

Standard Operating Procedures

**Field Water Sampling
For
Determining
Turbidity and Suspended Sediment Concentration**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

**Salmon Forever
1-25-01**

Prepared By _____

Date _____

Approved By _____

Date _____

Table of Contents

- 1. Scope**
- 2. Apparatus**
- 3. Calibration**
- 4. Sample Collection**
- 5. Handling Preservation**
- 6. Troubleshooting**
- 7. Data Acquisition, Calculations & Data Reduction**
- 8. Computer Hardware and Software Used**
- 9. Data Management & Records Management**
- 10. QA / QC**
- 11. References**

1. Scope:

This Standard Operating Procedure covers the proper way to collect water samples from various sites for representative turbidity and suspended sediment concentration determination. Grab Sampling provides only a single point representation of turbidity and suspended sediment concentration in a stream. Where possible samples will be compared with Depth-Integrated samples taken at the same time to provide a more representative understanding of the sediment distribution at a given point in time.

2. Apparatus:

Sample Containers - HACH Sample Cells, Plastic Bottles (various sizes), Glass Bottles (various sizes)
Stopwatch

Rite in the Rain note paper or book w/pencil

Tape measure

Orange peel or floating objects for velocity

Bottle of HCL solution (for sterilizing sample after turbidity is run)

Waterproof boots and raingear

Flashlight or headlamp

Staff Gauge for measuring water depth.

This can be:

1. 1-.1/4" or 1- 1/2" metal pipe staff gauge (to be driven into streambed in flatwater just upstream or downstream of the velocity gauging section)
2. Rod with markings driven in streambed
3. Marks on bridge piers or culverts

Sampling Equipment Suppliers

HACH Company:

PO Box 389

Loveland Colorado 80539

1-800-227-4224

www.hach.com

Turbidity Sample Cells # 24347

6 packs of cells \$16

Turbidimeters: 2100P

Rickley Hydrological Co.

2710 Joyce Avenue

Columbus, Ohio 43211

614-475-0717

www.rickley.com

Sediment Sampling, Stream Gaging

DH-48 Depth Integrated Sampler

Glass Pint Bottles Current Meters

All supplies used in 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 Leader. Lab water shall be retail distilled water purchased locally. The Lab Manager before use shall inspect sample bottles cleaned in the lab and affix a unique ID # sticker to each bottle before it is used in the field. Copies of equipment invoices shall be kept in the Sediment Lab and Salmon Forever Offices.

3. Calibration:

None of the sampling equipment requires calibration.

4. Sample Collection:

A. SAFETY FIRST!

1. Establish a safe path to the site: streambanks are soft and slippery.
2. Be careful! Please don't wade when you sample. We want all the grab samples to be consistently from the streambank. Remember, when you go out in the field, you do so as a volunteer and must assume responsibility for your own safety. Please take your time and be careful.

B. ESTABLISHING THE SITE

Before the rainy season begins, new sites need to be established. Existing sites must be checked for maintenance issues and accessibility. Know the route to your site and establish an alternate route and/or somebody else to sample in case of road flooding. Ask permission if a site is to be established on private property.

1. Locate a safe water-sampling site and give it a short name. (HH, SFELK, GG etc.)
2. Locate the appropriate site to measure water height. Measure down from a bridge guardrail, or measure water level on staff/stage gauge. Find a spot safe from flooding and one you can read at high water level.
3. Establish the velocity gauging section of the creek (straight, uniform stream reach, long enough to give velocities in the 6-12 second range at high flow if possible).
4. Measure the cross sectional area at the velocity gauging section. This can be accomplished during low flow by measuring flow depth at 1.0-foot intervals as you cross the stream but must also be correlated to the stream gauge. This needs to be established once or twice a year or more often if the creek bed or banks change. Others can help with this.
5. Photograph the site from identifiable site and make a location map. Describe the lens and focal length used for future use. Make a photocopy of a topographic map of the area with the sampling location marked if possible and give to the your watershed coordinator or the Sunny Brae Lab.

C. WHEN TO MONITOR

Aim to sample as the creek rises and throughout the storm event and as the water begins to go down. The goal is to collect representative samples that illustrate the full range of stream flow. A hydrograph, showing the rise and fall of water level in a creek, and the corresponding rise and fall of turbidity levels and PPM of sediment during a storm event will be produced with this data. The data will also show when turbidity levels that are injurious or lethal to salmonids are occurring and what sediment loads the individual creek is carrying. It is most useful to sample near the peak of the flows to get a good representation of the highest discharges (up to 90% of sediment transport may occur during high flow events). Photograph at the high stage!

1. Sample after the rain starts
2. As the creek rises (for long storms, sample at several stages.)
3. Sample at the **peak**, if at all possible
4. Sample as the creek falls (if it is a long duration storm, sample at several stages.)
5. During quiet times between storms you can minimize the number of samples taken to save the bottles for the next storm.

D. HOW TO MEASURE STAGE

Locate an appropriate site to measure creek water height (measure down from bridge guard rail, or measure water level on staff/stage gauge or distance down from the top of a culvert) to the **nearest inch or to the nearest 0.01 inch on a staff plate.**

If there is a bridge available record the height of the creek from the bridge. One does this by measuring the distance between the water's surface and a fixed point on the bridge (top of guardrail) to the nearest inch. The fixed point must be correlated to a spot on the stream bank and your x-section.

Measure cross sectional area at the velocity gauging section. This can be accomplished during the low flow by measuring flow depth in 1-foot horizontal segments as you cross the stream or with a builder's level at low flow. This must also be correlated to the stream gauge. This needs to be established once or twice a year or more often if the creek bed or banks change.

E. HOW TO MEASURE STREAM VELOCITY.

Set up a known measured length (to the **nearest 1/2 a foot**) beforehand (For example inserting two colored sticks in the ground 20 feet apart above the bank and out of flood levels). Time an orange peel or floating object as it travels between the two sticks to the **nearest tenth of a second** using your stopwatch. Velocity is the distance your orange peel travels divided by the time it took to travel that distance.

A volunteer releases an orange peel (or a stick, leaf, etc.) at one side of a bridge and records to the **nearest tenth of a second** how long it takes to go a measured number of feet to the other side of the bridge. For example, say it takes 10.0 seconds for the orange peel to reach the other side of a 20.0-foot bridge. That means the water is flowing 2 feet per second. Incidentally, Winnie the Pooh invented this method...

With other simple measurements done at low flow, Salmon Forever can estimate the discharge (creek volume). Using discharge and the grams/liter of sediment in a sample, we can estimate the amount of sediment travelling down your creek. This tells us how quickly your watershed is eroding. Erosion is a natural activity, however accelerated erosion is generally due to human activities. Sampling creeks without any obvious impacts is an important way to establish baseline information

F. TAKING THE GRAB SAMPLE FROM THE STREAM

Use the same location each time and take a sample by standing on the bank and holding a bottle in your hand and reach into the water. You can also sample from a bridge by tying a bottle to a string and lowering it into the water or set up a pole to hold a bottle and lower it into the water that way. If you sample from a bridge always sample at the same spot. You can put a mark on the bridge where you sample. Volunteers may be trained in other sampling methods as needs arise. Please keep your coordinator informed of changes in your schedule.

In general, sample away from the riverbank in the main current. Never sample stagnant water or backwater eddies. The outside curve of the river is often a good place to sample since the main current tends to hug this bank.

To collect water samples using screw-cap sample bottles, use the following procedures.

- 1. Label the bottle with the site name, date and time first.** Use a piece of tape to write on the plastic bottles and use a pencil only to write on the white portion of the glass HACH cell. Note site on ID # label also if possible.
- 2 Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle.
3. Collect a water sample 4 to 6 inches beneath the surface or mid-way between the surface and the bottom if the river reach is shallow.
4. From the streambank hold the bottle near its base and lower it (opening downward) below the water surface and turn the bottle mouth underwater up into the current and out.
5. Leave a small airspace in the HACH cell. Do not fill plastic bottles completely (2/3 is fine so that the sample can be shaken, just before analysis). **HACH cells must be filled to above the white line.** Recap the bottle.
6. Mark the water level in the plastic bottle at the time of sampling with a mark on a piece of tape on the outside of all sample bottles, **except the HACH cells.** We can tell if the bottle leaked if the water level is different when we receive them in the lab. Incomplete labeling often creates wasted effort. Use only a pencil to mark HACH Turbidity cells. Check legibility because wet bottles can turn good information into mud.
7. **WRITE IN YOUR NOTEBOOK:** date, time, location, the sample ID #, stage, stream width, and velocity at least for each sample

5. Handling Preservation:

A. PREPARING SAMPLE CONTAINERS

Sample containers and glassware must be cleaned and rinsed before the first sampling run and after each run. The lab may prep containers for volunteers beforehand. If there are dirty bottles in the lab when you sign-in your samples, please try to clean some for everyone else. Alconox soap shall be used.

The following method should be used when preparing all sample containers and glassware for monitoring.

1. Wash each sample bottle with a brush and phosphate-free detergent.
2. Rinse three times with cold tap water.
3. Rinse twice with distilled or de-ionized water.

B. STORING THE SAMPLE

Keep in a dark and cool place and / or refrigerate. Return to your Watershed coordinator or the Sunny Brae Sediment Lab ASAP. Make sure all samples are labeled. Ideally the turbidity (NTU's) should be run within 48 hours. If you take the turbidity reading put a drop of HCL in the sample afterwards to retard algae. Turbidity reading protocols will be on a separate sheet. Dump the lowest flow samples if you run out of bottles. The peak flow is the most important! Call your coordinator for directions or answers to questions.

6. Troubleshooting:

Try to keep field forms and bottles dry when writing down information. The more notes you take the easier it will be to correct mistakes. Write the ID# on the Field Form

7. Data Acquisition, Calculations & Data Reduction:

F. INFORMATION NEEDED FOR EACH SAMPLE ON THE FIELD FORM

You can't get all the data all the time so be sure to get # 1 – 2 – 3.

1. Location, date, time, ID #, who sampled and the approximate elapsed time since start of the storm
2. Record the staff/stage gauge water level (or distance down from the bridge guardrail)
3. Measure velocity (elapsed time for a floating object to pass through a measured section). If there is a high velocity strand and a low velocity strand, estimate width, depth and velocity for each. Note backwater eddies at the creek banks.
4. Record width of flow in velocity section and width of creek

We are trying to get an estimate of water volume traveling down a point on the creek. Therefore you must provide width, depth (stage), and the velocity for each sample to be usable. One velocity measurement and water depth is the minimum for each sample.

Volunteers will record field-sampling data using ready-made sheets in binders or Rite in the Rain Notebooks. The Field Managers or Watershed coordinator makes copies and returns the binder to samplers. Field sheets are archived for 10 years by sampler. Originals of Lab Sheets will be kept in the Sunny Brae Sediment lab. Copies of Field Sheets and Lab sheets will be kept in Salmon Forever Offices. Hard copies of all data as well as computer back-up disks will be maintained by Salmon Forever for at least 10 years. QA/QC sheets will be maintained by Salmon Forever for 10 years. All Sediment Lab data to 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.

All ISCO and Depth Integrated sample bottles and grab sample bottles shall be labeled in the field with the pertinent data and logged at the time of sampling. ISCO Sample bottles shall be labeled at the time they are taken from the sampler

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

The Volunteer is responsible for samples until they are picked up or measurements recorded by a Field Leader or Watershed Coordinator. The Field Leader or Watershed Coordinator is responsible for samples until they are checked into the lab. The Field Leader or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data. The Lab Leader is responsible for 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.

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.

Velocity of water = distance / time

8. Computer Hardware and Software Used:

No special hardware is needed for suspended sediment concentration determination, calculations and data analysis. Software used will primarily be Microsoft Word and Excel programs. Software may also include specialized statistical and graphing programs. Redwood Sciences Lab uses Pearl and S+ database and analysis software.

9. Data Management & Records Management:

Data is entered on data sheets in the field. Sample information is recorded on standardized field and data sheets. See Appendix 2 for examples of all data sheets. The Volunteer, Watershed Coordinator and Field Manager are responsible to double check and copy Field Data sheets and deliver them to the Project Manager. Salmon Forever and/or Watershed Coordinators will keep the originals. 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. Sheets will be numbered sequentially.

Data will be examined and rated on the basis of field codes pertaining to the quality of data. Any outliers or nonsensical data will be detected during calculations and transfer to electronic spreadsheet and documented. Data will be in a format acceptable to EPA, RSL and NCRWQCB. Data and calculations will be checked at the time of transfer from paper to spreadsheets.

Appendix 2: Data Forms

Sample Sign-In Sheet
Field Sampling Data Sheet
Training Sign-in

10. QA / QC:

Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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 make up at least 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 Manager. Precision calculations are described in A7 data quality objectives.

1. Grab Sampling

A. Internal QC:

Unique ID # on bottle - codes are in QAPP section B3

External QC: None

2. Floating Object Velocity Measurement

Internal QC: None

External QC: None

3. Manual Stage Measurement

Internal QC: None

External QC: None

Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses. QA activities include training of staff, documentation and development of methods and standard operating procedures, equipment maintenance, and appropriate handling, processing, and tracking of all data and samples collected. These activities are designed to ensure that study objectives are met.

1. Grab Sampling - including velocity and stage measurements

A. Internal QA: Proficiency Checklist Twice a season

B. External QA - None

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.

The Field Manager, Lab Manager, QA Manager and Watershed Coordinators during training will use these checklists to document volunteer proficiency.

The Field Manager, QA/QC manager 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/QC Manager or Watershed Coordinator is responsible for implementing these assessments and to document and file these checklists. Results shall be reported to the Project Manager

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

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 at least the Freshwater Creek or Elk River or South Fork Trinity or South Fork Eel watersheds at various locations. Training will consist of day or half-day sessions in the field and laboratory.

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. Back-up plans for volunteers to cover for each other will be developed. If volunteers cannot conduct the scheduled sampling, they are instructed to contact the field leader as soon as possible so an alternative monitor can be found.

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 A7b.

Back-up plans for volunteers to cover for each other will be developed. If volunteers cannot conduct the scheduled sampling, they are instructed to contact the field leader as soon as possible so an alternative monitor can be found.

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

11. References:

EPA:

Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995
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:

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.

SOP Field Sampling1-25-01/word98/cf/1-25-01

**Standard Operating Procedures
For**

**Determining
Turbidity
With the HACH 2100P Turbidimeter**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

**Sunny Brae Sediment Lab
Salmon Forever**

9-19-00

Prepared by _____

Date _____

Approved by _____

Date _____

Table of Contents

- 1. Scope**
- 2. Apparatus**
- 3. Calibration**
- 4. Sample Processing**
- 5. Handling Preservation**
- 6. Troubleshooting**
- 7. Data Acquisition, Calculations & Data Reduction**
- 8. Computer Hardware and Software Used**
- 9. Data Management & Records Management**
- 10. QA / QC**
- 11. References**

The HACH 2100P Turbidimeter operates on the nephelometric principle of turbidity measurement. Turbidity is the cloudiness or opacity of a normally clear liquid due to a suspension of solid particles or colloidal droplets. A light of a known intensity is directed through a liquid and the amount of light blocked by particles suspended in the liquid is the degree of turbidity.

This Standard Operating Procedure covers the proper handling of samples and turbidity determination for the Watershed Watch program. Since most samples are processed for suspended sediment concentration determination after turbidity determination, the handling and preservation protocols are essentially the same. Samples are processed for turbidity determination in the field and then brought into the Sunny Brae Sediment Lab for suspended sediment concentration determination or turbidity determination is done after transporting to the Lab.

2. Apparatus

The Hach 2100P Turbidimeter measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The instrument operates on 4 AA batteries. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1. The company can be contacted at Hach Company, 100 Dayton Ave, Ames IA 50010-0907, 1-800-227-4224.

The optical system includes a tungsten-filament lamp; a 90-degree detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90-degree and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Range: 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU.

Accuracy: + - 2% of reading plus stray light from 0-1000 NTU

Resolution: 0.01 NTU on lowest range

Repeatability: + - 1% of reading or 0.01 NTU, whichever is greater (with Gelex Standards)

HACH 2100P Turbidimeter - Serial # 960100009614	Catalog # 4650000
HACH 2100P Turbidimeter - Serial # 990800022423	Catalog # 4650000
HACH 2100P Turbidimeter - Serial # 990800022431	Catalog # 4650000
HACH 2100P Turbidimeter - Serial # 990800022441	Catalog # 4650000

StablCal Ampule Kit, 2100P Catalog # 26594-05

Gelex Standards Catalog # 24641-05

Sample Cells pk/6 Catalog # 24347-06

Instrument Manual Catalog # 46500-88

Silicone Oil Catalog # 1269-36

Oil Cloth Catalog # 47076-00

Calculator

SSC Data Sheet - Sign-in Sheet - Field Data Sheet - NTU Dilution Sheet

Carrying case, Beaker

3. Calibration

The HACH 2100P Turbidimeters is calibrated quarterly with the HACH StablCal Stabilized Formazin Ampule Kit #26594-05 or more frequently if needed. Calibration with these ampules will follow the manufacturer's instructions included in the kit. Ampules have a limited shelf life and will be not used after the expiration date. Turbidimeters shall not be used until Stablcal calibration is successfully completed.

StablCal Stabilized Formazin Primary Standards are cited as calibration standards in USEPA-accepted *HACH Method 8195 for Determination of Turbidity by Nephelometry*. The letter of acceptance states specifically that Method 8195 may be used for wastewater (NPDES) and drinking water (NPDWR) compliance monitoring.

The HACH 2100P Turbidimeters shall be checked with Gelex standards every month . If Gelex results are more than 5% different than the previous month's results the Turbidimeter shall not be used until recalibrated successfully with Stablcal standards. Gelex standards are assigned new values after every StablCal calibration.

Calibration records will be kept in the Sunny Brae Sediment Lab for 10 years. The Lab Manager is responsible for implementing and documenting calibration of HACH 2100P Turbidimeters. 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.

4. Sample Processing

Turbidity determination will follow turbidimeter manufacturer's instructions. Look in the manual for further instructions and/or clarifications. Turbidity is to be run on all samples as soon as samples enter the lab and recorded on sign-in sheet and data sheet. Turbidities are recorded, 3 drops of 1:1 HCL solution are added, and samples are placed back in order for SSC processing.

A. Use this protocol for running sample HACH cells in the HACH 2100P Turbidimeter.

1. Put 1 drop of silicone on HACH cell and wipe cell with black cloth; do not wipe off sample label.
2. Shake HACH cell for at least 10 seconds and then insert HACH cell into turbidimeter with white diamond point of HACH cell label aligned with bar on case of HACH 2100P Turbidimeter.
3. Wait 2 seconds for air bubbles to rise before pressing read button.
4. Record turbidity on sign-in sheet.

B. Use this protocol for samples in bottles other than HACH cells.

1. Shake sample bottle vigorously until no sediment is stuck to the bottom.
2. Pour shaken sample bottle water into HACH cell as quickly as possible.
3. Fill HACH cell up to white label line and run and record turbidity as in "A" above.

C. If HACH 2100P Turbidimeter reading is a flashing E3 or 1000+ then dilute the sample to get actual turbidity. Use NTU Dilution sheet to record and calculate dilution data.

If dilution is needed and you are proceeding directly afterwards to SSC processing, weigh the total sample bottle weight before running turbidity. If not proceeding directly to suspended sediment concentration processing, pour sample back into original container. Check the original volume mark if appropriate to see if water level is the same and store in a dark cool place until you are ready to dilute and run SSC.

1. Shake sample bottle thoroughly until no sediment is clinging to bottom.
2. Pour sample water into tared beaker and record sample weight in grams as "original volume".
3. Add appropriate dilution volume of distilled water into beaker (multiples of original volume) to original volume and record total water weight in grams as "1st dilution volume total". Use this additional dilution water to rinse interior of sample bottle and lid and/or HACH cell into beaker.
4. Mix sample water thoroughly and pour sample water into HACH cell.
5. Continue dilutions until turbidity reads and calculate actual turbidity.
6. For small dilutions pour sample water in beaker into HACH cell as soon as possible.
7. Stir large dilutions with spoon and dip HACH cell into beaker.
8. Run HACH cell in HACH 2100P Turbidimeter per protocol.
9. Either pour HACH cell water back into sample bottle or proceeded to SSC processing with HACH cell and remainder of sample.

5. Handling & Preservation

Avoid scratching the cells and wipe all moisture and fingerprints off the cells before oiling and inserting them into the instrument. Samples shall be kept in a cool, dry place and covered with black plastic. Samples will be transported to the Sunny Brae Sediment Lab as soon as possible after acquisition. Samples will try to be run within 48 hours of sampling.

Samples will have 3 drops of a 1:1 HCL solution added to retard algae growth only after turbidity determination. HCL Solution will interfere with the turbidity determination. The maximum sample holding time will be 1 year. Cells will be washed with Alco-nox lab detergent or an equivalent non-abrasive detergent. Cells will be rinsed 3 times with tap water and then rinsed three times with distilled water and allowed to dry.

6. Troubleshooting

The HACH 2100P Turbidimeter manual has a troubleshooting section beginning on page 53. Please consult this for specific problems. The turbidimeter will display error codes to indicate sample interferences and/or instrument malfunction.

If a turbidimeter is consistently reading 99.9 NTU on samples that are easily over that, check to make sure auto range is displayed on the readout. The range will be limited to 3 pre set ranges if auto range is not selected. The battery icon will flash when battery replacement is needed. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them.

Maintenance:

All equipment shall be inspected and maintained to EPA and Manufacturer requirements. The 2100P requires very little maintenance other than to keep the instrument clean. Maintenance logs will be kept on all appropriate 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.

7. Data Acquisition, Calculations & Data Reduction

Turbidity is read directly from the display of the HACH 2100P Turbidimeter and no calculations are involved. When sample turbidity is above 1000 NTU and the range of the turbidimeter, then the sample is diluted and actual turbidity is calculated. That calculation is included below.

Data Sheets:**A. Sign-in Sheet**

1. Persons bringing samples into the lab must record the date of samples brought into lab and name of person who brought the samples into the lab on the sign-in sheet.
2. Record the ID #, location, date, time of sample and who collected the sample on the sign-in sheet.
3. Run turbidity on sample per this SOP and record NTU, date, time and who conducted NTU determination.
4. If turbidity is too high initially for HACH 2100P Turbidimeter, note this by assigning the sample a turbidity code of 1 on sign-in sheet and the turbidity will be run by diluting by lab techs. at the time of suspended sediment concentration determinations. A sample with a turbidity of less than 1000 should have a recorded a turbidity code of 0.
5. Record stage, velocity, and type of sample and all other pertinent data on sign-in sheet.
6. Put samples in appropriate place and cover with a black piece of plastic or proceed with suspended sediment concentration determination using appropriate data sheet.

B. NTU Dilution Sheet

Use the NTU Dilution form to document dilutions of samples too turbid to determine turbidity as sampled. Transfer all identification data from the label and data sheet to dilution form for each sample. Conduct dilutions directly before Suspended Sediment procedures. Record to the nearest whole number.

Dilution Calculations: $\frac{\text{Original volume} \times \text{Dilution Turbidity}}{\text{Volume total}} = \text{Actual Turbidity}$

C. Field Data Sheet

Grab Sample labels shall at least include a sample location, sampling time and date. Data recorded shall at least include time and date, location, person sampling, velocity, and stage. If turbidity is determined in the field the Field Data Sheet shall include who conducted the determination and when.

Examples of these sheets are attached to the back of this SOP.

8. Computer Hardware and Software Used

No special hardware is needed for turbidity determination and calculations and data analysis. Software used will include Microsoft Word and Excel programs. Software may also include specialized statistical and graphing programs.

9. Data Management & Records Management

Turbidity determination results are written on the Lab sign-in sheet. These results are also transferred to the suspended sediment concentration data sheets as each sample is processed for ssc. These sheets are used to create databases for data analysis. Data and calculations are double-checked as data is entered into spreadsheets. Turbidity codes are also transferred from the sign-in sheets to suspended sediment concentration data sheets. Turbidity determination may also be done in the field and entered on Field Data sheets. This data will be transferred to the Lab sign-in sheet when samples are brought to the Lab.

The Volunteer, Watershed Coordinator and Field Manager are responsible to double check and copy Field Data sheets and deliver them to the Project Manager. The Lab Manager is responsible for double-checking and copying lab data sheets and delivering them to the Project Manager. Lab data sheet originals will be kept in the Sunny Brae Sediment Lab. Reports and data will be transferred to Excel spreadsheets and Word documents and computer disk 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. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

Data will be examined and rated on the basis of field and lab codes pertaining to the quality of data.

Turbidity Codes:

0 - Sample turbidity < 1000 NTU.

1 - Sample turbidity > 1000 NTU. Dilution needed for turbidity determination

Any outliers or nonsensical data will be detected during calculations and transfer to electronic spreadsheet and documented.

10. QC / QA

A. Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager.

Internal QC:

HACH 2100p Turbidimeter Monthly Gelex Standards Check
HACH 2100P Turbidimeter Quarterly Formazin Calibration

Details of these QC measures are in Section 3. Calibration

External QC: None

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses. 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.

Laboratory QA procedures are detailed in the Lab SOP in Appendix 1. The QA manager and Laboratory Manager will conduct QA laboratory procedures. The Laboratory Manager will train Lab Technicians before conducting turbidity determination and sediment processing on their own.

Proficiency checklists for certifying personnel in Turbidity determination shall be conducted and filed for all Lab Technicians in the beginning of the sampling season and once more mid sampling season. **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 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 and certified 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 Manager

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 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/QC Manager or Watershed Coordinator is

responsible for implementing these assessments and to document and file these checklists. Results shall be reported to the Project Manager.

HACH 2100P Turbidity Determination

Internal QA: Proficiency Checklist Twice a season

External QA - None

See Appendix 2 for Proficiency Checklists

11. References

HACH 2100P Portable Turbidimeter

Instrument and Procedure Manual Catalog # 46500-88

Volunteer Stream Monitoring: A Methods Manual EPA 841D 95001 April 1995

SOP Turbidity9-19-007-00/wd6.0/cf/5-00

**Standard Operating Procedures
For Determining**

**Discharge
Using
Price AA and Pygmy
Current Meters**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

Salmon Forever

9-19-00

Prepared by _____

Date _____

Approved by _____

Date _____

1. Scope:

This SOP covers the proper use of a current meter to determine the discharge of a stream or river. Stream discharge is the volume of water passing a cross-section per unit of time and is generally expressed as cubic feet per second. Simply, discharge is velocity times cross-sectional area. The purpose of discharge measurements is to create a rating curve. A rating curve is the graphical representation of the relationship between stage (water depth) and discharge.

The data can be used to develop discharge-rating curves for managed tributaries and baseline flows. Data can also be used for developing hydraulic geometry at a cross-section, and calibrating gaging equipment. Using the continuous streamflow gaging equipment and the hydraulic geometry, relationships between suspended sediment, flood peaks and frequency can be studied.

2. Apparatus:

USGS Price AA current meter

USGS Pygmy current meter

4 foot top set wading rod, Headphones

USGS Type A Crane with Type A 4-wheel truck with 2-60 lb counter weights

A-55 reel and Columbus weight with AA Price meter

Calculator, Data Sheet / Clipboard / Pencil, Waders / Bag for waders

Stopwatch, Measuring Tape (300 ft long and in 0.1 feet increments) / Spikes, Camera, Drying Cloth,

3. Calibration:

The manufacturer does calibration before purchase. The meter cannot be adjusted

4. Sample Collection:

There are no sample collection requirements. The proper measurement method is described in Data Acquisition. The meter only measures the velocity of water flowing past it.

5. Handling Preservation:

There are no sample handling requirements. The meter only measures the velocity of water flowing past it.

6. Troubleshooting:

Debris in the pivot bearing may slow the spin duration of the meter cups to below 90 seconds. Remove any debris and add a drop of oil and recheck spin duration. Check batteries on set ups that use them if no clicks. Check the wire for being too tight against the shaft if spin duration is low. Use tweezers. The pivot bearing may be worn and need replacing. This should not happen with new meters and is probably adjustment and/or wire pressure.

Periodically check the reel and wire of the A-55 cable/reel sampler for frayed wire or worn areas that should be replaced. Lubricate the wire and reel with the appropriate grease.

7. Data Acquisition, Calculations & Data Reduction:

Safety:

Never wade deeper than your waist. Always have a partner nearby. Look out for debris coming downstream.

Ideally measure discharge on the falling limb of the hydrograph or with flow at a steady stage

Select a stream reach optimally with:

1. A straight reach, with a uniform depth and as rectangular of a channel morphology as possible.
2. A streambed free of large rocks, weeds, and obstructions which would create turbulence.
3. A site with an existing cross section and stable stream bottom.

Setting Up:

1. Determine the wetted width of the stream. Set up a tape measure extending behind the left bank to beyond the right bank. Use a cloth or fiberglass tape and use spikes to secure either end so the tape is tight across the stream. Set up the tape perpendicular to the direction of flow. Determine and record on the data sheet the points on the tape measure of the Right-edge-of Water (REW) and LEW. Determine and record on the data sheet the dead right-edge-of Water (DREW) and DLEW. This can also be called zero velocity right and zero velocity left. This is the point where the water with no current meets the water with a current. This is done facing downstream.
2. Determine spacing of the subsections. Generally use 15 to 25 subsections. No subsection should have more than 5 % of the discharge.
3. Preferably discharge is taken consistently at the same x-section.

If the water depth is below 0.5 feet use the Pygmy current meter.

If water velocity is below 0.25 ft/sec use the Pygmy current meter.

Use the Price AA meter with a top set rod for depths up to 3 feet. Use a crane and weight for larger stages.

Top Set Wading Rod Use:

Place rod in stream so the base plate rests in the streambed.

Stand in a position that least affects the velocity of water passing the meter. Usually by facing the bank with the water flowing against the side of the leg.

Holding the wading rod at the tag line (tape measure line) stand 1 to 3 inches downstream of the tag line and 18 or more inches from the wading rod.

Read depth of water on hex rod.

The hex rod is marked with 1 line every 0.1 feet, 2 lines every 0.5 feet and 3 lines every 1.0 feet

The #'s on the handle at the top of the hex rod correspond to the tenths of a foot of water depth.

If water depth is 2.3 feet, squeeze rubber trigger and raise the round rod so the #2 mark on the round rod (representing 2 feet) is brought even to the #3 on the vernier scale at the top of the hex rod.

If the water depth is more than 2.5 feet and the stage is not rising or falling rapidly you may use the 0.2 / 0.8 method by taking measurements of 0.2 and 0.8 depth below surface and averaging them for the subsection velocity. To set the top set rod for the 0.8 depth below surface position, use depth numbers corresponding to 1/2 the water depth. To set the top set rod for the 0.2 depth below surface position, use depth numbers corresponding to twice (2) the water depth.

Keep Wading Rod in a vertical position and the meter parallel to flow while observing velocity
Generally place the meter ahead of and upstream of the feet.
Conduct measurements on a stable stage. Measure discharge preferably on a falling stage.

After meter is at the proper depth, allow it to adjust to the current before starting (usually 5 seconds).
Count revolutions made by meter in 40 to 70 second increments, usually just over 40 seconds.
Start stopwatch simultaneously with the end of the first click, starting counting with zero.
Stop the stopwatch at the end of the click after at least 40 seconds.
If flow is not at right angles to the measuring tapeline, measure the angle of flow and record it.

Rapid changes in the water depth will affect the quality of the measurements.
If the stage is rising rapidly, switch to 20-second measurements at 3-foot spacing.
If possible stop revolution count or time to match a revolution or time from the rating table.
Identify streambanks by LEW (Left edge of Water) or REW when facing downstream.

Bridge Use: A-55 Sounding Reel and Crane

The Columbus weight is lowered until the horizontal fins are level with the water surface.
The A-55 depth-measuring reel is zeroed out and the weight is lowered until it touches bottom.
The depth of water is read off the reel and a chart is consulted for the proper depth of the current meter.
The weight is raised to the proper depth and velocity measurements begin.
All other measurement procedures are the same as with the top set rod.

Write on your data sheet at least the following information.

The name of stream and exact location, any rebar point and/or photopoint.
Who is doing the measurements?
The date, type of meter suspension (top set rod or crane), and meter id #.
The distance points on the tape measure of the REW and LEW.
The distance points of DREW (dead right edge of water) and DLEW or zero velocity.
The distance point on the tape measure of each subsection.
Starting, Finishing and Elapsed time of the measurement in military time. Read the time to the nearest sec.
Record which bank of the stream is the starting point and bank of stream where measurement ends.
Record stage heights from a staff plate and corresponding times when staff plates are read (at least at beginning and end of measurement). Also record any electronic stage levels at the same time.
Record measurement method (0.6 depth from bottom position or others).
Record measurement time to the nearest tenth of a second and number of revolutions.
If flow is not at right angles to the measuring tapeline, measure the angle of flow and record it.
The spin duration check results
Rising or falling stage

Calculations:

To determine velocity with the Pygmy current meter use the following formula:

$$V = 0.977 R + 0.028 \quad V = \text{velocity in Feet /Second} \quad R = \text{Rev} / \text{Time in seconds (0.1)}$$

To determine velocity with the Price AA meter use the following formula:

$$\begin{array}{ll} \text{Less than 40 revolutions} & \text{More than 40 revolutions} \\ V = \frac{\text{Rev}}{\text{Time}} \times 2.180 + 0.020 & V = \frac{\text{Rev}}{\text{Time}} \times 2.170 + 0.030 \end{array}$$

The rating chart or velocity equation is used to determine velocity. The width and depth of each subsection is multiplied to calculate cross sectional area. The area multiplied by the velocity gives the discharge of each section. The discharge of each subsection is summed up to determine the total discharge in cubic feet per second at a certain stage. See USGS methods and Harrelson for more details

8. Computer Hardware and Software Used:

Excel and similar software will be used to create discharge-rating curves for stream locations. Some of the analysis will be carried out at Redwood Sciences Lab on a Unix operating system using S-Plus and Perl. The majority of the analysis tools and plotting routines for ISCO related sampling was written in S-Plus because of its powerful ability to manipulate and graphically represent the data.

9. Data Management & Records Management:

Copies of the discharge measurements will be given to the data analysis manager for analysis. Original discharge records will be kept at the Sunny Brae Sediment Lab and copies will be kept at Salmon Forever offices for 10 years.

10. QC / QA:

Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager.

Specialized equipment is needed to calibrate these meters. The USGS and the manufacturer calibrate each meter to determine rating charts for each meter before purchase. Calibration by the user is not possible.

AA Current Meter / Pygmy/ Discharge / Crane & Wading Rod Measurement

Internal QC: Spin Duration check

Spin duration shall be checked before each use. The meter should not be used if spin duration is not over 60 seconds.

External QC: None

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, equipment maintenance, and appropriate handling, processing, and tracking of all data and samples collected. These activities are designed to ensure that study objectives are met.

AA / Pygmy Current Meter / Discharge / Wading Rod Measurement

Internal QA: Proficiency Checklist once a season

External QA - None

QA Proficiency Checklists will be used on data collectors once a season to ensure volunteers proficiency in the use of these meters. The QA Manager will document and file the completed checklists in the Sunny Brae Sediment Lab. Copies will be kept for 10 years at the Salmon Forever offices.

11. Maintenance:

Clean and oil meter after each day's use. If measuring in dirty water, rinse immediately after each measurement with clean water. Clean and oil pivot bearing, pentagon teeth and shaft, cylindrical shaft bearing and thrust bearing. After oiling spin the rotor to make certain it operates freely. The duration of spin should be over 90 seconds. An obvious decrease in spin duration indicates the need for attention to the bearings.

Oil current meter after every 8 hours of use or at least once a week.

- Lube
1. Pivot or Pivot Bearing
 2. Upper Bearing in Contact chamber

When transporting a Price AA meter keep the pivot off the pivot bearing by tightening the nut beneath the cups. The nut is a reverse thread so rotate nut as if to loosen to tighten and vice versa. Tighten nut until cups no longer rotate freely. Completely loosen to use. When transporting a Pygmy meter replace the pivot bearing with the transport bearing. Repair minor dents in cups in the field. If there is major damage replace the set of cups.

12. References:

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.

Buchanan, Thomas J., 1973, Discharge Measurements at Gaging Stations, USGS, Chapter A8, Techniques of Water-Resources Investigations of the USGS, Book 3 Applications of Hydraulics.

**Standard Operating Procedures
For**

**Using an
ISCO 2100 Automatic Sampler
Sampling Station FTR**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

Salmon Forever

9-19-00

Prepared by _____

Date _____

Approved by _____

Date _____

Table of Contents

	Page
1. Scope	3
2. Apparatus	3
3. Calibration	4
4. Sample Collection	4
5. Handling Preservation	5
6. Troubleshooting	5
7. Data Acquisition, Calculations & Data Reduction	6
8. Computer Hardware and Software Used	8
9. Data Management & Records Management	8
10. QA / QC	8
11. References	9
12. CAMPBELL DATA LOGGER TURBIDITY THRESHOLD SAMPLING FIELD MANUAL - Freshwater Station (FTR) Rand Eads - Redwood Sciences Laboratory - USDA Forest Service Revised: 99 09 08	10

1. Scope:

This SOP covers the operation of an ISCO 2100 automatic pump sampler. By combining automatic pump sampling and turbidity threshold sampling one can efficiently determine the annual suspended sediment load of a stream.

The sampling program in the data logger controls the collection of information from the pressure transducer and turbidity probe, and activates the pump sampler at the appropriate turbidity thresholds. Sampling intervals will be consistent with RSL's turbidity threshold sampling protocols included in TTS V 3.1 software.

2. Apparatus:

The primary station on Freshwater Creek 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. Various configurations of this equipment may be used.

The 2100 Wastewater Sampler is 25 inches high by 20 inches in diameter. It weighs 40 pounds. The Model 2100 Wastewater Sampler is a portable device designed to collect up to 24 separate discrete samples of a pre-determined volume from a liquid source. It has a sampling interval of 1 to 999 minutes between samples. The samples can be collected on a time proportional basis using the internal sampler timing circuitry or on a flow proportional basis. It can pump up to 990 ml per sample but for this application it will pump 350 ml per sample. The sample volume repeatability is + - 10 ml. Up to 8 bottles can be filled at a time. Each sampling cycle includes an air prepurge and postpurge to clear the suction line both before and after sampling.

Technical Specifications can be found in Table 1.4-1 of the ISCO 2100 manual.

Equipment Required for a Turbidity Controlled Sediment Sampling Scheme - 02/12/98

Rand Eads - USDA Forest Service - Redwood Sciences Laboratory
707-825-2925

Note: Quantities are for one station. If item is indicated with an "**", then only one is required for multiple stations. Items with "~)" are optional, but recommended.

Data Logger and Accessories

Campbell Scientific (1-435-753-2342)

- 1 ea. CR10X-1M Data Logger with 1 megabyte
- 1 ea. 108-L Temperature Probe
- 1 ea. PC208W Window support software
- 1 ea. SC32A Optically Isolated Interface *
- 1 ea. COM200 Modem (requires phone line to site) (D
- 1 ea. ENC 12/14 Data logger enclosure
- 1 ea. 6571 Humidity card indicator
- 1 ea. DSC 20/4 Desiccant packs for enclosure
- 1 ea. Pressure transducer - Druck 1830

Radio Shack (local)

1 ea. 3-12V, 300mA adjustable power supply

Hardware/Electrical Store (local)

1 ea. 8 foot copper clad ground rod

1 ea. JA ground clamp

10 ft. #10 THHN or equivalent copper wire

Pumping Sampler

ISCO Inc. (1-800-228-4373)

2100 Sampler

intake tube

pump tube

connector

charger/battery pack

Turbidity Probe

D & A Instrument Co. (1-360-385-0272)

1 ea. OBS-3 Turbidity Probe (see Rand about specs.)

3. Calibration:

There is no calibration involved in the 2100 ISCO Automatic Pump Sampler. Sample volumes are adjusted in the field before sampling.

4. Sample Collection:

See sections 1 through 8 of

CAMPBELL DATA LOGGER TURBIDITY THRESHOLD SAMPLING FIELD MANUAL

Freshwater Station (FTR)

Rand Eads - Redwood Sciences Laboratory - USDA Forest Service

Revised: 99 09 08

5. Handling & Preservation:

See sections 7 of Rand Eads / NFS ISCO manual for sample handling and preservation
Sample bottles shall be taken to the Sunny Brae Sediment Lab after being taken from the ISCO barrel and stored in a cool dark place.

6. Troubleshooting:

If the sampler is completely inoperative and the displays do not light: Check for a dead battery or a blown 2-amp fuse. Replace or recharge battery, Replace front panel 2-amp fuse.

If the Sampler pump is inoperative but displays will light, look for a blown 5-amp fuse and replace front panel 5 amp fuse. If fuse blows repeatedly, check to see if pump is jammed.

If battery voltage is low check for loose connections or faulty charger. Low voltage can reset certain offsets and parameters to defaults. LED display may not work with low voltage in battery.

If sample volumes are incorrect:

Check if pump tubing is installed correctly and install correctly if not.

Check for defective tubing and replace if needed.

SUCTION HEAD and/or SUCTION LINE switches set incorrectly - set to spec.

If the numeric display for the CR10X datalogger is blank - turn off all windows and shut down the computer. The display might have used up all available RAM and needs to be cleaned out.

Maintenance:

All equipment shall be inspected and maintained to EPA and Manufacturer requirements. All maintenance records will be kept on the ISCO Field form. 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.

The case can be cleaned with soapy water. The suction line and pump may be cleaned by placing the end of the suction line in a Alconox cleaning solution and pumping the solution through the tubing system using the FWD position of the MODE switch. Follow with a distilled water rinse.

7. Data Acquisition, Calculations & Data Reduction:

See section 6 of TTS Field manual for downloading data from the Campbell CR10X datalogger
Calculation of Suspended Sediment Concentrations are in the LAB SSC SOP.
Calculation of Seasonal suspended sediment loads are in Redwood Sciences Lab SOP.
See RSL Website at <http://www.rsl.psw.fs.fed.us/projects/water/freshwater/index.html> for a description of HY 99 suspended sediment load calculations.

ISCO / Freshwater Datalogger Instructions for PC208W version 3.0

To View a File:

- 1) Click on view from the PC208W toolbar.
- 2) Choose FILE / OPEN or click on the OPEN icon

NOTE: You can also choose the file from the list located under FILE / RECENT FILES.

- 3) Choose the data file that you want to choose, i.e. FTR99.DAT.
- 4) You can also choose the *.FSL file that corresponds to the data file, i.e. TTS_V2_3.CSI. This enables column headings to be shown when viewing and plotting the data file.
- 5) If no *.FSL file is chosen then a dialogue box appears asking what you want . . .
 - Choose: I want to select an *.FSL file, if you know the corresponding *.FSL file related to the data file.
 - Choose: I do not want an *.FSL file for this data file, if you do not know the correct *.FSL file or you don't care to associate one.
- 6) Click OK.
- 7) If an *.FSL file is associated to the data file, you must click inside the data file to update the column headings.
- 8) To make the file easier to view, click on the EXTEND TABS icon to expand the file into neat columns.

To Graph a File:

- 1) With the data file already opened in view, click on the column or columns (up to 2) that you wish to plot.
- 2) Choose VIEW / GRAPH or click on the SHOW GRAPH (1Y AXIS) to plot the array(s) on a single y-axis versus time.
- 3) Choose VIEW / SEPARATE AXIS or click on the SHOW GRAPH (2Y AXIS) to plot 2 arrays on 2 different y-axis versus time.
- 4) If you click on the plot a box containing the value and time of that point is shown.
- 5) Use the scroll bar to scroll through the graph.
- 6) To zoom in on a point, hold down the left mouse button and draw a box from left to right around the region to be zoomed, then release the mouse button.
- 7) To zoom out, click on the MAGNIFYING GLASS icon or draw a box from left to right to restore the graph to full view.

Input Locations

thr_count A sample is collected when the value = 2 (second interval \geq threshold)
 thr_code baseflow = 0 rising = 1 falling = 2
 nxt_thresh The next expected threshold (assuming no reversal)

Program Sampling Thresholds & Rules

Rising Thresholds	Falling Thresholds
0	1900
20	1698
77	1507
170	1328
300	1160
467	1004
670	858
910	724
1187	602
1500	491
1850	391
	302
	225
	159
	105
	62
	30

Baseflow

This condition occurs when the stage is less than the "minimum stage". Minimum stage is the lowest stage where both the turbidity probe and ISCO intake are adequately submerged and functional. No ISCO sampling takes place in this mode.

Rising

At the first interval above minimum stage, if the turbidity is also above the first threshold, and no rising thresholds have been sampled in the past 3 hours, a sample is collected. The threshold becomes rising at the first interval above baseflow. For subsequent rising mode samples the current turbidity must be equal to, or greater than, the next rising threshold for 2 intervals.

Reversals

Turbidity mode switches between rising and falling. The turbidity must change direction for at least 2 intervals, and drop 10% from the prior peak or rise 20% from the prior trough, but at least 5 FTUs in both cases. A sample is collected if a threshold has been crossed since the previous peak or trough, but not if that threshold has been samples within the past hour.

Falling

Turbidity mode is falling and the current turbidity is less than, or equal to, the next falling threshold for 2 intervals.

8. Computer Hardware and Software Used:

A Campbell Scientific CR10X Datalogger is used and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software. The TTS software (V 3.1) is from Redwood Sciences Lab - USDA. Turbidity Threshold Sampling software is used to trigger the taking of pump samples by the ISCO 2100 Automatic Sampler in response to input from the OBS-3 continuous turbidimeter probe.

Software used for data analysis will include Microsoft Word and Excel programs. The analysis for estimated annual sediment loads will be carried out at Redwood Sciences Lab on a Unix operating system using S-Plus and Perl. The majority of the analysis tools and plotting routines for ISCO related sampling are written in S-Plus because of its ability to manipulate and graphically represent the data.

9. Data Management & Records Management:

Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically download turbidity data and take a floppy disk back to RSL for data analysis. Data shall be graphed and outliers noted and RSL Field Forms used to eliminate faulty data. Back-up floppy disks shall be kept at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

Data Forms

TTS (ISCO) Sampling SSC Data Sheet
SSC Calculations Data Sheet
Automatic (ISCO) Sampler Sheet: (RSL Field Form)

10. QA / QC:

A. Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager in the annual QA Report.

ISCO 2100P Sampling

Internal QC:

ISCO Split Sample w/ RSL: A QC split sample will be taken by manually starting pump with lid to one side and passing 2 bottles side by side under pump stream. QC splits will make up 10% of ISCO samples. Split QC samples should agree within 10%. If the difference is more than 10% the procedures and technicians handling the split samples shall be reviewed and documented. Each subsequent QC split samples shall be evaluated for the effectiveness of any corrective action. Validity of this method is still being investigated.

Volume Marks: See Lab SOP in Appendix 1

External QC: None

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses.

ISCO 2100P Sampling

Internal QA: Proficiency Checklist Twice a season.

External QA - None

11. References:

CAMPBELL DATA LOGGER TURBIDITY THRESHOLD SAMPLING FIELD MANUAL

Freshwater Station (FTR) - Revised: 99 09 08

Rand Eads - Redwood Sciences Laboratory - USDA Forest Service

Instruction Manual Model 2100 Wastewater Sampler - Revised January 1982

ISCO Inc. 3621 N.W. 36th Street, Lincoln, Nebraska 68524 800-228-4373

CR10X Measurement and Control Module - Operators Manual Revision 5/97

Campbell Scientific, Inc. 815 W. 1800 N.

Logan UT. 84321-1784 435-753-2342

**CAMPBELL DATA LOGGER
TURBIDITY THRESHOLD SAMPLING
FIELD MANUAL
Freshwater Station (FTR)**

**Rand Eads
Redwood Sciences Laboratory
USDA Forest Service
Revised: 99 09 08**

Campbell TTS Field Manual

1.0 Record Observations

- The computer and your wristwatch should always be checked/set with the telephone time recording (767-8900) before you service the field equipment.
- 1.1 Start a new field form (use carbon paper to make a duplicate).
- 1.2 Read the staff plate as accurately as possible and make a visual check up and downstream for changes to the channel, banks, or addition/loss of debris jams.
- 1.3 Complete the top two lines of the field form. This is important!
- 1.4 Note in the comment section of the field form any conditions that may affect data quality that you observed while reading the staff plate.

2.0 Check Equipment

- 2.1 Immediately following a wakeup remove debris from boom and periodically clean the T-Probe optical window with water/dish soap solution and toothbrush.
- 2.2 Note on the field form the "Boom Depth" (the depth marks on the vertical section) and the "Cable Mark" (the paint marks on the cable relative to the top of the reel).
- 2.3 Note the time under "Time Boom Lifted" on the field form.
- 2.4 Note on the field form if debris is present on the boom.
- 2.5 If debris is present, indicate if the debris was on or near the turbidity probe optics (the debris may only be lodged on the vertical section of the boom and not affecting the turbidity readings).
- 2.6 Remove the debris:

- Loosen the reel securing the horizontal position.
 - Unclip the D-snap to release the chain from the cable/link attached to the stump.
 - If the stage is 1.5 feet or less elevate the boom with the upper reel providing until the turbidity probe housing is out of the water then push the boom upstream until it contacts the tree.
 - If the stage is higher than about 1.5 feet, or it is unsafe to approach the edge of the stream, elevate the boom then swing it to a position behind the shelter (pushing the boom downstream then towards the shelter).
 - Remove the debris by hand (a garden hose can be used if the housing contains a lot of sediment).
 - Periodically (once a week or so depending on the time of year) clean the optics with the squirt bottle and soft bush
- 2.7** Return the boom to the sampling position:
- Push the boom to the approximate sampling location.
 - Lower the boom to the correct depth.
 - Fasten the chain and D-snap to the ring on the cable that is attached to the stump.
 - Take up the slack in the horizontal reel.
- 2.8** Note the time on the field form under "Time Boom Submerged".
- Cleaning the T-Probe may cause the program to collect an ISCO sample at the next wake-up because the turbidity dropped after removing the contamination.
- 2.9** Press the button on the left side of the ISCO controller labeled "Press to Read Display" then check the right LED display for the Next Sample number and record it on the field form.
- 2.10** With at least 5 minutes remaining until the next wake-up (wake-ups occur every 15 minutes, e.g. 1000, 1015, etc.):
- Unfasten the three bale rings holding the ISCO together.
 - Lift the mid-section and support it on the two wooden arms.
 - Note on the field form low/high sample volumes, missed samples (bottles should be about 1/3 full, depending on the stage), and whether the last pumped sample matches the display, less one bottle.
 - Re-assemble ISCO.

3.0 Establish Communications

- Skip this section if the connection is already established.

3.1 Connect the computer to the serial cable from the shelter.

3.2 After the Window's desktop appears, double-click on the Campbell icon.

3.3 Double-click on the "Connect" icon on the task bar.

3.4 Single-click the "Connect" button (lower right corner).

3.5 Communications are established when both the PC and data logger's date and time are displayed in the upper right corner and the two plugs in the box are "connected".

4.0 View the Current Data

4.1 Click on the "Numeric Display" tab on the lower left corner of the "Datalogger Connection" window. Note the following values on the field form:

- "station" time displayed in the lower right corner of the window
- "stage" (average stage)
- "med_turb" (median turbidity)
- "nxt_isco" (should match the ISCO's "Next Sample")
- "dump_cnt" (current data dump number)
- "bat_volt" (current battery voltage)

5.0 Manual Sample Options

5.1 Determine if a manual sample should be collected:

○ No manual sample if stage is less than the "min_stg" (minimum stage, see the parameter sheet) or the current turbidity is within a previously sampled range (see the Tally Sheet).

○ Collect a DI (depth-integrated) sample and simultaneous ISCO sample if the stage is above the minimum stage and the current turbidity range has not been previously sampled.

○ Collect an AUX (auxiliary) sample, without a matching DI, if:

- The "Next Sample" displayed on the ISCO is not the same as "nxt_isco"; or
- ISCO bottle volumes are too low/empty; or
- The stage is receding and nearing the minimum stage and less than 4 samples have been collected for the storm.

5.2 DI Sample

- 5.2.1 Assemble DI sampling equipment for a bridge or wading measurement.
- 5.2.2 The ISCO will sample on the next wake-up after the flag is set.
- 5.2.3 Plan to start the DI sample collection about 3-5 minutes before the wake-up.
- 5.2.4 With the cursor on the "Datalogger Connection" window, single click the "Ports/Flags" button.
- **SELECTING OR DESELECTING THE WRONG FLAG MAY CAUSE THE PROGRAM TO MALFUNCTION!**
- 5.2.5 Carefully click on the box next to the Flag labeled "DI" (it will darken when selected).
- 5.2.6 Click on the 113 in the upper right corner of the Ports/Flags window to close it.
- 5.2.7 Make a "hatch" mark on the DI Tally Sheet in the column most closely matching the current turbidity ("med_turb").

5.3 AUX Sample

- 5.3.1 With the cursor on the "Datalogger Connection" window, single-click the "Ports/Flags" button.
- 5.3.2 Carefully click on the box next to the Flag labeled "AUX" (it will darken when selected).
- 5.3.3 Click on the ~ in the upper right corner of the Ports/Flags window to close it.
- 5.3.4 Explain in the "Comments" why you collected an AUX sample.

6.0 Changing the ISCO Bottles, Incrementing the Dump Number, and Collecting the Data File

- IF COLLECTING A DI OR AUX SAMPLE WAIT UNTIL AFTER THE NEXT WAKE-UP AND SAMPLE COLLECTION BEFORE PROCEEDING WITH THE ISCO BOTTLE EXCHANGE AND INCREMENTING THE DATA DUMP NUMBER.
- 6.1 Change the ISCO bottles, increment data dump number, and "collect" the file if either of the following conditions is true:
 - If 8 or more bottles contain samples; or
 - There is a possibility of all 24 ISCO bottles filling before next visit
- 6.2 Remove the caps from the replacement bottles in the spare ISCO base and confirm that the bottles are labeled with the station "FTR", numbered 124, is in order, and that bottle 1 matches the # 1 position in the base.
- 6.3 Immediately following a wake-up exchange the ISCO bases (you have less than one wake-up interval to exchange the bottles, reset the ISCO, and increment the data dump number).
- 6.4 Detach the bale fasteners that attaches the base to the mid-section, keep the base on the floor of the shelter, then lift the mid-section onto the arm supports resting the ISCO on its handles. Slide the replacement base under the mid-section then re-assemble the ISCO.
- 6.5 Reset the ISCO to bottle position-1 (move the "Distribution Tube" switch to the "Reset" position, then release).
- 6.6 With the cursor on the "Datalogger Connection" window (assumes that communications are already established) single-click the "Ports/Flags" button.
- 6.7 Click on the box next to the Flag labeled "DUMP" (it will darken when selected). This will cause the program to increment the data dump counter ("dump_cnt") by 1 and to reset the "nxt_isco" counter to 1 at the next wake-up.
- 6.8 Click on the D3 in the upper right corner of the Ports/Flags window to close it.

6.9 Collect the file from the data logger and copy it to the hard disk.

- a. Click on the Collect button.
- b. A pop-up box will appear with a suggested filename; click on the Browse button.
- c. First make sure the path in the right side box is correct
Drive is C:

Folder is FTRyy (for example FTR00, for hydro year 2000)
- d. Each file will have a unique filename with the following format
(no longer one appended file such as FTR99.dat):
FT991003.02d
Where FT is the station (always the same, the "R" is dropped)
991003 the date (year month day) that the file was STARTED.
02d is the second data dump of the hydro year
- e. Click the OK button on the active window.
- f. Click the OK button on the other window (make sure the filename you entered is correct).
- g. Make sure that the entire file was collected (watch the "% Collected" box).

6.10 Copy the file from the hard disk to the backup floppy.

- a. Insert the floppy into the drive.
- b. Double click on Window Explorer.
- c. Under the C drive click on the current hydro year folder (for example FTR00).
- d. Locate the filename you just collected and drag and drop it into the A: drive icon towards the top of the screen (this will copy the file to the floppy).
- e. Remove the floppy.

7.0 Complete the Bottle Labeling (if there are two people this can be done while the data is being downloaded)

- 7.1 Wearing safety glasses and gloves carefully place 3 drops of a 1:1 HCL acid into each bottle containing a sample.
- 7.2 Tightly cap then remove the bottles containing samples.
- 7.3 Complete the bottle label as follows:
- Add the dump number in front of the station identifier: dd FTR—nn.
 - On bottle, number 01, in parenthesis, and after the bottle number, indicate the number of samples in the dump: dd FTR—01 (xx).
 - Place a 1-inch long piece of tape straddling the water surface on the thick edge of the bottle and carefully mark a horizontal line indicating the water surface with the bottles on a level surface.
- 7.4 Store the samples in an upright position in a box or bucket and cover them with black plastic.
- 7.5 Label the shoulder of each replacement bottle with a permanent marker and a strip of first aid tape.
- 7.6 Label the replacement bottles for the next dump with the station identifier and the bottle number: FTR—nn (leave space in front of "FTR" for the dump number).
- 7.7 Load the new bottles, in the correct order, in a spare ISCO base (double-check the number sequence of the bottles and confirm that the bottle-1 matches position #1 in the base).
- 7.8 Leave the bottles capped.

8.0 Adjusting the Stage Offset

Adjust the stage offset ("stg_off") when the electronic stage differs from the staff plate by more than 0.05 feet.

8.1 Calculate the correction to the offset (pay attention to the +/- signs):

The electronic stage is too high:

Calculate the error,

$$1.57' \text{ staff} - 1.64' \text{ electronic} = -0.07' \text{ error}$$

Calculate the new offset,

$$-0.475' \text{ current offset} + -0.07' \text{ error} = -0.545' \text{ new offset}$$

The electronic stage is too low:

Calculate the error,

$$2.45' \text{ staff} - 2.37' \text{ electronic} = +0.08 \text{ error}$$

Calculate the new offset,

$$-0.475' \text{ current offset} + 0.08' \text{ error} = -0.395' \text{ new offset}$$

Click on the "Numeric Display" tab on the lower left corner of the "Datalogger Connection" window to display the current values.

- 8.2 Place the arrow of the cursor on the value to the right of "stg_off", then right-click. An "Edit Value" window will appear. Left-click on the "Edit Value" window. The location highlights yellow. Type in the new value, with "-" in front, then press [ENTER] when done.
- 8.3 The new offset will become effective at the next wake-up.
- 8.4 Make a note on the field form under "Comments" and change the "Parameter Sheet" to reflect the new offset.

9.0 Adjusting the median Turbidity Offset

END

9

09/08/99

**Standard Operating Procedures
For
Laboratory Procedures
For
Determining
Suspended Sediment Concentration**

**Sunny Brae Sediment Lab
Salmon Forever
HY 2001**

9-19-2000

Prepared by _____ **Date** _____

Approved by _____ **Date** _____

Table of Contents

1. Scope	
2. Apparatus	3
3. Calibration	3
4. Sample Processing:	3
Types of Samples - Filter Preparation - Volume Marks	
Suspended Sediment Concentration determination	
Sand Fraction - Large Filter Procedure	
5. Handling Preservation	8
Holding Times - Notes - Washing	
6. Troubleshooting	10
7. Data Acquisition, Calculations and Data Reduction	10
Data Sheets - Drying and Weighing - Lab Codes	
Calculations	
8. Computer Hardware and Software Used	14
9. Data Management and Records Management	14
10. Quality Assurance / Quality Control	15
11. References	17

1. Scope:

This Standard Operating Procedure covers the proper handling of samples and suspended sediment concentration (SSC) or total suspended solids (TSS) determination. This SOP follows the Redwood Sciences Lab SOP for suspended sediment concentration determination. Suspended Sediment Concentration is determined by vacuuming water samples through tared 1-micron glass fiber filters with a vacuum assembly. Filters will be dried in an 105^o C oven, cooled in a dessicator and then weighed on a Mettler H20T balance to the nearest 0.00001 g. Sample water weight and sediment weight is used to calculate suspended sediment concentrations in mg/l. and PPM.

Depending on the size of a sediment particle, a stream transports the sediment by maintaining the particle in suspension with turbulent currents or by rolling or skipping the particle along the streambed. In general, fine-grained sediment (silt and clay) is transported in the water in a suspended state supported by the action of turbulence. Suspended sediment load is that part of the solid load the weight of which is transmitted by the fluid of the main flow to the fluid in the interstices of the grain bed. The excess or immersed weight of the suspended load must be equal to the mean upward flux of momentum by upward fluid currents in the turbulent eddies. (Leopold 1994).

2. Apparatus:

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 Leader. Lab water shall be retail distilled water purchased locally. The Lab Manager shall inspect sample bottles before use. Copies of equipment invoices shall be kept in the Sediment Lab and Salmon Forever Offices.

Mettler H20T Analytical Balance S/N 418151 and appropriate Checkweight
AND FY 3000 scale S/N 5608313 and appropriate checkweight
Filters - Gelman P/N 61631 Type A/E 47mm, 1 micron, glass fiber
Grieve Laboratory Oven LR270C
Dessicator /Sanplatec Co.
Desiccant
Humidity Reader - VWR Digital
Vacuum Pump and 47mm-filter filter flask and funnel vacuum assembly
Forceps
Distilled Water, spray bottles
Timer
Drying Racks

3. Calibration:

All equipment calibration records will be kept by the Lab Manager and are available upon request. The only equipment used in this SOP that requires calibration are the Mettler H20T Analytical Balance S/N 418151 and the AND FY 3000 scale S/N 5608313.

Balances are calibrated annually by Woolard and Sons - PO Box 3438, Eugene OR, 97302, 503-581-9669. Balances are calibrated and tested for accuracy in accordance with National Institute of Standards and Technology Circular No. 547, Section 1, of the Precision Laboratory Standards of Mass and Laboratory Weights and meet the manufacturers specifications for these balances in conformance with ANSI/NCSL 540-1-1994. These weights are directly traceable to the National Institute of Standards and Technology through our master set No. 349-A, Ainsworth Inc. Class "M", Serial No. 27572, Watson Bros. Inc. Test No. 1659, and directly traceable to NIST by Watson Bros. Inc. Set No. 1254-M, Serial No. 27925, NIST Test No. 523/240632. Balances shall be calibrated more frequently if needed. Scales shall not be used that have not been successfully calibrated.

The Lab Manager is responsible for calibrating balances and scales and taking out of use any scale or balance not in working order. The Lab Manager shall document all calibrations and keep records for at least 10 years.

4. Sample Processing:

The Volunteer is responsible for samples until they are brought to the Lab or until they are picked up or measurements are 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 Leader or Watershed Coordinator is responsible for collecting and checking the completeness of field samples and data. The Lab Manager is responsible for processing samples. The date and time of arrival at the Sediment Lab is recorded on the Lab Sign-In Sheet by whomever 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 format is presented in Appendix 2 of the QAPP.

Analytical procedures follow Redwood Science Lab (RSL), EPA, and Standard Methods (#2540B - Total Solids Dried at 103-105^o C) protocols. Suspended sediment concentration is determined by vacuuming water samples through tared 1-micron filters with a vacuum assembly. 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. The filters are dried at 105^o C and cooled in a dessicator before weighing. Sample water weight and sediment weight are used to calculate suspended sediment concentrations in mg/l. and PPM.

A. Types of samples:

TTS (Turbidity Threshold Sample) - ISCO Sampler

Samples are collected in ISCO 1000mL plastic bottles (the nominal sample volume is 350mL). These samples are collected under data logger program control where pre-established turbidity threshold criteria are met. See ISCO SOP for details

AUX (Auxiliary Samples) - ISCO Sampler

AUX samples are similar to TTS samples but are manually triggered via the data logger program. AUX samples are collected when too few samples have been collected during a storm and/or when equipment has malfunctioned. The label, in addition to normal ISCO identification, should also include "AUX".

DIS (Depth Integrated Samples) - DH-48 Sampler

Samples are collected in 500mL (1-pint) glass "milk bottles" in intervals across the width of the entire stream using a DH-48 sampler. They will be collected using the equal time retrieval method. See DIS SOP for details These samples represent the cross-sectional average of sediment concentration and are used as "truth" to correct the TTS pumped samples (which are not flow-averaged, but are point samples). A simultaneous pumped sample is collected, via the data logger program, while the field crew manually collects the DIS bottle. The plastic ISCO bottle, in addition to the normal identification, should also include "DI". (The DIS and matching ISCO "DI" bottle should always be analyzed as a pair; e.g. they both would require sand fraction analyses to permit comparison later).

Grab Samples

Samples are collected in HACH Sample Cells, 2 X 6 Plastic Bottles (2x6 P.B.), 3 x 8 plastic Bottles (3x8 P.B.), 500 mL glass "milk bottles" or any other useful container. These samples are usually taken by hand from shore or with string off a bridge. Usually collected by volunteers, these samples represent a single point sample. Labels will include location, date, and time sampled. See Field Sampling SOP for details.

B. Preparing Filters

1. Always handle filters with forceps.
2. A fingerprint weighs approximately 0.0001 g. This adds a 10% error for a sample weighing 0.0010g.
3. When first taking filters out of the box, inspect them carefully since they have a tendency to stick together; separate as necessary. Hold each filter up to the light to verify that there are no holes. Discard defective filters.
4. Write the filter ID number on "furry" side of filter with light pressure from a dull-pointed "Ultra-Fine Sharpie" marker. Underline the numbers so that they will not be confused when read upside down. Wait at least 10 minutes to allow the ink to dry before rinsing filter on vacuum assembly.
5. Record filter ID number on initial tare sheet. If a filter is contaminated or punctured, discard that filter and record it as "discarded" on tare sheet (the "missing" filter is then accounted for).
6. Seat filters, slightly off-center, with furry side down on the vacuum manifold.
7. Turn on the vacuum and rinse the filter several times with lab grade water to remove any loose fibers. Check for holes. If there is a hole, air will whistle through it and make a jet-like sound.
8. Turn off the vacuum and carefully remove filter with forceps. Place the filter on a wire rack and allow 1 hour for the filter to air-dry.
9. Place filters on a Teflon or glass or aluminum pan and heat in oven at 105°C for at least 1/2 hour.
10. Remove pan from oven and place in desiccator cabinet to cool for at least 1/2 hour before weighing. Do not remove filters from desiccator cabinet until ready to weigh since they will absorb moisture from the air.
11. Take out only 4 or 5 filters at a time. If the last filter in your batch has been out of the desiccator cabinet for more than 10 minutes before weighing, you have taken out too many filters. Reduce the number of filters the next time a new batch is removed. The filters should not be weighed when the relative humidity in the desiccator is more than 28%. Try to keep the humidity level in the desiccator between 10-25%. When the humidity approaches 20%, place the desiccant in the oven to bake overnight. Never weigh filters when your hair or clothing is wet.
12. Weigh each filter and record the weight on initial tare sheet. See Section 7 for details on weighing filters. Store prepared filters in a clean, dust-free container or a pan covered with aluminum foil. Do not stack or overlap the filters.

C. Volume Marks

1. Volume marks are made on all ISCO, DIS and AUX bottles in the field. The volume mark on plastic bottles is made on the middle of a strip of 3M-nylon first aid tape that is taped on the edge of the bottle. Bottles shall be taped in the field. The volume mark on glass DIS bottles is made on the vertically etched strip with a pencil or tape.
2. In the lab before processing place bottle on a level counter and loosen the cap if it is a plastic bottle.
3. Check the volume mark for accuracy when samples are signed into the lab. Compare the volume mark on the tape or etched glass to the actual water level (read the level from the bottom of the meniscus).
4. If the difference between the volume mark and the actual sample volume is more than 1.0 cm attempt to determine the cause (cap not tight, cracked bottle, tape did not adhere, mark missing, unknown cause, etc. Assign a Lab Code of 6 on the lab form.
5. After processing the sample, fill the bottle to the field volume mark then weigh the bottle and record the weight.
6. Make notes in "Comment" column.

D. Volume Measurement for a Missed Bottle Weight

1. After processing the sample, add filtered water to the bottle until the bottom of the meniscus matches the volume mark on the side of the bottle.
2. Weigh the bottle, with the water, with or without the cap depending on the type of sample, and write the value in total weight column. If there are no other problems with the sample, place a lab code of 6 on the data sheet. Pour the water from the bottle into a graduated cylinder, note the total volume, measured from the bottom of the meniscus (+/- 1mL), and write this volume in the comment column.

E. Suspended Sediment Determination

1. Use appropriate sheet for sampling method (ISCO,DIS,Grab).
See Section 7 for filling in appropriate data sheets before processing.
2. Use tared blank filters in numerical order.
Record the filter ID number on the appropriate data sheet.
3. Transfer the filter initial weight value to the data form.
4. Place a filter, numbered side down, on funnel support.
5. Turn on vacuum and wet the filter with lab grade water to check for tears or holes. Clamp the funnel on top of filter.
6. ISCO/DIS samples - Weigh the sample bottle with the cap off. Weigh container after drying to obtain tare bottle weight.
Grab Samples- Weigh sample bottle with the cap on.
7. Record the weight of the full bottle under the "Total Bottle Weight" column.
8. Pour the sample from the bottle into funnel. For faster filtration, try to pour the clear water through first without disturbing the sediment on the bottom of sample bottle. Then swirl last portion of water with settled sediment and pour into funnel. Rinse the inside of the cap into funnel.
10. Rinse sediment from bottom of the bottle into funnel, using lab grade water. Rinse the sample bottle several more times, making sure to remove all of the sediment. It may take several filters per sample to assure a reasonable filtering speed and drying time; if it takes more than two seconds per drop of filtrate (that part which passes through the filter), then another filter should be used.
11. Shake Grab Sample bottles thoroughly to get rid of any excess water and record bottle and cap weight under "Tare Bottle Weight" column. Weigh empty ISCO bottles after drying thoroughly.
12. Rinse funnel thoroughly with squirt bottle to wash sediment down onto filter and carefully remove funnel. If any sediment remains on inside rim of funnel after funnel is removed, carefully rinse off the funnel over the filter. Turn off vacuum.
13. Remove filter using forceps and place on wire rack for one hour. Do not touch fingers to filter.
14. Record the number of filters used under the column labeled "Filter Total". If total number filters used is one, the notation in column "Filter Total" would be "1 1", or one-of-one. If two filters are used, the notation would be "1 2" (one-of-two) for the first filter, and "2 2" (two of-two) for the second filter for the next line, and so on. Since it is difficult to determine how many filters per bottle will be required, process the bottles in numerical order (so enough space is available for multiple filters on the data sheet).
15. Remove any large organic debris (e.g. leaves, wood, algae, hair, etc.) with tweezers, and describe it in the "Comment" column. Try to remove the debris while the water is in the funnel to avoid the loss of sediment. If this proves too difficult, carefully remove the debris while the filter is on the drying rack.

16. Record spills, errors, or notes in the "Comment" column of the data form. It is important to record any observations or suspicions that may explain unusual results. Put a red dot next to entry on sign-in sheet after running suspended sediment concentration to signify that the sample has been run.

F. Sand Fraction Determination

1. This process may be requested for selected samples. When requested, the process is carried out before the routine filtering steps, but after weighing the full sample bottle.
2. This procedure uses the 0.063mm (#230) mesh sieve to separate sands from silts and clays. Determination of particles larger than sand size requires additional sieves, such as 0.5 mm, 1.0 mm and 2.0 mm. When determining more than one size fraction, the required sieves are stacked together, with the largest mesh on top and decreasing in size to the smallest mesh. Each sieve is rinsed and transferred to a separate filter.
3. Before starting, wet the sieve with lab grade water from a squirt bottle to reduce the surface tension, and rinse the bottom pan out with lab grade water. Then pour the sample through the 0.063mm sieve with pan in place beneath the sieve to catch the filtrate. Rinse the sample bottle into the sieve using lab grade water from a squirt bottle. Tilt the sieve in pan (keep the pan flat on the counter) and "chase" the sediment to the lower side of the sieve with a stream of water from the squirt bottle.
4. Rinse sieve thoroughly, up to 10 times, so that only sand particles remain in the sieve, and the suspended sediment fraction goes into the pan underneath. Use water efficiently to reduce the total volume that requires filtering.
5. Chase and rinse the sand particles from the sieve into a container (one with a pour-spout will make transferring the sample into the funnel much easier during the filtering process). Rinse the sieve thoroughly so that all the sand particles are transferred into the container.
6. Process the sand fraction sediment portion using the filtering method described previously in the "Suspended Sediment Determination" section. This yields the first filter (or more if necessary) for the sand fraction.
7. Pour the suspended sediment fraction (< 0.063mm) from the pan into a pour-spout container. Rinse the pan thoroughly with the squirt bottle to remove all of the sediment. Continue to process the suspended sediment fraction using the method described previously in the "Suspended Sediment Determination" section. These filters shall be numbered in a continuing sequence following the sand portion filter(s).
8. Record which filters are "sand fraction" and which are "suspended sediment fractions" in the "Comments" section of the data or put a checkmark in the appropriate column.
9. When finished, place the bottom of the sieve upside down to allow the remaining water to drain.

G. Large Filter Procedure

1. If a sediment sample contains a large amount of sediment and is taking an excess amount of time to process (usually more than 6-8 filters), then switch to large filters. Fold large filter to fit funnel.
2. Place a large folded filter on the funnel apparatus on top of a clean empty flask, because you will be refiltering this filtrate later on a small filter. (Remember to record the filter I.D. number on the lab form.)
3. Weigh and record the bottle's weight on the lab form.
4. Slowly pour the water from the bottle onto the filter. Aim for the center of the filter and be very careful not to spill any of the material over the edges of the filter. Squirt lab grade water into the sample bottle and rinse all the sediment over to one corner of the bottle. Slowly pour the sediment onto the center of the filter. Do this procedure several times without splashing or spilling sediment over the edges of the filter. Since the funnel is larger than the filter, sediment can spill over the edges and lodge itself on the underside of the filter. This could cause problems, especially if this sediment falls off unnoticed during the drying or weighing procedure.

5. Do not discard the filtrate from the flask. Save both the filtrate and the sample bottle portion that hasn't been washed out. Set these aside for the time being.
6. Put the large filter on the drying rack. Rinse the spatulas through the funnel and then rinse the funnel into the flask.
7. Set up a small filter on another vacuum flask apparatus. Make sure to record the filter I.D. on the lab form. Pour the filtrate (from the filter flask) onto the small filter. Rinse the flask three times. Repeat the same procedure with the sample bottle. Rinse the small filter funnel as normal and place filter on drying rack.
8. Oven-dry large filters for 2 hours (instead of the usual 1 and 1/2 hours). Cool filters in the dessicator for one hour, then weigh. The large filters absorb moisture more rapidly than the small filter. Remove no more than three large filters at a time from the dessicator and weigh them quickly.
9. Oven-dry the large filters again for 1/2 hour.
10. Cool the filters for 1/2 hour in the dessicator and weigh a second time. Make sure that the weight difference between the first and second weighing is 4% or less. If the weight difference is greater than 4% or greater than 0.5mg then repeat oven-drying for another 1/2 hour, cool in dessicator for another 1/2 hour and weigh. Repeat procedure until the weight difference stabilizes at 4% or below.
11. Record the second and third weight (only if needed) in the comment section of the lab form.
12. When processing a sand fraction sample, use the large filter for the suspended portion and the small filter for the sand portion.

5. Handling & Preservation:

The maximum holding time for all samples shall be 1 year.

All ISCO pump samples shall be given 3 drops of HCL solution. All other samples shall be given 2 or 3 drops of HCL after turbidity determination is done. This retards the growth of algae that can interfere with Turbidity determination. Samples will be kept in a cool dark place until processing. Samples will be covered with plastic to keep in the dark.

Washing Procedure

1. After processing samples, wash all sample bottles, lids, and glassware using Alconox soap and hot water. Rinse thoroughly with tap water twice, and then twice with lab grade water.
2. Set ISCO bottles upside down on pegs on the glassware dryers if available and turn switch on. Put lids on blue racks in the fume hood if available. Set Grab sample bottles on drying rack.
3. Tare the ISCO bottles, without lids, after making sure they are completely dry and are at room temperature.
4. Record the weight of the ISCO bottles in the appropriate column and place the lids back on the bottles when both are completely dry.
5. When the ISCO bottles are completely dry, tared, the lids replaced, and everything has been double-checked, the labels can be removed. Check with the supervisor first before removing any labels. Once approved, remove tape labels from bottles and return bottles to crates. Erase the pencil mark on the etched portion of the glass DIS bottles.
6. Watch for cracks, holes, or collapsed corners in plastic bottles. If any defects are noticed, discard the bottle after the label is removed.

Notes

The samples should be processed in approximately the same order in which they arrive at the lab. This limits the amount of evaporation from the bottles, reduces fading of the labels, and generally keeps the processing as parallel to the sampling as possible. Cover the bottles with black plastic to minimize light and fading of the labels. Store bottles in a cool location. Bottles that have been stored over a month or two may have significant evaporation and growth of algae. Samples will be kept in a refrigerator for long term storage.

Some bottles arrive empty or nearly empty. Check the field volume mark on the bottle to see if it was low in the field. Test for leaks by placing the bottle on paper towels for several hours. After processing, fill the bottle and place it on its side on paper towels to determine if the sampled leaked through the cap-seal.

Prepare and weigh about 50-200 new filters periodically, depending on backlog of samples and the size of the crew in the lab.

Monitor the number of bottles that are ready to be processed and organize them as you proceed.

Be aware of data dumps that have a higher priority and process them as directed by the Lab Manager

The sample bottles are very unstable and will fall over very easily. Therefore, never remove a bottle cap and set the bottle down to do something else. Keep the cap on until you are ready to filter the sample.

Plan the low-attention tasks (e.g. washing or stripping labels) when you feel you will be least alert.

Dry the desiccant every 3 weeks at 105 C for 4 hours min. or overnight. Keep the desiccator door closed as much as possible; transfer desiccant quickly. Periodically grease the door seal with silicon lubricant.

ISCO Samples are normally acidified in the field. If a sample requires acidification in the lab, use three drops of 1:1 HCL per sample. Samples should be acidified as soon as possible to reduce fungal growth and to flocculate the sediment, which speeds up filtering (laboratory turbidity measurements, if required, will be taken before acidification). Once the samples reach the lab, try not to disturb the samples after acidification, to allow the sediment to settle.

Use the following procedure to make a new batch of acid. **CAUTION:** Use face shield and gloves whenever handling acid. To make a batch of 1:1 HCL, add 100 mL of acid to 100 mL of water, in that order, acid to water. If acid should contact your skin, wash the area thoroughly with copious amounts of water **ONLY**, and notify your supervisor. A sodium bicarbonate solution should be kept near the acid; this will neutralize the effects of acid spilled on lab surfaces only. Mixing baking soda and water makes a sodium bicarbonate solution. This solution should never be used to neutralize acid spilled on skin, since the heat produced by neutralization will increase cellular damage. Use acid only under the fume hood in the lab.

6. Troubleshooting:

Troubleshooting:

Check existing tared filters in trays before labeling new filters to avoid duplicating #'s

Filters are clogged if water is dripping from filter assembly under vacuum more than 2 seconds apart. Add another filter to the assembly for that sample and pour water from clogged filter into new filter.

If analytical balance will not settle make sure doors are closed. Look for debris on balance pan if check weight is off.

Use spatula or table knife to support heavy loaded filters from filter assembly to drying rack to balance to avoid loss of sample from filter.

Maintenance:

All equipment shall be inspected and monthly. Maintenance logs will be kept on all appropriate equipment. The Lab Manager maintains a maintenance log book 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.

7. Data Acquisition, Calculations & Data Reduction:**A. Data Sheets:****Sign-in Sheet**

1. Persons bringing samples into the lab must record when samples are brought into lab and name of person who brought the samples into the lab on the sign-in sheet .
2. Record the sample ID #, location, date, time of sample and who collected the sample on the sign-in sheet.
3. Run turbidity on sample per Turbidity SOP and record NTU, date, time, turbidimeter # and who conducted NTU determination.
4. If turbidity is too high initially for the HACH 2100P Turbidimeter, note this by assigning the sample a turbidity code of 1 on sign-in sheet and the turbidity will be run by dilution by lab technicians at the time of suspended sediment concentration determinations. A sample with a turbidity of less than 1000 should have a recorded a turbidity code of 0. See Turbidity SOP for details
5. Record stage, velocity, and type of sample and all other pertinent data on "comment" portion of sign-in sheet.
6. Put samples in appropriate place and cover with a black piece of plastic or proceed with suspended sediment concentration determination using proper data sheet.

Grab Sample data sheet and Depth Integrated Sample (DIS) data sheet

1. Arrange the sample bottles by location and then by chronological order.
2. Start a new data sheet for each day's work in the lab. If different people work on the same day at different times, use a different data sheet for each person's work.
3. Data forms are filled out as each sample is processed.
4. Carefully read the bottle label and locate its entry on sign-in sheet.
5. Transfer ID #, location, date, and time from label and turbidity from sign-in sheet onto data form.
6. Run suspended sediment determination per this SOP. Put a red dot next to each samples entry on sign-in sheet after running suspended sediment concentration to signify sample has been processed.

Turbidity Threshold Sample (TTS / ISCO Bottles) Sheet

1. Arrange the sample bottles in order by.
Station ID - Data Dump # - Bottle Number
2. Start a new data form for each station.
3. Data forms are filled out as each file name / data dump is processed.
4. Under no circumstances should information for more than one station be recorded on the same data form. Record name of person running samples and date and HY and page numbers if more than one page is used.
5. You may include more than one data dump on a single form if the dumps are in sequential order.
6. Carefully read the bottle labels.
7. Transfer all data from bottle labels to the lab data forms (double-check the data as it is entered).
Put a red dot next to entry on sign-in sheet after running suspended sediment concentration.
8. The bottles are labeled as follows: Data Dump Number - station ID - Bottle Number For example, 04FTR11 would indicate data dump 4, station FTR, bottle number 11. In addition, the first bottle in the dump will have the number of bottles in the dump in parentheses on the bottle label.
9. Run suspended sediment determination per this SOP.

Suspended Sediment Concentration (SSC) Calculation Sheet

Transfer volume, NTU, and filter weight data to SSC calculation sheet and compute suspended sediment concentration using calculator and/or excel spreadsheet. When results are transferred from paper calculation worksheet to Excel database spreadsheet, the suspended sediment concentration shall be compared and any discrepancies investigated and resolved.

B. Data Sheet Completion

1. Make sure all the data is on the data form and check it for errors.
2. See that all pertinent remarks are recorded.
3. Confirm that the station, date, your initials and page numbers and Hydrologic Year are filled out on top of data form.
4. Complete the " Lab Code" column indicating the quality of the sample and processing procedure after the final filter weigh.

C. Drying and Weighing (Mettler H20t Balance)

1. After air-drying filters at least 1 hour on wire rack, place filters on a clean tray in rows of 4 and 5 filters and heat at 105° C for 1 and 1/2 hours for sediment sample filters and 1/2 hour for filter tares (blanks).
2. Remove tray from oven and immediately place in desiccator to cool for at least 1 hour for sample filters and 1/2 hour for filter tares before weighing. Only weigh filters when the humidity in the dessicator is below 25%. If it is above 25% ,stop and let humidity descend to 17% before proceeding.
3. Zero the balance between each weigh. Check the pan for debris, and if present, gently remove it using a brush or compressed air with the scale at full arrest.
4. Zero the balance by first full releasing the scale gently from full arrest with all weights at zero and let the balance settle for at least 10 seconds. Use the zero knob to set zero by moving the horizontal line corresponding to the numbers 00 on the lighted display between the split arrow marks with the zero knob. Return the scale gently to full arrest.

5. Weigh the check weight before weighing filters and for every 10th weigh and record it's weight on the data sheet and on the Check Weight data sheet. An acceptable weight for the one-gram Check Weight is between 1.00001 grams to 1.00013 grams.
6. **To weigh a Check Weight:**
Always use forceps to handle the checkweight. Make sure the balance is at full arrest. Open the sliding door and carefully place the Check Weight on the center of the weighing pan and then close the door. The general weight of the check weight is known so set the appropriate large weight knob and bring the balance to full release. Determine the remainder of the Check Weight's weight with the fine weight knob by bringing the horizontal line in between the split arrow marks. After letting the balance stabilize for at least 10 seconds and fine adjusting with the fine weight knob record the first 3 digits first on the sample data sheet. Then look back and adjust the fine weights and record the last 2 digits. Bring balance back to full arrest and zero the weight knobs. Open the door and remove the Check Weight and place in container. Close the balance door.
6. **To weigh a filter:**
Set balance gently to full release so scale is settling while transferring filters, open dessicator, remove sample tray and transfer a row of filters to another tray. Immediately put tray with the remainder of filters back into dessicator and close door. Zero the balance by setting the horizontal line corresponding to the numbers 00 on the lighted display between the split arrow marks with the zero knob. Bring balance back to full arrest.
Open the sliding door and carefully place the filter on the center of the weighing pan and then close the door. Determine filter weight to a tenth of a gram with half release. If downward pointing arrows appear at the bottom portion of lighted display at half release it means the selected tenth of a gram increment is too high. Bring balance to full arrest and reduce the tenth of a gram weight knob by a tenth of a gram and bring balance to half arrest again and observe if arrows appear. If arrows do not appear and display scrolls the other way the tenth of a gram setting is appropriate.

Set the balance to full release. Determine the remainder of the filter weight with fine weight knob by bringing the nearest horizontal line in between the split arrow marks. Record the first 3 digits first on the sample data sheet. Record last two after letting the balance stabilize for at least 10 seconds and fine adjusting with the fine weight knob. Bring balance back to full arrest and zero the weight knobs. Open the door and remove the filter and place on tray. Close the balance door.
7. Check the final weight against the initial weight. The final weight should be larger. If the initial weight is larger than the final weight try to determine where the error occurred. Record a lab code of 2 on the sample data sheet if the difference is less than 0.0005 grams and 7 if the difference is larger.
8. To store weighed / used filters, place weighed filters on foil in a box and cover with aluminum foil when layer is full. Lay another layer of filters on top and cover and so on until box is full.
9. After double checking the data forms, calculate data as soon as possible.

D. Lab Codes

Lab (SSC / TSS) codes (WY 2001) Lab quality

- | | |
|----|---|
| 0 | ok |
| 1 | organic debris or foreign materials present, but < 15% by mass includes any non-sediment items (leaves, wood, algae, hair, slug excrement) |
| 2 | minor weighing or volume errors other than spillage
- final weight less than initial weight by less than 0.0005 g
and very little sediment is present |
| 3 | spilled < 15% of sample volume before weighing bottle
- use this when water level differs from field mark by < 15%
- before refilling, record sample weight in comments
- refill to mark, reweigh, and record as "Total bottle weight" |
| 4 | spilled < 15% of sediment mass during or after filtering
- includes minor spillage transferring sediment to filter
- includes loss of sediment when handling filter |
| 5 | low volume, less than 150 ml, but processed |
| 6 | organic debris or foreign materials present as in code 1,
but > 15% of sediment by mass |
| 7 | major weighing or volume errors other than spillage, e.g.
- final weight < initial weight by more than 0.0005 g
- balance malfunction
- tare or total bottle weights missing |
| 8 | spillage before weighing bottle as in code 3,
but > 15% of sample volume |
| 9 | spillage during or after filtering as in code 4,
but > 15% of sediment mass |
| 10 | Label error |

E. Calculations: The calculation for PPM or Mg/L is as follows.

$$\text{mg/L} = (\text{Sediment weight} / \text{Total Volume}) \times 1,000,000$$

$$\text{Total Volume} = (\text{sediment volume} + \text{water volume})$$

$$\text{mg/L} = (a / ((a/2.65 + (b-a)))) \times 1,000,000$$

$$a = \text{sediment weight} \qquad b = \text{total bottle weight}$$

10. Hand calculations or a computer program will compute the concentration in PPM of the total suspended sediment (including sand fraction, if present) and the concentration in PPM of the sand fraction (if it was separated). The computation is as follows:

$$\frac{(\text{NetWt. sand fraction - mg}) + (\text{NetWt. suspended sediment - mg})}{\text{Total Volume - L}} \times 1,000,000 = \text{PPM of entire sample}$$

$$\frac{\text{NetWt. sand fraction - mg}}{\text{Total Volume - L}} \times 1,000,000 = \text{PPM of Sand Fraction}$$

$$\text{Where NetWt. (mg)} = (\text{Filter Final weight (mg)} - \text{Initial weight (mg)})$$

8. Computer Hardware and Software Used:

No special hardware is needed for suspended sediment concentration determination. Software used will include Microsoft Word and Excel programs. Software may also include specialized statistical and graphing programs such as Unix, Pearl and S+ for data analysis.

9. Data Management & Records Management:

All data sheets will have the Hydrologic Year, initials of the person entering data, the date of data entry, the sample ID # 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 Lab Manager is responsible for double-checking and copying lab data sheets and delivering them to the Project Manager. Lab data sheet originals will be kept in the Sunny Brae Sediment Lab. Reports and data will be transferred to Excel spreadsheets and Word documents and computer disk copies kept at the Sunny Brae Sediment Lab and Salmon Forever Offices.

Originals of Lab Sheets will be kept in the Sunny Brae Sediment lab. Copies of Lab sheets will be kept in Salmon Forever Offices. Hard copies of all data as well as computer back-up disks will be maintained by Salmon Forever for at least 10 years. QA/QC sheets will maintained by Salmon Forever for 10 years. All Sediment Lab data to 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 of ISCO data sheets will be given to RSL.

Data and calculations are double-checked as data is entered into spreadsheets. Suspended Sediment Concentration data is calculated twice by separate spreadsheets and compared. A check will be entered on the paper copy signifying correct data comparison. Data will be examined and rated on the basis of field and lab codes pertaining to the quality of data.

Data will be used to produce an annual report. 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. The final report will include raw data, Field Data Sheets, equipment calibration sheets, lab data sheets and QA/QC results. Data will be examined and rated on the basis of codes pertaining to the quality of data.

QAPP Appendix 2: Data Forms

- Sample Sign-In Sheet
- Field Sampling Data Sheet
- Field ISCO Form
- Field DI Sampling Data Sheet
- Field Discharge Data Sheet
- Tare Filter Weight Form
- Grab Sampling SSC Data Sheet
- TTS (ISCO) Sampling SSC Data Sheet
- Depth Integrated (DI) Sampling SSC Data Sheet
- SSC Calculations Data Sheet
- NTU Dilution Sheet
- Equipment Calibration forms
- Turbidimeter Calibration Form
- Training Sign-in

10. Quality Assurance/ Quality Control:

A. Quality Control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result) and precision (how reproducible) of your monitoring. Quality Control consists of the steps you will take 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. Results of analyses and corrective actions shall be reported to the Project Manager.

1. Suspended Sediment Sample Processing

Internal QC:

A. QC Filter Blanks are processed the same as sample filters every 10th filter: Final weights of QC filters will be checked as each data sheet set of filters is weighed. Any weights of over 10 mg of tare weight will be investigated and the problems resolved and documented by the Lab manager before other samples are run. Subsequent QC filters will be checked for the effectiveness of any corrective actions.

B. Bottle Weigh Check Weights: Every 10th weigh on the large scale will be a bottle checkweight. Bottle check weights are recorded as samples are run. Any check weight of over 1.0 grams from normal will be cause for no samples to be run until the difference is resolved and documented by the Lab manager.

C. Volume marks: If the difference between the volume mark and the actual sample volume is more than 1.0 cm attempt to determine the cause (cap not tight, cracked bottle, tape did not adhere, mark missing, unknown cause, etc. Assign a Lab Code of 6 on the lab form.

D. Lab Codes : RSL Lab Codes will be used for processing ssc samples.

External QC:

ISCO Split Sample w/ RSL: A QC split sample will be taken by manually starting pump with lid to one side and passing 2 bottles side by side under pump stream. QC splits will make up 10% of ISCO samples. Split QC samples should agree within 10%. If the difference is more than 10% the procedures and technicians handling the split samples shall be reviewed and documented. Each subsequent QC split samples shall be evaluated for the effectiveness of any corrective action. Validity of this method is still being investigated.

2. Filter Weighing Process

Internal QC:

A. Balance Calibration - The Salmon Forever Lab analytical balance will be calibrated and certified by Woolard & Sons annually in September or more frequently if needed.

B. Filter Weigh Check Weight used after every 9th weigh. An acceptable weight for the 1.00007 gram Filter Check Weight is between 1.00001 grams to 1.00013 grams. The balance will be zeroed and the Checkweight weighed again until it is in the acceptable range before proceeding with weighing filters.

C. Filter Reweighs: Reweighs of filters will be done randomly to see how much moisture is being absorbed during weighing process. Reweigh data will be used to limit exposure of filters to air before drying to acceptable limits. Filter exposure will be limited to assure they will not gain more than 0.2 mg/L.

External QC: None

Matrix	Parameter	Precision	Accuracy	Measurement Range
Water	Turbidity Grab	+/-2.0%	+/-2.0%	0-2000 NTU
Water	Turbidity Probe	+/-2.0%	+/-2.0%	0-2000 NTU
Water	Suspended Sediment Grab	+/-2.0 %	+/-2.0%	.00001-2.0 g/L
	DI	—	—	—
	ISCO	—	—	—

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality Assurance/Assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses. QA activities include training of staff, documentation, development of methods, standard operating procedures (QAPP Appendix 1), equipment maintenance, and appropriate handling, processing, and tracking of all data and samples collected. These activities are designed to ensure that study objectives are met.

1. Suspended Sediment Sample Processing

Internal QA: Proficiency Checklist twice a season
External QA - None

2. Filter Weighing Process

Internal QA: Proficiency Checklist twice a season
Set of 9 preweighed filters to check operator proficiency. Lab volunteers shall be checked with these once a season.
External QA - None

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

QA laboratory procedures will be conducted by the QA manager. The Laboratory Manager will train Lab Technicians before conducting sediment processing and on the job. Proficiency checklists for 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 Manager

The QA Manager and/or 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 should also re-examine and re-weigh sample filters periodically during the field season as a QA check.

During training, we will note any methods that the volunteers find confusing, and discuss modification of the method and the checklist. All 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 QA/QC Manager or Lab Manager is responsible for implementing these assessments and to document and file these checklists. Results shall be reported to the Project Manager.

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

11. References:

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:

Laboratory Theory and Methods for Sediment Analysis Chapter C1 Book 5

Field Methods for Measurement of Fluvial Sediment Chapter C2 Book 3

Others:

Leopold, L. B. 1994. *A View of the River.*, Harvard University Press, Cambridge Massachusetts.

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

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

SOP Lab Susp. Sed 9-19-00/wd98/cf

**Standard Operating Procedures
For Determining**

**Turbidity Levels
Using a
OBS-3 Continuous Turbidimeter**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

Salmon Forever

9-19-00

Prepared By _____

Date _____

Approved By _____

Date _____

1. Scope:

Turbidity is the cloudiness or opacity of a normally clear liquid due to a suspension of solid particles or colloidal droplets. This Standard Operating Procedure covers the proper use of the OBS-3 Turbidity Probe. The D&A OBS-3 Turbidity Probe operates with an optical sensor for measuring turbidity by detecting infrared (IR) radiation scattered from suspended matter. The probe "reads" the turbidity of passing water about 6 inches out in very clear water and about 2 inches out in high turbidity water.

Probe # 430 is used in conjunction with a CRX10 Campbell Data logger and a ISCO 2100 Automatic Pump Sampler to conduct Turbidity Threshold Sampling of water in Freshwater Creek, California. This site will be setup on the main stem of Freshwater Creek and is situated just above Graham Gulch. The pump sampler is programmed to take samples as turbidity levels rise and fall past pre-set thresholds. This provides an accurate and simplified data set of suspended sediment concentrations at varying stage levels.

The primary station on Freshwater Creek incorporates an ISCO model 2100 automatic pumping sampler, an Campbell CR101X datalogger, Druck 1830 pressure transducer, D&A OBS-3 turbidity probe and a Campbell 107LC Thermistor temperature probe. 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.

2. Apparatus:

D&A Instrument Co. OBS-3 Turbidity Probe	S/N # 430	Factory Calibrated	3-11-99
		Field Calibrated	11-14-99
D&A Instrument Co. OBS-3 Turbidity Probe	S/N # 370	Factory Calibrated	3-11-99
D&A Factory Manual Part # OBS-1/3 MAN			

The probe sensor consists of a high intensity infrared emitting diode (IRED), a detector (four photodiodes), and a linear, solid state temperature transducer. The IRED produces a beam with half-power points at 50° in the axial plane of the sensor and 30° in the radial plane. The detector integrates IR scattered between 140° and 160° . Visible light incident on the sensor is absorbed by a filter (< 1% transmission below 790 nm). Sensor components are potted in glass-filled polycarbonate with optical grade epoxy.

Range: 0.02 - 2,000 FTU
Nonlinearity: + - 2.0%

Probe #430 is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software. The TTS software is from Redwood Sciences Lab - USDA / HSU. The probe is attached to the datalogger by a 20-foot cable running through a boom to the probe in the stream. A probe housing has been fabricated to protect the probe at the end of the boom.

The OBS-3 includes:

- A) Small size and sample volume
- B) Linear response and wide dynamic range
- C) Insensitivity to bubbles and organic matter
- D) Ambient light rejection and low temperature coefficient

D & A can be contacted at 40-A Seton Road, Port Townsend, WA, 98368, 360-385-0272

Campbell Scientific can be contacted at

815 W. 1800N. , Logan Utah 84321-1784, 435-753-2342, www.campbellsci.com

3. Calibration:

Turbidity probes shall be calibrated twice a year. Calibration shall be at the beginning of the sampling season in November and once in the middle in February. Probes may be calibrated in the field with HACH Formazin solutions or sent to the manufacturer for factory calibration. Redwood Sciences Lab calibration procedures shall be used for calibration in the field. If a T-probe is unstable, has been repaired, or is placed in a different housing, then it shall be calibrated again and not used until calibration is documented. The Lab Manager is responsible for implementing and documenting calibrations. Calibration record shall be kept in the Sunny Brae Sediment Lab and Salmon Forever offices.

Salmon Forever and Watershed Watch use a 3-point calibration of 0.0 NTU, 750 NTU and 1500 NTU. All other procedures for the calibration of a probe are the same as Redwood Sciences Lab procedures. The HACH Formazin solution is mixed in the field and used within 6 hours. A HACH 2100P Turbidimeter sample shall check the Formazin calibration solutions below 1000 ntu. The calculated turbidity value and the grab sample value shall agree within 2%.

The QA Manager shall be responsible for taking any t-probe out of service if it is acting unstable and documenting any subsequent actions and recalibration.

Field Calibration of D&A OBS-3 Turbidity Probes

Connected to Campbell Data Loggers

R. Eads
Redwood Sciences Lab
USDA Forest Service

Document Revised: 99 10 19

General Information

The following instructions are used to periodically calibrate D&A OBS-3 turbidity probes connected to a Campbell data loggers. It is recommended that the turbidity probe be calibrated at the beginning and the mid-point of each season, if the data is suspect, or when the optics become scratched. It is worth noting that both new and factory re-calibrated probes may have minor calibration errors (multiplier and offset) induced during shipping or handling if jarring disrupts the trim-pot settings inside the probe. Expect the probe's LED light source to age about 3% in 2000 hours of operation resulting in a calibration shift (the output signal decreases exponentially over a period of about 5 to 8 years in normal deployment with TTS). During calibration at the factory the probe is opened while in the each calibration solution and manually adjusted, for example, at two point's 0 and 2000 FTUs. The procedure below does not manually adjust the calibration but compensates for shifts in calibration by changing the software parameters "offset" (intercept) and "multiplier" (slope). It is a recommended that the probes are returned for factory calibration every three to five years. The probe, when connected to a CR10X, CR10, CR510, or CR500, has a maximum output of 2500mV. The CR21X can accept a 5000mV-(5V) signal from the probe. For the following instructions, it is assumed that the probe has a turbidity range of 0 to 2000 FTUs and a maximum output of 2500mV (2.5V). Therefore, the factory calibration multiplier would be 0.8 and the offset 0 because $1 \text{ FTU} = 0.8\text{mV}$, derived from $2000\text{FTU} / 2500\text{mV}$. The following procedure will probably result in a non-zero offset and a multiplier slightly different than the factory derived value. The formazin standard is first prepared in the lab then the turbidity probe is calibrated in the field. The formazin standard must be prepared the same day that the field calibration is preformed because of the short shelf life of the standard once it is mixed. In the following example, a two-point calibration is

performed using a 0 FTU standard (distilled water) and a 400 FTU standard. Remember to always perform the calibration starting with distilled water and proceed to the formazin standard to prevent contamination.

Laboratory Preparation of the Formazin Standard

Supplies Needed:

Volumetric flasks

- Pipette
- Formazin 4000 FTU standard stock solution
- Calibration containers (see under field section)
- De-ionized water
- Funnel
- Paper towels

Protective Equipment Required:

- Latex gloves
- Long-sleeved shirt or lab coat
- Goggles
- Fan; vent hood; or adequate ventilation
- Material safety data sheet (MSDS) from formazin supplier

Calculate the amount of solution needed:

$$V_{stk} = V_{tot} * (T_{std} / T_{stk})$$

Where:

V_{stk} = Volume of 4000 FTU stock solution needed to make field standard

V_{tot} = Volume of field standard

T_{std} = Turbidity of field standard

Tstk = Turbidity of stock solution (4000 FTU)

The following example makes a 400 FTU field standard with the correct volume (and depth of 6 inches) for a 6.5-inch id, straight-sided, black rubber bucket.

$(400 / 4000) * 3500 = 350$ ml of 4000 FTU stock solution needed.

Calculate the amount of de-ionized water required: $3500\text{ml} - 350\text{ml} = 3150$ ml of de-ionized water.

Therefore the final solution would contain 3150ml of de-ionized water + 350ml of 4000 FTU stock standard, yielding 3500 ml of 400 FTU field standard.

Mixing Procedures:

The formazin 4000 FTU standard accuracy is +/- 2%. Careful preparation of the field standard is **critical** because inaccurate volume measurement could raise the error to unacceptable levels.

- Wear the protective clothing mentioned above and direct the fan toward an open window (or use a vent hood).
- Determine which size volumetric flasks will be needed to make the field standard (a combination of flasks may be required).
- Measure-out the formazin standard first. Thoroughly mix the stock standard bottle by inverting the bottle several times before pouring into the volumetric flask (do not introduce air bubbles by shaking).
- Slowly pour the solution into the flask until it is about 1/2 inch below the line on the flask.
- Use a pipette, fitted with a squeeze-bulb valve (**do not use your mouth to draw-up the standard**), to add the remaining stock standard up to the line. The bottom of the meniscus should be even with the line on the flask. Pour the solution into the transportation container.
- Next, thoroughly rinse out the used volumetric flasks if they will be reused for measuring the de-ionized water.
- Measure the de-ionized water for formazin stock solution using the same procedure listed above and pour the water into the same transportation container.
- Cap the calibration container and gently swirl the solution to complete the mixing.
- Wash and rinse all equipment used for preparing formazin standard.

NOTE: In case of spill use absorbent towels or a sponge to wipe up the solution. Rinse out the sponge/towels in the sink drain using plenty of running water.

Field Calibration (requires two persons)

Equipment Needed

- Bucket, 4 or 5 gal, for 0 FTU, painted flat black inside, 10" id at bottom
- 3 gallons of distilled water
- Bracket to hold turbidity probe 2.75" off bottom of buckets
- Black rubber, or brown plastic, bucket, 6.5", or larger at the base
- 3500ml of 400FTU field standard (more is required if used a larger container)
- Plunging rod (perforated disk with handle) for mixing field standard
- Tap water for washing turbidity probe
- Squirt bottle for washing turbidity probe
- Non-abrasive dish soap for washing turbidity probe
- Soft cloth and brush for washing turbidity probe
- 2 Large funnels to return distilled water and standard to carrying vessels
- Spill-proof container for transporting field standard
- Tools and nylon ties for removing/attaching turbidity probe to boom
- Tape measure
- Safety equipment listed under the lab procedures

Collect the Current File

Follow the instructions in the TTS manual and perform a data dump to collect the current file (the data file will probably be erased in memory while loading the calibration program) and make a backup copy of the file. Make sure you have the latest TTS program revision available and that the current parameters are recorded. Make notes on the field form.

Load the Calibration Program

Follow the instructions in the TTS manual for loading programs. The executable program is called “obs3_ftr.dld”.

Get the Probe Ready

- Remove turbidity probe from boom.
- Next, clean probe (and housing if PVC) first with tap water then with soap and a soft brush or cloth then rinse with tap water.
- Mount the probe on the calibration bracket (or place the entire housing in the container if the probe is mounted in a PVC housing) and place it into the zero FTU-bucket.
- Pour the distilled water into the zero FTU-bucket and move the probe around to dislodge any bubbles that may be adhering to the optics.
- Attach the calibration bracket to the side of the zero-FTU bucket wall container so that the probe is 2.75” above the bottom of the bucket and the optics are facing the opposite bucket wall at a minimum distance of 10”.

Start the Calibration Software

The program starts executing once it is loaded but it will not collect data until the flags are set. Open the “Numeric” and the “Port/Flags” windows.

Setting the flags invokes the following operations:

Flag #1	Starts the calibration for the distilled water
Flag #2	Starts the calibration for the 400 FTU standard
Flag #3	Computes the multiplier and offset

Paste these Input Locations into the Numeric Window:

1	holds the <u>lowest</u> raw turbidity reading (mV)
60	hold the <u>highest</u> raw turbidity reading (mV)
med_0	median turbidity of the distilled water (mV)
med_400	median turbidity of the 400 FTU standard (mV)
turb_mult	multiplier
turb_off	offset

Start the Zero FTU Calibration (distilled water)

- Highlight Flag #1 to start the distilled water data collection.
- The calibration is completed when the Flag #1 is no longer highlighted.
- You can view the data in the Numeric window.
- Either calibration may be repeated if the data are suspect and prior to calculating the multiplier and offset, but make sure the data from the distilled water calibration is OK before moving the probe to the next standard.
- Remove the probe and then save or discard the distilled water.

Start the 400 FTU Calibration

- Gently swirl the 400 FTU standard in the transportation container.
- Carefully pour the standard into the calibration container.
- Attach the probe bracket to the side of the bucket (or place the PVC housing in the bucket).
- Thoroughly mix the standard with the plunger, then stop mixing and highlight Flag #2 when 10 seconds remain until the next execution interval (watch the data logger's clock display).
- The calibration is complete when Flag #2 is no longer highlighted.
- When satisfied with the data, highlight Flag #3 to calculate the multiplier and slope.
- When the Flag #3 is no longer highlighted, you can view the results.
- Record all of values from the input locations in the Numeric window onto the field form.
- Remove and clean the probe, then remount to the boom and place in the water.
- Pour the 400 FTU standard back into the transportation container using the correct funnel.

Load and Start the TTS Program

Follow the instructions in the TTS manual to load and start the program. After the first TTS, wakeup open the Numeric window and paste in all the normal input locations. Then update the turbidity slope and offset values. Update the multiplier and slope on the parameter sheet. Complete the field form notes. The new values will take effect at the next wakeup.

End

4. Sample Collection:

The OBS-3 Turbidity probe records a data point every 15 minutes on the Campbell Datalogger. Data will be downloaded onto an on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically download turbidity data and take a floppy disk back to RSL for data analysis. Salmon Forever shall download data for data analysis and archiving monthly.

5. Handling & Preservation:

There are no handling and preservation requirements for the OBS-3 turbidity electronic data. See Sample Collection (#4) for data back-up procedures.

6. Troubleshooting / Maintenance:

Higher than possible turbidity readings may be from debris on the optics. Clean the optics with soap, toothbrush and water as frequently as possible, usually during a field visit to the site. Put a finger about a half an inch from the optics at a sensor data reading period and a NTU of at least a 1000 FTU should be registered. If no readings are coming at all, check the connections at the probe and datalogger. Cleaning the T-Probe optics may cause the program to collect an ISCO sample at the next wake-up because the turbidity dropped after removing the contamination.

Maintenance:

Periodically (once a week or so depending on the time of year) clean the optics with the squirt bottle and soft bush. Documentation on the cleaning of the probe optics is located in the RSL Field Form.

7. Data Acquisition, Calculations & Data Reduction:

The OBS-3 Turbidity probe records a data point every 15 minutes on the Campbell Datalogger. The probe produces turbidity data in mV and is converted to NTU using calibration slope and offset data. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download turbidity data and take a floppy disk back to RSL for data analysis. The analysis will be carried out at RSL on a Unix operating system using S-Plus and Perl. The majority of the analysis tools and plotting routines were written in S-Plus because of its powerful ability to manipulate and graphically represent the data.

8. Computer Hardware and Software Used:

The probe is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software. The TTS software (V3.1) is from Redwood Sciences Lab - USDA.

Campbell PC208W Window support software is used with a Campbell CR10X Datalogger. Turbidity Threshold Sampling software is used to trigger the taking of pump samples by the ISCO 2100 Automatic Sampler in response to input from the OBS-3 probe.

Software used for data analysis and calibration will include Microsoft Word and Excel programs. Redwood Sciences Lab software will be used to also conduct data analysis of probe and other instrument data. Software may also include specialized statistical and graphing programs.

Some of the analysis will be carried out at Redwood Sciences Lab on a Unix operating system using S-Plus and Perl. The majority of the analysis tools and plotting routines for ISCO related sampling were written in S-Plus because of its ability to manipulate and graphically represent the data.

9. Data Management & Records Management:

The OBS-3 Turbidity probe records a data point every 15 minutes on the Campbell Datalogger. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download turbidity data and take a floppy disk back to RSL for data analysis. Data shall be graphed and outliers noted and RSL Field Forms used to eliminate faulty data.

Back-up floppy disks shall be kept at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

10. QA / QC:

A. Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager in the annual QA Report.

Continuous Turbidimeter Measurement (OBS-3 Probe)

Internal QC:

A. Formazin Calibration beginning and mid-season per RSL protocol

B. HACH Turbidimeter Comparison monthly - 3 HACH cell grab samples shall be taken next to the probe optics at a field visit. The average of the 3 HACH cell readings shall agree with the probe readout to within 10%. If the difference is more than 10% the probe optics shall be washed and comparison run again. If readings are still more than 10% different the probe offset shall be changed to agree with the HACH reading.

External QC: None

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses.

Continuous Turbidimeter Measurement (OBS-3 Probe)

Internal QA: Computer readout check and documentation at field visit.

External QA - None

11. References:

D&A Instruction Manual OBS-1 & 3 March 1991

SOP Cont.Turb9-19-00/word98/cf/9-19-00

**Standard Operating Procedures
For
Determining**

**Stage Levels
Using a
Druck 1830 Pressure Transducer**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

**Salmon Forever
9-19-00**

Prepared By _____ **Date** _____

Approved By _____ **Date** _____

1. Scope:

This SOP covers the operation of a Druck 1830 pressure transducer. The primary station on Freshwater Creek incorporates an ISCO model 2100 automatic pumping sampler, an Campbell CR101X datalogger, Druck 1830 pressure transducer, D&A OBS-3 turbidity probe, Campbell 107LC Thermistor temperature probe and a TR525I Tipping Rain Gage. The Druck Pressure Transducer may be used in conjunction with any of these apparatus.

2. Apparatus:

Druck Model PCDR 1830 Pressure Transducer

This model comes with a pressure range between 5 and 900 psi
Accuracy + - 0.25% of the Full Scale Range.

A vent tube incorporated into the cable vents the sensor diaphragm to the atmosphere. This eliminates the need to compensate the water level measurement for changes in barometric pressure. The sensor uses a 6 wire connection to connect to a Campbell CR101X datalogger.

3. Calibration:

The Druck 1830 Pressure Transducer shall be calibrated twice a year. Calibration shall be at the beginning of the sampling season in November and once in the middle in February. Redwood Sciences Lab calibration procedures shall be used for calibration in the field. If a pressure transducer is unstable, has been repaired, or is placed in a different housing, then it shall be calibrated again and not used until calibration is documented. The Lab Manager is responsible for implementing and documenting calibrations. Calibration records shall be kept in the Sunny Brae Sediment Lab and Salmon Forever offices.

The QA Manager shall be responsible for taking any pressure transducer out of service if it is acting unstable and documenting any subsequent actions and recalibration.

**Field Calibration of the Druck 1830 Connected to
A Campbell Data Logger
Configured as a Full Bridge (P9)**

USDA Forest Service
Redwood Sciences Lab
R. Eads
Revised: 99 10 21

Equipment

- 1" PVC calibration pipe about 10 ft. in length, cap glued on bottom
- 10 ft. of cloth measuring tape in tenths of feet
- Electric tape
- Water bucket to fill pipe
- Ladder

End the TTS Program

- Follow the TTS manual and dump the data; back up the data on floppy
- Make notes on field form

Load the Calibration Program

- Follow the TTS manual and load the calibration program "druckcal.dld"
- After the first wakeup open the Numeric Window and paste in "avg_stg"
- The program runs every 20 seconds

Setup the Equipment

- Attach the zero on the tape at the small radial holes (don't block the holes)
- Stand on a ladder with pressure transducer
- Fill the pipe with water until it overflows
- Submerge the transducer just past the radial holes
- Tap transducer to dislodge bubbles in holes

Calibration

- Carefully lower the transducer to .25 ft, overflowing the water
- Keep the desired depth on the tape at the surface of the meniscus
- Keep the tape taught
- Keep everything still
- Accept the second reading (avg_stg) after stabilization
- Record the depth and avg_stg on the field form
- Lower to the next depth (4 or 5 points is enough, end about 8 ft.)

Plot the Data

- Enter the depth/avg_stg pairs into an Excel spreadsheet
- Regress the data and record the slope (multiplier)
- Record multiplier on field form and on parameter sheet

Start Normal Data Collection

- Secure pressure transducer in normal sampling position
- When finished will all calibrations load the TTS program
- After the first wakeup open the Numeric Window
- Edit the multiplier value for stage

Note

Whenever a new program version is loaded the “old” values for multipliers and offsets may be loaded instead of the current values. A better way (but more dangerous) is to edit the program, enter the new values, save the program and load it into the data logger. This will ensure the current values are preserved.

4. Sample Collection:

The Campbell Datalogger records a stage data point every 15 minutes. Data will be downloaded onto a on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

5. Handling & Preservation:

There are no handling and preservation requirements for the stage electronic data. See Sample Collection (#4) for data back-up procedures.

6. Troubleshooting:

Common causes of erroneous data include:

Poor sensor connection to the datalogger, damaged cables, damaged transducers, moisture in the vent tube. Check connections to the datalogger, Inspect the cable for wear, Check the vent tube for plugging and condensation.

Maintenance: 3 or 4 small desiccant packs shall be kept in the transducer enclosure and changed monthly.

Wiring will be inspected for physical condition. Inspect transducer cable conditions

Major and sudden differences between stage and staff plate readings may be caused by the transducer and cable being moved. Check the placement of the transducer in pipe and change stage offset to match staff plate.

7. Data Acquisition, Calculations & Data Reduction:

The Campbell Datalogger records a pressure transducer data point every 15 minutes. The probe produces stage data in mV and is converted to stage using calibration slope and offset data. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles

are changed. Redwood Sciences Lab will periodically, at least monthly, download turbidity data and take a floppy disk back to RSL for data analysis.

Offset shall be set by comparison with a documented staff plate. Both transducer stage and staff plate stage shall be documented on each RSL Field Form and compared with each new field form. Instructions for calculating the offset are in the RSL ISCO Manual in ISCO SOP.

Campbell TTS Field Manual
09/08/99

A. Adjusting the Stage Offset (8.0)

Adjust the stage offset ("stg_off") when the electronic stage differs from the staff plate by more than 0.05 feet.

A.1 Calculate the correction to the offset (pay attention to the +/- signs):

The electronic stage is too high:
Calculate the error,

$$1.57' \text{ staff} - 1.64' \text{ electronic} = -0.07' \text{ error}$$

Calculate the new offset,

$$-0.475' \text{ current offset} + -0.07' \text{ error} = -0.545' \text{ new offset}$$

The electronic stage is too low:

Calculate the error,

$$2.45' \text{ staff} - 2.37' \text{ electronic} = +0.08' \text{ error}$$

Calculate the new offset,

$$-0.475' \text{ current offset} + 0.08' \text{ error} = -0.395' \text{ new offset}$$

Click on the "Numeric Display" tab on the lower left corner of the "Datalogger Connection" window to display the current values.

A.2 Place the arrow of the cursor on the value to the right of "stg_off", then right-click. An "Edit Value" window will appear. Left-click on the "Edit Value" window. The location highlights yellow. Type in the new value, with "-" in front, then press [ENTER] when done.

A.3 The new offset will become effective at the next wake-up.

A.4 Make a note on the field form under "Comments" and change the "Parameter Sheet" to reflect the new offset.

8. Computer Hardware and Software Used:

The Druck 1830 Pressure Transducer is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software. The TTS software (V 3.1) is from Redwood Sciences Lab - USDA.

Software used for data analysis and calibration will include Microsoft Word and Excel programs. Some of the analysis will be carried out at Redwood Sciences Lab on a Unix operating system using S-Plus and Perl. The majority of the analysis tools and plotting routines for ISCO related sampling were written in S-Plus. A PC version of the analysis software is being developed at RSL and it is anticipated to use this for data analysis.

9. Data Management & Records Management:

The Druck Pressure Transducer records a data point every 15 minutes on the Campbell Datalogger. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download data and take a floppy disk back to RSL for data analysis. Data shall be graphed and outliers noted and RSL Field Forms used to eliminate faulty data. Back-up floppy disks shall be kept at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

10. QA / QC:

A. Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager in the annual QA Report.

Internal QC: Calibration by RSL methods at the beginning and middle of the sampling season
The transducer shall not be put in service unless it passes calibration. The transducer shall be checked against the staff plate immediately and the offset adjusted as needed.
External QC: None

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses.

Internal QA: Computer readout check against staff plate and documentation weekly
External QA - None

11. References

Application Note, 1998, Druck's Model 1230 and 1830 Pressure Transducers, Campbell Scientific Inc.

**Standard Operating Procedures
For Determining**

**Temperature Levels
Using a
Campbell 107 Thermistor temperature probe**

**In
Rivers and Streams
Of
Humboldt, Trinity and Mendocino Counties
California**

Salmon Forever

9-19-00

Prepared By _____

Date _____

Approved By _____

Date _____

1. Scope

App. Note Code: 2D-P Revision: 1

This SOP covers the proper use of the Campbell 107 Thermistor temperature probe.

2. Apparatus

1 - Campbell 107 Thermistor temperature probe.
Accuracy of + - 0.9 degree centigrade of - 38c to 53c

3. Calibration

The Campbell 107 Thermistor Temperature Probe shall be calibrated once a year. Calibration shall be at the beginning of the sampling season in November. Redwood Sciences Lab calibration procedures shall be used for calibration in the field. If a temperature probe is unstable, has been repaired, or is placed in a different housing, then it shall be calibrated again and not used until calibration is documented. The Lab Manager is responsible for implementing and documenting calibrations. Calibration records shall be kept in the Sunny Brae Sediment Lab and Salmon Forever offices.

The QA Manager shall be responsible for taking any pressure transducer out of service if it is acting unstable and documenting any subsequent actions and recalibration.

Field Calibration Check for Campbell 107 Thermistor Temperature Probes

USDA Forest Service
Redwood Sciences Lab
R. Eads
Revised: 99 10 21

Equipment

- Ice
- Warm water (about 30 deg C)
- Insulated calibration vessel
- ASTM MIG Thermometer (0.1 deg C resolution)
- Stirring rod

Dump the TTS Data

- Follow the instructions in the TTS manual and dump the data
- Make a backup to floppy disk

Load the Calibration Program

- Follow the instructions in the TTS manual and load "T107cal.dld"
- Open the Numeric Window and paste in "temp"
- You can also open a graphic window to watch the temperature equilibration
- The program will run every 30 seconds

Perform the Calibration

- In an insulated container add ice and then water
- Place the probe and thermometer in the center of the container
- Wait 4 minutes, then slowly stir while keep the probe and thermometer in the center of the container
- When the thermometer has stabilized (don't lift it out of the water to read it) you can accept and record the electronic temperature reading and thermometer reading on the field form
- Replace the cold water with warm water about 30 deg. C
- Repeat the instructions above.

Reload the TTS program

Follow the instruction in the TTS manual and reload the TTS program. Open the Numeric Window and paste in the appropriate variables.

4. Sample Collection

The Campbell Datalogger records a temperature data point every 15 minutes. Data will be downloaded onto a on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

5. Handling Preservation

There are no handling and preservation requirements for the stage electronic data. See Sample Collection (#4) for data back-up procedures.

6. Troubleshooting

Common causes of erroneous data include:

Poor sensor connections to the datalogger and damaged cables.

Check connections to the datalogger. Inspect the cable for wear.

7. Data Acquisition, Calculations & Data Reduction

The Campbell Datalogger records a temperature data point every 15 minutes. The probe produces temperature data in mV and is converted to stage using calibration slope and offset data. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

8. Computer Hardware and Software Used

The Campbell 107 Thermistor temperature probe is connected to a Campbell Scientific CR10X Datalogger and operated by Campbell PC208W Window support software and Turbidity Threshold Sampling software. The TTS (V 3.1) software is from Redwood Sciences Lab - USDA / HSU.

Software used for data analysis and calibration will include Microsoft Word and Excel programs. Some of the analysis will be carried out at Redwood Sciences Lab on a Unix operating system using S-Plus and Perl.

9. Data Management & Records Management

The Campbell 107 Thermistor temperature probe records a data point every 15 minutes on the Campbell Datalogger. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download data and take a floppy disk back to RSL for data analysis. Data shall be graphed and outliers noted and RSL Field Forms used to eliminate faulty data. Back-up floppy disks shall be kept at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

10. QA / QC

A. Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager in the annual QA Report.

Internal QC: Factory calibration or calibration by RSL methods at the beginning of the sampling season

The probe shall not be put in service unless it passes calibration.

External QC: None

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses.

Internal QA: Computer readout check and documentation weekly

External QA - None

11. References

Field Calibration Check for Campbell 107 Thermistor Temperature Probes

USDA Forest Service - Redwood Sciences Lab

R. Eads

Revised: 99 10 21

**Standard Operating Procedures
For
Determining**

Precipitation Quantity Totals

**Using A
Campbell TR525I Tipping Bucket Rain Gauge**

**Salmon Forever
5-1-00**

Prepared By _____

Date _____

Approved By _____

Date _____

1. Scope

This SOP covers the use of a Tipping Bucket Rain Gauge to record precipitation totals. The gauge is attached to a Campbell CR10X Datalogger. Each tip of the bucket is 0.01 of an inch of precipitation.

2. Apparatus

1- Texas Electronics Inc. Tipping Bucket Rain gauge Model # TR525I Serial # 23623-199.

3. Calibration

Field Calibration Check for Campbell TE52I Tipping Bucket Rain Gage

USDA Forest Service - Redwood Sciences Lab - R. Eads

Revised: 99 10 21

Equipment

- Soft brush, water in squirt bottle, and soap
- Calibrated vessel holding a known volume of water (411ml = 50 tips is the minimum volume to detect a calibration error of \approx 2 tips)
- Screwdriver
- Paper or cloth towels

Software

- Dump the TTS data and make a backup on floppy
- Follow the TTS manual instructions and load the calibration program "rain_cal.dll"
- Open the Numeric window and paste in "tips" (holds the number of tips)

Procedure

- Check the calibration at the beginning of the hydrologic year
- Remove and clean the screen
- Remove the outer shell of the rain gage.
- Dry-brush debris out of the buckets and base
- Holding the tipping mechanism with one hand wash out the tipping mechanism with soap and a soft brush
- Rinse with clear water and wipe dry
- Reassemble the rain gage but leave the screen off
- Using the squirt bottle slowly add water until one tip occurs
- Setup the water delivery vessel

- Slowly drip the water into the gage at a rate no faster than 1 drop every 35 seconds (411ml would take about 30 minutes)
- Compare the number of tips to volume delivered
- 1 tip = 0.01 inches = 8.23ml
- See the tipping bucket manual for calibration procedures
- The manual recommends adjustment if tip error exceeds $\frac{3 \text{ tips}}{100}$
- Follow the TTS manual and load the TTS program and paste the variables into the Numeric window following the first wakeup

4. Sample Collection

Opposing buckets on a teeter-totter arrangement are filled by precipitation through a screen and funnel. As one bucket fills and tips the other bucket is brought up under the funnel spout and when it fills and tips the other bucket is brought back up. The buckets hold a known volume before they tip and tips are summed up to provide an ongoing precipitation total. The Rain Gauge is a passive data collector and no special instructions are needed for sample collection. The Campbell Datalogger records a stage data point every 15 minutes. Data will be downloaded onto a on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

5. Handling & Preservation

No samples are preserved. As each bucket full of water is tipped it flows out the bottom of the instrument to the ground below.

6. Troubleshooting

If data is unusual or no tips are recording during rainfall the buckets and funnel should be inspected. The screen and funnel should be cleaned monthly. The tipping bucket should be checked monthly for debris collecting in the bucket.

7. Data Acquisition, Calculations & Data Reduction

The Campbell Datalogger records a stage data point every 15 minutes. Data will be downloaded onto a on-site computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed.

8. Computer Hardware and Software Used

The Campbell TR525I Tipping Bucket Rain Gauge is connected to a Campbell Scientific CR10X Datalogger and operated by Windows 95, Microsoft Explorer and Campbell PC208W Window support

software and Turbidity Threshold Sampling software. The TTS software is from Redwood Sciences Lab - USDA / HSU.

Software used for data analysis and calibration will include Microsoft Word and Excel programs. Some of the analysis will be carried out at Redwood Sciences Lab on a Unix operating system using S-Plus and Perl. The majority of the analysis tools and plotting routines for ISCO related sampling were written in S-Plus.

9. Data Management & Records Management

The datalogger records a data point every 15 minutes from the Gauge. Data will be downloaded onto a computer hard drive and a back-up floppy disk whenever the ISCO sampler bottles are changed. Redwood Sciences Lab will periodically, at least monthly, download data and take a floppy disk back to RSL for data analysis. Data shall be graphed and outliers noted and RSL Field Forms used to eliminate faulty data. Back-up floppy disks shall be kept at Sunny Brae Sediment Lab, Salmon Forever offices and Redwood Sciences Lab. Data will be in a format acceptable to EPA, RSL and NCRWQCB.

10. QA / QC

A. Quality control (QC) measures are those activities undertaken to demonstrate the accuracy (how close to the real result you are) and precision (how reproducible your results are) of your monitoring. Quality Control consists of the steps you will take 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. Results of analysis and corrective actions shall be reported to the Project Manager in the annual QA Report.

Campbell TR525I Tipping Bucket Rain Gauge

Internal QC: Calibration by RSL methods at the beginning of the sampling season
Calibration will be documented with a calibration sheet. Calibration will meet RSL tolerances or will be recalibrated again. The gauge will not be used unless it passes calibration.

External QC: None

B. Quality Assessment/Assurance (QA) generally refers to a broad plan for maintaining quality in all aspects of a program. Quality assurance/assessment is your assessment of the overall precision and accuracy of your data, after you've run the analyses.

Campbell TR525I Tipping Bucket Rain Gauge

Internal QA: Computer readout check against location rain-gauge and documentation weekly on the ISCO Field form. The rain gauge will be inspected and recalibrated if necessary if any discrepancies appear in comparison with local raingauge. QA manager will document any discrepancies and corrective action.

External QA - None

11. References