Group A Elements: Project Management
1. Title and Approval Sheets

Quality Assurance Project Plan

for

The Van Duzen Watershed Project

Toward a Working TMDL: A Watershed Plan for the Van Duzen River Basin

Agreement # 06-149-551-0

April 2007

Grant Organization

QA Officer: ______________________ Date: ______________________

Project Director: ______________________ Date: ______________________

Regional Board (SRWQCB)

QA Officer: ______________________ Date: ______________________

Project Manager: ______________________ Date: ______________________

2. Table of Contents

List of Tables

List of Appendices

3. Distribution List

1. Van Duzen Watershed Project - Paul Trichilo, Sal Steinberg, Tom Travis, Dave Heaton, Karen Bromley, Nick Simpson
2. FOER – Nadananda, William Thorington
3. Salmon Forever - Clark Fenton, Jesse Noel
4. Eel River Watershed Improvement Group (ERWIG) – Ryan Wells
5. Humboldt State University - Kristine Brenneman
6. Redwood National Park – Randy Klein
7. Redwood Sciences Laboratory – Leslie Reid
8. CA Water Quality Control Board (WQCB) – Janet Blake, Cindy Davis
9. CDFG – Steve Cannata
10. Humboldt Watershed Council – Mark Lovelace
11. Redwood Community Action Agency
12. Institute for Fisheries Resources – Pat Higgins
13. Adopt-A-Watershed – Kim Stokely
14. Hydesville, Cuddeback, Bridgeville, and Scotia Elementary Schools
15. Pacific Lumber Company
15. Fortuna Creeks Project – Pam Halstead
16. Grizzly Creek State Park - Robert Leiterman
17. Humboldt County Parks - Pat Boyles
18. County of Humboldt – Tom Hofweber (Planning Division)
19. Humboldt State University Library
20. Humboldt County Library

<u>Introduction.</u>

This Quality Assurance Project Plan (QAPP) covers volunteer monitoring conducted by The Van Duzen Watershed Project (VDWP) within the Lower Van Duzen River Basin. Through the work of volunteers, Friends of the Van Duzen River (FOVDR) has been monitoring streams of historic significance to salmon populations since 2001. As an offshoot of FOVDR, the Van Duzen Watershed Project promotes continued monitoring of water quality by volunteers and cooperation between our research activities and state agencies. Monitoring efforts are intended to record water quality conditions, including sediment loading, sediment transport, and turbidity, and to develop an understanding of, and record the relationship between water quality and land use within the basin.

4. Project Task/Organization

Involved Parties and Roles.

The Van Duzen Watershed Project (VDWP) is the lead organization in the formulation and operation of this project. VDWP is responsible for purchasing equipment, training volunteers, processing and analyzing collected samples, and producing reports. Salmon Forever, a non-profit water quality analysis organization based in Humboldt County, CA has provided technical evaluation of grab sampling methods, assistance in installation and operation of sampling instruments, and data analysis. Salmon Forever, Redwood National Park, Redwood Sciences Laboratory (RSL), Humboldt State University (HSU), CA Department of Fish & Game (CDFG), and the North Coast Regional Water Quality Control Board (NCRWQB) will serve as technical advisors on this project. Principal data users will include VDWP, Salmon Forever, Humboldt State University, CDFG, and the Water Quality Control Board (WQCB).

The persons assigned to the positions listed below are responsible for oversight of their respective project tasks:

- Project Director: Paul Trichilo, VDWP (707-725-0232)
- Community Coordinator: Sal Steinberg, VDWP (707-768-3189)
- Water Quality Specialist: Karen Bromley, VDWP
- Geologist: Dave Heaton, VDWP
- Aquatic Biologist: Jon Lee, VDWP
- Laboratory Manager: Ed Brenneman, VDWP
- Interim Quality Assurance (QA) Managers: Clark Fenton, Salmon Forever; Jesse Noel, Salmon Forever; Dr. Kristine Brenneman, Humboldt State University.
- Data/GIS Analyst: Paul Trichilo, VDWP.
- Field Manager: Sal Steinberg VDWP
- Watershed Coordinators - Long-term, committed volunteers within each planning watershed

The Project Director is responsible for question formulation, parameter selection, and developing the sampling design in cooperation with the Technical Advisory Group (TAC) panel. The project director and quality assurance managers review all field and laboratory data for QAPP objectives and reject or qualify data. The project director is responsible for producing and distributing reports and will use the results of reports to implement any necessary changes to the study for subsequent sampling seasons. The director will also be responsible for the smooth functioning and general administration of the project, of all scheduled meetings and presentations, and will assess and present the overall progress and accomplishments of the project to the community and the Water Quality Control Board.

The Community Coordinator is responsible for organizing all community-related activities of the project, including appropriate scheduling of up-coming events such as annual training sessions for the Community Monitoring Group, Salmon Watch meetings, TAC meetings, biannual stakeholder meetings, and the Annual and Final Watershed Workshop/Conference to the Community near the end of each fiscal year. The Community Coordinator is also responsible for organizing volunteers and projects involving members of the community, as well as for generating community interest in upcoming events, through the use of public service announcements, and radio and newspaper advertisements.

The Water Quality Specialist is responsible for taking water samples of the river and critical streams at the designated monitoring sites. Samples will be taken bimonthly (twice per month) on a regular basis throughout the year. Data will include water temperature, pH, dissolved oxygen, conductivity, discharge (when conditions permit), stage, turbidity, and suspended sediment. Samples will be measured for turbidity and suspended sediment concentration at the Water Quality Laboratory at Humboldt State University. The water quality specialist will submit data and report results to the project director, and at scheduled meetings.

The Geologist is responsible for conducting all rod and transit work related to establishing staff gaging plates, and collecting all physical data describing stream and main stem cross sections associated with each monitoring site. The geologist is also responsible for finding and supplying the project with all relevant geological information pertaining to the VDR Basin. Relevant information includes all available published or unpublished documents relating to the geology and/or geologic history of the area, all spatial or GIS compatible data available for the area, such as imagery, grids, coverages, and /or shapefiles of geologic importance. The geologist will be responsible for transferring data/information and reporting results to the project director, and at scheduled meetings.

The Aquatic Biologist will be responsible for collecting samples and data on macro invertebrates endemic to the Van Duzen River Basin. Important criteria will include taxa (keyed to at least the Family level), numbers and density of each type, habitat (e.g., which types are associated with pools, riffles, and runs, and which types are more associated with impaired versus pristine habitats). Methods will involve using two established sampling protocols: 1) EPA RAPD bioassessment of macro invertebrates, and 2) CLBP (CDFG 1998), used by most state agencies and consultants to assess macro invertebrate communities. The aquatic biologist will also be responsible for saving preserved samples for demonstrations to the community, for recording types and numbers associated with each stream and habitat, and for submitting data and reporting results to the project director, and at scheduled meetings.

The Lab Manager will supervise and train volunteers in the processing of lab samples, and checking and copying field data. This person also maintains 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 Quality Assurance (QA) Manager will conduct lab and field certification, document lab and field volunteer proficiency through proficiency checklists, and conduct periodic visits to observe lab and field technique. The QA Manager and the Field Manager will share responsibility for maintenance, operation and documentation for the continuous, turbidity-controlled ISCO automatic sampling stations. The QA Manager will perform Quality Control (QC) and check approximately 10% of data collected in the project, review all field and lab data for QAPP objectives, and correct 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/GIS Analyst will proof read data entered into databases against the original data sheets, verify re-testing, clarify ambiguous issues with field operators, and review all field and lab data for QAPP objectives. The data/GIS analyst will also assist the Field Manager and Lab Manager in presentations for data users and presentations for field operators. The data analyst will be responsible for all GIS data, and analysis of all turbidity and suspended sediment data, using statistically acceptable methods of analysis, and reporting results in the form of formal reports to WQCB and presentations at scheduled meetings.

The Field Manager will conduct stream reconnaissance, select and document monitoring site locations, provide field training including on-call technical support; collect and check completeness of field samples; and verify the field data. The Field Manager is also responsible for checking the activities of volunteers in the field and the quality of the monitoring effort, as well as motivating volunteers to take well timed and accurate water quality samples.

5. Problem Definition/Background

Problem Statement.

Thirteen years ago, the Environmental Protection Agency listed the “wild and scenic” Van Duzen River (VDR) as sediment-impaired under section 303(D) of the California Clean Water Act (CSWRCB, 1998). Some of the reasons for this listing were that, 1) potentially controllable sediment accounts for nearly 36% of the total sediment in the VDR (Pacific Watershed Associates 1999), 2) controllable sources of sedimentation include road and skid trails and timber harvest, 3) since 1999 Pacific Lumber Company has harvested over 60% of their 24,000-acre holdings in the basin, and 4) of 33 geomorphic units surveyed for Pacific Lumber Company, 26 did not meet properly functioning conditions due to either high fines or embeddedness (Tetra Tech 2002). Today North Coast rivers (including the VDR) are filled with silt, and salmon stocks hover near the brink of extinction (Brown, et al. 1994). Sediment can contribute to the decline of fish populations through several mechanisms including, but not limited to, clogging spawning gravel (Chapman, 1988), interfering with feeding ability and growth rates (Newcombe and MacDonald, 1991), and simplifying habitat by filling in pools and low gradient reaches (Frissel, 1992).

Project goals:

- Provide baseline data useful for implementing a TMDL by identifying background and current turbidity and suspended sediment concentrations (SSC) throughout the lower basin.
- Provide information and recommendations for fisheries restoration based on varying levels of impairment within the basin.
- Facilitate education, involvement, and empowerment of watershed residents by organizing a community-based volunteer program for monitoring.

- Recommend approaches to monitoring water quality and evaluation of impacts that can be applied to other systems.
- Bring together staff, stakeholders, and members of the community to formulate and critically review annual reports, and the draft watershed management plan.

Objectives:

- Establish key locations for monitoring sites within the Lower VDR Basin.
- Train members of the community in procedures and protocols for taking turbidity and suspended sediment samples at weekly intervals, as well as during storm events.
- Sample and quantify physical and chemical data including turbidity, suspended sediment, temperature, pH, dissolved oxygen, conductivity, discharge, and stream habitat, as well as biological data including macro invertebrates.
- Develop a rigorous ArcView GIS project to produce maps and document all stream and upslope conditions for analysis.
- Distribute information including maps through the web site, www.fovd.org and newsletter (The Eel River Reporter), whereby all results will be presented and discussed.
- Develop a watershed management plan for recovery within the Lower VDR Basin

6. Project/Task Descriptions

Collaborating with local landowners, state and county parks, and community volunteers, at least 10 water quality monitoring sites have been identified on the main stem and its tributaries. A monitoring strategy for turbidity and SSC will be established at these sites taking grab samples at regular intervals, as well as during and after storm events. Other data including temperature, pH, dissolved oxygen (DO), and conductivity will be collected at 7 of the 10 monitoring sites. Data on macro invertebrates (types and numbers) will be collected to determine the health of key habitats along the main stem and tributaries. Project priorities will include establishing ties between staff and local residents in working closely with the California Department of Fish and Game recording annual salmon migrations.

The project will bring together a team of scientists, community members, and public agencies to quantify water quality conditions and create a GIS database documenting the physical and biological conditions of the basin, in order to target specific problem areas and define measurable parameters for sediment reduction. Members of the project will conduct analyses on physical and biological data; and share results with the community, the Water Quality Control Board (WQCB), and other agencies, to develop a watershed management plan for the recovery of the VDR Basin.

Water is collected primarily via grab samples for turbidity and suspended sediment concentration (SSC) determination. For the first year of sampling, 3 Hach cell replicates are dipped into the stream simultaneously, to facilitate an estimate of sample accuracy and precision. Volunteers collect turbidity samples on a weekly basis at each of 10 monitoring sites, and more frequently during and after storm events. As hydrologic year (HY) 2007 appears to be a relatively dry year with less than average rainfall, approximately 500 grab samples will be collected. To compensate for HY 2007, at least 750 to 800 grab samples are planned for HY 2008. Due to the timing of funding availability in HY 2007, fewer grab samples will be taken for suspended sediment analysis than previously anticipated, and will likely only reach approximately 30 to 50 samples. During HY 2008, approximately 150 to 200 grab samples will be processed for suspended sediment concentration.

A continuous monitoring station is in operation at Cummings Creek to supplement grab samples with those automatically obtained by samplers that measure turbidity and suspended sediment with time. These results are compared to grab samples collected at the same time to identify differences or biases between the two methods. The automated samples also provide turbidity and suspended sediment data for periods when no grab samples are taken. The station at Cummings Creek that houses a continuous, turbidity threshold sampling station (Lewis, 1996), includes a continuous turbidity probe, stage recorder, and an ISCO automatic sampler capable of collecting 24 sediment samples. Sample collection is controlled by the rate of change of turbidity and stage. Sample collection from the ISCO involves loading and unloading sample bottles, downloading data from the on-site data logger, and occasional calibration of the pressure transducer and the turbidity probe. Data are entered into a computerized management system and checked by the data processing team prior to analysis. Regular analysis of data with review by designated Salmon Forever advisors will facilitate timely detection of error or the need for modification of protocols. Analysis is conducted when data processing is completed. At least one additional continuous turbidity and suspended sediment monitoring station will be installed on the main stem VDR at Rainbow Bridge adjacent to the USGS gaging station at Bridgeville (USGS Station No. 11478500), or at the main stem Weare monitoring site.

Differences and bias between the two sampling methods (grab versus automatic) will be evaluated. Automated sample collection is controlled by the rate of change of turbidity and stage. Therefore, additional measurements are also needed to evaluate the impacts of turbidity and SSC, including 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.

Stream samples will be processed at four different laboratory type facilities, established at the residences of the Lab Manager and three Lab Assistants who have been certified in the reading of turbidity using USEPA approved turbidimeters. All samples that register higher than the 1000 NTU threshold available with the current turbidimeters in use will be brought to the Lab Manager for processing. The Lab Manager will use a standard dilution technique to measure and then calculate the actual turbidity levels of these high concentration samples. Quality Assurance Protocol developed by Salmon Forever will be used, which requires rapid processing of samples to avoid the complications of algae growth within the samples.

Turbidity readings are copied onto a paper record sheet, and then later photocopied and entered into a computer (spreadsheet) database. Data are reviewed and checked by the data analyst prior to analysis. Regular analysis of data will occur with review by appropriate project personnel. Technical Advisory Committee (TAC) members will facilitate timely detection of errors or the need for modification of protocols. Sediment grab samples, taken by volunteers, are transported to the Sunnybrae Salmon Forever Lab for analysis of turbidity and suspended sediment concentration (SSC). Data analysis will be conducted after sample processing has been completed, data sheets submitted and verified for accuracy, and data entered into spreadsheets.

Additional data on discharge, temperature, dissolved oxygen, pH, and conductivity are collected throughout the year twice per month at seven monitoring sites considered most important based on stream size, perennial nature, catchment area, and ease of access. These parameters are sampled and measured on site, using appropriate meters and/or instruments that will be described in full in the standard operating procedures (SOP). Additional water samples will be taken at each monitoring site and transported to the laboratory at Humboldt State University, where they will be analyzed for turbidity and suspended sediment concentration.

Other studies and data that have been conducted with regard to the Van Duzen River Basin will be identified, and a search will ensue for all available data pertaining to water quality, salmonid reproduction and survival, and upslope (land use) conditions. Gaps in available data will be noted accordingly and compatibility between historical data and that collected for this project will be evaluated to ensure only compatible data are compared.

All pertinent spatial data currently available on the VDR Basin will be added and summarized in the GIS database, including current hydrologic and geographic information, climate history, stream flow, existing aquifers, wells and pumping history (if available), geology, soils, erosion processes, channel networks, area, elevation, and topography, additional large scale stream and road networks (including digitizing of logging roads from digital ortho quarter quads [DOQs] and road reconnaissance), vegetation, land use, change scene detection, timber harvest history DOQs, topo maps, etc. Summaries will lead to the development of a concurrent ArcView data and mapping project. The GIS project and database will be updated on a continual basis. We will also develop the framework for a Watershed Resource Inventory that catalogues all of the watershed information collected. The Inventory will contain a list of existing data, projects, contacts, and other information designed to assist stakeholders in accessing watershed information. The inventory will be posted on our web site.

The main stem Van Duzen River and three to five tributaries (i.e., Grizzly, Hely, Cummings, Fox, and/or Wolverton Gulch Creeks) will be walked by project personnel during Spring, Summer, and/or Fall to collect and quantify macro invertebrate populations. Where possible, GPS devices will be used to record steam habitat type. Otherwise, standard measuring devices will be used to describe and quantify stream data. Observations will be made in accordance with CDFG protocols, and data will be entered into the GIS database.

In conjunction with the monitoring/GIS database study, individuals associated with the Van Duzen Firesafe Council project will walk critical roads within the upper reaches of the study area with GPS, and assess the condition of roads and culverts within critical planning watersheds of the project. Outcomes of this part of the project will include: recommendations for road rehabilitation and culvert reconstruction, and where appropriate; assessment of fuel conditions and identification of hazardous fuels; reduction of hazardous fuels for fire control needs. All road and hazardous fuel data will be uploaded to GIS database and incorporated for analysis.

Table 1. Project Schedule

WORK ITEM	COMPLETION DATE
Submit PAEP	February 28, 2007
Submit QAPP	March 31, 2007
Submit Expenditure Invoices	Monthly beginning in November 06
Submit Work Invoices	Monthly beginning in November 06
Submit Summary Invoices	September 30, 2007/2008

Adjoining Landowner Notification

Notify Landowners of Project Initiation	October 30, 2006
Inform WQCB Grant Manager	October 30, 2006

Technical Advisory Group

Send out public notices regarding meetings	Quarterly beginning in 11/06
Post meeting agenda and minutes on web site	Quarterly beginning in 12/06
Submit summary report and post	Quarterly in 07 & 08

Stakeholder characterization and database development

Post information and notices	Biannually beginning in 4/07
Post meeting agenda and minutes	Biannually beginning in 4/07
Submit summary and final reports of meetings	May 30, of 07 & 08
Submit summary and final report of workshops	May 30, of 07 & 08

Watershed Resource Inventory

Post database inventory survey forms	September 31, of 07 & 08
Post results of database analyses	October 31, of 07 & 08
Submit data inventory and progress reports	Monthly
Submit results of Firesafe Council (roads, fuels)	October 31 of 07 & 08

Community Outreach & Technology Transfer

Post results of training sessions	November 30 of 06 & 07
Post results plus photos of Salmon Watch	August 31 of 07 & 08
Post results of field trips	October 31 of 07 & 08
Post results of GPS field excursions	October 31, of 07 & 08

Watershed Analysis

Submit monitoring plan	February 28, 2007
Update results of sampling and monitoring activities	Annually beginning in October 07
Post GIS and roads database, additions and updates	Annually beginning in October 07
Submit annual report	December 31, 07
Submit Final Report	December 31, 08

Watershed Management Plan

Submit Final Watershed Management Plan.	August 31, 09
Post Final Watershed Plan to Website	August 31, 09

Geographical Setting:

The Van Duzen Watershed Project study area extends approximately from the town of Bridgeville, CA to the mouth where the Van Duzen River merges with the Eel River near the town of Alton, CA. The area contains eight subbasins, six of which are identical to CA planning watersheds, while Yager Creek subbasin is comprised of 14 planning watersheds, and Grizzly Creek is comprised of two. Please see monitoring_sites.pdf, and Project GPS Information (GPSd_monitoring_sites.doc).

7. Quality Objectives and Criteria for Measurement

Data quality objectives (DQOs) are quantitative and qualitative statements of the overall level of uncertainty that project personnel are 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 (Salmon Forever 2001).

Data collected will consist primarily of physical measurements of stream pollution due to turbidity and suspended sediment. These data will be used to support the VDR TMDL and provide analysis of watershed conditions within the basin. Monitoring data will be compared to action levels for turbidity and suspended sediment concentrations listed in applicable regulations and guidelines. Action levels listed in the North Coast Basin Plan state that turbidity shall not be increased more than 20% above naturally occurring background levels and that 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).

Parameters to be measured in the project include: turbidity, suspended sediment concentration (SSC), temperature, dissolved oxygen (DO), conductivity, pH, stream discharge, and stage. Estimates of variability are site and measurement range dependent. The best means to ensure data quality is strict adherence to accepted sample collection and analysis methods described in the Standard Operating Procedures (SOPs – Appendix 1). Additional efforts to quantify variability and reliability include developing the relationship between continuous turbidity sensor readings and grab samples, and comparing discharge (flow) readings using a current meter versus standard float velocity-derived calculations.

a. Accuracy, Precision, and Measurement Range Objectives

Accuracy is the degree to which a measured value agrees with an accepted known or true value (Salmon Forever 2001). For instruments, accuracy is specified by the manufacturer and assured by proper calibration and maintenance of the instruments. Laboratory turbidity instrument accuracy is maintained using Formazin and Gelex calibration standards. SSC accuracy is maintained by periodically checking blank filter weights, filter re-weighs, and other standard QA methods (Salmon Forever, 2001).

Precision is the measure of variability among repeated independent observations of the same property under controlled similar conditions. Precision is quantified using split samples analyzed independently in the laboratory. The goal of training and initial calibration is to ensure that estimates of subjective parameters in samples collected by volunteers meet the DQOs. Additionally, mid-season comparison of measurements will be used to assess precision, which will be estimated for sampling methods by repeating the measurement and comparing results.

Accuracy, precision, and measurement range were estimated for all parameters of interest in the project (Table 2). Values, provided by VDWP and Salmon Forever, are derived from knowledge of measurement device characteristics and accuracy, and also accounting for expected field and laboratory conditions. Accuracy and precision are a function of the magnitude of the measurement value.

b. Comparability

Comparability is a measure of similarity between different methods and data sets (Salmon Forever 2001). Different turbidity meters or sensors return different turbidity readings for the same sample. The USGS recognizes these differences and provides guidance on how to properly report turbidity data (http://water.usgs.gov/owq/FieldManual/Chapter6/6.7_contents.html). In this project, continuous turbidity data are collected using the DTS 12 sensor (FTS Forest Technology Systems LTD) while turbidity data from grab samples are determined using a Hach 2100P meter. Dual measurements on a subset of samples will provide a mathematical means to adjust values from one to the other so they can be compared.

Comparability of the suspended sediment concentration data will be evaluated using parallel sampling, audit samples (See Sec. 20, Assessments & Response Actions), and laboratory and field split samples – methods that call for multiple, consecutive samples, or the splitting of the sample to allow for appropriate comparisons (Please see SOP 4 in Appendix 1). To ensure comparability, all monitoring activities will follow EPA approved protocols.

Table 2. Precision, accuracy, and measurement range for study parameters.

Matrix	Parameter	Measurement Method	Precision	Accuracy	Measurement Range
Water	Turbidity	Nephelometer	± 5.0%	± 2.0%	0-2000 NTU
Water	Turbidity	Probe	± 5.0%	± 2.0%	0-2000 NTU
Water	Turbidity	Turbidimeter	± 5.0%	± 2.0%	0-1000 NTU
Water	Suspended Sediment	Gravimetric	± 5.0 %	± 2.0%	0.00001-2.0 g/L
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%	0.1 ft	0 - 20 feet
	Depth	Pressure Transducer	Not Applicable	0.05 ft	0 - 10 feet

Water	DO	Meter	± 0.5 mg/l	± 0.5 mg/l	0 – 20 mg/l
Water	Temperature	Meter	± 0.5 ^oC	± 0.5 ^oC	-5 – 45 ^oC
Water	pH	Meter	± 0.5 units	± 0.5 units	-0.1 - 15
Water	Conductivity	Meter	± 0.5%	± 0.5%	0 – 4999 ms/cm

c. Completeness

Completeness is the relation between the amount of valid data obtained during the course of the project, and the amount originally anticipated (Salmon Forever 2001). Our completeness goal is to sample turbidity and suspended sediment concentration on a regular basis and during and after all storm events at each monitoring site. At the end of each hydrologic year, sampling frequency at each monitoring site will be compared with daily rainfall, to determine how well sampling reflected and covered actual hydrologic conditions in the Lower Basin. Moreover, additional measurements (DO, temperature, pH, and conductivity) will be measured bimonthly at five stream monitoring sites and two main stem monitoring sites. Lack of volunteers and variability in volunteer commitment to sampling, 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:

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

Following data entry into the project database, 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.

d. Representativeness

Representativeness is the degree to which data actually mimic a population or environmental condition (Salmon Forever 2001) (e.g., a statistic versus the population parameter). Sampling methods are designed to be as representative as possible, providing sufficient replication to allow adequate degrees of freedom in analysis for a reliable way to address the hypothesis. For turbidity and suspended sediment, different methods of measuring a given parameter will be compared, so as to quantify representativeness of sampling and analysis methods. Several sampling techniques designed to assess representativeness are listed below. These techniques include:

- Continuous sampling methods will be used at a range of flows to allow correlation with grab samples collected 6 to 8 inches below the water surface at the Cummings Creek and Rainbow Bridge stations.
- Stream discharge at a range of flows will be measured on an interval basis by using both a current meter and a standard float method, in order to evaluate the accuracy of the float method.
- Previous monitoring conducted by Redwood Sciences Laboratory and Salmon Forever has shown that the highest levels of suspended sediment concentration at a given discharge 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 accurately estimate the sediment transport during a storm. At least 15 samples will be needed at each monitoring site to establish a suspended sediment rating curve for load estimation. Timing of sampling activities can only be predicted a few hours in advance, and therefore it may be difficult to ensure full coverage during each storm event. It is assumed however, that frequent sampling of many storms will allow reasonably accurate load estimation for each monitoring site. Transferrability of data with respect to SSC rating curves from one site to another is currently unknown (Salmon Forever 2001).

Representativeness will also be addressed by selecting sites that represent subbasins of variable size and geology. The lower VDR Basin offers a variety of subbasins that differ to varying degrees in size and geology, such as Hely Creek versus Yager Creek.

e. Data Quality Ratings

All methods of measurement have inherent limitations in their ability to accurately represent the population parameter. 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 3. 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 the timed floating method, the rating for that data point is 1 + 2 = 3. Lower rating numbers indicate measurement methods that are more likely to be representative 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 3. Field measurement rating values (QAPP, Salmon Forever 2001).

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

Timed Bucket Filling at Low Flow	2		
Timed floating method (FM)	2		
Stage reading w/rating curve derived from FOV	2		
No discharge estimate	3		

8. Special Training Needs/Certification

Although no specialized training is needed, all field staff participate in an initial day-long training and certification program consisting of combined class and field instruction, during both the first and second season. All volunteers and staff collecting or analyzing samples receive consistent training from experts from the Salmon Forever Laboratory and Redwood National Park. These volunteers will be observed and certified by the QA Manager for performance of the SOPs specific to their tasks. The goal of the training program will be to educate volunteers so that estimates of subjective parameters will meet Data Quality Objectives (DQOs). As the project progresses, experienced staff members and volunteers will become sufficiently proficient to train and certify others. Field training and additional instruction (as may be required) is conducted at established monitoring sites. Laboratory training is conducted at the FOER office building in Fortuna, and Citizen's Monitoring Group workshops are conducted at the home of the Field Manager on the banks of the Van Duzen River.

Training topics will include:

- Safety
- Data Recording
- Selecting and preparing sampling locations
- Grab Sampling methods
- Stage measurement
- Velocity measurement
- Cross-section measurements for discharge
- ISCO Automatic Sampler use
- USGS Type AA/Pygmy Current Meter use
- Turbidity Measurements using a Turbidimeter
- Suspended Sediment Sample Processing

Proficiency checklists (Appendix 2), listing the sequence of sampling steps, data collection tasks, and notes on their proper execution, have been prepared for evaluating the performance of volunteers (Salmon Forever 2001). The Field Manager, Lab Manager, QA Manager and/or Watershed Coordinators will use these checklists during training to document the level of volunteer proficiency.

The Field Manager, QA Manager or Watershed Coordinators conduct all field trainings. Volunteers are also assembled once during the field season, for "calibration" in the collection of depth, velocity, and 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 greatest hazard for volunteers. Therefore monitoring stations are selected with safety being the most important criterion. Under no circumstances will anyone risk injury for the collection of data (See Appendix 1 – Health and Safety).

One of the major purposes of training sessions is to encourage commitment and responsibility of volunteers as well as imparting an awareness for sources of error and uncertainty. Requirements for volunteers include good physical health, the ability to consistently repeat sampling procedures, and sufficient time to devote to sampling and analyzing data.

9. Documents and Records

The Project Director will ensure that the most current QAPP version is available to all sponsoring and cooperating 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 will be made available to any individual or organization requesting one.

Field data will be recorded on appropriate data sheets (Appendix 3). Volunteers will be encouraged to maintain field books where they record any additional or supplemental information that they collect. All field data sheets and notebooks will be reviewed by the Project Director at the end of the sampling season.

The recording of laboratory data will vary with the analysis. Grab samples will be analyzed for turbidity using a HACH 2100P Turbidimeter. Larger sample bottles (500 ml) will be processed for suspended sediment concentration (see Appendix 1: SOP2, SOP4). All data will be recorded on paper data worksheets in pen with indelible ink, and later uploaded and maintained in spreadsheet format, with external hard drive backups.

ISCO samples will be analyzed using the HACH 2100P Turbidimeter and then processed for suspended sediment concentration. The ISCO station also collects continuous turbidity (using a DTS 12 turbidity sensor) and stage (using a pressure transducer). These data are recorded electronically with a Campbell CR10X data logger and post-processed by Salmon Forever using software developed by Redwood Science Lab scientists. A mathematical relationship between data from the Hach 2100P and the DTS-12 (continuous turbidimeter) will allow data from the one to be adjusted to comparable values of the other for comparisons.

All raw data will be uploaded to the computer and stored in standard software formats. Paper copies are on 8-1/2 by 11 or 8-1/2 by 14 paper. All data sheets will 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 will be numbered sequentially as they are used. Laboratory data sheets will be 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 WQCB.

Originals of all field and laboratory data sheets, QA/QC analyses, and computer databases will be kept at the VDWP central office. Copies of field and laboratory data sheets, QA/QC analyses, and computer back-ups will be maintained at the office of the Project Director. VDWP will maintain hard copies of all data sets and computer back-ups for at least 10 years. Original ISCO Automatic Sampler field sheets will be stored for 10 years at the VDWP central office. Copies of these documents will also be given to Salmon Forever.

A QA report and an annual project report will be prepared for each hydrologic year with a tentative deliverable date of October 30. Final reports will include field observations, turbidity, suspended sediment, and other physical-chemical data, equipment calibration, laboratory analyses, and QA/QC results.

Group B: Data Generation and Acquisition

Sampling methods, handling, and custody, as well as analytical methods are described in the Standard Operating Procedures (SOPs) in Appendix 1. Included in the SOPs are:

- Field Grab Sample collection
- Turbidity Measurement using the Hach 2100P Turbidimeter
- Discharge measurements – Crane and wading with the Price AA current meter
- Suspended sediment concentration laboratory measurement
- ISCO 2100 Automatic Sampler Sampling
- Continuous turbidity measurements using the DTS 12 sensor
- Stage measurement using the DRUCK 1830 Stage/Pressure Transducer
- Temperature
- Dissolved oxygen
- pH
- Conductivity
- Use of the Flow Meter
- The Timed Float Method to determine Flow
- Macro Invertebrates – taxa, numbers, and quantity
- Health & Safety

10. Sampling Process Design

Sample collection points and a justification for selection sites are described in the Monitoring Plan. 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 the Lower Van Duzen Basin
- To measure conditions in relatively undisturbed sites to define “background” conditions
- To identify the effects of land use activities in the watershed, and to sample above and below select locations within a watershed.

Our monitoring objective is to establish 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/or temporal distribution of sampling. With these limitations, sampling is fundamentally a standard procedure but also by necessity, opportunistic.

11. Sampling Methods

Standard operating procedures (SOPs) provided in Appendix 1 contain detailed information on the methods used for sample collection and analysis. A description of sampling methods is also provided in the Monitoring Plan. Two methods are used to collect turbidity and suspended sediment samples: 1) surface grab sampling, and 2) turbidity-controlled suspended sediment collection using an ISCO automatic sampler (Lewis 1996). Turbidity and SSC values determined from simultaneous sampling using two different sample collection methods will be used to quantify data quality.

Methods used to measure stage, discharge, cross-section and other channel characteristics needed to evaluate the turbidity or SSC data will be adopted from USGS or USDA Forest Service (Harrellson, C. C. et al., 1994) protocols.

12. Sample Handling and Custody

Grab samples will be 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 will procure these stickers, keep a logbook of the ID numbers, and label all sample bottles before they are used in the field. Circular stickers will be placed on the bottle cap for the HACH cell samples so they do not interfere with turbidity measurements. All other sample containers will receive a sticker on the side of the bottle. After turbidity and SSC processing, the sticker will be removed from the sample bottle and replaced with a new sticker. The numbering system for the stickers will be a 7 letter alphanumeric code described in Table 4.

Table 4. Description of code used for sample containers (QAPP, Salmon Forever 2001).

ID number examples	07HC24A, 01D1234, 99I1234
Code description	
If a Grab Sample, First two digits Two letters indicating monitoring site Last 2 digits Last letter	Hydrologic year (e.g., 99, 01, 07) HC - Hely Creek, YA – Yager Creek, etc. Unique, sequential number for each site A, B, or C – When 3 replicates per sample
If other than grab sample, then Letter indicating sample method type	I – ISCO sample D – depth integrated sample

All ISCO, DIS and grab sample bottles will be 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 # will also be written on the field form at the time of sampling. The chain of custody will be as follows.

- Volunteers will be responsible for samples until they are brought to the Lab or until they are picked up and measurements recorded by the Lab Manager or Lab Assistant (under the direction of the Lab Manager).
- The Lab Manager and/or Lab Assistants will be responsible for samples until they are checked into the lab. The Lab Manager and/or Lab Assistants are responsible for collecting and checking the completeness of field samples and data.
- The Lab Manager and/or Lab Assistants will be responsible for storing and processing samples. Grab sediment samples in 500 ml plastic bottles will be taken to the Salmon Forever Lab for processing and measurement of suspended sediment concentration (SSC). 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.

With four turbidimeters in use, virtually all samples from the 10 monitoring sites are processed within the EPA Handbook designated time limit of 48 hours following collection of the sample. If processing does not occur immediately following collection, samples are kept refrigerated until they can be read for turbidity. Prior to placement in the turbidimeter, Hach cell sample bottles are brought to room temperature (if previously refrigerated), and wiped clean with a drop of silicone oil and a felt cloth. Samples are gently shaken according to an established procedure and then immediately placed in the turbidimeter and read for turbidity. After the first tubidimeter reading, the Hach cell bottle is removed, and shaken again before being placed back in the turbidimeter for a second reading. This process is repeated once again for a total of three readings per Hach cell sample.

After samples are read, bottles (Hach cells) are emptied, rinsed, and washed in a light solution of moderately hot water and Alco-nox lab detergent. Bottles are then rinsed three times with tap water, rinsed again three times with distilled water, and set out to dry. Bottle caps are soaked in warm soapy water, and labels removed. Caps are then rinsed several times with tap water, again with distilled water, and set out to dry.

13. Analytical Methods

Analytical procedures will follow Redwood Science Lab (RSL 2001), EPA, and Standard Methods for the Examination of Water and Wastewater (AWWA, 1990) where appropriate, and are listed in the Standard Operating Procedures (Appendix 1). Salmon Forever will perform SSC determination on QC split samples taken during the sampling season. VDWP will perform grab sample turbidity measurements, and Salmon Forever will perform continuous turbidity and SSC determinations.

Volunteer grab samples will be analyzed for turbidity with a HACH 2100P Turbidimeter, and less numerous 500 ml bottles will be processed for suspended sediment concentrations using the vacuum filtration method through tarred 1.0-micron filters. 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 Data Analyst and QA Manager will be responsible for correcting any failures in the analytical system (Tables 5 & 6). Detailed information on the corrective actions will be recorded.

Table 5. Field analytical methods

Analyte	Laboratory/ Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method		Achievable Laboratory Limits	
				Analytical Method/ SOP	Modified for Method yes/no	MDLs (1)	Method (1)
pH	Field monitoring by VDWP field staff	6 - 9 pH units	NA	Standard Methods (*) VDWP SOP 10	None		
Conductivity	Same	> 1500 micromhos	10 micromhos	Standard Methods VDWP SOP 11	None		
Dissolved Oxygen	Same	< 5 mg/L	0.1 mg/L	Standard Methods VDWP SOP 9	None		
Temperature	Same	5 – 18 ^{o} C	-5 ^{o} C	Standard Methods VDWP SOP 4	None		

(*) *Standard Methods for the Examination of Water and Wastewater*, 20th edition.

Table 6. Laboratory analytical methods

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method		Achievable Laboratory Limits	
				Analytical Method/ SOP	Modified for Method yes/no	MDLs (1)	Method (1)
Turbidity	VDWP In-House Lab	25 NTU		Standard Methods VDWP SOPs 1 & 2	None		
Suspended Sediment	Salmon Forever SSC Lab	25 mg/l		Standard Methods VDWP SOP 4	None		

14. Quality Control

There is potential for variability in any sample collection, analysis, or measurement activity. Field variability generally contributes more than laboratory variability. Experimental error can result from between sampling unit variability (influenced by design error and/or inherent spatial variability), and within-sampling-unit variability (due to sampling, analytical, and/or data manipulation).

The QA Manager will be responsible for implementing, recording and analyzing the quality control measures undertaken to ensure data quality objectives are met (SOPs in Appendix 1). Quality control will be performed on 10% of the data collected in the study. Results of quality control analyses and corrective actions will be reported to the Project Director and described in the Annual Report. Sampling methods and in-house laboratory methods have been described in detail in the monitoring plan and other parts of this document. For example, during the first year, and at random regular intervals in the second year, turbidity samples will be taken in triplicate (as 3 replicates), and each sample will be read for turbidity three times per bottle. Data will be recorded for all values recovered during the course of the project. While the median of the three turbidimeter readings will constitute the value for that particular replicate, medians for each of the three replicates will be analyzed statistically and expressed as average, range, standard deviation (s), and coefficient of variation (V).

15. Instrument/Equipment Testing

A list of equipment used for the monitoring process is provided below (Table 7). 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 either the Cuddeback School Lab or the Salmon Forever Sediment Lab. All spare parts are stored at the 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 8 summarizes the inspection frequency and performance assessments used to identify equipment malfunctions.

Table 7. List of analytical equipment.

Instrument	Number Owned/Used	Serial/ID Numbers
ISCO 6712 Automatic Sampler	1	1880
DTS 12 Turbidimeter	1	22002
CR10X Campbell Data Logger	1	X47544
Druck 1830 Pressure Transducer	1	2318424
HACH 2100P Turbidimeters	4	22431, 37816, 19904, 19954
Global Flow Probe FP101	1	24879
Precisa XB 120A Analytical Balance	1	S/N P68181
AND FY 3000 scale	1	S/N 5608313
Laboratory Oven LR270C	1	LR270C
VWR Vacuum Apparatus	1	Model # 2522B-01 S/N 040000000715

Table 8. Equipment inspection and performance assessment measures (QAPP, Salmon Forever 2001).

Equipment	Inspection Frequency	Type of Inspection or Assessment	Inspector
Balances	Each use	Weigh check weights	SSC Lab manager or responsible volunteer
Hach 2100 turbidimeters	Each use	Proper operation	Lab manager or Lab Assistant
ISCO samplers	Each bottle change	Proper operation	Monitoring Specialist
Data loggers	Each data download	Check computer operation	Monitoring Specialist
Pressure transducer	Weekly	Check computer operation and compare to staff plate	Monitoring Specialist
DH-48 and DH-49 samples	Each use	Visual inspection	Quality Assurance Manager
DTS 12 Turbidity Sensor	Each Hydrologic Year	Cleaning of Sensor Optics	Quality Assurance Manager
Price AA	Each use	Visual inspection and spin test	Water Quality Specialist

16. Instrument/Equipment Calibration and Frequency

All equipment calibration records are kept by the Quality Assurance Manager, the Lab Manager, and/or Lab Assistants, and are available upon request. Each piece of equipment has an identifying number that is linked to calibration records (SOPs in Appendix 1). Instrument calibration schedule is described in Table 9.

Table 9. Instrument calibration schedule (QAPP, Salmon Forever 2001).

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 2100P turbidimeters	Quarterly	Stablcal Calibration	Laboratory Manager
Pressure transducers	Beginning/mid-season	RSL protocol	Quality Assurance Manager
DTS 12 turbidity sensor	Beginning/mid-season	RSL protocol (calibration to	Quality Assurance Manager

sensor	season	(calibration to formazine standards)	Manager

17. Inspection/Acceptance of Supplies and Consumables

Not Applicable

18. Non-Direct Measurements (Existing Data)

Project volunteers will collect most of the data required to analyze the turbidity response and sediment transport at the monitoring sites. Where continuous records of discharge have been or are recorded and determined by others, copies of the data will be requested. All data that meet the measurement, analysis, and quality control procedures and criteria outlined in this QAPP will be accepted and used in the analysis. For example, while the Van Duzen Watershed Project will involve collection of turbidity data at numerous monitoring sites, data collected prior to the project will be used as additional evidence if these data meet the criteria discussed above. Additionally, a collection of maps and aerial photographs of sampling sites and target watersheds will be available through the GIS part of the project.

19. Data Management

Sample information and data will be recorded on standardized field and laboratory data forms (Appendix 3). The Field and Laboratory Managers will be responsible for checking and copying field data sheets and delivering them to the Project Director. The Laboratory Manager will be responsible for checking and copying lab data sheets and delivering them to the Data Analyst. Original laboratory data sheets will be kept in the VDWP central office. Reports and data will be transferred to spreadsheet and word processing documents, and copies kept at the VDWP Office and in the office of the Project Director.

All data will be rated based on values related to quality of data (Table 3). Outliers or nonsensical data will be detected during calculations and/or transfer to electronic spreadsheet, and documented by the Data Analyst and/or the QA Manager.

Data handling equipment will include data sheets, data loggers, Redwood Science Lab (RSL) spreadsheets and programs, hand calculators, and spreadsheet and word processing software. Data collected at the ISCO station will be entered directly into RSL-developed analysis programs. Data will be presented in a format acceptable to EPA, RSL, and WQCB.

Data will be used to produce annual reports, and will be maintained in both hard copy and electronic formats in documents and spreadsheets. Data and calculations will be checked at the time of transfer from paper to spreadsheets.

Group C: Assessment and Oversight

Quality assurance (QA) will be the shared responsibility of all project managers and analysts (Field, Lab, and Data), Watershed Coordinators, and our Technical Advisory Committee 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. Volunteers will be validated for proficiency in the sampling process (Appendix 2 – Proficiency Check List).

20. Assessments & Response Actions

The Project Director

The Project Director will be responsible for overseeing the collection, processing, and analysis of all water quality monitoring data, and the writing of reports. All watershed coordinators will provide clear, concise, and detailed descriptions of their activities to the Project Director on a monthly basis. Any problems in the sampling/monitoring process will be immediately reported to the Project Director. The Director will in turn notify and/or seek to remedy problems by contacting either the Field Manager, Lab Manager, or both. The Project Director, Field Manager, and Lab Manager will review all field and laboratory data to determine if the data meet the Data Quality Objectives. Decisions to reject or qualify data well be made by these individuals.

Watershed Coordinators

Watershed Coordinators meet with the Project Director and Field Manager on a quarterly basis to compare progress, discuss and resolve problems, and to address any issues resulting from internal QA checks. Meetings will provide an opportunity to identify problems with sampling procedures or field conditions, as well as other difficulties encountered in various situations. Discussions will be entertained to address corrective actions and/or appropriate modifications for standardizing sampling methods, as deemed suitable by the participants, as well as the Project Director and Field Manager.

Field Manager/Community Coordinator

The Field Manager/Community Coordinator, along with the Laboratory and QA Manager will observe each volunteer at the beginning of the project, and again at least once a year, while conducting sampling. Proficiency Checklists (Appendix 2 – Salmon Forever 2001) will be used evaluate volunteer performance. All volunteers will be 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 leave the monitoring program. Volunteers will be required to perform all sampling procedures correctly before their data is included in any databases or used for analyses. Methods that the volunteers find confusing will be noted, and modifications to the method, the training, or the checklist will be adopted as deemed necessary.

Laboratory and QA Managers
Either the QA Manager or Laboratory Manager will conduct QA laboratory procedures. The Laboratory Manager trains lab assistants/technicians before they begin conducting sample processing and observes their proficiency on the job until they are certified to work independently. Lab technicians work under direct supervision for a minimum of 2 sessions. Certification using the proficiency checklists for turbidity, 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 QA/Lab Manager reviews technician data for errors and incomplete data entry. The QA/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 opportunity for external review of the research and QA activities. Personnel from WQCB, RSL, HSU, or Salmon Forever may audit this project during the field season. Findings will be discussed with the volunteers and summarized in audit reports submitted to Salmon Forever and WQCB.
The objectives of System Audits will be to:
- observe implementation of field methods by volunteers.
- assess personnel performance, equipment, and procedures.
- evaluate VDWP training methods.
- assess consistency of volunteers in implementing field methods.
- answer questions arising regarding sampling design or methods.
- determine that DQOs are being met by reviewing quality assurance data

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

21. Reports to Management

An annual report will be produced and distributed at the end of August of each year. The Project Director will be responsible for report production and distribution. Reports will be forwarded to state and regional agencies, and members of the Technical Review/Advisory Committee. Reports will contain data analysis for the previous year’s monitoring and GIS projects, an update on project status and findings, volunteer highlights, results of quality assessment audits and internal assessments, and will identify any significant QA problems and their recommended solutions. The Project Director will incorporate recommendations in this report by implementing any changes deemed necessary to the study during the following sampling season.

An annual QA report will also be prepared by the Data Analyst, based on recommendations included in the QA Review Audit. The Report will summarize 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, and data management) and data sheets.

The QA Report will also summarize the results of quality assurance activities including identifying the greatest sources of error, and evaluation of SOPs, DQOs, and training effectiveness. Interim and final reports will be produced according to Table 10.

Table 10. Schedule of reports to be filed throughout duration of project.

Item	DESCRIPTION	CRITICAL DUE DATE	ESTIMATED DUE DATE
1.	Grant Summary Form		Day 90
2.	Progress Reports by the twentieth (20^{th}) of the month		Monthly
3.	Natural Resource Projects Inventory (NRPI) Project Survey Form	Before final invoice	
5	Watershed Analysis Report		10/08
6.	Watershed Management Goals and Strategies Report		10/08
7.	Draft Watershed Management Plan		4/09
8.	Final Watershed Management Plan		8/09
9.	Draft Project Report		3/09
10	Final Project Report		7/09

Group D: Validation and Usability

22. Data Review, Verification, and Validation Requirements

Data generated by project activities will be reviewed with respect to the data quality objectives cited in Element 7 and the quality assurance/quality control practices cited in Elements 14, 15, 16, and 17. Obvious errors will be corrected, and outliers and inconsistencies flagged for further review. In addition, personnel from 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 will be ranked as poor, fair, or good, based on field sampling ratings (Table 3).

23. Verification and Validation Methods

The Data Analyst will be responsible for proof-reading all data entered into the electronic database from the original data sheets. The Project Director, QA Manager, and Data Analyst will review all field and laboratory results, and check approximately 10% of the data collected in the project, whereby field and lab data will be reviewed to determine if they meet QAPP objectives. Any failures in the analytical system will be corrected, and problems with data quality will be discussed in the Annual Report. The QA Manager will then evaluate all project data using graphical comparisons and statistical analysis provided by the Data Analyst. Results of the data analysis will be included in the Annual Report.

24. Reconciliation with User Requirements

Calculations of precision, accuracy, representativeness, and completeness will be made and included in the Annual and Final Reports. 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 spatial data are incomplete, renewed effort will be exerted to acquire additional needed data and fill data gaps. All baseline data (water quality and spatial) will be reviewed for accuracy and ability to meet project goals. Spatial baseline data used to develop additional relational characteristics and analyses will be reviewed for accuracy and acceptability. New relational data created from baseline data (e.g., road density, road-stream crossings) will be checked for accuracy and reliability with respect to the original data.

Scientifically acceptable statistics will be performed on the data to adequately demonstrate the implications of project results. Use of parametric statistics when appropriate will include mean, range, standard deviation, coefficient of variation, and confidence intervals about the mean. Additionally, data will be analyzed for more in-depth population characteristics, variability, and trends, using standard tests of the null hypothesis, including t-tests, ANOVA, and regression analysis. Where appropriate (e.g., correlation of a dependent variable such as turbidity or temperature to several independent variables), multiple regression analyses will be performed.

If failure to meet project specifications is found to be unrelated to equipment, methods, or sampling error, specifications may be revised for the next sampling season. Revisions will be submitted to the TAC and WQCB quality assurance officers for approval. Limitations on the use of data will be reported in the Annual Report.

25. References

AWWA. 1990. Standard Methods for the Examination of Water and Wastewater 1990 2540 B. Total Solids Dried at 103-105 ^{o}C

Brown, L. R., P. B. Moyle, and R. M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. N. Am. J. Fish. Manage. 14:237-261.

Brungs, W.A. and B.R. Jones. 1977. Temperature criteria for freshwater fish: protocol and procedures. EPA-600-3-77-061. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency. 136 p.

California Department of Fish and Game. 1998. California Stream Bioassessment Protocol. http://www.dfg.cagov/cabw/protocols.html

CSWRCB (California State Water Resources Control Board). 1998. http://www.sqrcb.ca.gov/tmdl/303d_lists.html. Web page last updated 1/16/01.

Chapman. D.W. 1988. Critical Review of Variables Used to Define Effects of Fines in Redds of Large Salmonids. Transactions of the American Fisheries Society. 117: 1-21.

Frissell, C.A. 1992. Cumulative effects of land use on salmonid habitat on southwest Oregon streams. Ph.D. thesis, Oregon State University, Corvalis, OR.

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.

Klein, R. 2003. Duration of turbidity and suspended sediment transport in salmonid-bearing streams, North Coastal California. A Report to the US Environmental Protection Agency (USEPA) Region IX. San Francisco, California 94105

Lewis, J. 1996. Turbidity-controlled suspended sediment sampling for runoff-event load estimation. Water Resources Research 32(7) : 2299-2310.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems. North American Journal of Fisheries Management. 11: 72-82.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. N. Amer. Journal Fisheries Research, v. 16, no. 4. Pp. 693-727.

NCRWQCB. 1993. North Coast Basin Plan. December 1993. http://www.swrcb.ca.gov/rwqcb1/download/basin_plan.pdf.

Pacific Watershed Associates. 1999. Sediment source investigation for the Van Duzen River

Watershed. Final Report. Prepared for Tetra Tech, Inc. & the U.S. Environmental Protection Agency.

Redwood Sciences Laboratory. 2001. Laboratory Procedure for Suspended Sediment Concentration. USDA Forest Service, Arcata, CA.

Salmon Forever. 2001. Volunteer monitoring of suspended sediment concentrations and turbidity in Humboldt, Mendocino, and Trinity Counties, California. Quality Assurance Project Plan.

Stein, R.A., P.E. Reimers, and J.D. Hall. 1972. Social interactions between juvenile coho (Oncorhynchus kisutch) and fall chinook (O. tshawytscha) in Sixes River, Oregon. Journal of Fisheries Resources Board of Canada. 29(12): 1737-1748.

Tetra Tech. 2002. Van Duzen River watershed analysis. Public Review Draft. Tetra Tech, Inc. Arcata, CA.

USDA Forest Service. 1997. 1997 Northwest Forest Plan – An Ecosystem Management Approach.

USEPA. 1996. The Volunteer Monitor's Guide To QUALITY ASSURANCE PROJECT PLANS Office of Wetlands, Oceans and Watersheds EPA 841-B-96-003. September 1996. http://www.epa.gov/OWOW/monitoring/volunteer/qapp/vol_qapp.pdf.

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