________	Date	____________
USEPA Project Manager	________________________	Date	____________
USEPA QA Officer	________________________	Date	____________
Field Manager	________________________	Date	____________
Lab Manager	________________________	Date	____________

A2. TABLE OF CONTENTS

List of Tables

A3. Distribution List

1. Freshwater Watershed Group / Terry Roelofs *
2. Salmon Forever / Jesse Noell / Clark Fenton *
3. USEPA / Janet Parrish / Chris Heppe/ Mark Kutnink / Palma Reisner*
4. North Coast Regional Water Quality Review Board / Ranjit Gill/ Fred Blatt *
5. Redwood Sciences Laboratory USFS / Rand Eads / Leslie Reid *
6. Humboldt State University / Margaret Lang / Bill Trush / Hobie Perry*
7. National Marine Fisheries Service / Sam Flanagan / Sharon Kramer/ Advisory Board*
8. Humboldt Fish Action Council / Doug Kelly*
9. Dept. of Fish and Wildlife / John Peters
10. Dept. of Fish & Game / Mark Moore
11. California Dept. of Forestry / John Marshall / Pete Cafferata
12. California Dept. of Mines and Geology / Jim Falls
13. USGS
14. Humboldt County - Natural Resources Division / Don Tuttle
15. Resource Conservation District –
16. Trinity County Planning / Tom Stokely
17. City of Arcata / Mark Andre
18. Pacific Lumber Company / Simpson Lumber Co. / SPI / Barnum
19. Humboldt Watershed Council / NEC / EPIC /
20. Redwood Community Action Agency
21. Humboldt Redwoods State Parks / Patrick Vaughn
22. Bureau of Land Management / Linda Roush
23. Redwood National Park / Marianne Madaj
24. Humboldt State University Library
25. Humboldt County Library

*Names of all people receiving approved QAPP
Others will receive the study plan (A5)

A4. Project / Task Organization

Salmon Forever is the lead organization implementing this study. Salmon Forever is responsible for purchasing equipment, training volunteers, processing and analyzing samples collected and producing reports. Redwood Sciences Lab (USFS) has provided technical evaluation of grab sampling methods. Redwood Sciences Lab, Humboldt State University, EPA, NCRWQB and NMFS act as technical advisors of this study. Principal data users include U.S. Forest Service, EPA, Trinity River Advisory Committee, North Coast Regional Water Quality Control Board, Salmon Forever, HSU, Redwood Sciences Laboratory and National Marine Fisheries Service. There are subcontractors related to environmental data operations.

Project Director- Jesse Noell / Salmon Forever

QA Manager -

Data Processing Manager- Jesse Noell / Salmon Forever

Laboratory Manager - Clark Fenton / Salmon Forever

Field Manager- Jesse Noell / Salmon Forever

The Project Director is responsible for question formulation, parameter selection and will develop a sampling design with RSL consultants. With the QA Manager, the Project Director will review all field and laboratory data for QAPP objectives and reject or qualify data. The Project Director is responsible for all report production and distribution and will use the results of reports to implement any needed changes to the study for the next sampling season.

The QA Manager will conduct lab and field training, document lab and field volunteer proficiency through proficiency checklists and conduct periodic visits to observe lab and field technique. The QA Manager will implement, record and analyze Quality Control Measures (10% of data collected in the study) and will review all field and lab data for QAPP objectives and correct any failures in the analytical system. The QA Officer will analyze QC field tests and QC lab tests performed by the Field Manager and Lab Manager respectively. Results of analysis and corrective actions will be reported to the Project Director.

The Data Processing Manager will proofread data against original data sheets, verify re-testing and clarify ambiguous issues with field operators and review all field and lab data for QAPP objectives. The Data processing manager will assist the Field Manager and Lab Manager in presentations for data users and in presentations for field operators.

The Lab Manager will process lab samples, check and copy field data, be responsible for lab and field equipment supplies and service, keep all equipment calibration records, train lab technicians, maintain on call technical support and maintain field and lab QA proficiency checklists.

The Field Manager will be responsible for creek reconnaissance, station selection and station location documentation . The Field Manager will conduct field training and re-training, provide on call technical support, collect and check completeness of field samples and verify the accuracy of field data. The Field Manager and the Lab Manager will correct problems and failures at the ISCO sampling station and document any ISCO downtime.

Task #	Function name	Description	Labor per event	Phase/Status/# of times	Responsible party (title)	Responsible party (name &affiliation)	Completion Date
1	Question formulation	Are suspended sediment rating curves, turbidity vs. discharge rating curves, chronic turbidity exposure levels significantly higher than naturally occurring background conditions for similar soil and parent rock types?	3 hrs	Initiation	Project Director	Jesse Noell	
2	Parameter selection	Turbidity, SSC, stream discharge, velocity, cross-section area, stage, watershed area, soil parent material	3 hrs	Initiation	Project Director	Jesse Noell	
3	Data quality objectives development	Define tolerable error (combined precision and accuracy) and adequate resolution and/or detection limit for each parameter	8 hrs	Initiation	Lab Manager Field Manager	Jesse Noell, Clark Fenton	
4	Selection and purchase of kits, instruments, and standards	Scan catalogues, talk to manufacturers' sales and tech support staff to select equipment (or obtain all ordering information from recommendations in guidance documents). Order equipment and assure shipping/payments	16 hrs	Initiation	Lab Manager Field Manager	Jesse Noell, Clark Fenton	
5	New Instrument documentation	Filling out the "Instrument/method" and "Standards" sheets in the Project Database file	2 hrs	Initiation	Lab Manager	Clark Fenton	
6	Testing of new kits, instruments, and sampling equipment	Determine if equipment performance is within specifications, write standard operating procedures	12 hrs	Initiation	Lab Manager	Clark Fenton	
7	Completion of field kit box	Provide field forms, stop watch, tape measure, pencil, 5 gallon bucket, sample bottles, etc.	2 hrs	Initiation	Field Manager	Jesse Noell	
8	Tailored Field data sheet	Prepare a project-specific field data sheet with parameter suite and Instrument IDs	2 hrs	Initiation	Lab Manager	Clark Fenton	
9	Creek reconnaissance	Visit the creek at multiple access points and record: legality, safety & ease of access, sampling access (bank/bridge), survey cross-section, establish velocity reach, set bench mark and stage gauge, representation of creek conditions	10-16 hrs	Initiation	Field Manager	Jesse Noell	
10	Development of sampling design	Revisit monitoring questions and develop spatial and temporal sampling design (monitoring frequency, time of day, etc.)	40 hrs	Annual	Consultants, Project Director	Dr. Leslie Reid USFS RSL. Jesse Noell	
11	Station selection	Revisit monitoring questions, sufficiency of data collected during hydrologic year, prioritize resources and select stations	15 hrs	As needed	Field Manager	Jesse Noell	
12	Station Location documentation	Filling out the "Location" sheet in the Project Database file	1 hr	Initiation	Field Manager	Jesse Noell	
13	**Develop Monitoring Plan**		16 hrs	Initiation	Project Director	Jesse Noell	

14	**Develop Quality Assurance Project Plan**	See draft	40 hrs	Initiation	Project Director, Lab Manager, Field Manager, EPA, RSL, Region 1 WQ, State WQ, DFG, HS University	Clark Fenton' Jesse Noell, Mark Kutnik, Dr. Leslie Reid, Ranjit Gill, Revital K, Bill Condon, Dr. Margaret Lang, Bill Trush
15	Recruitment/Awareness training of Field Operators	Provide "monitoring introduction" to potential field operators regarding monitoring objectives, awareness of error, honest reporting, full documentation, and safety issues	4 hrs init.	Initiation and ongoing	Volunteer team member	Jesse Noell, Clark Fenton, Stacey Kett, Michelle Anderson
16	Measurement-Skills Training and drilling of Field Operators	Teach operators how to calibrate instruments and keep calibration records, conduct measurements, and fill out the field data sheet.	4 hrs init.	Initiation x2 and ongoing	Volunteer team member	Jesse Noell, Clark Fenton, Stacey Kett, Michelle Anderson
17	Field-notes Custody	Photocopy all field records, secure [originals], and [mail] [copy] to reviewer	1 hr	Each event	Volunteer team member	
18	Field-notes Review	Review all field records for completeness and to see if the values "make sense". Verify re-testing and clarify ambiguous issues with field operators.	30 min	Each event	Data Base member	Jesse Noell, Clark Fenton, Nate, Ben Bray
19	Kit box maintenance/replenishing	Provide field forms, stop watch, tape measure, pencil, 5 gallon bucket, sample bottles, etc.	30min	ongoing	Volunteer team member	
20	Equipment "service"	Purchase filters, distilled water, desicants, calibration of equipment, send faulty equipment for service, etc. and UPDATE "instrument" sheet in the Project Database file	20hr/yr	On call	Lab Manager, Field Manager	Jesse Noell, Clark Fenton
21	On-call technical support	Answer questions on the phone as needed	20hr/yr	On call	Lab Manager, Field Manager	Jesse Noell, Clark Fenton
22	Periodic QA Officer visits to observe field monitoring technique	Observe measurement of cross-sectional area, stream velocity, water quality sampling technique, check for compliance	100 hr/yr	As appropriate, during rainstorm events	QA Officer	
23	Periodic field monitoring	Measurement of cross-sectional area, stream velocity, water quality sampling technique	3000 hrs	Ongoing during rainstorms events, 3/yr	Field Manager, volunteers	Volunteers, Jesse Noell
24	Formal QA/QC events	Conduct instrument/kit calibration/testing events and "Round Robin" testing. Review, summarize, interpret, and report results	16 hrs		Lab Manager, Field Manager	
25	Data management training	Teach "computer operators" how to transfer field records (i.e., calibration, observations, and measurement results & documentation) into the designated sheets in the Project Database file	20 hr/yr	As needed	Lab Manager	Clark Fenton
26	Data Entry	Enter all field records into "DATA", "Calibration", and ("QC" lab results and field sheets in the Project Database file)	150 hr./yr.		computer operator	Nate Lomba
27	Data Calculation (discharge)	Enter data from discharge field forms into spreadsheet	100 hr./yr.		data base	Ben Bray, Jesse Noell
28	Project QA/QC review	Review all sheets of the Project Database file for completeness, spot-check entries against data sheets, clarify and correct as needed. Review (eyeball or plot) the actual data to see if it "makes sense" and verify re-testing by field operators.	40 hr./yr.	As needed	QA/QC Officer	
29	QA/QC certification check lists: lab	Test performance of personel to comply with standard operating proceedures– (3) laboratory proceedures; filter weighs, processing of suspended sediment samples, turbidity determination	50 hr/yr	As needed	QA/QC Officer, Lab Manager	Clark Fenton,
30	QA/QC certification check lists: field	Observe measurement of cross-sectional area, stream velocity, and water quality sampling technique to certify compliance with protocols	100 hr./yr.	As needed	QA/QC Officer, Field Manager	Jesse Noell, volunteer coordinators
31	Project QA/QC report chapter	Calculate RPDs, %CV, % recovery, and other QA/QC endpoints from the database entries. Develop a full Project QA/QC report chapter report including results of formal QA/QC events.	40 hrs	annually	Data Manager Project Manager	
32	Independent QA/QC review	Review methods and data, identify areas for improvement	40 hr./yr	As needed	EPA, State Water Quality	Mark Kutnik, Revital K

33	Project annual report, Presentation of results to data users	Presentations to CDF, WQ, DFG, NMFS personal, collaborators, funders, place data on website, ect.	200 hr./yr.	As needed	Field Manager, Lab Manager, data member	Jesse Noell, Clark Fenton, Ben Bray
34	Presentation of project monitoring results and meaning to field operators	Seminars, Workshops, Conferences	100 hr./yr.	As needed	Field Manager, Lab Manager, data member	Jesse Noell, Clark Fenton, Ben Bray

Table 2: Tasks for SECOND year

1	Adaptive Result Evaluation	Revisit questions, monitoring design, parameter suite, and DQOs in light of first year findings	6 hrs	As needed	Project Manager Lab Manager Data Manager	Jesse Noell Clark Fenton
2	Develop/Refine monitoring plan	Question formulation Parameter selection Data quality objectives development	6 hrs	As needed	Project Manager Lab Manager Data Manager	Jesse Noell Clark Fenton
3	Develop/Refine QAPP	Review QAPP, Discuss with Project Manager, Lab Manager, Data Manager, QA Officer and Technical Advisory Board	16 hrs	As needed		

Table 3: ADDITIONAL Tasks for Projects with sampling for analytical laboratory analyses

1	Communications with Laboratory	Negotiate with lab for processing split samples to clarify: analyses cost, sample volume, containers, shipping/receiving days and carriers, lab QA, reporting formats/spreadsheets	3 hrs	Initiation	Lab Manager	Clark Fenton
2	Train operators	Teach sampling procedures, field QA/QC (dups, blanks etc.), chain of custody procedures	0 hrs	Initiation	Field Manager Lab Manager	Jesse Noell Clark Fenton
3	Coordinate sampling & shipping	Receive containers, pack and send samples, inform lab	10 hrs	ongoing	Lab Manager	Clark Fenton
4	Review lab reports	Review Lab Tech. Work and correct as needed:	30 hrs	ongoing	Lab Manager	Clark Fenton
5	Enter electronic lab data	Transfer data from hard copy to spreadsheets and check results against hard copy calculations	150 hr./yr.	ongoing	Data Manager Lab Tech.	Clark Fenton

Table A4:
Project Tasks

Organizations Involved

1. Salmon Forever - Jesse Noell
   PO Box 3014 McKinleyville CA 95519 707-839-7552

2. Redwood Sciences Laboratory-USFS - Rand Eads / Leslie Reid
   1700 Bayview Arcata CA 95521 707-825-2925

3. Humboldt State University - Margaret Lang
   Arcata CA 95521 707-826-3619

4. USEPA Region IX - Chris Heppe
   1695 Heindon Dr. Arcata Ca 95521 707-825-2311

5. USEPA Region IX - Janet Parish / Mark Kutnink
   PMD - 3 US EPA 75 Hawthorne Street San Francisco CA 94105-3901

6. North Coast Regional Water Quality Board - Ranjit Gill
   5550 Skylane Ave. Santa Rosa CA 707-576-2066

7. SF Regional Water Quality Control Board - Revital KatzNelson
   1515 Clay Suite 1400 Oakland Ca 94612

8. National Marine Fisheries Service - Sam Flanagan
   NMFS 1125 16th St. Room 209, Arcata CA 95521

9. Freshwater Watershed Working Group - Terry Roelofs
   120 Pacific Lumber Camp Road Eureka CA 95503 444-8239

10. Humboldt Bay Fisheries Council- Action Group, Doug Kelly

Technical Advisory Panel

Dr. Margaret Lang
Rand Eads
Dr. Bret Harvey
Dr. Tom Lisle
Dr. William Condon
Dr. Sharon Kramer
Dr. Donald Grey
Sam Flanagan

A5. Problem Definition / Background/ Study Design

The South Fork Trinity River watershed has been identified as impaired due to sediment under the Clean water Act, sec 303d. A TMDL has recently been developed to help reverse these impacts and provide for attainment of Basin Plan water quality objectives. In addition, the watershed has been identified as key for salmonid production by the Northwest Forest Plan. Anadromous fish stocks on the North Coast of California have recently declined from historically high levels. Elevated levels of sediment are considered to be a primary cause of declining fish populations by clogging spawning gravels, filling in pools, reducing channel conveyance capacity, as well as directly impacting growth rates. Extensive efforts to restore the fishery are planned, and the effectiveness of these efforts would benefit from actual measurement of suspended sediment impact levels and duration.

As storm events occur, the quantity of sediment generated in tributary watersheds and transported through the tributary stream systems is expected to reach levels significantly above background levels due to sediment yield from management activities. Substantial areas of forest within the South Fork of the Trinity River have been, or are scheduled to be, cut using industrial forestry methods. An extensive road system has been constructed throughout the watershed. Large portions of some areas have been burned by wildfire during the past 15 years. Other areas are grazed. Five major soil types are present.

Federal lands within the watershed were designated as the Hayfork Adaptive Management Area by the Northwest Forest Plan, requiring development of substantive cooperation and partnerships between residents of the area and the federal agencies responsible for overseeing land-management activities on public lands. The watershed is thus an excellent example of a location where opportunities exist to modify land-management practices in such a way as to reduce the levels of existing impact, restore fisheries and aquatic ecosystems, and develop a level of understanding within the community that will ensure perpetuation of watershed values. However, a very basic requirement for addressing these issues is currently missing: we need data to document existing levels and locations of impact and to identify the association between specific land uses and levels of impact. This proposal outlines a set of closely related studies that are designed to provide such information.

Project Goal

1. To provide information necessary to adapt management practices to better meet the objectives of the Northwest Forest Plan by quantifying the association between management activities and downstream turbidity levels.
1. To provide information useful for implementing the TMDL by identifying background and current turbidity regimes in portions of the South Fork Trinity channel system.

1. To provide information necessary for planning fisheries restoration by determining whether salmonids are likely to be exposed to harmful levels of turbidity in portions of the South Fork Trinity channel system.
1. Facilitate education and empowerment of watershed residents by organizing a community-based volunteer program for monitoring turbidity.
1. To provide approaches to monitoring and impact evaluation which can be applied to other watersheds.

Objectives

1. Identify the association between land-use practices and turbidity (and suspended sediment) by:

a. Identifying stream turbidity and suspended sediment regimes in an array of small watersheds undergoing different intensities of recent logging and road use

b. Identifying stream turbidity and suspended sediment regimes in an array of small watersheds before and after the onset of summer grazing

c. Identifying stream turbidity and suspended sediment regimes upstream and downstream of in-stream mining operations

d. Measuring influences of gravel-road drainage on turbidity regimes by monitoring turbidity levels upstream and downstream of road crossings.

2. Quantify turbidity and suspended sediment exposures in the mainstem South Fork Trinity and in selected tributaries.

3. Develop associations applicable to other watersheds

Methods (numbers refer to objectives above)

1a. Influence of logging and road use: Between 5 and 15 small watersheds of 100 to 2000 acres which have undergone different intensities of recent logging and road use (including "control" sites with very low intensities) will be selected on a particular litho-topo unit (i.e., having similar geology and topography). Each watershed will be assessed for previous land-use history, roading, and vegetation distribution. If haul roads are in use during wet weather, site-specific turbidity monitoring may be conducted to isolate the influence of this sediment source.

Turbidity "signatures" will be defined for each sampling station by measuring turbidity and discharge at a variety of stages during representative storms. Data will be analyzed by plotting turbidity against discharge to remove the major source of variability. These "turbidity rating curves" can then be compared between the sample sites, and levels of the curves correlated against measures of land-use intensity in those sampled watersheds. Where pristine sites are not available, comparisons can be made for equivalent levels of land use on different rock types. (For example, data from pristine sites on units A and B could be used to compare relative production of turbidity; if unit C does not include accessible pristine sites, then data from moderately-disturbed sites on unit C can be compared with data from moderately-disturbed sites on units A and B to determine the susceptibility of C relative to A and B.) A portion of the samples will also be analyzed for suspended sediment concentration to allow instantaneous suspended sediment loads to be calculated from turbidity and discharge measurements.

Depth Integrated Sampling (DIS) will be conducted to measure turbidity and suspended sediment at various depths in various parts of the stream. DIS results will then be correlated with those obtained by grab sampling for a more accurate picture of sediment concentrations in the stream than can be ascertained from grab sampling alone. This results in a more reliable stream signature.

A field laboratory will be set up in the area to allow timely analysis for turbidity. The Quality Assurance protocol developed by Salmon Forever requires rapid processing of samples to prevent algae growth. Samples will be transported to Salmon Forever's Sunnybrae Sediment Lab for filtering, oven drying, desiccation, and weighing. Regular analysis of data with review by appropriate Salmon Forever Technical Advisory Panel members will facilitate timely detection of error or need for modification of protocols. Quality Assurance is the responsibility of the Quality Assurance Officer.

1b. Influence of grazing: Three to six 2nd- to 4th-order streams draining mountain meadows in the north Yolla Bolly Wilderness Area will be monitored for turbidity, suspended sediment, and discharge before and after the seasonal influx of cattle to the meadows. The methods used for analysis are as described above, but in this case the comparison will be between turbidity regimes before and after the cattle arrive.

The monitoring will be carried out during the Spring, Summer and Fall, and thus will complement the wet-season monitoring program designed to assess logging-related impacts. Winter samples will be obtained from sites determined by ease of access.

1c. Influence of in-stream mining: Sites in or near the South Fork Trinity watershed will be identified that have safe public access upstream and downstream of one or more in-stream gold-dredges. Turbidity and suspended sediment levels will be compared upstream and downstream of the dredging for periods during active dredging and at intervals after dredging is discontinued to determine the level of increase due to dredging and the length of time required for the effects to dissipate. If possible, measurements will be made at a series of locations downstream to allow the long-stream influence also to be quantified. If river access is limited, it may be possible to carry out the measurements using a kayak.

This monitoring phase, too, will be carried out during the summer, allowing an efficient distribution of personnel and laboratory use.

2. Duration and magnitude of turbidity exposure: Turbidity samples will be collected at 1- to 3-day intervals at stations along the mainstem South Fork Trinity River and at locations on selected tributaries throughout the wet season. Water stage will also be noted as each sample is collected. Occasional missing data are expected, but comparison of stage records from nearby stations and at-a-station relationships between stage and turbidity will allow a high proportion of missing values to be interpolated. Exposure levels will be calculated at each station using the method described by Newcombe and MacDonald (1991), and exposures will be compared to those reported to injure salmonids. Peak turbidities will not necessarily be assessed using this approach, as

these change from hour to hour. Of more interest, however, is the protracted level of chronic turbidity; this approach is designed to assess these chronic turbidity levels rather than the short-term peaks.

A6. Project / Task Description

From June 1999 through September 2001 Salmon Forever will conduct initial volunteer recruitment and training, and monitor grazing impacts. A second recruitment drive as well as training will be held from September 2000 to November 2001.

It is anticipated that more than 1,600 grab samples will be collected, and that more than 400 of these will be processed to determine the suspended sediment concentrations. Depth Integrated Sampling (DIS) will be conducted in larger streams to measure turbidity and suspended sediment at various depths in various parts of the stream. DIS results can be correlated with those obtained by grab sampling for a more accurate picture of sediment concentrations in the stream than can be ascertained from grab sampling alone. This results in a more reliable stream signature.

Measurements necessary to determine stream discharge must be recorded at the time water samples are collected. These may include stage, velocity, cross-sectional area, date and time. If possible, rising, peak, or falling limb of the hydro-graph will be noted. The appropriate equipment and techniques will be applied to gather this information, dependent on site conditions at the time of sampling.

A field laboratory will be set up in the area to allow timely analysis for turbidity. The Quality Assurance protocol developed by Salmon Forever requires rapid processing of samples to prevent algae growth. Samples will be transported to Salmon Forever's Sunnybrae Sediment Lab for filtering, oven drying, desiccation, and weighing. Regular analysis of data with review by appropriate Salmon Forever Technical Advisory Panel members will facilitate timely detection of error or need for modification of protocols. Quality Assurance is the responsibility of the quality assurance officer.

Data will be entered into the computerized management system and checked by the data processing team prior to analysis. Analysis will be conducted as the results of data processing become available. A water year report will be distributed in August 2001. A QA report will be produced in August 2001.

Major Tasks	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Volunteer Recruitment									x	x	x
Training	x	x	x						x	x	x
ISCO training								x	x	x	x
Site Selection							x	x	x	x	
Crossections								x	x	x	x
Sampling	x	x	x	x	x						x
Lab Analysis	x	x	x	x	x	x	x	x	x	x	x
Data Analysis	x	x	x	x	x	x	x	x	x	x	x
Reporting								x		x	

Table A6:
Timelines

A7. Data Quality Objectives for Measurement Data

Data quality objectives (DQOs) are "quantitative and qualitative statements of the overall level of uncertainty that a decision-maker is willing to accept in results or in decisions derived from environmental data." The overall level of uncertainty is based on estimates of measurement error, sampling error, and site variability. The intended use of the data is to inform TMDL development and implementation consistent with action levels found in the applicable basin plan. Water quality objectives found in the North Coast Basin Plan provide action levels for the parameters of turbidity (turbidity shall not be increased more than 20% above naturally occurring background levels) and suspended sediment (the suspended sediment load and suspended sediment rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial use). It is difficult to state DQOs for many of the variables measured in this study because estimates of variability are not available but will be determined by the relationship of depth integrated sampling to turbidity sensor readings, current meter readings to float velocity, etc. Variability also exists at the site scale.

Rating curves will be developed using sample results grouped by category of management impact and litho-topo type. Using AIC (Basian) statistical methods, each category will be tested to provide an estimate of the magnitude of the differences between individual sites (inter-site variability) and a confidence interval around the estimate of magnitude. Then, given that the turbidity objective of the North Coast Basin Plan provides an idea of what an important difference is, if the confidence interval is very narrow; we have our answer. On the other hand, if the confidence interval is wide enough to include both important and **unimportant differences**, we will assume either; 1) more data is needed, or 2) more effective methods are needed.

Once inter-site variability has been evaluated, turbidity v. discharge rating curves from categories of management will be developed. These rating curves will be compared to test for important differences using statistical procedures. If no important difference is found, it may be an indication that sample size was too small. Assuming an important difference is found, estimates of the magnitude of the difference and the confidence interval around the estimate will be determined.

All sites will use the same methods for sample collection. If there is a bias in the estimated relationships between turbidity and discharge (i.e. turbidity for a given discharge is either overestimated or underestimated), the bias is expected to be similar for each site.

It is EPA's policy that all environmental data collection activities be planned and implemented through the development of data quality objectives. Based on the DQOs, acceptance criteria for measurement data are defined for certain attributes of data quality: precision, accuracy, completeness, comparability, and representativeness.

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA QUALITY

The following formulas will be used to calculate data quality attributes. The values obtained should be within the data quality objectives set for this study (Table A7b). Confidence Intervals for discharge, turbidity and suspended sediment concentration will be established. Confidence intervals for correlation between depth integrated sampling and ISCO sampling and grab sampling will also be established.

Accuracy

Accuracy is the degree to which a measured value agrees with an accepted known or true value. Accuracy in this project will be determined by calibration of sampling equipment, scales used in the laboratory and measuring equipment. Volunteer accuracy will be measured by observing sampling with checklists and comparing grab sampling with ISCO and DI sampling. Laboratory accuracy will also be checked by check weights, filter re-weighs, field splits, filter blanks and other methods.

Accuracy will be estimated for depth, velocity, turbidity, suspended sediment load at different stages, cross-section and velocity measurements. Accuracy, the degree of agreement between an observed value and an accepted reference value, will be expressed as percent agreement or percent difference, and calculated by the following formulas:

Root Mean Square error or

$$\% \text{ Agreement} = \frac{\text{\# of measurements - \# of incorrect measurements}}{\text{\# of measurements}} \times 100$$

$$\% \text{ difference} = \frac{\text{\# of measurements - \# of correct measurements}}{\text{\# of measurements}} \times 100$$

Precision

Precision is the measure of variation among repeated independent observations of the same property under controlled similar conditions. The goal of training and initial calibration is to train crewmembers so their estimates of subjective variable meets the DQO's in Table A7b. There will also be mid season checks. Laboratory precision will be checked by repeated sets of weighs of the balance check weight. Suspended Sediment Concentration duplicate samples cannot be fabricated with any confidence at this time.

Volunteer precision will be estimated for stage, velocity, and grab sampling. Precision, the degree of variation among individual measurements of the same variable, will be expressed as relative standard deviation, standard deviation, variance, or range.

For two or more repeat measures (between volunteer precision), relative standard deviation will be calculated as follows:

$CV = (S/y) \times 100\%$

Where: CV = coefficient of variation
S = standard deviation
y = mean of the repeat measurements

Frequency distributions of differences will be plotted to show between-volunteer precision. The slope and r-squared values resulting from regression analysis of repeat measurements collected for stage, velocity, and turbidity sampling for the duration of the field season will provide estimates of volunteer precision.

Comparability

Comparability, a measure of the degree to which different methods and data sets can be represented as similar, will be assessed in terms of accuracy and precision for most site measurements. Comparability of the suspended sediment load data will be evaluated based on results from analysis of audit samples and laboratory and field splits.

To ensure comparability the monitoring volunteers will follow the monitoring protocols established and approved by the EPA and Redwood Sciences Laboratory. See SOP's in Appendix 1 for sampling and laboratory protocols.

Completeness

Completeness is the ratio or percentage of the amount of valid data obtained compared to the planned amount. Our completeness goal is to sample suspended sediment load during all major storm events in study tributaries. Lack of volunteers, breakdown of equipment, frequency of major storms, etc... may hamper completeness

At the end of the season the amount of data and samples collected will be compared to the planned amount and be presented as a % of each variable. Completeness will be subjective because the number of samples is dependant upon weather patterns and the number of storms passing through the area and volunteers availability. Reasons for not meeting the 100% completeness objective will be recorded. It is expected that samples will be collected from at least 90% of the sites unless unanticipated weather conditions prevent sampling.

At the end of the field season, completeness will be assessed as the amount of data (and samples) actually collected compared to the planned amount and will be calculated by the following formulas:

$$\%\text{ Completeness (data)} = \frac{\text{data collected}}{\text{planned data collected}} \times 100$$

$$\%\text{ Completeness (samples)} = \frac{\text{samples collected}}{\text{planned samples collected}} \times 100$$

Following data entry, the amount of validated data will be compared to the amount of data collected, using formulas similar to those above. The measurement quality objective is 100% completeness. The accuracy and precision objectives are listed in A7b.

Parameter	**# of Valid Samples Anticipated**	**# of Valid Samples Collected & Analyzed**	**%Complete**
A. Suspended Sediment	1600	not yet tabulated	
B. Turbidity	1600	not yet tabulated	
C. Stage	1600	not yet tabulated	
D. Velocity	1600	not yet tabulated	
E. Discharge,(Price AA)	100	not yet tabulated	

Table A7a.
Completeness

Representativeness

Representativeness is the degree to which data truly characterize a population or environmental condition. Sampling methods are designed to be representative . Sampling design is described in section B1.

Previous monitoring conducted by Redwood Sciences Laboratory and Salmon Forever has shown that the highest levels of suspended sediment transport occur on the rising limb of the hydro-graph during large storms. Therefore, samples collected on the rising limb, at peak discharge, and on the falling limb are necessary to truly characterize the "sedi-graph" of watershed response. The actual timing of sampling activities cannot be predicted with much accuracy by more than a few hours in advance. Fifteen or more samples may be needed at each monitoring site to establish a suspended sediment concentration correlation that characterizes the full range of stream discharge response. This portion of the QAPP is subject to revision as the results of the Freshwater Station grab sampling effectiveness evaluation lead to improvement in sampling methods.

Where stream discharge is sufficiently energetic to transport large particles (such as sand) in the lower water column, depth integrated sampling (DIS) will be conducted at a range of flows, representative of the hydro-graph, to provide a correlation to grab sampling.

Stream velocity, in streams large enough to permit use of a current meter, will be measured with a current meter at a range of flows representative of the hydro-graph, to provide a correlation to float velocity for use in estimating discharge.

Stream discharge in streams too small to permit use of a current meter, will be measured with a bucket if a culvert is available and measurement is feasible. Stage will also be measured at the culvert entrance invert to develop a correlation.

Stratification of a statistically significant number of sample sites by soil/rock type should ensure representativeness for each of the major soil/rock types.

Study design incorporates representativeness to the extent possible by site selection using a gradation of watershed sizes. Adjacent watershed basins as small as 100 acres and as large as 2000 acres will be chosen where feasible. Constraints on access to sites due to winter snow conditions, closed roads and private timberlands may limit representativeness to subsets of a given litho-topo type. However access is sufficient to permit representative sampling of a substantial fraction of the litho-topo types.

Field Measurement Rating

Rating Total		A. Discharge method		B. Sample method
Level (1)	2	1	Price AA	1 (grab) small stream
		1	Stream gauge W/rating curve	
Level (2)	3	2	Floating object Velocity (FOV)	2 (grab) large stream
		1	Rating curve based On FOV	
Level (3)	4			
Level (4)	5	3	No velocity Or stage and Rating curve	

Table A7b.
Field Measurement Rating

A variety of methods will be used in the field to obtain measurements; each method has an inherent limitation to the accuracy of the estimate obtained by using it. For ease of tracking data sets a rating will be assigned to each data point based on the following criteria: Sample from a site with an established discharge rating curve developed using Price AA current meter, or discharge measured at time of sampling with with a Price AA meter in-stream or the bucket method at culvert outfall: Rates a 1
Floating object velocity method rates a 2.
The sample method rating will be added to the discharge method rating to get a rating total. The lower the number the better the rating level. The rating will be noted on the Field Form.

Precision, Accuracy, Measurement Range Objectives

The following table illustrates the precision, accuracy and measurement range estimated for the parameters of interest for the study. Values have been estimated from knowledge of measurement device characteristics and accuracy and also accounting for expected field and laboratory conditions.

Matrix	Parameter	Precision	Accuracy	Measurement Range
Water	Turbidity Grab	+-5.0%	+-2.0%	0-2000 NTU
Water	Turbidity Probe	+-5.0%	+-2.0%	0-2000 NTU
Water	Suspended Sediment			
	Grab	+-5.0 %	+-2.0%	.00001-2.0 g/L
	DI	_	_	_
	ISCO	_	_	_
Water	Velocity/ Float	+-8.0%	1.0 ft/sec	0-10 ft/sec
	Velocity/Meter	+ -8.0%	+ -8.0%	0.25 - 8.0 ft/sec
Water	Depth/Staff plate	+-5.0%	.5 inches	0-20 feet
	Depth/Transducer	_	0.2 inches	0 - 10 feet
Streambed Cross section	width/depth	+- 5.0%	.1 feet	0-200 feet

Accuracy, Precision, Measurement Range Objectives
Table A7c

A8. Training Requirements / Certification

Requirements for volunteers include good physical health, the ability to consistently repeat sampling procedures and time to spend sampling and analyzing data. Most of the procedures are not physically demanding. No special certification is required but all volunteers will go through training before sampling. The goal of training is to educate volunteers so their estimates of subjective variables meets the DQO's in Table A7c.

Personnel from Salmon Forever will initially conduct training. As the study progresses volunteer samplers will become proficient to train others. Field training will take place in

South Fork Trinity at various locations. Training will consist of day or half-day sessions in the field and Sunny Brae Sediment Lab.

Training topics will include:
Data Recording
Locating sample locations
Grab Sampling Methods
Stage measurement
Safety
Velocity measurement
Cross-Section measurement
Depth Integrated Sampling
ISCO Sampler use
USGS Type AA/Pygmy Current Meter use
Laboratory Protocols/ Suspended Sediment Processing/ Filter Weighing Procedures

Proficiency checklists (Appendix 3), listing the sequence of sampling and data collection tasks, and notes on proper execution of methods, have been prepared for evaluating implementation of methods by individuals and teams. The Field Manager, Lab Manager, QA Manager and Watershed Coordinators during training will use these checklists to document volunteer proficiency. .

The Field Manager and QA Manager and Watershed Coordinators will conduct all field training. All volunteers will be assembled in various groups once during the field season, for "calibration" in the collection of depth, velocity, cross-section and grab sampling measurements.

Safety procedures for sampling and taking measurements in stormy or hazardous conditions will be explained at every training session. High stream flows during storm events will be the main hazard the volunteers will encounter. Sampling points will be designed for safety at all times. Under no circumstances is anyone to risk injury for data.

A9. Documentation

The **Project Manager** will be responsible for ensuring the most current QAPP version is available to organizations involved in this study. A current copy will be mailed out to the organizations listed in A4 at the beginning of the sampling season. A current copy will be given to any organization requesting one. See Appendix 2 (Data Forms) for examples of all data sheets

Data report information and records will be in Word and Excel software formats. Paper copy will be in 8 1/2 by 11 paper with some data sheets in 8 1/2 by 14 paper. All data sheets will have the Hydrologic Year, initials of the person entering data, the date of data entry and the date of copying. Sign-in sheets will be numbered sequentially. Filter tare sheets will be numbered sequentially. Lab data sheets will be filed chronologically and given sequential numbers at the end of the Hydrologic Year. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

The final report will include raw data, Field Data Sheets, suspended sediment data sheets, equipment calibration sheets, lab data sheets and QA/QC results. A Final QA report will be prepared with a tentative deliverable date of August 1st. A final report will be completed September 1st.

Volunteer grab samples will be analyzed for turbidity with a HACH 2100P Turbidimeter and then processed for suspended sediment concentrations through a 1-micron filter on a vacuum assembly. Sample sign-in, turbidity determination, and suspended sediment concentration data is recorded in pen on all appropriate data sheets. Suspended sediment calculations will be done on a spreadsheet and written on paper worksheets.

ISCO samples will be run first on the HACH Turbidimeter and then will be processed for suspended sediment concentration. The ISCO station will include data from a continuous recording turbidimeter, a continuous recording stage/pressure transducer. This data will be recorded electronically with a Campbell CR10X Datalogger and processed at RSL using Pearl / S+ software.

Volunteers will record field-sampling data using Rite in the Rain paper Field Data Sheets. The Field Managers or Watershed coordinator or Lab Manager will make copies for entry into databases. Originals of Lab Sheets will be kept in the SunnyBrae Sediment lab. Copies of Field Sheets and Lab data sheets will be kept in Salmon Forever Offices.. Salmon Forever will maintain hard copies of all data as well as computer back-up disks for at least 10 years. Salmon Forever will maintain QA/QC sheets for 10 years. All Sediment Lab data will be maintained by Salmon Forever for 10 years. Originals of ISCO Automatic Sampler field sheets will be maintained for 10 years at the Salmon Forever Sediment Lab location. Copies will be given to RSL.

Appendix 1: Standard Operating Procedures
Appendix 2: Data Forms
Appendix 3: Proficiency Checklists

B: Measurement / Data Acquisition

B1. Sampling Process Design

Sites are selected to provide for the most representative measure of sediment load (Total Suspended Solids) by using a spatial distribution of sites, representative of a range of basin sizes which are then categorized by level of management activity for a given litho/topo unit. The water quality parameters analyzed at each location are turbidity (in NTU's) and suspended sediment (in mg/l). Turbidity is analyzed for each grab sample taken, using a HACH model 2100P turbidimeter.

As the turbidity /suspended sediment concentration relationship becomes sufficiently defined, most samples will be processed for turbidity only with suspended sediment concentration determined on an infrequent basis. Measurements will be taken and correlated to the rising limb, peak, and falling limb of the hydro-graph curve. Peak stage gauges and data from pressure transducers will be used to determine if a sample was taken on a rising or falling limb of the hydro-graph. Depth integrated sampling will be conducted to provide a correlation to a full range of stage and discharge measurements. Grab Sampling will be done concurrent with DIS and any ISCO sampling at the ISCO Station site several times during the sampling season to define the relationship between the 3 sampling methods. Grab sampling will be done concurrent with DIS sampling at several sites and stages to define that relationship further.

The main sampling season will be the rainy season in Trinity and Humboldt County. The rainy season typically begins in October and continues through April. The number of samples taken at each grab sample location will depend on storm conditions and volunteer availability. All measurements taken will be critical measurements and very little will be for informational only.

A continuous monitoring station on Freshwater Creek provides a baseline data set to evaluate the effectiveness of these grab sampling methods. The station collects baseline data against which simultaneous grab, DIS, and ISCO sample data can be compared. This Freshwater station incorporates an ISCO model 2100 automatic pumping sampler, an Campbell CR101X datalogger, Druck 1830 pressure transducer, OBS-3 turbidity probe, Campbell 107 Thermistor temperature probe and a Campbell TR525I Tipping Bucket gain gauge. The sampling program (Turbidity Threshold Sampling V 2.2) in the data logger controls the collection of information from the pressure transducer and turbidity probe, and activates the pumping sampler at the appropriate turbidity thresholds. Sampling intervals will be consistent with RSL's turbidity threshold sampling protocols. Data is retrieved from the data logger in the field several times a month. A back-up disc of data will be kept on-site also. A plotting program allows field personnel to check for valid program operation, examine stage and turbidity data for reasonable values, and detect equipment malfunctions. The relation between TSS (total suspended solids) and turbidity is quite good when particle sizes and types remain nearly constant or are well-related to TSS. Applying storm-by-storm calibrations improves load estimates by accounting for the temporal variability in the relation between TSS and turbidity caused by particle variations, incremental contamination of the sensor's optics, and sensor drift.

The datapod records the stage (water level) every 15 minutes. The mechanism for this is a pressure transducer that is contained at the edge of the stream bank. The transducer sends an electronic signal to the datapod, which converts it to stage and records the value, along with the time and date, onto an electronic chip. This provides a continuous stage record for that particular station. With the use of a rating curve (stage/discharge relationship) we are able to know the stream discharge (in cfs) at the time a given water sample was taken.

The volunteer sampling stations are sampled occasionally using a depth-integrated hand sampler. Staff plates, which portray the stream stage, are located at some stations. The stage and water velocity is manually recorded each time a sample is collected. This allows for correlation between stage and that particular water sample. These stations are generally sampled during periods of high water.

Topo Maps : showing sampling locations
Map 1 Hyampom 7.5 minute quad
Map 1a Metzger Map - Humboldt County
Map 2 Halfway Ridge 7.5 minute quad
Map 2a Hyampom 7.5 minute quad
Map 2c Sims Mountain 7.5 minute quad
Map 4 Hennessy Peak 7.5 minute quad

Aerial Photos:
1944 Hyampom Quad (Map 2a & 2c) 5 sheets 000-54-(79-80-81-82-83)
1944 Hennessy Peak Quad (Map 4) 2 sheets 000-58- (15-16)
1970 Hennessy Peak Quad (Map 4) 6 sheets EVZ 6- (164-165-166-186-187-188)
1995 Hennessy Peak Quad (Map 4) 5 sheets 16 615100 995 - (17-18-19-20-45)

These sheets are inserted in the hard copy QAPP

Type of Sample	# of Samples	Sampling Frequency	Sampling Period
Susp. Sediment	1600	Storm dependent	Nov. to June
Turbidity	1600		Nov. to June
Velocity	1600		Nov. to June
Discharge	50		Nov. to June
Crossection	20		Nov. to Sept.

Table B1.
Sampling Frequencies

B2. Sampling Methods Requirements

The SOP's, attached to this document in Appendix 1, contains detailed information on procedures for collecting samples and sampling methods and materials needed. The process for preparation and decontamination of sampling equipment, the selection and preparation of sample containers, sample volumes, preservation methods, and maximum holding times to sample analysis are detailed in Lab and Field Standard Operating Procedures in Appendix 1.

The table below summarizes a portion of this information.

Matrix	Parameter	Sampling Equipment	Sample Holding Container	Sample Preservation Method	Maximum Holding Time
Water	Suspended Sediment Load	ISCO Sampler	ISCO Bottle	HCL	1 year
Water	Turbidity & Susp. Sed. Conc.	Volunteer / Grab	Sample Cell Sample Bottles	HCL	1 year
Water	Turbidity & Suspended Sediment Conc.	DH-48/DH-49 Sampler Crane/Hand	Glass Sample Bottle	HCL	1 year

Sampling Methods
Table B2.

When any problems are encountered with the ISCO sampling station, the Field Manager, Watershed Coordinator or QA/QC Manager shall first try to correct the failure and then call Appropriate Redwood Sciences Lab personnel to correct the failure as quickly as possible. Any downtime on the station shall be documented. The Lab Manager shall be responsible for correcting any lab equipment failures as soon as possible and documenting any failures.

B3. Sampling Handling and Custody Requirements

All sample handling will be done following approved Field and Lab and ISCO Standard Operating Procedures in Appendix 1.

At the beginning of the hydrologic year all bottles used in sampling will be given a waterproof sticker with a unique ID number. This includes ISCO bottles, DIS bottles, HACH cells and other grab sample bottles. The Lab Manager will be responsible for procuring the stickers, keeping a logbook of numbers used and labeling all sample bottles before they are used in the field. Stickers will be circular and be able to fit on the bottom of a HACH cell as not to interfere with turbidity determination. All other sample containers will receive a sticker on the side of the bottle. After Turbidity and Suspended Sediment processing the sticker will be taken off the sample bottle and a new one put on.

The numbering system will be as follows:

00G1234 00D1234 00I1234

A. 1st two digits - Hydrologic Year 00 01 02

B. Letter for Type of Sample:

G for grab sample
I for ISCO sample
D for Depth Integrated Sample (DIS)

C. The last 4 digits shall be consecutive numbers till the end of the sampling season.

All ISCO and Depth Integrated sample bottles and grab sample bottles shall be labeled in the field with the pertinent data and logged in sign-in sheets at the time of being brought in the lab. ISCO Sample bottles shall be labeled when taken out of sampler. The sample ID # shall be written on the field form at the time of sampling, sign-in sheet and data sheets.

The chain-of-custody for these samples is as follows:

The Volunteer Team Member is responsible for samples until they are brought to the Lab or until they are picked up or measurements recorded by the Field Manager or Watershed Coordinator. The Field Manager or Watershed Coordinator is responsible for samples until they are checked into the lab. The Field Manager or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data. The Lab Manager is responsible for storing and processing samples. The date and time of arrival at the Sediment Lab is recorded on the Lab Sign In sheet by whoever brings the sample into the lab. Samples at the lab shall be kept in a cool dark place until processing. The lab sign-in sheet is in Appendix 2.

B4. Analytical Methods Requirements

Analytical procedures follow Redwood Science Lab, EPA and Standard Methods (#2540B - Total Solids Dried at 103-105^0 C) protocols and are detailed in the Standard Operating Procedures found in Appendix 1. Redwood Sciences Lab will perform TSS determination on QC split samples taken during the sampling season. Salmon Forever will do all other Turbidity and SSC determinations. Standard Operating Procedures for SSC/TSS determination are virtually the same for the two laboratories.

SOP used in each measurement:

Field / Grab Sampling	Field / Grab Sampling SOP
Turbidity Determination	Turbidity SOP
ISCO Sampling	ISCO 2100 Automatic Sampler SOP
Turbidity Determination	OBS-3 Continuous Turbidimeter SOP
Stage determination	DRUCK 1830 Stage/Pressure TransducerSOP
Depth Integrated Sampling det.	DIS Sampling/Crane & Wading SOP
Discharge determination	Discharge Current Meter Crane & Wading SOP
Susp. Sed. Conc. Determination	Laboratory Procedure SOP

Volunteer grab samples will be analyzed for turbidity with a HACH 2100P Turbidimeter and then processed for suspended sediment concentrations through tared 1.0-micron filters on a vacuum assembly. ISCO samples will be run on the HACH Turbidimeter and will be processed for suspended sediment concentration until a sufficient range of samples are analyzed to develop a turbidity v. suspended sediment correlation. Suspended Sediment Concentration filters will be dried in an oven, cooled in a dessicator and then weighed on a Mettler H20T balance to the nearest 0.00001 gram. The filter used is Gelman P/N 61631 Type A/E 47mm. Sample volumes will be calculated from weighing sample bottles full and empty on an AND FY3000 balance. Suspended sediment calculations will be done on an Excel spreadsheet and written on paper worksheets. Actual calculations are in the Lab SOP in Appendix 1.

The Lab Manager and QA/QC Manager shall be responsible for correcting any failures in the analytical system. Detailed information on the corrective actions and any samples affected shall be kept in the lab records.

List of analytical equipment:

ISCO 2100 Automatic Sampler Serial # xxxxxxxxxxxxxx
HACH 2100P Turbidimeter - Serial # 960100009614
HACH 2100P Turbidimeter - Serial # 990800022423
HACH 2100P Turbidimeter - Serial # 990800022431
HACH 2100P Turbidimeter - Serial # 990800022441
2 -Current Meters USGS Type AA
1- Current Meter USGS Pygmy
1- Turbidity Probe OBS-3 S/N 430
1- CR10X Campbell Data Logger

Druck 1830 Pressure Transducer S/N 1088275
3 - DH-48 Depth Integrated Samplers
1- Mettler H20T Analytical Balance S/N 418151
1- AND FY 3000 scale S/N 5608313
Gelman P/N 61631 Type A/E 47mm glass fiber filter 1 micron
Gelman P / N 60301 Supor-200 47mm membrane filter 0.22 micron
1- Grieve Laboratory Oven LR270C

B.5 Quality Control Requirements

Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result) and precision (how reproducible results are) of the monitoring. Quality Control consists of the steps taken to determine the validity of specific sampling and analytical procedures.

The Quality Assurance Manager will be responsible for implementing and recording and analyzing these measures. Quality Control measures will be 10% of the data collected in this study. Most measures will be taken after every 9th sample or measurement. Some will be done on every sample. Results of analysis and corrective actions shall be reported to the Project Director.

Detailed QC procedures and frequency of checks and the required control limits, corrective action and determining effectiveness of these checks are in the Standard Operating Procedures in Appendix 1. Quality assessment procedures are covered in Section C1 and the SOP's in Appendix 1 .

B5.C Quality Control Procedures: Information Management

Sample information is recorded on standardized data forms (Appendix 2)
Data is entered on a data sheet. Data report information and records will be in Word and Excel software formats. Paper copy will be in 8 1/2 by 11 paper with some data sheets in 8 1/2 by 14 paper. All data sheets will have the Hydrologic Year, initials of the person entering data, the date of data entry and the date of copying. Sign-in sheets will be numbered sequentially. Filter tare sheets will be numbered sequentially. Lab data sheets will be filed chronologically and given sequential numbers at the end of the Hydrologic Year.

All suspended sediment and turbidity data sheets are entered into Excel spreadsheets. Data from field forms and sign-in sheets and data sheets are entered into Excel spreadsheets for data analysis. A PC version of Redwood Sciences Lab S+ analysis program will hopefully be developed for ISCO data analysis. After data entry was complete, the Field or Lab Manager verified accurate entry by Mg/L comparisons with the original calculation sheet, and reviewed data for evidence of missing groups and accuracy of data. If any disagreements between the original data sheets and the excel data set were found, the entries in the excel data set were corrected by the crew leader to reflect the data entered on the original data sheets. The Data Manager is responsible for data analysis.

B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

All equipment shall be inspected and maintained to EPA and Manufacturer requirements. Records will be kept on all appropriate equipment. The Lab Manager maintains records to track scheduled maintenance on all equipment. All records and lab equipment will be kept at the Sediment Lab. All spare parts will be kept at the Sediment Lab. Adequate replacement parts will be kept at the lab and are the responsibility of the Lab Manager. If equipment is found to be out of spec or not working, it shall not be used until inspection by the QA Manager and documented.

Equipment Type	Inspection Frequency	Type of Inspection
Balances	annually at calibration	inspection/lubrication
HACH Turbidimeters	each use	operating properly
ISCO Sampler	each bottle change	operating properly
Data Loggers	every data dump	computer check
Pressure Transducer	weekly	computer check
DH-48 Samplers	each use	visual inspection
AA Current Meters	each use	visual insp. /spin check

Table B6.
Instrument Inspection and Maintenance

B7. Instrument Calibration and Frequency

Inspection calibration descriptions and frequencies are found in the appropriate SOP's in Appendix 1. All equipment calibration records will be kept by the Lab Manager and are available upon request. All equipment shall have an identifying number and linked to calibration records.

Equipment Type	Calibration Frequency	Type of Calibration
Balances	annually	Check to Standard Wts.
HACH Turbidimeters	quarterly	Stablcal Calibration
Pressure Transducer	beginning/mid season	RSL Protocol
Continuous Turbidimeter	beginning/mid season	RSL Protocol

Table B7.
Instrument Calibration and Frequency

B.8 Inspection and Acceptance Requirements for Supplies

All supplies used in the Study will be either ordered from the manufacturer or through a scientific supply house. Supplies will not be accepted unless in proper working order. All supplies and equipment are purchased and inspected under the supervision of the Lab and Field Manager. Lab water shall be retail distilled water purchased locally. The Lab Manager before use shall inspect sample bottles cleaned in the lab. Copies of equipment invoices shall be kept in the Sediment Lab and Salmon Forever Offices.

B.9 Data Acquisition Requirements

"Data obtained through non-measurement sources"

Maps and Aerial Photos of sampling sites are located in Section B1.

B10. Data Management

Data is entered on data sheets in the field and laboratory. Sample information is recorded on standardized field and lab data forms. See Appendix 2 for examples of all data forms. The Field Manager and Lab Manager are responsible to double check and copy Field Data sheets and deliver them to the Project Director. The Lab Manager is responsible for double check and copy lab data sheets and delivering them to the Project Manager. Lab originals will be kept in the Sunny Brae Sediment Lab. Reports and data will be transferred to Excel spreadsheets and Word documents and copies kept at the Sunny Brae Sediment Lab and Salmon Forever Offices.

All data sheets will have the Hydrologic Year, initials of the person entering data, the date of data entry and the date of copying. Sign-in sheets will be numbered sequentially. Filter tare sheets will be numbered sequentially. Lab data sheets will be filed chronologically and given sequential numbers at the end of the Hydrologic Year.

Data will be examined and rated on the basis of field and lab codes pertaining to the quality of data. Codes are in the SOP's and Table A7b. Any outliers or nonsensical data will be detected during calculations and transfer to electronic spreadsheet and documented.

Data handling equipment includes data sheets, data loggers, RSL spreadsheets and programs, hand calculators, Excel spreadsheets and Microsoft Word documents. Data collected at the ISCO station will be entered directly into RSL Pearl / S+ program. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

Data is used to produce annual reports and is kept on paper copies and electronic copies on Word documents and Excel spreadsheets. Data and calculations will be checked at the time of transfer from paper to spreadsheets.

C: Assessment and Oversight

C.1A Assessments and Response Actions

Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. QA activities include training of staff, documentation and development of methods and standard operating procedures (Appendix 1), equipment maintenance (Section B6), and appropriate handling, processing, and tracking of all data and samples collected. These activities are designed to ensure that study objectives are met. This section describes how we will document implementation of all QA procedures.

Proficiency checklists (Appendix 3), listing the sequence of sampling and data collection tasks, and notes on proper execution of methods, have been prepared for evaluating implementation of methods by individuals and teams.

These checklists will be used by the QA Manager, Field Manager, Lab Manager, Watershed Coordinators during training and field data collection, and possibly by HSU/EPA/RSL staff.

QA Watershed Coordinator checks:

Watershed Coordinators will meet every 2 months to compare progress, to discuss and resolve problems that they may have encountered, and to address any issues brought to their attention by the external audits of internal QA checks. These meetings will be extremely important in terms of preventing data quality problems, variation in execution of sampling procedures. Topics for discussion may include:

A. Progress in the field sampling and laboratory analyses or activities.

B. Identify problems with sampling procedures or logistics in the field. Discuss difficulties encountered in specific situations and adopt corrective actions. Develop and adopt appropriate modifications for standardizing use of methods among crews.

C. Discuss personnel performance problems

C1.B Field Quality Assurance/Assessment

The Field Manager, QA Officer or Watershed Coordinator shall observe each volunteer at the beginning of the project and again at least once a year conducting sampling using a proficiency checklist. Any problems shall be discussed and corrected at that time. During training, we will note any methods that the volunteers find confusing, and discuss modification of the method, the training schedule and the checklist. Volunteers will be required to perform all sampling procedures correctly for their data to be used. Volunteers will be rated on a scale as to the quality of data collection for later data quality evaluation. All field protocols will be re-evaluated following the training. All volunteers will be required to pass proficiency criteria during training. If volunteers do not pass the proficiency criteria, they will receive additional training until they are proficient or they will not be utilized in this study. The Field Manager, QA Officer or Watershed Coordinator is responsible for implementing these assessments and to document and file these checklists. Results shall be reported to the Project Director. Details and examples of Proficiency Checklists are to be found in Appendix 3.

C1.C Laboratory Quality Assurance/Assessment

Laboratory QA procedures are detailed in the Lab SOP in Appendix 1. QA laboratory procedures will be conducted by QA Manager and Laboratory Manager. The Laboratory Manager will train Lab Technicians before conducting sediment processing and on the job. Proficiency checklists for Turbidity determination and Suspended Sediment Concentrations and Filter Weighing shall be conducted and filed for all Lab Technicians in the beginning of the sampling season and once more mid sampling season. The Lab

Manager will review technician data for errors and incomplete data entry. Technicians will work under direct supervision for 2 sessions and if performing satisfactorily will be allowed to conduct processing independently. The Lab Manager is responsible for implementing these assessments and correcting technician deficiencies and keeping the checklists on file in the lab. Results shall be reported to the Project Director.

The Lab Manager will prepare a set of 9 filters, corresponding to varying sample filter weights, to use in conjunction with the filter weighing proficiency checklist. This set of filters will be prepared by the lab manager and weighed by all lab technicians. Each technician's results must be within 1.0% of the standard weight of each filter before they can work independently and weigh current sample filters. Lab technicians will repeat the procedure until proficient. The Lab Manager may re-examine and re-weigh sample filters periodically during the field season as a QA check.

C1.D Performance and System Audits:

Technical systems audits provide an external review of the research and QA activities. This project may be audited by staff during each field season. Findings will be discussed with the researchers and summarized in audit reports submitted to EPA and RSL and HSU.

The objectives of field visits by EPA/RSL/NCRWQCB QA staff are: (1) to observe implementation of field methods by the field crews; (2) to observe Salmon Forever training methods; (3) to qualitatively assess consistency of Crew Leaders in implementation of field methods, assessment of individual proficiency, and answering questions. If deficiencies or problems are identified, QA staff will make recommendations to the Field and Lab Managers and Watershed Coordinators.

This external evaluation may include: (1) an assessment of personnel performance, equipment, and procedures; (2) review implementation of the QA project plan; (3) determine whether DQOs are being met (review QC data collected to date); (4) assess consistency of field methods implementation by the volunteers. Any deficiencies or problems will be discussed with the Project Director and summarized in an audit report.

C.2 Reports to Management

The South Fork Trinity Report will be produced and distributed in August 2001. The Project Director is responsible for all report production and distribution. The Report will be forwarded to the county, state, regional EPA office, and other members of the Advisory Panel. The report will consist of data results, interpretation of data, information on project status, volunteer highlights, results of QC audits and internal assessments, any significant QA problems and recommended solutions. Summaries of all reports, highlighting the assessment results, project status, and volunteer achievements, will be distributed to all appropriate agencies and organizations. The Project Director will use the results of this report to implement any needed changes to the study for the next sampling season.

The report will include:

A. The Field Operations Report will contain the following:
1. Introduction
a. Project Description, Objectives, Schedule
b. Site Selection

2. Training summary
a. Description of training, including agenda, instructors, material covered, locations, and training materials.
b. List of proficiency criteria for testing trainees; actions taken when trainees did not pass proficiency criteria; Summary of training results, including quantitative assessment of trainees' performance, improvements and changes made in field methods, and recommendations for future training.
c. Description of corrective actions following field training visit by QA staff and EPA Project Leader.

3. Field Data Collection Activities
a. List of sites sampled;
b. Summary of samples collected; description of any samples lost and why; estimate of completeness for samples; Time estimates, including average number of sites sampled per day, amount of time spent at each site, displayed as distribution (range) of time required to sample a site;
c. Description of corrective actions following field audit by HSU/RSL/EPA QA staff;
d. QC data will be summarized statistically, displayed graphically, and evaluated in terms of DQO achievement. Summary of logistics and safety issues, including sampling difficult sites, access, lodging, accommodations, sampling equipment and supplies.
4. Laboratory Operations
a. Balance calibration records;
b. Summary of QC data for blanks, duplicates, and audit samples;
c. Estimate of completeness - summary of samples analyzed vs. the number collected;
Summary and Recommendations
a. Conclusion and recommendations for future studies.
B. The QA Report will contain the following:

1. Introduction
a. Project Description, Objectives, and Schedule;
b. Site Selection.

2. Data and Information Management
a. Summary of data entry errors, any difficulties with data;
b. Evaluation of data entry - completeness;
c. Documentation of project activities, including content and location project notebooks (field, laboratory, data management), preparing additional reports.

3. Summary of QC data

4. Discussion
a. Summary of greatest sources of error;
b. Summary evaluation of protocols, DQOS, and training;
c. Recommendations for future studies;
e. How will data quality affect study results?

D: Data Validation and Usability

D.1 Data Review, Validation and Verification Requirements

All field and laboratory data is reviewed by the Project Director, QA Manager and the Data Processing Manager to determine if the data meets the QAPP objectives. In addition, personnel from the EPA and RSL and HSU who are not directly connected to the project may also review data on a quarterly basis. Decisions to reject or qualify data are made by the Project Director and the QA Manager.

All data will be rated by several methods to rank usefulness. Data will be ranked poor, fair or good. Field, Lab and Turbidity Codes will be used in addition to proficiency checklists to rank data. See Lab and Turbidity Codes in SOP's in Appendix 1.

D.2 Validation and Verification Methods

1. Once data has been entered into the database, the Data Processing Manager will proofread it against the original data sheets. Errors in data entry will be corrected. Outliers and inconsistencies will be flagged for further review, or discarded. Problems with data quality will be discussed in the final report to data users.
2. Quality Control data will be analyzed including:
   a. Chain of custody information
   b. Spikes
   c. Equipment calibrations
   d. Examining raw data for outliers or nonsensical readings
   e. Lab and Field Codes
3. Reviewing graphs, tables, and charts.
4. Description of how errors, if detected will be corrected.
5. Data qualification issues shall be discussed with project managers and advisory agencies and data users and resolved to data users satisfaction.
6. Results will be conveyed to data users through the final report in August.

D.3 Reconciliation with Data Quality Objectives

As soon as possible, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications. data may be discarded. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is found to be sampling error, volunteers will be retrained. Any limitations on data use will be detailed in the final report, and other documentation as needed.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the RSL and EPA quality assurance officers for approval. Limitations on the use of data will be reported in the QA report in August.

E. Appendices

Appendix 1: Standard Operating Procedures
Appendix 2: Data Forms
Appendix 3: Proficiency Checklists

Appendix 1: Standard Operating Procedures (SOP)

Field / Grab Sampling SOP
Turbidity Determination SOP
SSC / TSS Laboratory Procedure SOP
DIS Sampling / Crane & Wading SOP
Discharge Current Meter Crane & Wading SOP
ISCO 2100 Automatic Sampler SOP
OBS-3 Continuous Turbidimeter SOP
DRUCK 1830 Stage/Pressure Transducer SOP

Appendix 2: Data Forms

Sample Sign-In Sheet
Field Sampling Data Sheet
Field DI Sampling Data Sheet
Turbidity Dilution Data Sheet
Grab Sampling SSC Data Sheet
TTS (ISCO) Sampling SSC Data Sheet
Depth Integrated (DI) Sampling SSC Data Sheet
SSC Calculations Data Sheet
Discharge/ AA Current Meter/ Crane & Wading Data Sheet
Automatic (ISCO) Sampler Sheet: (RSL Field Form)
Cross Section Measurement Data Sheet
Equipment Calibration forms
Training Sign-in
Instrument Sheet

Appendix 3: Proficiency Checklists
Listing the sequence of sampling and data collection tasks, and proper execution of methods.

Field:
1. Grab Sampling
3. ISCO Sampling
4. DIS DH-48 / DH-49 / Crane & Wading Measurement
5. Discharge - Current Meter / Crane & Wading Measurement
7. OBS-3 Continuous Turbidimeter Measurement
8. Druck 1830 Pressure Transducer / Stage Measurement

Appendix 3: Proficiency Checklists - continued.

Laboratory:
1. Suspended Sediment Sample Processing
2. HACH 2100P Turbidity Measurement
3. Filter Weighing Process

References:

EPA:
Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995
EPA QA/G-4 Guidance for the Data Quality Objectives Process
EPA QA/G-5 Guidance for Quality Assurance Project Plans
EPA QA/G-6 Guidance for the Preparation of Standard Operating Procedures (SOP's) for Quality Related Documents
EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations

USGS:
Techniques of Water-Resources Investigations of the USGS:
Stage Measurements at Gaging Stations Book 3 Chapter A7
Discharge Measurements at Gaging Stations Book 3 Chapter A8
Laboratory Theory and Methods for Sediment Analysis Chapter C1 Book 5
Field Methods for Measurement of Fluvial Sediment Chapter C2 Book 3
Surface Water Techniques:
Discharge Ratings at Gaging Stations - Hydraulic Measurement and Computation Book 1 Chapter 12 1965

Others:
Standard Methods for the Examination of Water and Wastewater 1990 2540 B. Total Solids Dried at 103-105^0 C

Laboratory Procedure for Total Suspended Solids, Redwood Sciences Laboratory, USDA Forest Service, Arcata Ca, Rand Eads, 12-10-98

Harrellson, C. C., 1994, Stream Channel Reference Sites: An Illustrated Guide to Field Technique: USFS, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-245.

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A5. Problem Definition / Background/ Study Design

Freshwater Creek, a 22,000-acre watershed, which flows into Humboldt Bay near Eureka, California is our experimental design site and will be used to test the effectiveness of grab sampling methods. The watershed is primarily forested with one large industrial landowner and several smaller residential properties in the lower basin.

Anadromous fish stocks on the North Coast of California have recently declined from historically high levels. Elevated levels of sediment is considered to be a primary cause of declining fish populations by clogging spawning gravels, filling in pools, reducing channel capacity, as well as directly impacting growth rates. Freshwater Creek is listed as impaired, according to section 303.d of the Clean Water Act due to elevated levels of sediment. Although sediment is implicated as a primary problem in the basin, consistent long-term sediment monitoring data has not been established.

Documentation of existing impairment and trends is needed to evaluate land use practices and to suggest actions sufficient to meet future total maximum daily load levels in accordance with the Clean Water Act.

Large areas of forest within the Freshwater and other watersheds have been, or are scheduled to be, cut using industrial forestry methods. As storm events occur, the quantity of sediment generated in tributary watersheds and transported through the stream system towards Humboldt Bay is expected to further increase beyond background levels. Excessive sediment loading causes:

a.) turbidity to increase beyond background levels and basin plan standards
b.) high turbidity levels to be maintained for longer durations
c.) channel aggradation, bank erosion and channel migration
d.) reduced channel capacity and conveyance, and subsequent flooding
e.) degraded fish habitat
f.) impaired water quality for domestic and agricultural uses

Project Goal

Determine suspended sediment concentration, turbidity, discharge and current channel characteristics to provide a data base for management decisions and further studies. Estimate suspended sediment yield at monitoring sites. Develop turbidity vs. discharge rating curves for managed tributaries and baseline streams. The project goals will be achieved by:

Measuring suspended sediment concentration, turbidity and discharge during the rainy season. Estimate suspended sediment yield during storm runoff from data collected at one continuous monitoring station located on mainstem Freshwater Creek above the tidal influence.

Measuring suspended sediment concentration, turbidity and discharge during storm runoff in tributaries with varying land use of Freshwater Creek and other Humboldt County tributaries by grab sampling. Develop the relationship between turbidity and discharge for large and small tributaries.

Measuring suspended sediment concentration, turbidity and discharge during storm runoff in undisturbed tributaries of Humboldt Redwood State Park to use as a baseline to determine natural background levels. Develop relationship between turbidity and discharge.

Develop an annual discharge hydrograph for the mainstem of Freshwater.

Establish and measure channel cross-sections at sites to identify areas of degradation and aggradation following large storms.

Project Objectives

This study is intended to provide data sufficient to answer the following questions:

What is the relationship between turbidity and discharge (illustrated with turbidity-discharge rating curves) for a representative range of North Coast streams and tributaries during hydrologic years 1998-1999-2000?

Are the turbidity levels, using rating curves of study tributaries, significantly higher than the "baseline" turbidity levels of less-disturbed tributaries (such as that which can be defined using information being collected by Redwood National Park at Little Lost Man Creek or Godwood Creek in Prairie Creek State Park) on similar soil types/geologic parent material/physiography/vegetation type in the region?

In those cases where a soil type is not represented in a less-disturbed area, and baseline thus cannot be estimated for the soil type, how do turbidity levels in that soil type compare with the distribution of baseline and disturbed area turbidity levels for other soil types. Is the difference consistent with expected differences in soil erodibility?

What is the total estimated suspended sediment yield of Freshwater Creek for the 1998-99 water year? What is the qualitative measure of sediment yield for grab sampled sites?

What is the duration of chronic levels of turbidity in mainstem Freshwater Creek?

In addition, this data will be available for use by future studies that might be implemented to assess the association between turbidity response & management variables such as stream crossings, road density, clear-cut areas and landslide frequency

A6. Project / Task Description

From July through September, 1999, Salmon Forever will conduct initial volunteer recruitment and training . A second recruitment drive as well as training will be held from September 1999, to November, 1999.

One sampling site will be equipped with an automatic ISCO pump sampler, one instream turbidity probe, one rainfall gage, one water depth pressure transducer and one instream temperature probe. This site will be set up on the main stem of Freshwater Creek and is situated just above Graham Gulch. Volunteers will maintain and supply new sample bottles to these samplers and process and analyze the suspended sediment data from the sampler.

The ISCO sampler will use Turbidity Threshold Sampling (TTS) software routines developed by Redwood Sciences Lab. The ISCO sampler will pump samples when rising and falling turbidity level thresholds are reached. This allows for less samples to give an accurate picture of suspended sediment concentration levels for storm events.

Volunteers will also take and analyze data from grab sampling, continuous turbidimeter data, water velocity, crossection, stage and precipitation measurements at various locations and watersheds. Depth integrated (DI) sampling will be performed periodically, concurrent with ISCO sampling and will be used to define the relationship of the ISCO data to the entire water column. DI samples will be processed for turbidity and suspended sediment concentrations. Grab samples will also be taken concurrent with ISCO sampling and Depth Integrated sampling and will be analyzed for turbidity and suspended sediment concentration to define the relationship between the three sampling methods.

Sampling of turbidity, suspended sediment concentration, water depth, and velocity will occur throughout the water year at numerous sites. This data is needed in order to estimate suspended sediment yield and to develop baseline data.

EPA and RSL protocols will be used to assure comparability and use of data. All data will be entered into the computerized management system and checked by the data processing team prior to analysis. A water year report will be distributed in August. A QA report and will be produced in August.