

STANDARD OPERATING PROCEDURES

VOLUME IV OF VI
SURFACE WATER

ROCKY FLATS PLANT
ENVIRONMENTAL MONITORING AND ASSESSMENT DIVISION
P.O. Box 464
Golden, CO 80402

February 1991

REVIEWED FOR CLASSIFICATION/UCM
By V. A. Muenchow *ann*
Date 6/11/91

A-SW-000143

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STANDARD OPERATING PROCEDURES

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SURFACE WATER**

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SURFACE WATER DATA
COLLECTION ACTIVITIES

J. W. Langman

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) in the performance of field activities at surface water collection sites. This SOP describes initial site evaluation procedures and outlines an order of data collection activities to be performed at each site by a two-member team. Details are provided in this document so that all sampling personnel following these procedures will deliver samples to the laboratory and will perform discharge and field parameter measurements in a consistent manner.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

The project manager or task leader is responsible for assigning project staff to complete surface water data collection activities at RFP property. The task leader is also responsible for ensuring that this and other appropriate procedures are followed by project personnel.

Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel. The subcontractor's project manager will document personnel qualifications related to this procedure in the subcontractor's project QA files.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure.

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General Environmental Protection Program. DOE Order 5400.1 November 1988.

Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. EPA/540/g-89/004, October 1988.

RCRA Facility Investigation Guidance. USEPA, Interim Final. May 1989.

Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, SW-846. EPA. September 1986.

NPDES Compliance Sampling Inspection Manual. USEPA, MCD-51. 1979.

4.2 INTERNAL REFERENCES

Related SOP's cross-referenced by this SOP are:

- SOP 1.3, General Equipment Decontamination
- SOP 1.6, Handling of Personal Protective Equipment
- SOP 1.7, Handling of Decontamination Water & Wash Water
- SOP 1.10, Receiving, Labeling, and Handling Waste Containers
- SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP 4.1, Surface Water Collection Activities
- SOP 4.2, Field Measurement of Surface Water Parameters
- SOP 4.3, Surface Water Sampling
- SOP 4.4, Discharge Measurements
- SOP 4.5, Base Laboratory Work



5.0 METHODS

5.1 PREPARATIONS FOR FIELD ACTIVITIES

To prepare for the daily field data collection activities, SOP 4.5, Base Laboratory Work, will be followed. In addition, the field teams will verify that items required in the field equipment checklist (Form 4.1B) are in the field vehicle and are in proper working order before leaving for the field each day.

5.2 SITE EVALUATION

Upon arrival at the field data collection site, the field crew will park the field vehicle on the most level ground available, as close to the surface water site as is practical. The crew will review the sample site field folder to locate the sampling point and to become familiar with historical conditions at the site.

The crew will select an area to perform decontamination procedures. The decontamination facility must be located between the sampling site and the field vehicle. Decontamination equipment will be placed on plastic sheeting a reasonable distance away from both the sampling site and the field vehicle, and will be arranged for efficient use.

The crew will carry the following to the data collection site: (1) instruments for measuring in-stream water quality parameters and temperature, (2) equipment for measuring discharge appropriate to the flow regime, and (3) water sampling equipment and containers. However, typically, the crew will be able to work directly from the field vehicle. In this case, the crew will proceed to the stream or data collection point.

The team will then collect representative water quality samples as outlined in SOP 4.3, Surface Water Sampling, and will perform discharge measurements as described in SOP 4.4, Discharge

Measurement. Water quality samples will always be obtained before discharge measurement.

5.3 DATA COLLECTION

A suggested sequence for data collection and site activities is as follows:

- In accordance with the field folder, SOP 4.3, Surface Water Sampling, and SOP 4.4, Discharge Measurement, a technician will select and assemble water sampling equipment, discharge measuring equipment, and decontamination equipment. The equipment will be arranged conveniently on plastic sheeting.
- A technician will assemble and set up the pH meter, and the conductivity meter.
- A technician will record Site I.D., date, names of party members, weather conditions, and air temperature.
- A technician will observe and record site-specific conditions which impact selection of flow measurement or water sampling techniques.
- A technician will evaluate the site and determine the point at which sampling and discharge measurements will be accomplished, as per guidelines in SOP 4.3, Surface Water Sampling and SOP 4.4, Discharge Measurement.
- A technician will measure and record the water temperature in the field logbook, and will set up the dissolved oxygen (D.O.) meter for in-situ measurement. The D.O. probe will be calibrated, as described in SOP 4.2, Field Measurement of Surface Water Field Parameters. The D.O. will then be measured and recorded in accordance with SOP 4.2.

- If the water is to be sampled for VOCs, Cyanide, or BNA analysis, a technician will collect a representative sample from the stream to be analyzed for Total Residual Chlorine. This is needed to determine preservation requirements for those samples. Total Residual Chlorine measurements will be made in accordance with SOP 4.2, Field Measurements of Surface Water Field Parameters.
- A technician will then employ the appropriate method to collect representative water quality samples from the stream in accordance with SOP 4.3, Surface Water Sampling, and will perform the remaining field parameter measurements. A technician will record the sample time, to the nearest five minutes, and carry the water samples to the decontamination area.
- A technician will decontaminate and package the samples, according to SOP 1.13, Containerizing, Preserving, Handling and Shipping of Soil and Water Samples.
- A technician will perform a premeasurement spin test of the current meter if it is to be used for discharge measurement, and will record the result of the spin test. This test will be performed in a place sheltered from the wind.
- A technician will measure discharge by using the method appropriate to the flow regime, as described in SOP 4.4, Discharge Measurement.
- A technician will perform a post-measurement spin test of the current meter if it has been used for discharge measurement, and will record the result on the Surface Water Data Collection Field Notes.
- A technician will check and/or calibrate the pH meter, dissolved oxygen meter, and conductivity meter as described in SOP 4.2, Field Measurement of Surface

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Water Field Parameters. A technician will measure pH, specific conductance, alkalinity, and other field parameters, and filter samples as required in SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Field parameter measurements and sampling times will be recorded on the field form.

- A technician will assist the other technician in sample packaging, preserving, and recording. A technician will record sample preparation as set forth in SOP 1.13, Containerizing, Preserving, Handling and Shipping of Soil and Water Samples.
- A technician will disassemble, decontaminate, and store the data collection instruments. Decontamination methods are detailed in SOP 1.3, General Equipment Decontamination.
- Liquid wastes, including decontamination water, residual samples, and wash water will be handled as described in SOP 1.7, Handling of Decontamination Water & Wash Water.
- Solid waste will be handled in accordance with SOP 1.10, Receiving, Labeling, and Handling Waste Containers.
- Both technicians will survey the area to verify that all equipment has been returned to the vehicle.
- The technicians will perform personal decontamination in accordance with SOP 1.6, Handling of Personal Protective Equipment, before entering the field vehicle or proceeding to the next data collection site or the base laboratory operation facility.

The foregoing sequence of data collection and site activities may vary with site conditions. For example, discharge may not be measured if a site contains no flow. However, field activities will be generally guided by the list, and a technician initiating a specific task will carry the task to completion.

6.0 DOCUMENTATION

All field activities will be recorded in the field logbooks or on field forms. The Surface Water Data Collection Form (Form 4.1A) is used for surface water sample collection data. Descriptions of problems encountered, deviations from the SOP, and the number of Surface Water Data Collection Forms are used to record field team activities for a given day will also be included.

The Surface Water Data Collection Form is used to record the majority of data collected at each site. Initials of the individual entering the information onto the form should be written next to each entry as it is made. All data routinely obtained in surface water data collection activities will be on the surface water field note which has spaces for most surface water data entries. The surface water data collection form also contains sampling condition, method, stream, and weather sections in which the field personnel are to circle the appropriate descriptions. Field note entries will include, at a minimum the following information:

- Date and time of each entry or activity
- Names of field personnel
- Names of all visitors to the site during field activities
- Location of field activities
- Description of sampling conditions, location, method, sampler types, materials, and weather.
- Field Measurements
- Values of field parameters

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- List of samples collected; analytes; and preservation techniques
- Discharge measurements
- Calculations
- Comments and observations

SURFACE WATER DATA COLLECTION FIELD NOTES

FIELD CALIBRATION								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
pH			UNITS					
SC								
DO			MG/L					

DEPTH _____ FIELD MEASUREMENTS								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
T air			°C		--	--		
T H ₂ O			°C		--	--		
DO			MG/L		--			
pH					4/10			
SC			mS/CM					
ALKA			MG/L		1.6/16 N H ₂ SO ₄	DIGITAL CNTS		
CL ₂			MG/L		DPD	--		
SILICA								
GAGE HT.								

DEPTH _____ FIELD MEASUREMENTS								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
T air			°C		--	--		
T H ₂ O			°C		--	--		
DO			MG/L		--			
pH					4/10			
SC			mS/CM					
ALKA			MG/L		1.6/16 N H ₂ SO ₄	DIGITAL CNTS		
CL ₂			MG/L		DPD	--		
SILICA								
GAGE HT.								

SURFACE WATER DATA COLLECTION FIELD NOTES

A. DO CALIBRATION CALCULATIONS

Temperature (4°C) = _____, Multiplication Factor (MF) = _____

Barometric Pressure = _____, Multiplication Factor (MF) = _____

Temp (MF) _____ x BB (MF) _____ = _____ mg/L O₂

B. ALKALINITY MEASUREMENT CALCULATIONS

Fixed End Point: _____

Normality H₂SO₄ 1.600 _____ 0.160 _____ Other _____

Original pH _____ Final pH _____

Sample Size _____ mL Digital Count (D.C.) ___ Factor (2.0; 0.2; 1.0; 0.1)

DC _____ x Factor _____ = Alkalinity _____ mg/L as CaCO₃

Original pH _____ Final pH _____

Sample Size _____ mL Digital Count (D.C.) ___ Factor (2.0; 0.2; 1.0; 0.1)

DC _____ x Factor _____ = Alkalinity _____ mg/L as CaCO₃

Original pH _____ Final pH _____

Sample Size _____ mL Digital Count (D.C.) ___ Factor (2.0; 0.2; 1.0; 0.1)

DC _____ x Factor _____ = Alkalinity _____ mg/L as CaCO₃

Original pH _____ Final pH _____

Sample Size _____ mL Digital Count (D.C.) ___ Factor (2.0; 0.2; 1.0; 0.1)

DC _____ x Factor _____ = Alkalinity _____ mg/L as CaCO₃

COMMENTS/OBSERVATIONS:

FIELD EQUIPMENT CHECKLIST

1. SW Equipment

- Conductivity Meter _____
- pH meter _____
- D.O. meter _____
- Alkalinity equipment: titrator, stir bars, stirrer, acid cartridges (.16 and 1.6N H₂SO₄) _____
- Sample bottles (plus extras of each) _____
- Thermometers _____
- Samplers for all sampling conditions (including extension rods) _____
- Coolers containing sample containers _____
- Blue ice _____
- Extra sample containers (2 of each type used, in a closed box) _____
- Buffers _____
- Standards _____
- Gloves _____
- Churn splitter (if required) _____
- Peristaltic pump _____
- Preservatives, as required (such as HNO₃, H₂SO₄, NaOH, and sodium thiosulfate: Na₂S₂O₃) _____
- pH paper _____
- Lab glassware _____
- Filters (0.45 μm in-line filters) _____
- Non-breakable volumetric flasks with lids: 50 ml and 100 ml _____
- Plastic storage bags for samples _____
- Sample labels _____
- Chain-of-custody forms _____
- Marker Pens _____

2. Personal Equipment

- Communication radio _____
- PPE, as discussed in the Health & Safety Plan _____

- Wrist or pocket watch _____
- Rain gear _____
- Duct tape _____
- Pocket knife _____
- First aid kit _____
- Water cooler, filled with drinking water, and paper cups _____

3.Stream-Gaging Equipment

- Clipboard with string to attach to hydrographer (if desired) _____
- Velocity chart _____
- Type AA current meters with spare parts (for high flow conditions only) _____
- 1 pygmy meter, with very small screwdriver _____
- 1 wading rod (complete) _____
- 1 head set (complete for wading measurements) and/or velocity meter _____
- 1 pair waders carried in pack sack or equivalent (for high flow conditions only) _____
- 1 pair hip boots carried in pack sack or equivalent _____
- 1 stop watch _____
- 2 life jackets (for high flow conditions only) _____
- Calibrated volumetric containers _____
- Pack sack _____
- Steel tapes and/or taglines, as required _____
- Axe _____
- Shovel _____
- Flashlight _____
- Meter Oil _____

4.Decontamination Equipment

- Nonphosphate detergent _____
- Distilled water, and, if desired, potable water _____
- Buckets with lids, or other containers for wastewater _____
- Brushes _____
- Plastic Sheeting _____

5. Hand Tools and Supplies

- Tool box _____
- 1 claw hammer _____
- 2 to 4 screwdrivers (small to large) _____
- 1 ordinary pliers _____
- 1 roll electrician's tape _____

6. Forms and Supplies

- 1 briefcase equipped with the following:
 - Applicable SOPs, HSP, FSP, and other required documentation _____
- All necessary forms _____
- Logbooks _____
- Field folders for site to be evaluated _____

7. Automotive Equipment

- Jack _____
- Chains _____
- Spare tire _____
- Automobile accident forms _____
- Credit cards _____
- Tow rope or chain _____
- Jumper cables _____

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FIELD MEASUREMENT OF SURFACE
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Approved By:

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METER B-1

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) to obtain measurements of surface water parameters in the field. These parameters are temperature, dissolved oxygen, pH, alkalinity, specific conductance, total residual chlorine, free chlorine, turbidity, and silica. This SOP describes field measurement procedures, personnel responsibilities and qualifications, and quality assurance/quality control (QA/QC).

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel measuring surface water field parameters will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. U.S. Environmental Protection Agency. Washington, D.C. 1987.

Data Quality Objectives for Remedial Activities Development Process. EPA/540/G-87/003. U.S. Environmental Protection Agency. Washington, D.C. 1987.

Field Guidelines for Collection, Treatment and Analysis of Water Samples, Arizona District. L.R. Kister and W.B. Garrett. 1984.

HACH DR/2000 Spectrophotometer Handbook, 1988.

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HACH ONE Electrode System Manual. 9-8-89-SED. HACH Company. Loveland, CO. 1989.

HACH Quick Reference Card. K81-2ED. HACH Company. Loveland, CO.

Instruction Manual. Model 44600 Conductivity/TDS meter 5-23-89-6ED. HACH Company. Loveland, CO. 1989.

Standard Methods for the Examination of Water and Wastewater. 16th Edition. Method 212. 1985.

The Environmental Survey Manual. DOE/EH-0053. Appendix E, "Field Protocols and Guidance." U.S. Department of Energy. Washington, D.C. August 1987.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are:

- SOP 1.3, General Equipment Decontamination
- SOP 1.7, Handling of Decontamination Water and Wash Water
- SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP 4.3, Surface Water Sampling

5.0 FIELD MEASUREMENT PROCEDURES

Calibration procedures for the equipment described in this section are found in Appendixes A and B. Solutions used for standardizing, calibrating, or titrating will be checked prior to use in field activities to determine if the expiration dates have been exceeded. Expired solutions will be discarded and replaced with new solutions.

5.1 TEMPERATURE

Temperature measurements will be made with a high quality mercury-filled thermometer or thermistor having an analog or digital readout device. This thermometer is to have been standardized by comparison with a thermometer calibrated against a National Institute of Standards and Technology (NIST) calibrated thermometer. All temperature-measuring devices will be scaled to indicate degrees Celsius and marked as appropriate to meet data quality objectives. Glass thermometers will be transported in a protective case to prevent breakage. Thermometers will be Teflon® coated safety type, 305 mm in length, and scaled from -20°C to +110°C in 1° increments (VWR CAT No. 61017-823 or equivalent). Field thermometers will also be enclosed in an armored casing to prevent breakage (VWR CAT No. 61017-562 or equivalent).

Temperature measurements made for the purpose of providing adjustment factors for other field parameters will be conducted simultaneously with those related measurements. Volumes and methods of collection will be determined by the procedural requirements of the primary field measurement taken. Thermometer or thermistors used in the field will be standardized at least monthly against an NIST traceable thermometer.

Procedure:

- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field temperature measurements.
- Only mercury-filled thermometers or thermistors that are in calibration will be used.
- Inspect the thermometer before each field trip to ensure that there are neither cracks in the glass nor air spaces or bubbles in the mercury.

- If a thermometer should be broken in the field, the location will be noted in the logbook and the site supervisor and health and safety officer will be notified immediately.
- Allow the thermometer or thermistor enough time to equilibrate to outside temperature when removed from a field vehicle.
- Insert the thermometer or thermistor into the stream. Swirl the thermometer or thermistor if the medium is calm and take the temperature reading when the mercury column or digital readout stabilizes.
- Record the temperature reading in the field logbook to the nearest $\pm 0.5^{\circ}\text{C}$.
- Decontaminate the thermometer or thermistor in accordance with SOP 1.3, General Equipment Decontamination.
- Liquids from decontamination operations will be handled in accordance with SOP No. 1.7, Handling of Decontamination Water and Wash Water.

5.2 TOTAL RESIDUAL CHLORINE

Collect a representative 500-ml grab sample from the collection point into a sample bottle in accordance with SOP 4.3, Surface Water Sampling. Pour off approximately 50 ml to be used to determine residual chlorine concentration. Cap remaining sample and retain in a cool location for later use in determining pH, alkalinity, and other field parameters.

Samples for analytes that are susceptible to changes in chemical composition due to high levels of residual chlorine must be specially preserved when this condition exists. Before collection of samples at a sampling site, the total residual chlorine concentration must be measured. At sites

where the concentration is measured to be ≥ 0.20 mg/l, volatile organic analysis (VOA), cyanide and BNA samples will be preserved in accordance with SOP 1.13, Containerizing, Preserving, Handling and Shipping of Soil and Water Samples.

Total residual chlorine measurements at RFP will be conducted with a HACH DR/2000 spectrophotometer or equivalent. See equipment manufacturer's instructions for equipment-specific procedures.

5.3 FREE CHLORINE

The procedure for the measurement of this field parameter is included here to provide a reference for programs which may include this parameter (i.e., NPDES sampling).

The procedure for free chlorine is the same as for total residual chlorine with the following exception:

- Use a DPD Free Chlorine Accuvac Ampul.

5.4 DISSOLVED OXYGEN (D.O.)

A YSI Model 57 D.O. meter will be used as follows:

- Inspect the membrane before each field use for air bubbles, oily film, and/or holes. If the membrane is defective, it must be replaced and soaked before recalibration in accordance with manufacturer's literature.
- Calibrate the meter in the field prior to use at each site.

- Perform an in-situ measurement by placing the D.O. electrode into the solution to be measured and reading the D.O. meter to the nearest 0.1 mg/L. Record the range setting of the D.O. meter.
- If the D.O. meter is equipped with an operational thermometer, read the water temperature at the time the D.O. is measured. If the meter does not provide a temperature reading, measure the water temperature as described in Subsection 5.1. Record the water temperature.
- Consult Table 1 of Appendix B for the solubility of oxygen at the recorded temperature. If the measured D.O. value exceeds the solubility of oxygen at the given temperature, the D.O. value should be verified in the field by another method. The HACH DR/2000 can be used for this purpose. Consult the HACH manual for detailed instructions. Record the second D.O. value in the comment section of the field data collection form.
- Keep the YSI D.O. probe protected when not in use to prevent the membrane from drying out or freezing.
- Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in SOP 1.3, General Equipment Decontamination.
- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field D.O. measurements.
- Manufacturer's operating manuals and calibration procedures will be followed.

5.5 pH

Measurements of pH are affected by changes in temperature. Mechanical and chemical changes in pH measuring electrodes due to temperature change can cause erroneous pH readings. The HACH One pH meter is a temperature compensating device. This or similar devices should be used for pH measurement to avoid introducing error.

The pH of water is also affected by exposure to the atmosphere. Carbon dioxide can escape from an exposed grab sample, thus altering pH in the sample. As described in Subsection 5.2, Total Residual Chlorine, the grab sample used for field parameter measurements should be capped and retained in a cool location to avoid pH changes.

Meters will be calibrated daily in the laboratory or field trailer prior to field use. Meters will also be checked against a pH 7.0 buffer in the field prior to use at each sampling site. Buffer solutions will be changed periodically for calibration checks.

Alkalinity measurements will accompany and immediately follow pH measurements detailed in this procedure and are to be considered an extension of the pH measuring process; not as an independent operation.

Measurements in the field will be performed in the following manner:

- Before each field activity, check the meter for cracked or fouled electrodes and battery condition in accordance with manufacturer's recommendations.
- Check the instrument prior to use at the site by observing the reading obtained with a pH 7.0 buffer solution. Recalibrate the instrument if the pH reads less than 6.8 or greater than 7.2.

- Thoroughly rinse the electrode and temperature probe with distilled water and remove excess water.

Sulfuric acid reagent (0.1600N or 1.600N) will be used in the alkalinity titrations. The 0.1600N H₂SO₄ reagent is preferable for alkalinities less than 100 mg/l. Above 100 mg/l, the 1.600N H₂SO₄ is preferable due to time constraints, but this higher concentration of acid is only to be used after previously recorded titrations indicate alkalinity greater than 100 mg/l.

- If the 0.1600N reagent has been selected, measure 50 ml of the 500-ml sample in a volumetric flask, then pour it into a 100-ml beaker containing a magnetic stir bar. This sample must be exactly 50 ml.
- If the 1.600N reagent has been selected, place 50 ml of the grab sample into a 100-ml beaker as above, or place 100 ml into a 250-ml beaker containing a magnetic stir bar. Leave the magnetic stirring device off until the alkalinity titration procedure has begun. The sample, whether 50 ml or 100 ml, is measured with a volumetric flask and must be exact.
- Place the electrode and the temperature probe into a beaker containing 100 ml of the 500-ml sample and swirl the electrode at a constant rate until the meter reading stabilizes. The stirring rate should be maintained so as to minimize the surface disturbance of the sample.
- Note and record the indicated temperature of the sample to the nearest $\pm 0.1^\circ$ C, and the pH to the nearest ± 0.01 pH unit.
- Rinse the electrode and temperature probe thoroughly with distilled water and store in accordance with manufacturer's recommendations.

- Agitate the sample designated for turbidity measurement so that all sediments are suspended. Pour 25 ml of the sample into another clean sample cell; place into the cell holder and close the light shield.
- Press "Read/Enter" and the display will show "wait" and then the result in FTUs will be displayed.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA) and quality control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP. Equipment inspection and calibration QC requirements for each field parameter measurement procedure are described in Section 5.0 of this SOP.

7.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Collection Field Notes Form (Form 4.1A). Use of these forms is described in SOP 4.1, Surface Water Data Collection Activities. Data required by this SOP include calibration records and measurements of temperature, dissolved oxygen, pH, alkalinity, specific conductance, total residual chlorine, free chlorine, turbidity, and silica.

- Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in SOP 1.3, General Equipment Decontamination.
- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field pH measurements.

5.6 ALKALINITY

Alkalinity measurements will accompany and immediately follow pH measurements detailed in Subsection 5.5 of this procedure. Titration with an appropriate acid reagent will be used to measure alkalinity. Alkalinity measurements at the RFP will be conducted with a HACH digital titrator or equivalent. Follow the general procedures described below and see equipment manufacturer's instructions for detailed equipment-specific titration procedures.

- Sampling personnel will wear chemical-resistant gloves, which will be disposed of between sites, when performing alkalinity measurements.
- Determine the appropriate end-point pH according to alkalinity species in question.
- Prepare sample and titration assembly.
- Titrate to endpoint pH by making smaller additions of acid as the endpoint is approached.
- Use appropriate conversions based on reagent normality and sample size to calculate alkalinity.

5.7 SPECIFIC CONDUCTANCE

Conductance is a measure of the ability of an aqueous solution to conduct electrical current and is expressed in reciprocal ohms (mhos). The International System of Units uses the siemen(s) to represent mhos. The siemen will be the unit used in this SOP.

The physical dimensions of a conductance measuring probe define the cell constant for the probe. When this constant is known and applied, conductance is converted to units of specific conductance (a.k.a., conductivity). Most waters have a specific conductance much less than 1 siemen; therefore, data will be reported in millisiemens (ms)/cm or microsiemens (μ s)/cm.

Specific conductance increases with temperature. The HACH 44600 Conductivity/TDS meter is temperature compensating, correcting readings to the standard temperature 25°C, over the temperature range 0-100°C. Thus, no error should be introduced in conductivity measurements due to temperature.

The HACH 44600 Conductivity/TDS meter will be standardized each day before field activities against a 1000 μ s/cm solution and a 10,000 μ s/cm solution. These standards define the limits, between which conductivity readings are reliable. Solutions of particularly high ionic strength (with conductivity > 10,000 μ s/cm) should be diluted to 50 percent strength until readings fall within the prescribed limits.

The following method will be used to measure specific conductance in the field:

- Before each field activity, check the meter for damage to the probe and for weak batteries in accordance with manufacturer's recommendations.
- Calibrate the meter in the field prior to use at each site.

- Thoroughly rinse the probe in distilled water and remove excess water by gently shaking and drying with clean paper towel before immersion in the sample.
- A 250-ml portion of the 500-ml grab sample described in Subsection 5.2, Total Residual Chlorine, will be measured for specific conductance.
- Immerse the probe into the sample to a depth of at least 1 inch below the surface of the sample. Agitate the probe gently to dislodge any trapped air bubbles and allow the meter reading to stabilize.
- Record the temperature and the temperature-compensated reading in the daily field logbook.
- Rinse the probe thoroughly with distilled water after use and dry with a clean paper towel.
- Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in SOP 1.3, General Equipment Decontamination.
- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field conductivity measurements.

5.8 SILICA

In the event that SiO_2 measurements are needed, the Silicomolybdate method is used to measure silica in the range of 0 - 100 mg/l, and the Heteropoly Blue method measures silica in the 0 - 1.6 mg/l range. Silica measurements at RFP will be conducted with a HACH DR/2000

spectrophotometer or equivalent. See equipment manufacturer's instructions for equipment-specific procedures.

5.9 TURBIDITY

This procedure describes the measurement of turbidity using the HACH DR2000 Spectrophotometer absorptometric method. The turbidity test measures an optical property of the water sample which results from the scattering and absorbing of light by the particulate matter present. The amount of turbidity registered is dependent on such variables as the size, shape, and refractive properties of the particles. This procedure is calibrated using formazin turbidity standards, and the readings are in terms of formazin turbidity units (FTU).

- Sampling personnel will wear chemical-resistant gloves, which will be disposed between sites, when performing turbidity measurements.
- Enter the stored program number for turbidity; press "750 Read/Enter." The display will show "Dial nm to 450."
- Rotate the wave length dial until the small display shows "450 nm."
- Press "Read/Enter." The display will show "FTU Turbidity."
- Pour 25 ml of deionized water (blank) into a sample cell.
- Place the blank into the cell holder and close the light shield.
- Press "zero" and the display will show "wait" and then "0 . FTU Turbidity."

APPENDIX A

**CALIBRATION AND STANDARDIZATION
PROCEDURES**

APPENDIX A - CALIBRATION AND STANDARDIZATION PROCEDURES

These instructions are for the use of persons who will use these field measurements on a daily basis and are not intended to either supersede or supplement required periodic laboratory calibration or manufacturer's guidance for initiation of new equipment. In all cases, care will be taken to ensure that reagents and standards are employed that have not exceeded their expiration dates.

Standardization is the process of determining the deviation between the known value of a standard and the value for that standard measured by an instrument. Calibration is the process of adjusting an instrument by that deviation such that known and measured values for a standard are equivalent.

Solutions used for calibrating, standardizing, or titrating will be checked before use to determine if the expiration dates have been exceeded. Expired solutions will be discarded and replaced with new solutions.

A.1 THERMOMETER AND THERMISTOR STANDARDIZATION

Measured values of specific conductance, pH, and D.O. are all temperature-dependent and the instruments used to measure these parameters also measure and/or compensate for temperature effects. Therefore, accuracy of the temperature measurements obtained with these instruments, as well as any thermometers utilized to measure temperature, must be determined and a record maintained.

Laboratory temperature standardization of these instruments will be performed and documented on each instrument monthly. The thermometers and thermistors in each instrument being utilized will be standardized against a thermometer traceable to an NIST calibrated thermometer. Accuracy will be determined throughout the expected working range (generally 0° to 35°C). A three-point standardization within the working range will be used to verify accuracy. The following procedure will be followed:

1. Have ready solutions of water in the following temperature ranges: 0 to 10 degrees C; 15 to 25 degrees C; 30 to 40 degrees C.
2. Immerse the thermistor or thermometer and the NIST traceable thermometer into the 0-10 degree C solution. After allowing time for readings to stabilize, record the readings of the NIST traceable thermometer and the thermistor or thermometer being standardized.

3. Repeat Step 2 using the 30-40 degree C solution. If the temperature value of the thermistor can be adjusted from external control knobs on the instrument, then the temperature reading of the instrument should be adjusted to the temperature reading of the NIST traceable thermometer and the adjusted value noted in the logbook.
4. Repeat Step 2 using the 15-25 degree C solution.
5. Thermometers must read within $\pm 1.0^{\circ}\text{C}$ of the NIST traceable thermometer. Thermometers reading outside this range will not be used for field measurements. Thermistor readings should be within $\pm 2^{\circ}\text{C}$ of the NIST traceable thermometer. Instruments with temperature readings outside this range should be returned to the factory for calibration.

A.2 CALIBRATION OF THE HACH DR-100 SPECTROPHOTOMETER

The HACH DR-100 Spectrophotometer, used in the measurement of total residual chlorine and other parameters, is pre-calibrated by the manufacturer. Consult the HACH instrument manual in the event instrument problems occur.

A.3 CALIBRATION OF THE YSI DISSOLVED OXYGEN METER

A.3.1 Calibration in the Field Trailer

Calibration of the D.O. meter will be performed daily before leaving the field trailer to check the meter to see if it is in proper working order. This calibration procedure is as follows:

- Prepare an oxygen-saturated calibration solution by agitating 200 ml to one liter of distilled water vigorously for approximately five minutes.
- Turn the instrument to the "Red Line" setting and adjust the meter needle to correspond to the red line on the instrument.
- Turn the instrument to the zero setting and adjust the meter reading to read zero.

- Place the probe into the saturated water. Read both the temperature and the D.O. value. Consult the chart in the manufacturer's literature and adjust the meter scale to the value of saturation at the measured temperature and atmospheric pressure.
- If the instrument cannot be calibrated to within ± 10 percent of the standard value, it will require maintenance and recalibration prior to use.

A.3.2 FIELD CALIBRATION

Calibration of the D.O. meter in the field will be performed at each sample site with an Air Calibration Chamber. This device (YSI number 5075, or equivalent) permits calibration of the D.O. meter at the temperature of the water in which the D.O. is to be measured, thereby minimizing errors due to temperature differences. Steps to follow for calibration are listed in the instruction manual for the YSI Model 57 Dissolved Oxygen Meter. Please refer to page 12 of Appendix B for calibration procedures. Figure 8, also on page 12, is a useful diagram found in Appendix B, illustrating the parts of the calibration unit and the D.O. probe, and is referred to in the calibration text.

A.4 CALIBRATION OF THE HACH ONE pH METER

All pH instruments will receive a daily pre-use calibration and a post-use standardization, both of which will be recorded in field logbooks. Before use at each site, the instrument will be checked against the pH 7.0 standard buffer. If the instrument reading is not within ± 0.1 pH units of the standard buffer, the instrument must be recalibrated.

These procedures will require the use of buffer solutions of the type listed below as required by the manufacturer:

pH 4 buffer - potassium hydrogen phthalate

pH 7 buffer - potassium phosphate, monobasic, and sodium phosphate, dibasic

pH 10 buffer - sodium carbonate-bicarbonate

Instructions for calibration are:

- Turn meter on by pressing POWER key. The display will light.

- Depress the pH key.
- Next, press the AUTO/MANUAL key. The AUTO indicator should now be lit, the S1 and pH indicators flashing, and all zeroes appearing on the display.
- Remove the cap from the electrode/temperature probe and place the probe into a stirring pH 4 buffer solution and press the potassium chloride dispenser button. Allow approximately 30 seconds after dispensing electrolyte before performing the next operation.
- The STANDARD key may now be depressed. Wait until the pH indicator stops flashing. The S2 indicator will begin flashing and the actual pH value will appear on the display. (Note: The display will indicate the actual pH value at the actual temperature of the buffer solution. Consult the variation chart provided with the instrument to determine if the instrument is within appropriate parameters.) Record the indicated pH value and temperature, and the adjusted pH value of the buffer at the indicated temperature from the chart in the logbook.
- Rinse the electrode/temperature probe with distilled water and blot dry with a clean paper towel.
- Place the electrode/temperature probe into a stirring pH 10 buffer solution and again press the dispenser button. Wait at least 30 seconds before continuing.
- Once again, press the STANDARD key. S2 will stop flashing. After the pH indicator stops flashing, the actual pH value at the given temperature will appear on the display. Record the indicated pH value and temperature, and the adjusted pH value of the buffer in the logbook.
- If, during calibration, the digital readout fails to stabilize in any of the solutions, replacement of the pH electrode and/or the temperature probe may be necessary.
- DO NOT PRESS ANY KEY OTHER THAN THE pH KEY at this point or the entire calibration procedure will be nullified.
- Press the pH key.

- Rinse the electrode/temperature probe with distilled water and blot dry with a clean paper towel.
- Place the cap on the probe and place the instrument in the case.
- This instrument is now ready to perform pH measurements.

At the end of the day, a post-use standardization will be performed on the instrument. The pH of the 4, 7, and 10 buffer standards will be measured with the instrument. The values of the standards and measured values will be recorded in the appropriate base lab logbook. Measurement and documentation of the standard buffers will ensure and document that the instrument is still functioning within acceptable limits. Acceptable limits for the instrument will be within ± 0.2 pH units of the standard. If the instrument does not consistently stay within these acceptance limits, then it will become necessary to calibrate the instrument prior to use at every site. The sample manager will consult with the site supervisor and QA officer, and the QA officer will decide if calibration at each site is necessary.

A.5 STANDARDIZATION INSTRUCTIONS FOR THE HACH DIGITAL TITRATOR AND ALKALINITY TITRANT REAGENT USED FOR THE FIELD MEASUREMENT OF ALKALINITY*

Calibration of the pH meter will first be accomplished in accordance with Section A.4 of this Appendix. Standardization of the digital titrator with sulfuric acid reagent (0.1600N or 1.600N) will be done monthly or each time a new lot of reagent is received. The standardization procedure will be accomplished as follows:

- Measure 50 ml of a 100-ppm alkalinity standard in a 50 ml volumetric flask.
- Transfer this solution into a clean beaker with a magnetic stir bar.
- Place the beaker on a magnetic stir plate.
- Load the digital titrator with the appropriate reagent cartridge (0.1600N or 1.600N H₂SO₄).

* This procedure assumes that the concentration of the purchased alkalinity standard is correct, and therefore the reagent titrant is the solution being standardized.

- Position the pH electrode and digital titrator-dispensing tube into the beaker containing the 50 mls of the 100-ppm alkalinity standard.
- Adjust digital count setting knob to ensure that the counts on the digital titrator are set at zero.
- Turn on the stir plate and stir the 50 mls of the 100-ppm alkalinity standard at a rate that will keep the solution well mixed but not cause splashing.
- Measure the initial pH of the solution.
- Slowly add titrant to the solution. Decrease the rate of addition as the pH approaches 5.0.
- Continue to add titrant until the pH lowers to 4.5.
- Record the amount of titrant (number of digital counts) required to bring the pH to 4.5.
- Multiply the number of digital counts by the appropriate conversion factor (0.2 if the 0.1600N H₂SO₄ was used, and 2.0 if the 1.600N reagent was used).
- Record this result as ppm alkalinity in the base lab notebook.
- If the value obtained is not within ± 10 percent of the alkalinity standard, then either the acid reagent concentration is not correct or the digital titrator is not dispensing accurately. The problem must be resolved and corrected. Acceptable titration to within ± 10 percent of the alkalinity standard will be obtained before the titrator and sulfuric acid reagent is to be used.

A.6 CALIBRATION INSTRUCTIONS FOR HACH MODEL 44600 CONDUCTIVITY/TDS METER

The HACH Model 44600 Conductivity/TDS meter will be calibrated daily in the laboratory prior to use in the field. The instrument will not receive a post-standardization since it will be standardized in the field prior to use at each site.

Note: A reading within ± 10 percent of the value of the conductivity standard (10,000 or 1,000 $\mu\text{S}/\text{cm}$) and 100 $\mu\text{S}/\text{cm}$ for the zero conductivity standard (distilled water) is within acceptable

limits and the meter may be used for field measurements. However, the meter should always be set to read as close as possible to the concentration of the standard. The procedure for calibration of the meter is as follows:

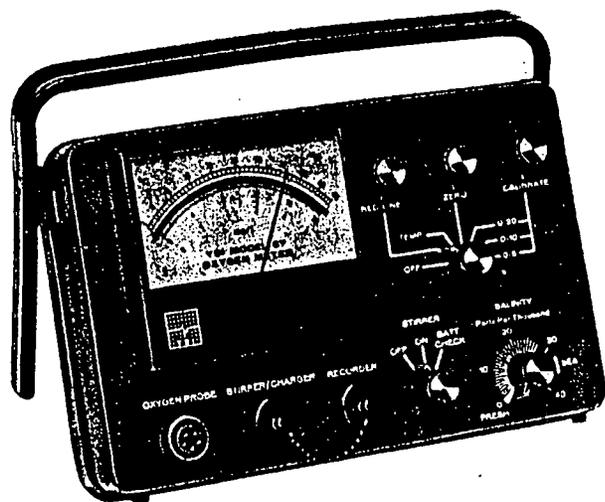
- Press the POWER 1 key and CND key. Verify that the LO BAT indication does not appear. If LO BAT is indicated, the battery will be replaced.
- Place the instrument probe into the calibration solution to a depth of 1 inch or more beyond the vent holes and agitate vertically to release entrapped air bubbles.
- Adjust the displayed reading to the value of the conductivity standard and allow the reading to stabilize.
- Record the display reading in the logbook.
- Press the °C key and record the display reading in the logbook.
- Remove the probe from the solution and rinse thoroughly with distilled water.
- Place the probe into fresh, distilled water and repeat the steps indicated above, recording the appropriate readings. This establishes a zero point or lower bracket reading.
- The instrument is now ready to perform measurements.
- Repackage the instrument and probe in the case for transport.

Note: In the field the instrument will be standardized against an appropriate 10,000 or 1,000 $\mu\text{S}/\text{cm}$ standard solution.

APPENDIX B

**INSTRUCTION MANUAL FOR YSI MODEL 57
DISSOLVED OXYGEN METER**

**INSTRUCTION MANUAL
YSI MODEL 57
DISSOLVED OXYGEN METER**



YSI Incorporated

Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio 45387 USA
Phone 513 767-7241 • 800 343-HELP • Fax 513 767-9353 • Telex 205437

PRICE INCLUDING HANDLING \$6.00

SUMMARY OF OPERATING INSTRUCTIONS

1. CALIBRATION

- A. Switch instrument to OFF and adjust meter mechanical zero.
- B. Switch to RED LINE and adjust.
- C. Prepare probe for operation, plug into instrument, wait up to 15 minutes for probe to stabilize. Probe can be located in calibration chamber (see instruction manual) or ambient air.
- D. Switch to ZERO and adjust.
- E. Adjust SALINITY knob to FRESH.
- F. Switch to TEMP and read.
- G. Use probe temperature and true local atmospheric pressure (or feet above sea level) to determine correct calibration values from Table I and II. (See pages 13 and 14).

EXAMPLE: Probe temperature = 21°C; Altitude = 1000 feet. From Table I the calibration value for 21°C is 8.9 mg/l. From Table II the altitude factor for 1000 feet is approximately .96. The correct calibration value is:

$$8.9 \text{ mg/l} \times .96 \text{ factor} = 8.54 \text{ mg/l}$$

- H. Switch to desired dissolved oxygen range 0-5, 0-10, or 0-20 and with calibrate control adjust meter to correct calibration value determined in Step G.

NOTE: It is desirable to calibrate probe in a high humidity environment. See instruction manual for more detail on calibration and other instrument and probe characteristics.

2. MEASUREMENT

- A. Adjust the SALINITY knob to the salinity of the sample.
- B. Place the probe and stirrer in the sample and switch the STIRRER control to ON.
- C. When the meter has stabilized switch to the appropriate range and read D.O.
- D. We recommend the instrument be left on between measurements to avoid necessity for repolarizing the probe.

3. GENERAL CARE

- A. Replace the instrument batteries when unable to adjust to red line. Use (2) Eveready No. 935 "C" size or equivalent.
- B. In the BATT CHECK position the voltage of the stirrer batteries is displayed on the red 0-10 scale. Do not discharge below 6.0 Volts. Recharge for 14-16 hrs. with YSI No. 5728 charger.
- C. Membrane will last indefinitely, depending on usage. Average replacement is 2-4 weeks. Probe should be stored in humid environment to prevent drying out.
- D. Calibrate daily.

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GENERAL DESCRIPTION

The YSI Model 57 Dissolved Oxygen Meter is intended for dissolved oxygen and temperature measurement in water and wastewater applications, but is also suitable for use in certain other liquids. Dissolved Oxygen is indicated in mg/l (milligrams per liter) on 0-5, 0-10 and 0-20 mg/l scales. Temperature is indicated in °C on a -5° to +45°C scale. The dissolved oxygen ranges are automatically temperature compensated for solubility of oxygen in water and permeability of the probe membrane, and manually salinity compensated.

The probes use Clark-type membrane covered polarographic sensors with built in thermistors for temperature measurement and compensation. A thin, permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows oxygen and certain other gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

SPECIFICATIONS

I. Instrument

Oxygen Measurement

Ranges: 0-5, 0-10 and 0-20 mg/l (0-2.5, 0-5 and 0-10 mg/l with YSI 5776 High Sensitivity Membrane)

Accuracy: $\pm 1\%$ of full scale at calibration temperature (± 0.1 mg/l on 0-10 scale), or 0.1 mg/l (whichever is larger).

Readability: .025 mg/l on 0.5 scale; .05 mg/l on 0-10 scale; 0.1 mg/l on 0-20 scale.

Temperature Measurement

Range: -5° to +45°C

Accuracy: $\pm 0.5^\circ\text{C}$ plus probe which is $\pm 0.1^\circ\text{C}$

Readability: 0.25°C

Temperature Compensation

$\pm 1\%$ of D.O. reading for measurements made within $\pm 5^\circ\text{C}$ of calibration temperature.

$\pm 3\%$ of D.O. reading over entire range of -5 to +45°C probe temperature.

System Response Time

Typical response for temperature and D.O. readings is 90% in 10 seconds at a constant temperature of 30°C with YSI 5775 Membranes. D.O. response at low temperature and low D.O. is typically 90% in 30 seconds. YSI 5776 High Sensitivity Membranes can be used to improve response at low temperature and low D.O. concentrations. If response time under any operating conditions exceeds two minutes, probe service is indicated.

Operating Temperature Range

Instrument and probe operating range is -5° to +45°C. Large ambient temperature changes will result in 2% loss of accuracy unless Red Line and Zero are reset.

Recorder Output

0 to 114-136 mV. Recorder should have 50,000 ohms minimum input impedance.

Power Supply

The YSI Model 57 is powered by two disposable "C" size carbon zinc batteries (Eveready 935C or equal) providing approximately 1000 hour operation.

II. Probe

Cathode: Gold

Anode: Silver

Membrane: .001" FEP Teflon

(.0005" FEP Teflon available)

Electrolyte: Half saturated KCl

Temperature Compensation: (See SPECIFICATIONS, I. Instrument)

Pressure Compensation: Effective 1/2% of reading with pressures to 100 psi (230 ft. sea water)

Polarizing Voltage: 0.8 volts nominal

Probe Current: Air at 30°C = 19 microamps nominal

Nitrogen at 30°C = .15 microamps or less

III. Accessories and Replacement Parts

YSI 5720A — Self Stirring BOD Bottle Probe

YSI 5750 — Non Stirring BOD Bottle Probe

YSI 5739 — Oxygen Temperature Probe for field use. Combine with one of the following 4 cables for desired lead length:

Detachable leads for use with YSI 5739:

YSI 5740- 10 10' Cable

YSI 5740- 25 25' Cable

YSI 5740- 50 50' Cable

YSI 5740-100 100' Cable

YSI 5740-150 150' Cable

YSI 5740-200 200' Cable

YSI 5721 — Battery and charger pack operates YSI 5791A and 5795A Submersible Stirrers.

YSI 5791A — Submersible Stirrer for field use.

YSI 5795A — Submersible Stirrer.

YSI 5075A — Calibration Chamber for use with field probe.

YSI 5890 — Carrying Case.

YSI 5775 — Membrane and KCl Kit, Standard — includes 2 each 15-membrane packets (.001" thick standard membranes) and a 30 ml bottle KCl with Kodak photo flo.

YSI 5776 — Membrane and KCl Kit, High Sensitivity — includes 2 each 15-membrane packets (.0005" thick membranes) and a 30 ml bottle KCl with Kodak photo flo.

YSI 5680 — Probe Reconditioning Kit

YSI 5945 — Ring Pack — includes (6) "O" rings for each YSI DO Probe
YSI 5486 — Water Boot Kit — includes (1) A-05486 Boot, (1) A-05484
Tip, (2) A-05485 Spring. Used only on 5720A and discontinued
5420A.

YSI 5986 — Diaphragm Kit for use only with YSI 5739 D.O. Probe.

YSI 5735 — Adaptor makes it possible to use YSI 5739, YSI 5720A and
YSI 5750 Probes with discontinued YSI Models 51A, 54RC
and 54BP

OXYGEN PROBES AND EQUIPMENT

There are three oxygen probes for use with the YSI Model 57 Dissolved Oxygen Meters. Descriptions of where they are used are contained in the following paragraphs.

I. YSI 5739 D.O. Probe

The YSI 5739 probe is designed for use with the 5740 detachable cable and replaces the discontinued YSI 5418, 5419, 5718 and 5719 probes. (See Figure 1)

For user convenience the probe is equipped with a disconnecting cable to facilitate changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is *not* designed for casual disconnection and should only be disconnected when necessary.

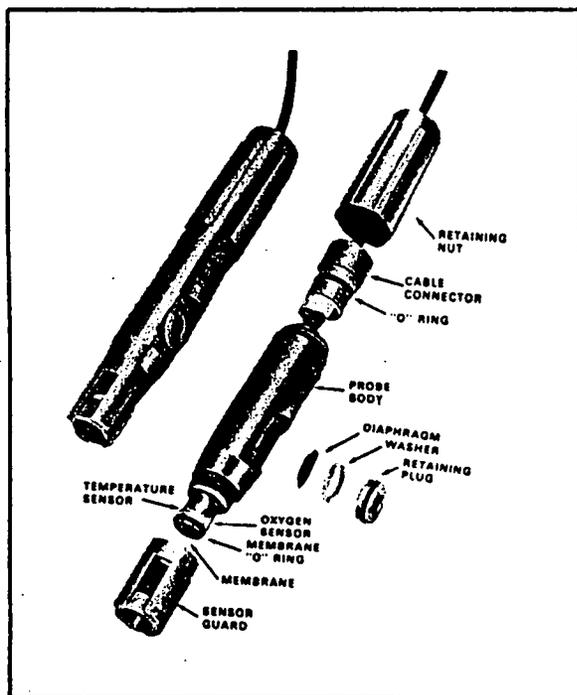


FIGURE 1

Disconnect the cable unscrew the retaining nut and slide it down the cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble, inspect the connector and "O" ring for cleanliness. If the "O" ring is frayed or damaged remove it by squeezing it in the groove causing it to bulge, then roll it out of the groove and off the connector. A replacement "O" ring is supplied with the cable.

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the "O" ring will make reassembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, *hand tight only*. NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If present, dry out and reconnect, replacing the "O" ring, if necessary.

Pressure Compensation

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 1/2% of reading with pressures to 100 psi (230 ft. water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. (See OPERATING PROCEDURES.) The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. A spare is supplied with the probe. Using a coin unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (convolution side in), replace the washer, and screw in the retaining plug.

II. YSI 5720A B.O.D. Bottle Probe

The YSI 5720A B.O.D. Bottle Probe replaces the discontinued YSI 5420A B.O.D. Bottle Probe for measuring dissolved oxygen and temperature in standard B.O.D. bottles. It is provided with an agitator for stirring the sample solution, available in models for 117VAC (95-135VAC, 50-60 Hz) or 230VAC (190-250VAC, 50-60 Hz) operation. (See Figure 2)

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off place the tapered probe end into the B.O.D. bottle and switch agitator "ON" with switch on top of probe. The probe should be operated with a minimum of trapped air in the B.O.D. bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but no bubbles should be around the thermistor or oxygen sensor.

Stirrer Boot

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications boot life is normally several years, but this may be shortened by exposure to hydrocarbons, moderate to strong acids or bases.

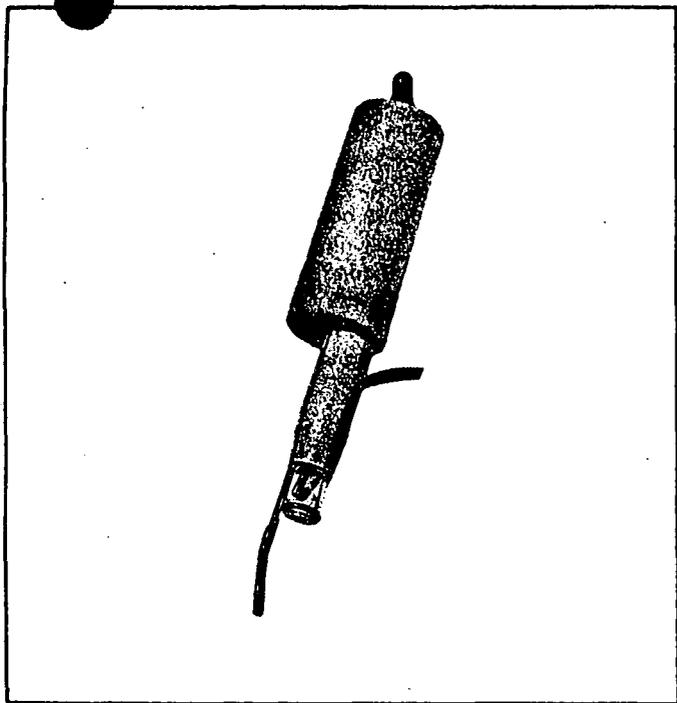


FIGURE 2

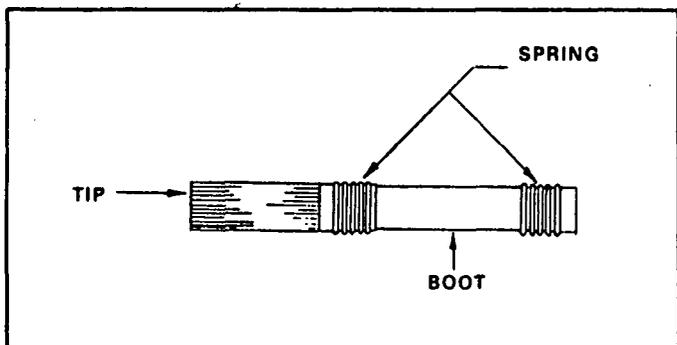


FIGURE 3

ozone, or direct sunlight. For maximum life rinse the boot after use in contaminated samples. (See Figure 3)

Boot replacement is as follows:

1. Pull off old assembly and clean shaft.
2. Slide on new assembly making sure the back spring is on the grooved area of the shaft. A small amount of rubber cement may be used.
3. Check that there is sufficient clearance between the tip and the end of the shaft to permit turning without binding.

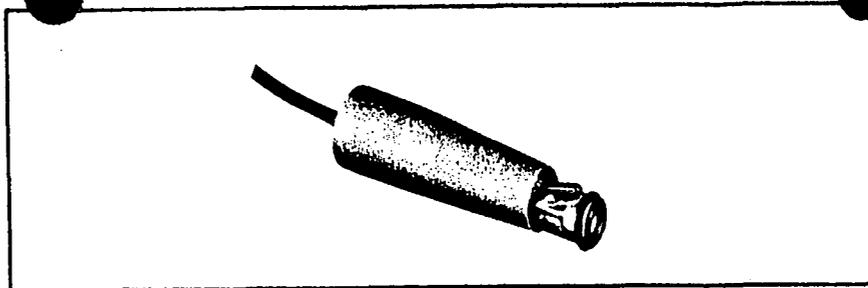


FIGURE 4

III. YSI 5750 B.O.D. Bottle Probe

The YSI 5750 B.O.D. Bottle Probe replaces the discontinued YSI 5450 B.O.D. Bottle Probe. It is similar to the YSI 5720A B.O.D. Bottle Probe, except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer. (See Figure 4)

IV. Cable Adaptors

All YSI 5700 Series Probes are designed for direct use with the YSI Model 57 Dissolved Oxygen Meter.

V. YSI 5791A and 5795A Submersible Stirrers

The YSI submersible stirrers are accessories that perform the function of stirring the sample being studied when making dissolved oxygen measurements in the field. The YSI 5791A stirrer can be used with the following dissolved oxygen probes: YSI 5418, 5419, 5718, 5719, and 5739. The YSI 5795A stirrer is only for use with the YSI 5739 Probe. (See Figure 5)

When a stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted hermetically sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the media across the oxygen sensor. (See sales literature and instruction sheets for further information).

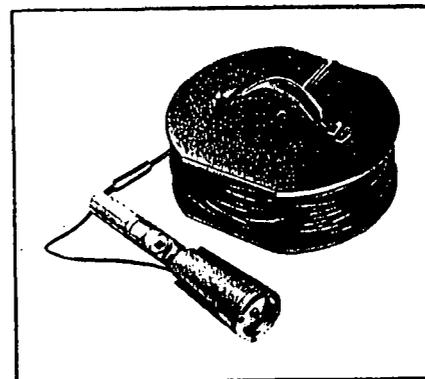


FIGURE 5

VI. YSI 5721 Battery Pack and Charger

The YSI 5721 Battery Pack and Charger is offered as an accessory to operate either the YSI 5791A or 5795A Submersible Stirrer when the stirrer is used in conjunction with the YSI Model 57 Oxygen Meter. The YSI 5721 can be purchased with the YSI Model 57 or installed at a later time. (See sales literature and instruction sheet for further information).

OPERATING PROCEDURES

I. Preparing the Probe

All YSI 5700 Series Probes have similar sensors and should be cared for in the same manner. They are precision devices relying on good treatment if high accuracy measurements are to be made. Prepare the probes as follows. (See Figure 6)

ALL PROBES ARE SHIPPED DRY — YOU MUST FOLLOW THESE INSTRUCTIONS

1. Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
2. Unscrew the sensor guard from the probe (YSI 5739 only) and then remove the "O" ring and membrane. Thoroughly rinse the sensor with KCl solution.
3. Fill the probe with electrolyte as follows:
 - A. Grasp the probe in your left hand. When preparing the YSI 5739 probe the pressure compensating vent should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or similar soft, blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice you can hold the probe and pump with one hand while filling with the other.) When preparing the YSI 5720A and 5750 probes, simply fill the sensor body until no more air bubbles appear.
 - B. Secure a membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode.
NOTE: Handle membrane material with care, keeping it clean and dust free, touching it only at the ends.
 - C. With the thumb and forefinger of your other hand, grasp the free end of the membrane.
 - D. Using a continuous motion *stretch* the membrane *UP, OVER,* and *DOWN* the other side of the sensor. Stretching forms the membrane to the contour of the probe.
 - E. Secure the end of the membrane under the forefinger of the hand holding the probe.
 - F. Roll the "O" ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the "O" ring.
 - G. Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.
4. Shake off excess KCl and reinstall the sensor guard.
5. A bottomless plastic bottle is provided with the YSI 5739 probe for convenient storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This keeps the electrolyte from drying out. The YSI 5720A and 5750 probes can be stored in a B.O.D. bottle containing about 1" water.

Membranes will last indefinitely, depending on usage. Average replacement is 2-4 weeks. However, should the electrolyte be allowed to evaporate and an excessive amount of bubbles form under the membrane, or the membrane become damaged, thoroughly flush the reservoir with KCl and install a new membrane.

7. Also replace the membrane if erratic readings are observed or calibration is not stable.
8. "Home brew" electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.
9. The gold cathode should always be bright and untarnished. If it is tarnished (which can result from contact with certain gases) or plated with silver (which can result from extended use with a loose or wrinkled membrane), return it to the factory for service or else clean it with the YSI 5680 Probe Reconditioning Kit. Never use chemicals or any abrasive other than that supplied with this kit.
10. It is also possible that the silver anode may become contaminated, which will prevent successful calibration. Try soaking the probe overnight in a 3% ammonia solution; rinse with deionized water, recharge with electrolyte, and install a new membrane. If still unable to calibrate, return the probe for service.
11. H_2S , SO_2 , Halogens, Neon, Nitrous Oxide and CO are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause. These gases have been tested for response.

100% Carbon Monoxide-Less than 1%	100% Helium-none
100% Carbon Dioxide-Around 1%	100% Nitrous Oxide-1/3 O_2 response
100% Hydrogen-Less than 1%	100% Ethylene-none
100% Chlorine-2/3 O_2 response	100% Nitric Oxide-1/3 O_2 response

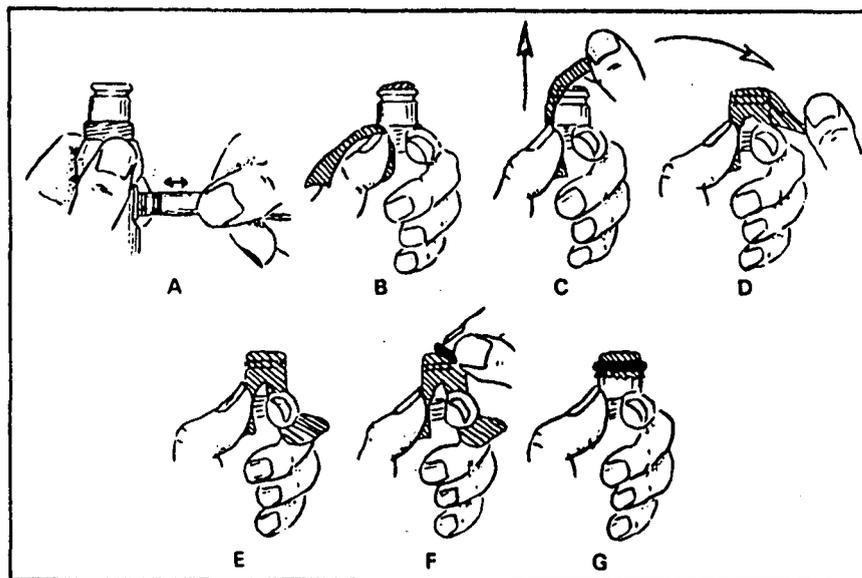


FIGURE 6

II. Preparing the Instrument

It is important that the instrument be placed in the intended operating position vertical, tilted, or on its back — before it is prepared for use and calibrated. (See Figure 7). Readjustment may be necessary when the instrument operating position is changed. After preparing the probe proceed as follows:

1. With switch in the OFF position, adjust the meter pointer to Zero with the screw in the center of the meter panel. Readjustment may be necessary if the instrument position is changed.
2. Switch to RED LINE and adjust the RED LINE knob until the meter needle aligns with the red mark at the 31°C position.
3. Switch to ZERO and adjust to zero with zero control knob.
4. Attach the prepared probe to the PROBE connector of the instrument and adjust the retaining ring finger tight.
5. Before calibrating allow 15 minutes for optimum probe stabilization. Repolarize whenever the instrument has been OFF or the probe has been disconnected.

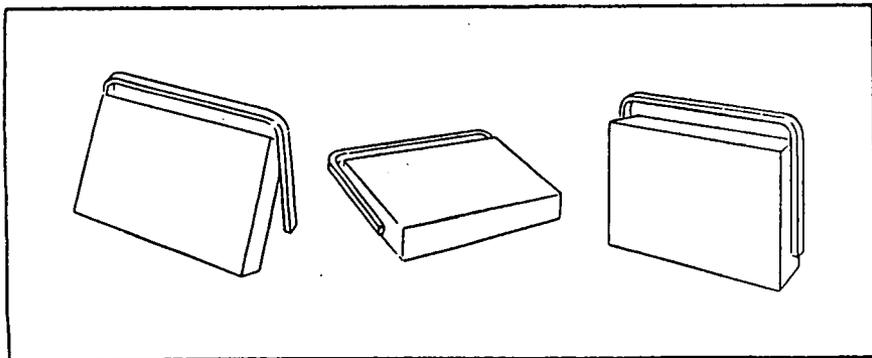


FIGURE 7

III. Calibration

The operator has a choice of three calibration methods — Winkler Titration, Saturated Water, and Air. Experience has shown that air calibration is quite reliable, yet far simpler than the other two methods. The three methods are described in the following paragraphs.

Winkler Titration

1. Draw a volume of water from a common source and carefully divide into four samples. Determine the oxygen in three samples using the Winkler Titration technique and average the three values. If one of the values differs from the other 2 by more than 0.5 mg/l, discard that value and average the remaining two.
2. Place the probe in the fourth sample and stir.
3. Set the SALINITY control to zero or the appropriate salinity value of the sample.
4. Switch to desired mg/l range and adjust the CALIBRATION control to the average value determined in Step 1. Allow the probe to remain in the sample for at least two minutes before setting the calibration value, and leave in the sample for an additional 2 minutes to verify stability. Readjust if necessary.

Saturated Water

1. Saturate a volume of water (300-500cc) by aerating or stirring for at least 15 minutes at a relatively constant temperature.
2. Place the probe in the sample and stir. Switch to TEMPERATURE. Refer to Calibration Table I for the mg/l value corresponding to the temperature.
3. Determine local altitude or the "true" atmospheric pressure (note that "true" atmospheric pressure is as read on a mercury barometer. Weather Bureau reporting of atmospheric pressure is corrected to sea level). Using Table II determine the correct factor for your pressure or altitude.
4. Multiply the mg/l value from Table I by the correction factor from Table II to determine the corrected calibration value for your conditions.
EXAMPLE: Assume temperature = 21°C and altitude = 1000 feet. From Table I the calibration value for 21°C is 8.9 mg/l. From Table II the correction factor for 1000 feet is about 0.96. The corrected calibration value is $8.9 \text{ mg/l} \times 0.96 = 8.54 \text{ mg/l}$.
5. Switch to an appropriate mg/l range, set the SALINITY knob to zero, and adjust the CALIBRATE knob while stirring until the meter reads the corrected calibration value from Step 4. Leave the probe in the sample for two minutes to verify calibration stability. Readjust if necessary.

Air Calibration

1. Place the probe in moist air. BOD probes can be placed in partially filled (50 mL) BOD bottles. Other probes can be placed in the YSI 5075A Calibration Chamber (refer to the following section describing calibration chamber) or the small storage bottle (the one with the hole in the bottom) along with a few drops of water. The probe can also be wrapped loosely in a damp cloth taking care the cloth does not touch the membrane. Wait approximately 10 minutes for temperature stabilization.
2. Switch to TEMPERATURE and read. Refer to Table I — Solubility of Oxygen in Fresh Water, and determine calibration value.
3. Determine altitude or atmospheric correction factor from Table II.
4. Multiply the calibration value from Table I by the correction factor from Table II.
EXAMPLE: Assume temperature = 21°C and altitude = 1000 feet. From Table I the calibration value for 21°C is 8.9 mg/l. From Table II the correction factor for 1000 feet is about 0.96. Therefore, the corrected calibration value is $8.9 \text{ mg/l} \times 0.96 = 8.54 \text{ mg/l}$.
5. Switch to the appropriate mg/l range, set the SALINITY knob to zero and adjust the CALIBRATE knob until the meter reads the correct calibration value from Step 4. Wait two minutes to verify calibration stability. Readjust if necessary.

The probe is now calibrated and should hold this calibration value for many measurements. Calibration can be disturbed by physical shock, touching the membrane, or drying out of the electrolyte. Check calibration after each series of measurements and in time you will develop a realistic schedule for recalibration. For best results when not in use, follow the storage procedures recommended for the various probes described under OXYGEN PROBES AND EQUIPMENT. This will reduce drying out and the need to change membranes.

Calibration Chamber

The YSI 5075A Calibration Chamber is an accessory that helps obtain optimum calibration in the field and is also a useful tool for measuring at shallow depths (less than 4').

As shown in Figure (A), it consists of a 4-1/2 foot stainless steel tube (1) attached to the calibration chamber (2), the measuring ring (3), and two stoppers (4) and (5).

For calibration, insert the solid stopper (4) in the bottom of the calibration chamber (2). Push the oxygen probe (6) through the hollow stopper (5) as shown in Figure (B). Place the probe in the measuring ring, Figure (C), and immerse the probe in the sample to be measured for five minutes to thermally equilibrate the probe. Quickly transfer the probe to the calibration chamber (5) draining excess water from the chamber and shaking any excess droplets from the probe membrane. For maximum accuracy, wet the inside of the calibration chamber with fresh water. This creates a 100% relative humidity environment for calibration. Place the chamber in the sample for an additional five minutes for final thermal equilibrium. Calibrate the probe as described in the air-calibration procedure. Keep the handle above water at all times.

After calibration, return the probe to the measurement ring for shallow measurements. Move the probe up and down, or horizontally, approximately one foot a second while measuring. In rapidly flowing streams (greater than 5'/second) install the probe in the measuring ring with the pressure compensating diaphragm towards the chamber.

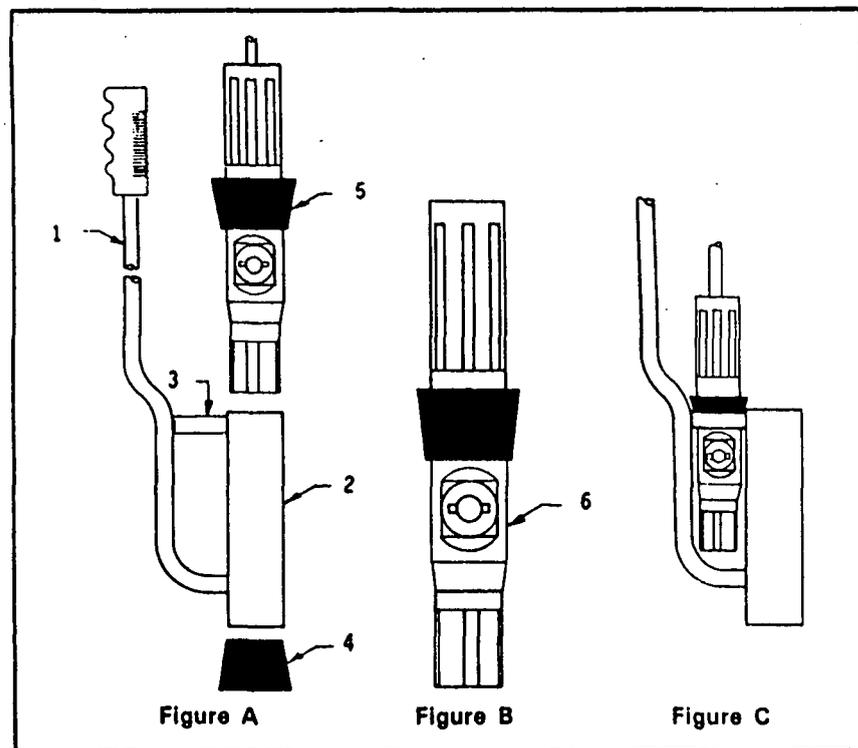


FIGURE 8

IV. Dissolved Oxygen Measurement

With the instrument prepared for use and the probe calibrated, place the probe in the sample to be measured and provide stirring.

1. Stirring for the 5739 Probe can best be accomplished with a YSI submersible stirrer. Turn the STIRRER knob ON. If the submersible stirrer is not used, provide manual stirring by raising and lowering the probe about 1 ft. per second. If the 5075A Calibration Chamber is used, the entire chamber may be moved up and down in the water at about 1 ft. per second.
2. The YSI 5720A has a built-in power driven stirrer.
3. With the YSI 5750 sample stirring must be accomplished by other means such as with the use of a magnetic stirring bar.
4. Adjust the SALINITY knob to the salinity of the sample.
5. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen. Read dissolved oxygen.

V. Calibration Tables

Table I shows the amount of oxygen in mg/l that is dissolved in air saturated fresh water at sea level (760 mmHg atmospheric pressure) as temperature varies from 0° to 45°C.

Table I — Solubility of Oxygen in Fresh Water

Temperature °C	mg/l Dissolved Oxygen	Temperature °C	mg/l Dissolved Oxygen
0	14.60	23	8.56
1	14.19	24	8.40
2	13.81	25	8.24
3	13.44	26	8.09
4	13.09	27	7.95
5	12.75	28	7.81
6	12.43	29	7.67
7	12.12	30	7.54
8	11.83	31	7.41
9	11.55	32	7.28
10	11.27	33	7.16
11	11.01	34	7.05
12	10.76	35	6.93
13	10.52	36	6.82
14	10.29	37	6.71
15	10.07	38	6.61
16	9.85	39	6.51
17	9.65	40	6.41
18	9.45	41	6.31
19	9.26	42	6.22
20	9.07	43	6.13
21	8.90	44	6.04
22	8.72	45	5.95

Source: Derived from 15th Edition "Standard Methods for the Examination of Water and Wastewater."

Table II shows the correction factor that should be used to correct the calibration value for the effects of atmospheric pressure or altitude. Find true atmospheric pressure in the left hand column and read across to the right hand column to determine the correction factor. (Note that "true" atmospheric pressure is as read on a barometer. Weather Bureau reporting of atmospheric pressure is corrected to seal level.) If atmospheric pressure is unknown, the local altitude may be substituted. Select the altitude in the center column and read across to the right hand column for the correction factor.

Table II — Altitude Correction Factor

Atmospheric Pressure mmHg	or Equivalent Altitude Ft.	= Correction Factor
775	540	1.02
760	0	1.00
745	542	.98
730	1094	.96
714	1688	.94
699	2274	.92
684	2864	.90
669	3466	.88
654	4082	.86
638	4756	.84
623	5403	.82
608	6065	.80
593	6744	.78
578	7440	.76
562	8204	.74
547	8939	.72
532	9694	.70
517	10472	.68
502	11273	.66

Source: Derived from 15th Edition "Standard Materials for the Examination of Water and Wastewater."

VI. HIGH SENSITIVITY MEMBRANE

Use of high sensitivity .0005" membranes (YSI 5776) in place of standard .001" membranes (YSI 5775) when measurements are to be made consistently at low temperatures (less than 15°C). Calibration and readings will be made just as if the standard YSI 5775 membrane was being used.

The YSI 5776 High Sensitivity Membrane can also be used in certain situations to increase sensitivity at temperatures above 15°C. The ranges thus become 0-2.5, 0-5 and 0-10 mg/l. When calibration with high sensitivity membranes is attempted at temperatures greater than 15°C the selector switch must be set to 0-20 mg/l. Multiply the calculated calibration value by 2. For example: at 21°C and 1000 ft. altitude the calibration value would be 8.6 x 2 or 17.2. Remember the 0-5, 0-10 and 0-20 mg/l ranges are now 0-2.5, 0-5 and 0-10 mg/l, and all mg/l readings must be divided by 2 for a final reading. When operating in this manner accuracy will be degraded slightly.

RECORDER OUTPUT

Output at full scale is 114 to 136 mV.

Use a 50K or higher input impedance recorder and operate it with the terminals ungrounded.

Many recorders have an adjustable full scale sensitivity feature. When using this type, use the 100 mV range and adjust the full scale (span, range control, sensitivity, etc.) control to give full scale chart deflection with full scale oxygen meter deflection. Refer to the recorder instructions. For recorders without this feature, a simple driver network as shown below can be constructed. This is adequate to adjust the signal for full scale chart and meter deflection on the 100 mV fixed range recorders.

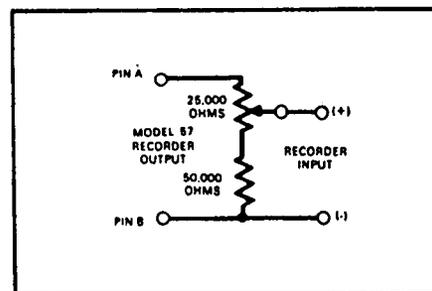


FIGURE 9

Recorder Output Plug

The YSI Model 57 is supplied with the necessary parts to construct a waterproof recorder plug for the YSI Model 57 Dissolved Oxygen Meter. The cable and potting materials are not included. (See Figure 10).

General purpose epoxy potting materials of medium viscosity and moderate cure rate are recommended. The two tube kits available in hardware stores are satisfactory.

1. Prepare the cable end by stripping back 3/16" (5MM) of insulation. Tin the ends with rosin core solder. If polarity is important pin "A" is the (+) terminal.
2. Disassemble the connector pieces and slide the mold, ring, extension, and coupling nut over the cable. Solder the leads to the appropriate connector pins with rosin core solder.
3. Check all connections. The two leads should show electrical continuity to the pins and should not contact the body or each other.
4. Re-assemble the pieces and hold the connector upright. Pour the epoxy mix into the plastic mold until full. Refill as the epoxy settles.
5. After the epoxy cures the plastic mold may be removed with pliers or knife.

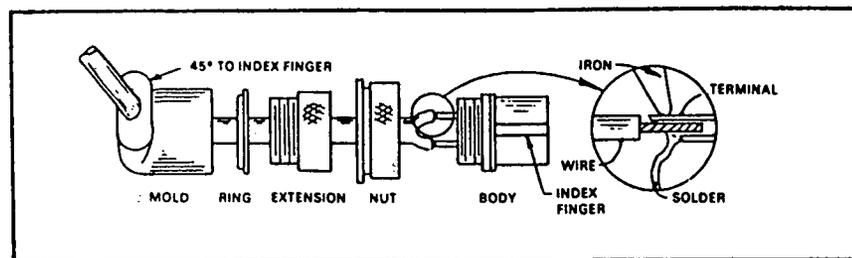


FIGURE 10

DISCUSSION OF MEASUREMENT ERRORS

There are three basic types of errors which can occur. Type I errors are related to limitations of the instrument design and tolerances of the instrument components. These are chiefly the meter linearity and resistor tolerances. Type II errors are due to basic probe accuracy tolerances, chiefly background signal, probe linearity, and variations in membrane temperature coefficient. Type III errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, Type III errors are appropriately reduced.

Individual Sources of Error

This description of sources of error can be used to attach a confidence to any particular reading of dissolved oxygen. The particular example given is for a near extreme set of conditions. As a generality, overall error is diminished when the probe and instrument are calibrated under conditions of temperature and dissolved oxygen which closely match the sample temperature and dissolved oxygen.

Type I

- A. Is the error due to the meter linearity.
Error = $\pm 1\%$ of full scale of the measurement range.
- B. Is the error due to tolerances in the instrument when transferring a reading from one range to another.
Error = $\pm 1\%$ of the meter reading if the reading is taken on a range one range away from the calibration range.
Error = $\pm 2\%$ of the meter reading if the reading is taken on a range two ranges away from the calibration range.
- C. Is the error due to the design and components of the instrument salinity compensation circuit.
Error = $\pm 2.5\%$ of the meter reading $\times \frac{\text{sample salinity ppt}}{40 \text{ ppt salinity}}$

Type II

- A. errors are due to probe background current.
Error = $0.5\% \left(\frac{\text{meter reading mg/l}}{1 - \text{Calib value}} \right) \times \text{X calib. value, mg/l}$
- B. errors are due to the probe non-linearity
Error = 0.3% of reading
- C. error is caused by variability in the probe membrane temperature coefficient.
Error = zero if readings are taken at the calibration temperature.
Error = $\pm 1\%$ of meter reading if readings are taken with 5°C of the calibration temperature.
Error = $\pm 3\%$ of meter reading all other conditions.

Type III

- A. errors are due to the accuracy of the instrument thermometer when used to measure the exact probe temperature during calibration.
Error = $\pm 1.5\%$ of reading.
- B. errors are due to the assumption of mean, barometric pressure.
Daily variation is usually less than 1.7%
Error = $\pm 1.7\%$ of reading.

errors assume an ability to estimate altitude to within ± 500 ft. when putting the altitude correction factor.

Error = 1.8% of reading.

- D. errors consider the possibility of only 50% relative humidity when calibrating the probe. If the actual relative humidity is 50% instead of 100% the errors will be as follows:

Calibration Temperature \pm C	Error in Percent of Reading
0	(-) 0.3
10	(-) 0.6
20	(-) 1.15
30	(-) 2.11
40	(-) 3.60

Example of a Typical Error Calculation

The example given presumes the air calibration technique. If calibration is done with air saturated water, the relative humidity consideration (III-D) is eliminated. If the Winkler calibration method is used, Type III errors are deleted and replaced by the uncertainty attributable to the overall Winkler determination.

Data: Instrument calibrated at 25°C , elevation estimated at 2000 feet ± 500 feet, normal barometric pressure presumed, calibrated on 0-10 mg/l scale at 7.8 mg/l. Readings taken on 0-5 mg/l range at 4.5 mg/l, temperature 20°C . Salinity of 20 ppt.

Type	Description	Calculations	Error mg/l
IA	Linearity	= $.01 \times 4.5 \text{ mg/l}$	.045
IB	Range Change	= $.01 \times 4.5 \text{ mg/l}$	.045
IC	Salinity	= $.025 \times 4.5 \text{ mg/l} \times 40 \text{ ppt}$	.056
IIA	Probe Background	= $.005 \times \left(1 - \frac{4.5 \text{ mg/l}}{7.8 \text{ mg/l}} \right) \times 7.8 \text{ mg/l}$	.016
IIB	Probe Linearity	= $.003 \times 4.5 \text{ mg/l}$	.014
IIC	Temp. Compensation	= $.01 \times 4.5 \text{ mg/l}$	.045
IIIA	Temp. Measurement	= $.015 \times 4.5 \text{ mg/l}$	.068
IIIB	Pressure	= $.017 \times 4.5 \text{ mg/l}$	.076
IIIC	Altitude	= $.018 \times 4.5 \text{ mg/l}$	.081
IIID	R.H.	= $.016 \times 4.5 \text{ mg/l}$	.072
Maximum Possible Error =			.518 mg/l
Probable Error			$\pm .259$

Considering a statistical treatment of the probable error at any time for any instrument, it is likely that the actual error in any measurement will be about 1/2 of the possible error. In this case the probable error is about $\pm .26$ mg/l out of a reading of 4.5 mg/l or 5.8% of the reading.

INSTRUMENT CASE

The instrument case is water resistant when properly closed. As a precaution against damaged gaskets or loose fittings, the instrument case should be opened and inspected for moisture whenever the instrument has been subjected to immersion or heavy spray. The instrument case is opened by removing the screws on the rear cover and lifting the cover off.

INSTRUMENT BATTERIES

The instrument batteries are two "C" size carbon-zinc cells located inside the instrument on the meter end. These should be replaced when the RED LINE knob is at its extreme adjustment or at least annually. The amount of remaining adjustment is an indication of the battery condition. The batteries are replaced by removing the screws on the rear cover of the instrument and removing the two batteries at the end of the instrument near the meter. When installing the new batteries the plus (+) end fits into the red washer on the battery holder. (See Figure 11.)

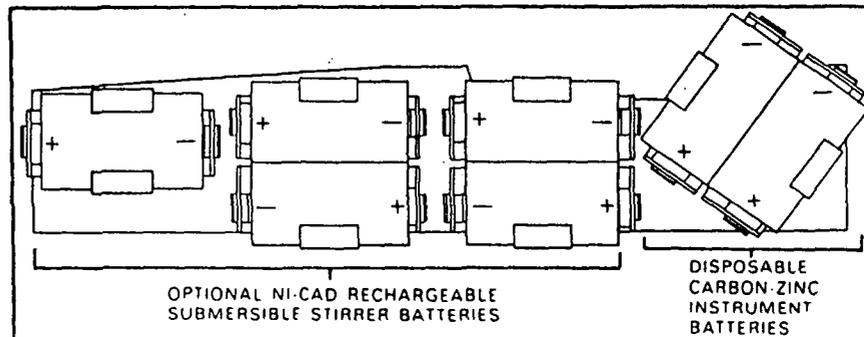


FIGURE 11

WARRANTY AND REPAIR

All YSI products carry a one-year warranty on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge, if possible, when the item is returned to the factory or to an authorized YSI dealer.

If you are experiencing difficulty with any YSI product, it may be returned for repair, even if the warranty has expired. YSI maintains complete facilities for prompt servicing for all YSI products.

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TITLE:
SURFACE WATER SAMPLING

Approved By:

J. W. Langford

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes sampling procedures, documentation, and equipment that will be used to collect water quality samples from surface water data collection sites at Rocky Flats Plant (RFP). More than one sampling method is required because flow conditions vary from site to site. In consideration of these varied conditions, this SOP describes methods that are to be used based on the site-specific flow conditions.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

The project manager or task leader is responsible for assigning project staff to complete surface water data collection activities at the RFP. The task leader is also responsible for ensuring that this and other appropriate procedures are followed by project personnel.

Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

Kister, L. R. and W. B. Garrett. Field Guidelines for Collection, Treatment, and Analysis of Water Samples-Arizona District. U.S. Geological Survey, Water Resources Division. November 1984.

Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, SW-846. EPA. September 1986.

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U.S. Department of Energy. The Environmental Survey Manual. DOE/EH-0053, Washington, D.C. August 1987.

U.S. Department of the Interior. National Handbook for Recommended Methods for Water-Data Acquisition. Office of Water Data Coordination, Geological Survey. Reston, VA. 1977.

U.S. Environmental Protection Agency. Standard Operating Procedures and Quality Assurance Manual. Environmental Services Division, Region IV. Athens, GA. April 1986.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are:

- SOP 4.1, Surface Water Collection Activities
- SOP 4.2, Field Measurement of Surface Water Parameters
- SOP 4.4, Discharge Measurements
- SOP 4.8, Pond Sampling
- SOP 4.9, Industrial Effluent and Pond Discharge Sampling

5.0 METHODS

Surface water flow conditions vary geographically and seasonally. Therefore, the following list will be used as a guideline in identifying techniques of sampling which will correspond to the sample site flow conditions. This list is based upon the most often observed flow conditions at the RFP surface water sites. If field sampling crews encounter flow conditions not described under any of the listed categories, they will use their best judgement in varying one of the approved techniques in order to obtain samples. The technicians will carefully document the site conditions which necessitated

deviation from the approved methods and will also carefully note the method used to obtain the samples.

The flow conditions which have been most frequently encountered, and sections of this SOP containing methods to be used at these sites, are:

1. Flowing, channelized streams:

The sampler will use methods described in Subsection 5.3.2, Samples Collected by Container Immersion.

2. Pipes:

Depending on site conditions, use Subsection 5.3.3, Sampling of Standing Water, Subsection 5.3.4, Remote Sampling; or Subsection 5.3.5, Sampling Under Low Flow Conditions. If the pipe discharges sufficient volume into a channelized stream, use Subsection 5.3.2, Samples Collected by Container Immersion or as described in SOP 4.9, Industrial Effluent and Pond Discharge Sampling. The sample container should not contact the pipe in order to avoid mobilizing materials which may be loosely attached to the pipe causing these materials to contaminate the sample.

3. Small ponds:

The sampler will use Subsection 5.3.3, Sampling of Standing Water or Subsection 5.3.4, Remote Sampling.

4. Interceptor ditches:

Samples may be obtained by methods described in Subsection 5.3.3, Sampling of Standing Water, Subsection 5.3.4, Remote Sampling or Subsection 5.3.5, Sampling Under Low Flow Conditions, or Subsection 5.3.2, Samples Collected by Container Immersion, depending on conditions.

5. Sumps or Standpipes:

These will typically contain low volumes of water, and are sampled by methods detailed in Subsection 5.3.3, Sampling of Standing Water or Subsection 5.3.4, Remote Sampling.

6. Low Flow Conditions:

Samples will be obtained in accordance with Subsection 5.3.5, Sampling Under Low Flow Conditions.

7. Seep Areas:

Samples are to be collected in accordance with Subsection 5.3.5, Sampling of Standing Water.

5.1 OVERVIEW

Surface water samples are to be collected as grab samples. Grab samples characterize a medium at a particular point in space and time. Grab water samples are collected by sample container immersion or by using a transfer device, such as a beaker or dipper as described in Subsection 5.3.2,

Samples Collected by Container Immersion and Subsection 5.2.2, Sample Transfer Devices, respectively.

5.2 EQUIPMENT FOR COLLECTING SAMPLES

Equipment used for collecting surface water samples will include:

- Laboratory-provided sample containers
- Sample transfer devices

5.2.1 Laboratory-Provided Sample Containers

Wherever possible, laboratory-provided sample containers will be used to collect water quality samples. Alternatively, the containers may be purchased from a supplier who certifies that bottles have been pre-cleaned to EPA specifications. Records of container certification will be kept for these containers.

5.2.2 Sample Transfer Devices

Beakers or dippers, composed of Teflon®, stainless steel or glass, may be used if site conditions prevent sampling by sample container immersion. The selected type of transfer device, the composition of this device, and the volume of the device will be recorded in the field notes. The device is placed with the opening upstream at the midpoint of the stream flow. The sample will be poured directly from the beaker or dipper into the sample container. The sampler will attempt to minimize the disturbance of bottom materials.

5.3 PROCEDURES

Samples will be collected from the same cross-section of the stream as that used for the discharge measurement. Always collect samples prior to making discharge measurements.

5.3.1 Sample Order of Collection

The sample for total residual chlorine analysis will be collected prior to the collection of any other samples or measurement of any other parameters.

The following list represents the total variety of sample types to be collected on a monthly basis at each surface water site, and generally guides the order of collection of the samples. The Project Work Plan may require different combinations of sample types and containers.

<u>Priority</u>	<u>Analytes</u>
1	TCL, VOCs
2	Oil and Grease
3	Gross Alpha/Beta, U (233, 234, 235/238)
4	TCL BNAs
5	Pesticides/PCBs
6	TAL Metals-Dissolved
7	Major Ions: Cl, F, SO ₄ , Si, CO ₃ , HCO ₃ ; TDS and TSS
8	TAL Metals-Total
9	Nitrate/Nitrite (as N)
10	Tritium
11	Total Radionuclides
12	Pu 239/240, Am 241
13	Sr 89/90, Cs 137, Ra (226, 228)
14	Cyanide
15	Sulfide (H ₂ S)
16	Rad Screen

Preferred methods of surface water sample collection are as follows:

1. Volatile organic samples will be collected as described in Subsection 5.3.2.1; Collection of Samples for Analysis of Volatile Organic Compounds.
2. Oil and grease will be collected as described in Subsection 5.3.2.2; Collection of Samples for Oil and Grease.
3. The remaining samples, depending on surface water flow conditions and location, will be collected as described in Subsection 5.3.2, Samples Collected by Container Immersion or Subsection 5.2.2, Sample Transfer Devices.

5.3.2 Sample Collected by Container Immersion

Collection of samples will be performed as follows:

1. Submerge the sample bottle below the water surface with the opening pointed upstream at the midpoint of the stream flow.
2. The sampler will attempt to minimize the disturbance of bottom materials.
3. Allow container to fill to desired volume.
4. Remove the container from the water.
5. Preserve the sample, if necessary, and place the cap on the container and tighten.
6. Decontaminate the container's outside surface.

5.3.2.1 Collection of Samples for Analysis of Volatile Organic Compounds (VOCs)

Samples collected for analysis of VOCs must be collected with minimal disturbance to limit aeration. The preferred method of sampling for VOCs is the collection of a grab sample directly into the sample container. The container used for the collection of VOC's is a 40-ml glass vial with a cap containing a Teflon®-coated septum. The following method will be strictly followed:

1. At the approximate center of the discharge stream, submerge the container just below the surface and collect a single sample. Minimize disturbance as much as possible in order to protect the integrity of the sample's volatile constituents.
2. Allow the vial to fill and form a meniscus at the top. Place the cap over the vial so that the Teflon®-coated side of the septum is in contact with the sample.
3. Firmly tighten the cap.
4. Invert and gently tap the vial to verify that there are no entrapped air bubbles. If air bubbles are present, dispose of the sample and vial, then select another container and resample.
5. Decontaminate the outside surface of the container.
6. If conditions preclude the collection of surface water directly into the sample container, samples to be analyzed for volatile constituents may be collected by the use of a transfer device. The beaker or dipper should be submerged, filled, and retrieved with minimal disturbance and delay. After retrieval, the sample container should be tilted at a slight angle against the edge of the beaker or dipper allowing the water in the beaker or dipper to slowly empty into the container. The sample stream should flow gently down the side

of the container to ensure minimal sample aeration, then handle the sample as described in Steps 2-5 listed above.

5.3.2.2 Collection of Samples for Oil and Grease

Because oil and grease are relatively insoluble in water and tend to float on the surface of the water, samples for oil and grease analysis will be collected, whenever possible, by partial container immersion. Samples will be collected in the following manner:

1. Lower the bottle into the water so that the open mouth of the bottle faces upstream.
2. Partially submerge the sample container so that the mouth of the bottle collects the sample at the water surface.
3. The bottle will not be held around the top of the open mouth, as this may result in oil and grease attaching to the holder instead of entering the bottle.
4. Allow the container to fill to within about 1.5 inch from the top of the bottle (if the bottles are not pre-preserved, allow enough remaining room for addition of the H_2SO_4 preservative). Once the sample is collected, water may not be poured off the top of the containers because this will probably result in the loss of a significant portion of any oil and grease in the sample.
5. Remove the container from the water, add the preservative, and screw on the cap tightly.
6. Decontaminate the container's outside surface.

While this method tends to collect a worst-case oil and grease sample, it is the only method that will ensure consistent sample collection and eliminate the possibility of underestimating the oil and grease concentration. Areas where oil and grease levels are a concern may be sampled later by collection of samples at the surface and at additional depths if an estimate of average concentrations is desired.

If low flow conditions prohibit collection of oil and grease as described above, samples may be collected by partial immersion in cooperation with the low flow collation method described last in Subsection 5.3.5, Sampling Under Low Flow Conditions.

5.3.3 Sampling of Standing Water

Special considerations must be taken when sampling pools of standing water which are often found as detention storage or on saturated ground surfaces. Because there is no measurable discharge at these locations, the volume of water present will be measured by estimating the depth of water and the surface area covered by the water.

Due to the possibility of small volumes of water in areas of standing water the priority of sampling collection discussed in Subsection 5.3.1 Sample Order of Collection will be followed. The method of collection for the sampling of an area of standing water with a small volume of water will follow guidelines set forth in Subsection 5.3.5, Sampling Under Low Flow Conditions.

Only small pools, sumps, or ditches containing stagnant water that allow sampling from the approximate center of the pool will be sampled. Such a pool will generally be less than 4 feet in diameter or width and less than 1 foot deep. The procedure for the sampling of pools larger than 4 feet in diameter is covered in SOP 4.8, Pond Sampling.

5.3.4 Remote Sampling

Standpipes or sumps typically contain small, relatively nonstratified volumes of standing water. In general, the volumes of these bodies of water are sufficiently small so that it is assumed that the action of lowering a sample container into the standing water will produce adequate mixing to eliminate any stratification which may exist.

The preferred method for sampling in standpipes or sumps is by container immersion. A stainless steel clamp or Teflon® attached to a stainless steel or aluminum extending rod will be used to hold the sample container. Only stainless steel or aluminum rods will be used for remote sampling. The material (stainless steel or aluminum) composition of the rod will be recorded on the field notes.

The container will be carefully lowered into the standing water and allowed to fill. The field crew member will not allow the extension rod or the sample container to make contact with the sides or bottom of the standpipe or sump, nor with any pumps or other structures inside the standpipe or sump. Such contact may dislodge materials loosely attached to these surfaces and create a potential to contaminate the sample.

If a sample container cannot be filled by container immersion, then a stainless steel, Teflon®, or glass beaker or dipper attached to a remote sampling extension rod will be used to obtain a dip sample. The sample will be poured directly from the beaker or dipper into the sample container. The sampling personnel will record in the field note the type of container used and the material of which the container is made.

5.3.5 Sampling Under Low Flow Conditions

Flow conditions at surface water sampling sites vary seasonally. Some of the sites may possess low discharges with depth of flow being less than 0.5 inch. The field sampling crew will attempt to

obtain samples of water at these sites by use of a transfer device. The sampler will attempt to minimize the disturbance of bottom materials.

Sample containers will be filled as long as it is possible to dip water from the small stream into a beaker. If flow is so low that all sample bottles cannot be filled, collect as many samples as possible while following the order of collection described in Subsection 5.3.1 and record the site flow conditions.

Surface water sites possessing flow depth of less than 0.5 inch, and having no defined channel (i.e. seeps), are known to exist at RFP. Field crews may attempt to obtain water samples at such sites as follows:

1. Dig a small depression in the soil within the path of flow.
2. Place a stainless steel bowl in this depression, with the rim of the bowl below the water surface.
3. Allow the bowl to become full of water, to overflow, and to continue to overflow for several minutes until sample clarity is achieved.
4. Obtain samples from the bowl by container immersion or by the dip and transfer method.

6.0 DECONTAMINATION

Procedures for decontamination are set forth in the site-specific health and safety plan and SOP 1.3, General Equipment Decontamination.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP.

QA samples fall into five categories:

- Duplicate
- Matrix spike
- Matrix spike duplicate
- Equipment rinsate
- Field blank

SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. Applicable project plans specify QA sample frequencies.

Sample collection procedures for duplicate, matrix spike, and duplicate matrix spike samples will be the same as those described in Section 5.0. Duplicate samples will be collected immediately after the suite of analytes have been collected. These samples are to be taken in the same location as the original samples.

A rinsate sample from sampling equipment is intended to check for potential contamination of the sample by the sampling equipment. For the surface water sampling operation, a rinsate sample will be collected from sampling equipment before the sampling equipment is used. Approximately 3 liters of distilled water will be rinsed over a decontaminated sampler and collected in a large decontaminated stainless steel bowl. A decontaminated glass or stainless steel beaker will be used to dip the water from the bowl and fill the sample bottles. The rinsate samples will be analyzed for the same parameters as the surface water samples.

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Field blank samples are containers filled with distilled or deionized water that are handled and transported the same as the other samples to check for potential cross-contamination resulting from field handling and transportation procedures.

8.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Collection Field Notes form. See SOP 4.1, Surface Water Data Collection Activities.

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BASE LABORATORY WORK

J.W. Langman

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2.0 PURPOSE AND SCOPE

The purpose of this standard operating procedure (SOP) is to define the order of procedures routinely performed at a base laboratory at the Rocky Flats Plant (RFP). The goal of the base laboratory is to obtain and document data in order to meet acceptable standards of accuracy, precision, comparability, representativeness, and completeness. This document is intended to provide details so that all personnel perform base lab tasks consistently.

The base lab is to be located in an area designated by the EG&G project manager. This facility will be utilized by the contracting party for activities described, but not limited to those listed as follows:

- As a staging area for personnel sampling activities
- As a storage and preparation area for sample containers and to compile sample sets
- As a receiving, preparation, and shipping area for samples collected in the field
- For equipment calibration and secure storage

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel. Personnel will be geologists, chemists, hydrologists, environmental scientists, engineers, or field technicians with an appropriate amount of applicable experience or on-the-job training under supervision of another qualified person.

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4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure.

A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. December 1987.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. October 1988.

RCRA Facility Investigation Guidance. Interim Final. May 1989.

Standard Methods for the Examination of Water and Wastewater. 17th Edition. 1989, et. seq. APHA-AWWA-WPCF.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are:

- SOP 1.6, Handling of Personal Protective Equipment
- SOP 1.7, Handling of Decontamination Water and Wash Water
- SOP 1.10, Receiving, Labeling and Handling Waste Containers
- SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP 4.2, Field Measurement of Surface Water Field Parameters

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5.0 METHODS

Base lab procedures will be performed as described in the following subsections. The order in which tasks are performed may vary depending on time requirements or other day-to-day events.

5.1 PRE-FIELD ACTIVITIES

Provisions will be made at the base lab for an area where personnel may change from their street clothes into field clothing appropriate to the season. No PPE, clean or otherwise, will be worn in these areas.

Equipment used for field measurement of surface water parameters will be calibrated and/or standardized before use, in accordance with SOP 4.2, Field Measurement of Surface Water Field Parameters. An area of the base lab facilities will be dedicated to this purpose.

Coolers for transporting sample containers, pre-labeled and identified by the sample manager, will be assembled for use by field personnel. The sample manager will also ensure that containers for the collection of samples requiring preservation have had the proper preservatives placed in them. Glass containers will be placed into the coolers in such a manner as to prevent breakage while being transported to the sampling site.

Field crews will be responsible for the inventory of sampling supplies and equipment in the field vehicles and ensuring that necessary items are on hand to complete the day's activities prior to leaving the base lab. They will report the status of quantities of supplies in storage at the base lab to the sample manager in time to reorder and receive items before the stock is depleted.

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Each field team leader will ensure that field folders pertaining to the day's activities are obtained from the base lab office files and, if necessary, that security personnel or other concerned personnel are notified of the day's intended activities.

5.2 BASE LABORATORY ACTIVITIES

The sample manager will have primary responsibility for proper pre-use calibration and post-use standardization practices. An adequate supply of all standards and solutions will be maintained and records of calibration/standardization activities will be filed in a secured area at the base lab office.

The sample manager will interface with the contracted chemical laboratories and provide control of sample containers, field samples, and related activities in accordance with SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

The sample manager will utilize available time while teams are in the field to prepare solutions and supplies for the following day's activities.

5.3 POST-FIELD WORK ACTIVITIES

Crews returning to the base lab from field sampling activities will deliver radiation screening samples to the on-site laboratory.

Contact with the sample manager will be made immediately upon arrival at the base lab, and samples transferred to his/her custody. One member of the delivering field crew will assist the sample manager in preparing the samples for storage and/or shipment.

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A sampling team member will perform post-use instrument calibration/standardization procedures according to SOP 4.2, Field Measurement of Surface Water Parameters. Instruments will be stored in a locked room when field or base lab personnel are not present.

Data forms not completed in the field will be completed after each day's activities.

Field personnel will remove waste from the vehicles and properly dispose of it in accordance with SOP 1.6, Handling of Personal Protective Equipment; SOP 1.7, Handling of Decontamination Water and Wash Water; and SOP 1.10, Receiving, Labeling, and Handling of Waste Containers.

The base lab facilities will remain locked when project personnel are not present. The last person out is responsible for ensuring that all accesses to the facility are properly secured (that is, locked) before leaving at the end of the workday.

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DISCHARGE MEASUREMENT

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) to measure surface water discharge in streams and ditches or from seeps and pipes. Discharge is defined as the volume rate of flow of water, including any substances suspended or dissolved in the water. This document outlines a set of standard methods for various flow conditions at RFP.

This SOP describes equipment and procedures that will be used for field data collection and documentation in order to attain acceptable standards of accuracy, precision, comparability, representativeness, and completeness.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health & Safety Plan. Personnel obtaining surface water discharge measurements will be hydrologists, geologists, engineers or field technicians with an appropriate amount of applicable field experience or on-the-job training under the supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to writing this procedure:

Driscoll, Fletcher G., Ph.D. Groundwater and Wells. Second edition. F Johnson Filtration Systems, Inc., St. Paul, Minnesota. 1986.

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Linsley, Ray K. and Joseph B. Franzini. Water-Resources Engineering. McGraw-Hill, Inc. 1964.

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

Rouse, Hunter, ed. Engineering Hydraulics: Proceedings of the Fourth Hydraulics Conference. Iowa Institute of Hydraulic Research, June 12-15, 1949. John Wiley & Sons, Inc., New York.

U.S. Environmental Protection Agency. Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual. Environmental Services Division, Region IV. Athens, GA. April 1986.

U.S. Department of the Interior. Hydraulic Measurement and Computation: "Discharge Measurements at Gaging Stations." Book 1, Chapter 11, Geological Survey. Reston, VA. 1965.

U.S. Department of the Interior. National Handbook of Recommended Methods for Water-Data Acquisition. Office of Water Data Coordination, Geological Survey. Reston, VA, 1977.

4.2 INTERNAL REFERENCES

SOP 4.1, Surface Water Data Collection Activities is cross-referenced in this SOP.

5.0 METHODS

This SOP describes Environmental Protection Agency (EPA)-approved discharge measurement methods. Methods are based on known conditions at RFP. A variety of discharge measurement methods are required because flow conditions differ from site to site. In consideration of these varied conditions, this SOP describes possible flow conditions that may be encountered and describes methods that are to be used based on the site-specific flow conditions.

Because of the dynamic nature of surface water behavior, flow measurement by the methods described in this document may be impossible at some sites. If immeasurable flow conditions are encountered at a surface water data collection site, the field crew will attempt to measure flow at a point upstream or downstream of the site. Whether or not a measurement is made, the crew will note the conditions that inhibited accurate flow measurement.

Selection of discharge measurement methods is based on the following existing conditions at RFP:

- Flumes to be installed at RFP are Parshall flumes
- Pipes in and around the perimeter security zone (PSZ) contain gravity flow (These may be difficult to reach with a velocity measuring device)
- Many stream channels are rocky and historical stream discharge measurements indicate that portable flumes failed to adequately contain flow

In view of these physical constraints, Table 4.4-1, Discharge Measurement Methods Based on the Type of Site, will be consulted to select the method used at a particular site. Two

Table 4.4-1
DISCHARGE MEASUREMENT METHODS
BASED ON THE TYPE OF SITE

<u>Type of Site</u>	<u>Method</u>
Pipe	Volumetric
Flume	Flume
Flume, with aquatic vegetation	Velocity-area
Stream channel, no flume	Velocity-area
Ditch	Velocity-area

of the listed methods, the velocity-area method and the control structure (flume) method, may be used for discharge measurements in streams or ditches. The third method, the volumetric method, is to be used only for measurement of discharge from pipes.

This SOP also describes the use of specific flumes in discharge measurement. It is recommended that the velocity-area method be used at specific sites where aquatic vegetation or other materials located in the channel downstream from the flume may produce backwater conditions. Backwater conditions are discussed in Subsection 5.1.3.2,

which describes required measurement conditions for flumes.

If none of the methods described above can be used to measure discharge at a particular site, then other methods may be selected and added as addenda to this SOP; or, the measurement point will be evaluated in terms of whether it can either be relocated to a point which permits discharge measurement or whether the point should be eliminated. Any such change will occur only after concurrence between the subcontractor's project manager and the EG&G technical staff.

A particular type of flow which cannot be measured by the procedures described herein is overland flow, which is known to exist at RFP. The term overland flow usually refers to water flowing on the land surface without the ordinary constraint of definable, continuous channel boundaries. Most commonly, the term refers to flow occurring when storm rainfall rates exceed surface infiltration rates. Another type of overland flow occurs when a stream leaves its normal channel and the water flows on normally dry surfaces.

Overland flow is generally determined in an indirect or derived manner. For this reason, measurement of related watershed and meteorological variables is required. Infiltration capacity, rainfall intensity, rainfall depth, and carrying capacity are all required to determine loads carried by overland flow. Two approaches used in research studies for the measurement of overland flow are:

1. Measurement of overland flow velocity by following the progress of a tracer introduced at a known point at a known time.
2. Interrupt the flow and collect the discharge from a measured surface width into a volumetric tank, flume, or other device for measuring small scale flows.

Specific projects may be performed at RFP to assess loads carried by overland flow; however, measurement of overland flow is beyond the scope of typical discharge measurements. SOP addenda which describe the procedures for measurement of overland flow must be prepared and approached on a project-specific basis.

5.1 EQUIPMENT AND PROCEDURES

5.1.1 Volumetric Method

The volumetric method is a simple and accurate method for measuring flow from small discharges and will be utilized at RFP to measure gravity flow discharges from pipe outlets. This method involves observing the time required to fill a container of known capacity, or the time required to partly fill a calibrated container to a known volume. Alternatively, in the case of measuring discharge remotely in a sump or standpipe setting, the volumetric method may be performed by capturing flow in a container for a set period of time: no less than 10 seconds. This volume of water is then measured and discharge is determined.

5.1.1.1 Equipment

The "bucket and stopwatch" technique is particularly useful for the measurement of small flows. Equipment required to make this measurement is a calibrated container and a stopwatch. For measurements at RFP, calibrated containers of varying sizes will include:

- 5-gallon calibrated bucket
- 2-liter graduated cylinder
- 1-liter graduated cylinder
- 1-liter beaker

- 500-milliliter beaker
- 250-milliliter beaker

Remote measurement extension rods will be used to hold a container for capturing flow in enclosed areas containing discharging pipes.

5.1.1.2 Maintenance and Calibration Procedures

The volume of the graduated cylinder is incremented in terms of milliliters and can be easily converted to gallons. The volume of the 5-gallon bucket will be incremented by adding water of known increments of volume and noting the depth of water in the container after the addition of each increment.

5.1.1.3 Field Procedures

In accordance with SOP 4.1, Surface Water Data Collection Activities, the field crew will assess the type of site being visited. Upon arrival at the site, the field technicians will evaluate the flow conditions to select the appropriate method for flow measurement. If the flow conditions meet those outlined in Subsection 5.1.1., then the technicians will observe and use judgement in approximating the flow volume and will select an appropriately sized volumetric container to use the volumetric method of flow measurement.

The technician will use a stopwatch to measure the time required to fill a volumetric container. The technician will time flow into the container for a minimum of 10 seconds. Three consecutive measurements will be made and noted, and the results averaged to determine the discharge.

If remote measurement is necessary, a container will be attached to an extension rod. The

technician will time flow into the container for a minimum of 10 seconds. The volume of water will be poured into a calibrated container, measured, and recorded. Three such measurements will be made and noted, and the results averaged to determine the discharge.

5.1.1.4 Discharge Calculations

Discharge will be determined initially in gallons per second (gal/s) or in milliliters per second (ml/s). These values will be noted, but the averaged value will be reported in cubic feet per second (cfs). Calculations will be performed as follows:

- Record each of the three measurements in terms of gallons per second or in terms of milliliters per second, depending on the increments used on the volumetric container.
- If any one of the three measurements is 50 percent or more different from one or both of the other two measurements, then these values will not be used. Instead, three additional measurements will be taken and, provided that none of these three measurements differs by 50 percent or more from the other two measurements, these values will be used. This re-measurement is to be repeated for a reasonable period of time until three measurements are obtained with no value being 50 percent or more different from the other two values.
- Average the three values.
- Convert the averaged value to cfs as follows:

- to convert ml/s to cfs, multiply by 3.53×10^{-5}
- to convert gal/s to cfs, multiply by 0.134

- Record discharge in cubic feet per second (cfs).

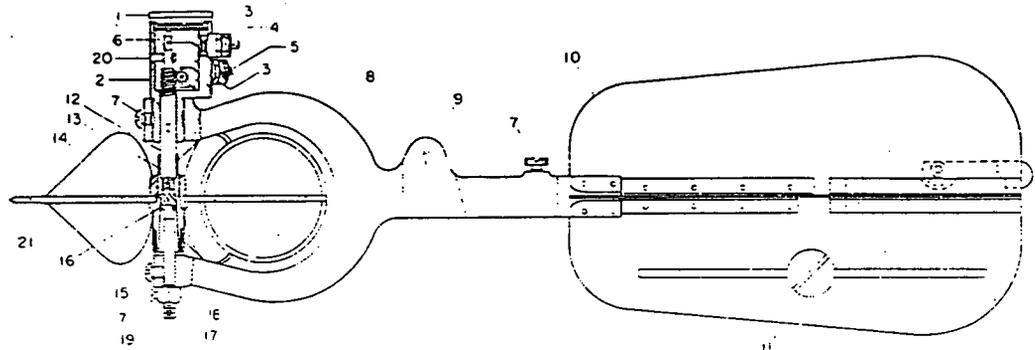
5.1.2 Velocity-Area Method

The majority of the surface water data collection sites at RFP are not controlled by flumes. Some of the stream reaches controlled by flumes contain heavy aquatic vegetation or other materials in the channel downstream of the flume. Surface flow in stream channels and ditches that either lack flumes or contain materials in the channel downstream of the flume will be measured by using the traditional stream gaging technique, the velocity-area method.

The vertical axis current meter has been selected to perform velocity-area method discharge measurements. A common type of vertical axis current meter is the Price meter, type AA (see Figure 4.4-1). The standard Price meter has a rotor 5 inches in diameter and 2 inches high with six cone-shaped cups mounted on a stainless steel shaft. A pivot bearing supports the rotor shaft. The contact chamber houses both the upper part of the shaft and a slender bronze wire (cat's whisker) attached to a binding post. With each revolution, an eccentric contact on the shaft makes contact with a bead of solder at the end of the cat's whisker. A separate reduction gear (pentagear), wire, and binding post provide a contact each time the rotor makes five revolutions. A tailpiece keeps the meter pointing into the current.

In addition to the type AA meters, a Price pygmy meter will be used in shallow depths (see Figure 4.4-1). The pygmy meter is scaled two-fifths as large as the standard meter and has neither a tailpiece nor a pentagear. The contact chamber is an integral part of

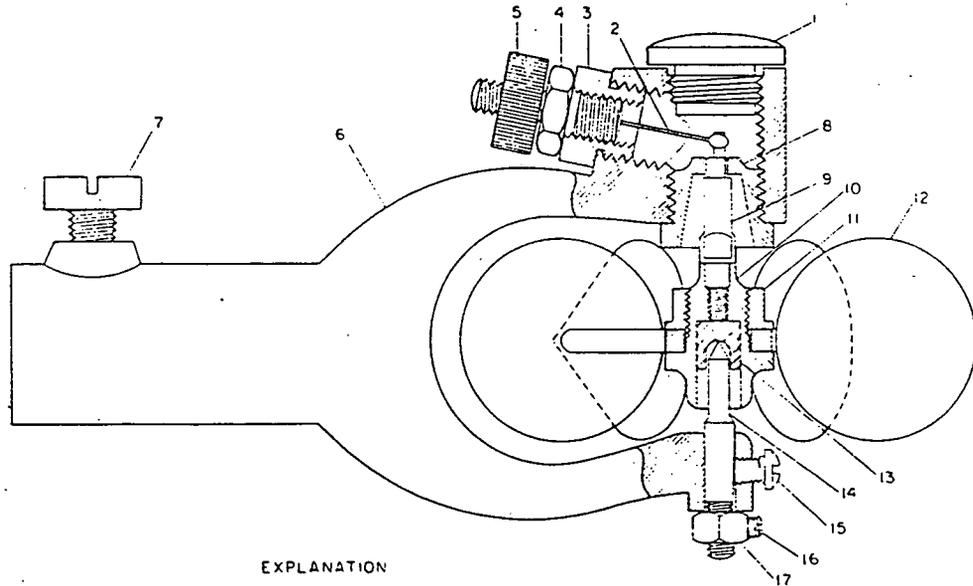
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EXPLANATION

- | | |
|---|---|
| 1 Cap for contact chamber | 11. Balance weight |
| 2 Contact chamber | 12 Shaft |
| 3 Insulating bushing for contact binding post | 13 Bucket-wheel hub |
| 4 Single-contact binding post | 14 Bucket-wheel hub nut |
| 5 Penta-contact binding post | 15 Raising nut |
| 6 Penta gear | 16 Pivot bearing |
| 7 Set screw | 17 Pivot |
| 8 Yoke | 18. Pivot-adjusting nut |
| 9 Hole for hanger screw | 19 Keeper screw for pivot-adjusting nut |
| 10 Tailpiece | 20 Bearing lug |
| | 21 Bucket wheel |

Assembly diagram of type-AA Price current meter.



EXPLANATION

- | | |
|------------------------------------|--------------------------------------|
| 1. Cap for contact chamber | 10. Bucket-wheel hub |
| 2. Binding-post beaded wire | 11. Bucket-wheel hub nut |
| 3. Binding-post insulating bushing | 12. Bucket wheel |
| 4. Binding-post body | 13. Pivot bearing |
| 5. Binding-post nut | 14. Pivot |
| 6. Yoke | 15. Pivot set screw |
| 7. Yoke set screw | 16. Pivot-adjusting nut |
| 8. Upper bearing | 17. Pivot-adjusting nut keeper screw |
| 9. Shaft | 17. Pivot-adjusting nut |

Assembly diagram of pygmy current meter.

SOURCE: WRI BOOK 8, CHAPTER B2

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Prepared by: M.R.R.

Date: 2/18/91

PRICE TYPE AA METER, TOP,
PRICE PYGMY METER, BOTTOM
Figure 4.4-1

the yoke of the meter. The pygmy meter makes one contact per revolution. The predominant flow conditions in channelized streams at RFP indicate that the pygmy meter will be used far more frequently than the Price AA meter.

5.1.2.1 Introduction

The current meter measures velocity at a point. The velocity-area method of making discharge measurements at a cross section requires measurement of the mean velocity in multiple portions of the cross section at each of the selected verticals. By dividing the stream width into subsections, discharge becomes the total of discharges measured in each subsection (see Figure 4.4-2). Velocity (v) is measured at each subsection, and discharge becomes the sum of the products of each point velocity and cross sectional area of each subsection:

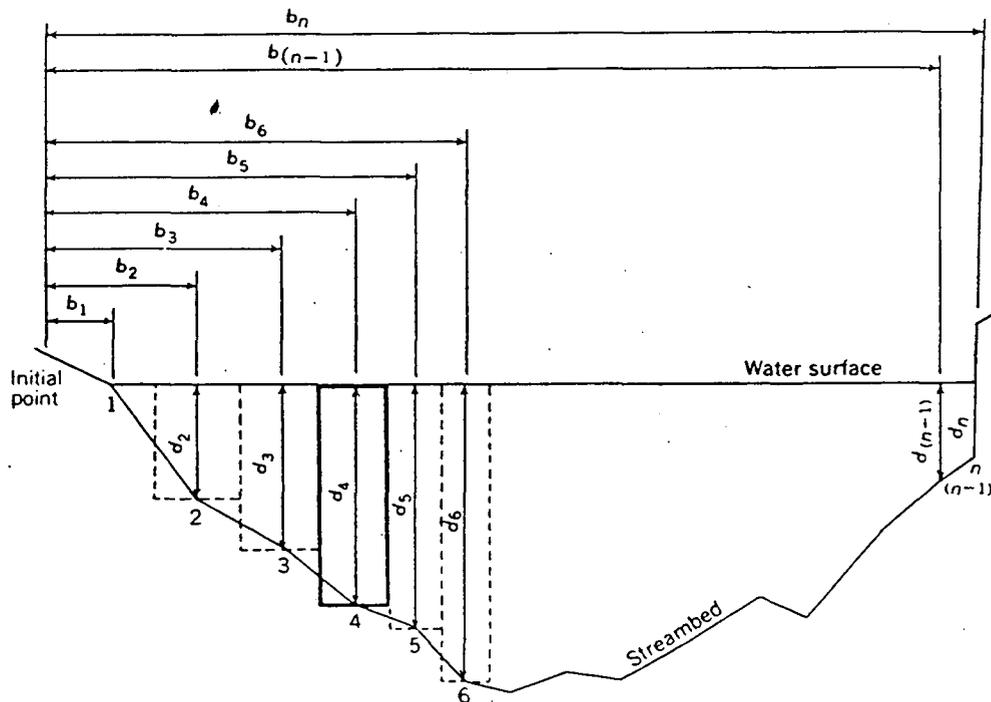
$$Q = \sum va$$

Where Q is total discharge, v is point velocity, and a is the area of the subsection.

In the dual interests of conserving time while maximizing measurement accuracy, the current-meter measurements performed in channelized streams at RFP will be based on selecting subsections to include approximately 10 percent of the total discharge.

In general, depending on average depth and velocity distribution, a stream less than 4 feet wide will require no more than 8 subsections. Streams greater than 4 feet wide may require about 10 subsections. Streams wider than 8 feet may require more subsections. Further, subsections need not be of identical width. For example, because velocities near banks are generally lower than velocities near the center of streams, these subsections may be wider than subsections near the center. Subsections will also be more closely spaced if a stream has an unusually deep portion in the cross section, or if velocities are higher

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EXPLANATION

- 1, 2, 3 n Observation verticals
- $b_1, b_2, b_3, \dots, b_n$ Distance, in feet or meters, from the initial point to the observation vertical
- $d_1, d_2, d_3, \dots, d_n$ Depth of water, in feet or meters, at the observation vertical
- Dashed lines Boundaries of subsections; one heavily outlined is discussed in text

SOURCE: GEOLOGICAL SURVEY
WATER-SUPPLY PAPER
2175, 1982

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DEFINITION SKETCH OF MIDSECTION
METHOD OF COMPUTING CROSS-SECTION
AREA FOR DISCHARGE MEASUREMENTS
Figure 4.4-2

than usual for the cross section.

Typically, velocities will be measured by current meter for a 40-70 second period. It is recognized that 40 to 70 seconds is not long enough to ensure the accuracy of a single point-observation of velocity. However, because pulsations caused by turbulent eddying effects are random and because velocity observations during a discharge measurement are made at several verticals, there is little likelihood that the pulsations will bias the total measured discharge of a stream. Longer periods of current meter observation at a point are not used because (1) it is desirable to complete a discharge measurement before the stage changes significantly and, (2) the use of longer observation periods may add significantly to the operating cost of data collection.

5.1.2.2 Required Measurement Conditions

In order to make a velocity-area discharge measurement, the following conditions are required:

1. The stream must be channelized; that is, observable banks must channel the stream flow.
2. Depth must be greater than 0.2 foot across most of the cross section being measured.

The ideal channel cross section is trapezoidal in shape, completely smooth in boundary materials, and possesses a uniform velocity distribution. It is recognized that no such cross sectional areas exist at RFP. Therefore, minor modifications to the stream channels will be used in order to optimize measurement conditions. These modifications will include removal of aquatic growth or ice, moving large stones which impact velocity

upstream or downstream of the cross section, and narrowing or deepening of the cross section.

Current meter measurements will be made by wading, if conditions permit. The type AA or pygmy meter is used for wading measurements. Table 4.4-2 lists the type of meter and velocity method to be used for wading measurements at various depths.

TABLE 4.4-2
CURRENT METER SELECTION

Stream Depth (ft)	Meter (% of Depth)	Velocity Method
2.5 or more	Type AA	0.2 and 0.8
1.5 - 2.5	Optional	0.6
0.3 - 1.5	Pygmy	0.6
<0.3	Pygmy	0.5

Some departure from Table 4.4-2 will be permitted. For example, if a type AA meter is being used in a measurement section that has most of its depth greater than 1.5 feet, the pygmy meter should not be substituted for a few depths that are less than 1.5 feet, or vice versa. The type AA meter will normally not be used in depths less than 1.25 feet.

Under open channel laminar flow conditions, the effect of fluid contact with the bed of a stream channel and the air is a vertical distribution of velocities. Consistent with this velocity distribution, actual observation and mathematical theory has demonstrated that a single measurement of velocity taken at 0.6-depth or the average of two point velocities taken at 0.2 and 0.8 of the depth below the surface accurately results in mean velocity in the vertical (U.S.G.S. Water-Supply Paper 2175,133-134pp).

If the stream is generally less than 2.5 feet deep, use the six-tenths (0.6) method. If the stream is generally greater than 2.5 feet, the two-and-eight-tenths (0.2 and 0.8) method, also known as the two-point method, will be used. A complete discussion concerning how to set the wading rod to place the current meter at proper depths is contained in Subsection 5.1.2.5.

In the 0.6-depth method, an observation of velocity made in the vertical at 0.6 of the depth below the surface is used as the mean velocity in the vertical. In the two-point method of measuring velocities, observations are made in each vertical at 0.2 and 0.8 of the depth below the surface. The average of the two observations is taken as the mean velocity in the vertical.

A depth of 1.25 feet will accommodate the 0.6-depth method without causing the meter to be set closer than 0.5 feet from the streambed; if the meter is set any closer to the streambed, it will under-register the velocity. However, if the technician is using the type AA meter in a measurement section that has only a few verticals shallower than 1.25 feet, the technician may use the meter for depths that are even as shallow as 0.5 feet without changing to a pygmy meter, if the shallow depth flow represents less than 10 percent of the total discharge.

Vertical axis current meters do not register velocities accurately when placed close to a vertical wall. A Price meter held close to a right-bank vertical wall will under-register because the slower water velocity near the wall strikes the effective (concave) face of the cups. The converse is true at a left-bank vertical wall. (The terms "left bank" and "right bank" designate direction from the center of a stream for an observer facing downstream.) The Price meter also under-registers when positioned close to the water surface or close to the streambed.

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5.1.2.3 Equipment

Current meters, timers, depth and width measuring devices, and a means of counting meter revolutions are needed for measurement of discharge. The equipment includes:

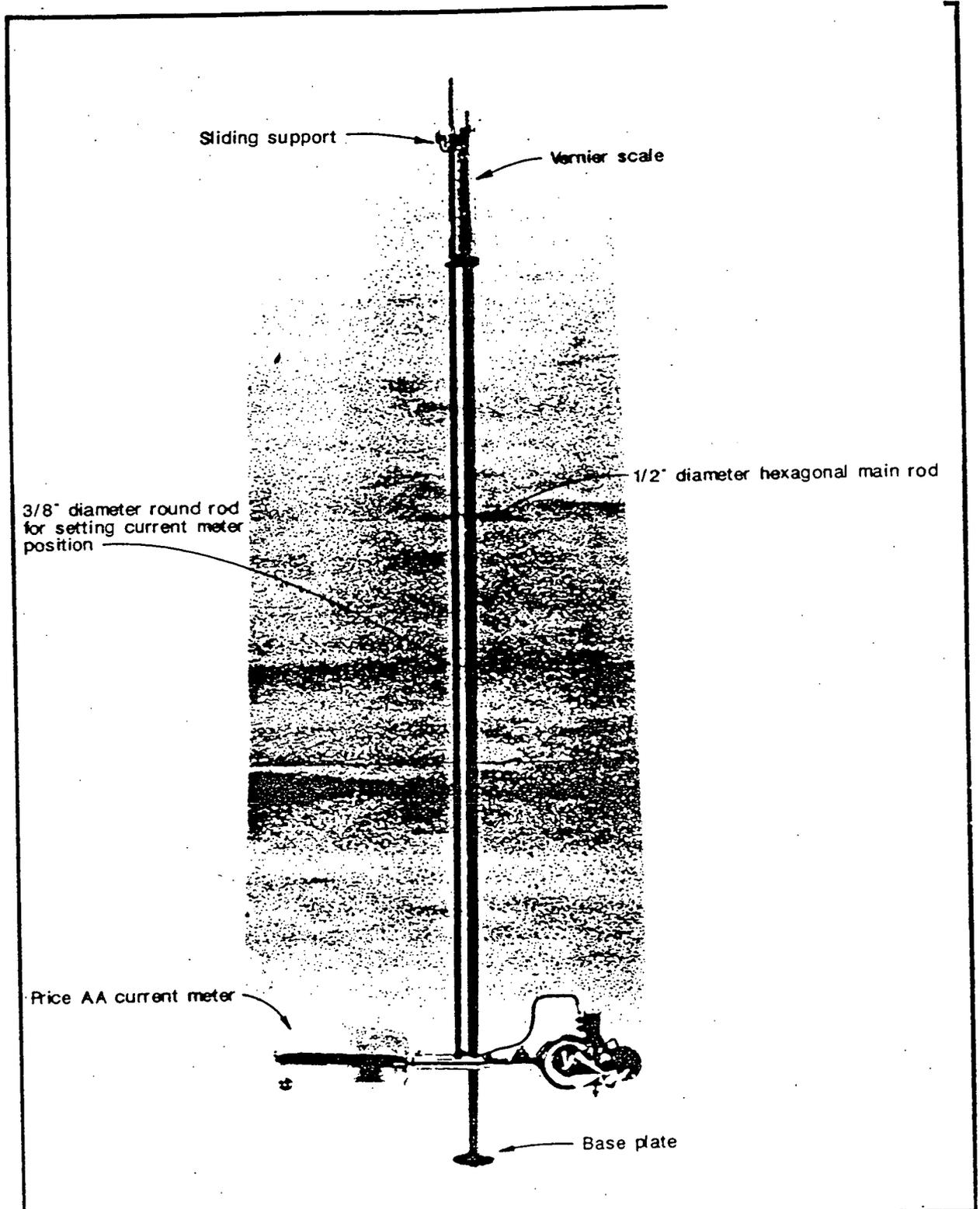
- Depth-measuring device
- Current meter
- Width-measuring devices, either engineer's tape or tagline
- Digital counter or headset
- Stopwatch

5.1.2.3.1 Depth-Measuring Device. The depth-measuring device that will be used is the wading rod. The current meter is attached to a wading rod. The top-setting rod is preferred for use at RFP because of the convenience in setting the meter at the proper depth and because the hydrographer's hands remain dry in the process. The top-setting wading rod has a 1/2-inch hexagonal main rod for measuring depth and a 3/8-inch diameter round rod for setting the position of the current meter (see Figure 4.4-3).

5.1.2.3.2 Current Meter. A current meter is an instrument used to measure the velocity of flowing water. The principle of operation is based on the proportionality between the velocity of the water and the resulting angular velocity of the meter rotor. By placing a current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

The number of revolutions of the rotor is obtained by an electrical circuit through the contact chamber. Contact points in the chamber are designed to complete an electrical circuit at selected frequencies of revolution. The contact chambers selected for discharge measurements at RFP have contact points that will complete the circuit once per

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Sliding support

Vernier scale

1/2" diameter hexagonal main rod

3/8" diameter round rod for setting current meter position

Price AA current meter

Base plate

SOURCE: GEOLOGICAL SURVEY
WATER-SUPPLY PAPER
2175, 1982

Job No. : 4011-455

Prepared by: M.R.R.

Date: 2/18/91

TOP-SETTING WADING ROD WITH METER
ATTACHED

Figure 4.4-3

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revolution. The electrical impulse produces an audible click in a headphone. The intervals during which meter revolutions are counted are timed with a stopwatch.

5.1.2.3.3 Engineer's Tape or Tagline. Steel tapes, metallic tapes, or premarked taglines are used for stream width measurements. Orientation normal to the flow pattern of the river and elimination of most of the sag, through support or tension, are recommended for improved accuracy.

5.1.2.3.4 Digital Revolution Counter or Headset. The digital revolution counter attaches to an electronic connection at the top of the wading rod. The digital display shows the number of seconds of elapsed time. The hydrographer stops the counter after 40 or more seconds, and the counter automatically displays the velocity.

If the digital counters are unavailable, the headset will be used as a means for determining the number of revolutions. A headset attaches to an electronic connection at the upper end of the wading rod. The hydrographer wears this headset to listen to audible clicking sounds which are produced when a rotating gear in the current meter makes contact with a thin wire (cat's whisker) in the contact chamber. The rotating gear contacts the cat's whisker once each time the series of cups on the meter revolves one complete turn. The number of rotations are counted and timed. The relationship between rotations and time is the point velocity. Velocities as a function of time are listed on a velocity chart, which is kept in the current-meter carrying case.

5.1.2.3.5 Stopwatch. A stopwatch is used to measure time during which velocity is measured at each point in the cross section.

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5.1.2.4 Maintenance and Calibration Procedures

Prior to use of the current meter, and following use of the meter, spin tests will be conducted to ensure that the unit performs acceptably.

The spin test will be performed in an enclosed area, such as in the cab of a truck or in the enclosed rear of a truck, to prevent wind interference. The test is to be performed prior to attaching the current meter to the wading rod. While holding the meter steady in an area sheltered from breezes, the technicians will spin the rotor and then press the start button on the stopwatch. The technician will observe the meter until the rotor ceases to spin.

The duration of the spin for the pygmy meter will be more than 40 seconds, and for the Price AA meter, it will be more than 90 seconds. If the meter fails to meet the time-of-spin criteria, the meter will be cleaned and oiled before use. If the meter continues to spin well beyond these time limits, the record will indicate that the meter spun for 40+ seconds, in the case of the pygmy meter, or for 90+ seconds in the case of the Price AA meter.

To ensure reliable observations of velocity, it is necessary that the current meter be kept in good condition. Before and after each discharge measurement, the meter cups or vanes, pivot and bearing, and shaft will be examined for damage, wear, or faulty alignment. During measurements, the meter will be observed periodically when it is out of the water to be sure that the rotor spins freely.

Meters will be cleaned and oiled daily when in use. If measurements are made in sediment-laden water, the meter will be cleaned immediately after each measurement. After oiling, the rotor will be spun to make sure that it operates freely. If the rotor stops

abruptly, the cause of the trouble will be sought and corrected before using the meter.

In addition to meter maintenance, the entire unit consisting of current meter, wading rod, and digital counter or headset will be checked before departure to the field each day as follows:

- Attach the current meter and digital counter/headset to the wading rod.
- Check the digital counter by ensuring that the readout is visible when the unit is turned on.
- If a headset is being used:
 - Spin the current meter to ensure that audible clicks occur.
 - If audible clicks do not occur, the following steps should be taken:
 - Check that electronic connections are tight.
 - Check that the cat's whisker lightly contacts the upper part of the shaft.
 - Spin again. If audible clicks still do not occur, check that the battery in the headset is properly aligned. Replace the battery, if necessary.

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5.1.2.5 Field Procedures

5.1.2.5.1 Overview. In accordance with SOP 4.1, Surface Water Data Collection Activities, the field crew will determine the type of site to be visited. Upon arrival at the site, the field technicians will evaluate the flow conditions to verify that the velocity-area method is the appropriate method for flow measurement. Based on approximate depths, either the Price AA meter or the pygmy meter will be selected to perform a velocity-area measurement.

At each measurement point (or station) across the stream cross section, depth is measured prior to measurement of velocity. Placement of the wading rod about 0.5 feet downstream from the tagline prevents contact between the tagline and the current meter when the meter is lowered into measuring position. The wading rod is placed in the stream so the base plate rests on the streambed, and the depth of water is read from the graduated main rod. The main rod is graduated into 0.1-foot increments. These increments are indicated by a single score in the metal. Half-foot increments are marked by two scores in the metal, and each foot is marked by three scores in the metal. A vernier scale on the upper handle of the rod corresponds to 0.1-foot increments, and has 1 through 9 in raised numbers next to raised marks. A sliding, adjustable rod, known as the setting rod, to which the meter is attached, has single scored marks which are aligned with values on the vernier scale.

The technician reads water depth directly from the main rod. In high velocity areas, it is recommended that depth be read as the value between depth on the upstream side of the rod and depth on the downstream side of the rod. Depth is measured to the nearest 0.02 foot. This depth is used to set the vertical location on the current meter.

The setting rod is then adjusted downward so that the scored mark of the setting rod

which corresponds to the range of depth in feet (e.g., if depth = 0.46, range in feet = 0; or if depth = 1.72, range in feet = 1) is aligned with the stream depth value transposed to the vernier scale. This automatically positions the meter for use in the 0.6 method as the meter is then six-tenths of the total depth from the surface of the water.

For using the two-point method of velocity measurement, the depth of water is divided by 2. This value is set so that the meter will be at the 0.2-depth position from the water surface. The depth of water is then multiplied by 2, and this value is set. The meter will then be at the 0.8-depth position measured down from the water surface. These two positions represent the conventional 0.2- and 0.8-depth positions. If depths are less than 0.30 foot, the 0.5 method may be used. The observation depth recorded will then be 0.5 of the total depth.

5.1.2.5.2 Steps to be Followed in Measuring Discharge. If water quality or sediments are being sampled in conjunction with discharge measurement, samples will be collected prior to making discharge measurements. The following steps are to be followed in discharge measurement:

- Evaluate the measurement location. The measurement location should be chosen where flow is least turbulent. Laminar flow is preferred for accurate measurements. If the prescribed location is in a stream reach with highly turbulent flow conditions, try to select a location immediately upstream or downstream from the prescribed location. If depths or velocities under natural conditions are too low for a dependable current meter measurement, the cross section should be modified, if practical, to provide acceptable conditions. Neither the type AA meter nor the pygmy meter will be used for measuring velocities slower than 0.1 fps unless absolutely necessary.

- Record the following: distance from initial point, width, depth, observation depth, revolutions, time in seconds, velocity, area, discharge.
- Note the distance in feet, and the stream direction, that this cross section lies from the prescribed location. For example, the note may read "25 feet downstream" or "15 feet upstream." This is recorded in a manner similar to that of the discharge measurement notes (Figure 4.4-4).
- If the selected cross section contains aquatic growth, ice, boulders, or slack-water areas that can either interfere with operation of the current meter or otherwise impede accurate measurement, use a shovel to remove minor flow impediments. When such modifications are made, great care will be exercised to avoid unnecessary movement of sediments or the splashing of sediments or water onto field personnel. After clearing the cross section, flow will be allowed to stabilize before the current meter measurement begins.
- Several measurement locations are required from one side of the stream to the other. Position a tape (for small streams) or the tagline (for large streams) about 1 foot above the surface of the water. Secure the tape so that it remains taut and so that it is perpendicular to the channel.
- Select a starting point at either the left bank (left edge of water, LEW) or the right bank (right edge of water, REW).
- Measure the width of the stream, in feet. After selecting the Price AA or pygmy meter (see Table 4.4-2), follow guidelines in Subsection 5.1.2.1 to select the number of subsections in which to measure velocity.

- After determining the distance desired between measuring points, commonly referred to as stations, measurement can begin. Record the time and bank at which measurement starts on the discharge measurement note as "REW Start 0000", using REW or LEW depending upon whether starting at the right or the left edge of the water. The 24-hour clock is used, and is recorded to the nearest five minutes. Figure 4.4-5, Computation Notes of a Current Meter Measurement, shows how REW and LEW are noted.
- Note the distance to the beginning edge of water from the initial point. The initial point is an arbitrary point on the tape, preferably a whole number, which lies on the shoreside of the stream. All subsequent station locations are recorded as distances from the initial point.
- Proceed to the first station. Record the distance from the initial point on the discharge measurement notes. Place the wading rod into the stream so the base plate rests on the stream bed.
- Stand downstream of the tagline or tape and face upstream. Raise the current meter on the wading rod so that it is well above the surface of the water.
- Measure stream depth at the measurement point as indicated on the wading rod. Individual lines on the wading rod indicate 0.10 foot. Double lines indicate 0.50-foot, and triple lines indicate 1.00-foot increments. Record the stream depth to the nearest 0.02 foot (for example 0.32 feet or 1.54 feet).

- Lower the meter to the required depth and record in the logbook the observation depth. The observation depth as a fraction of total depth is 0.6, 0.2, 0.8 or occasionally 0.5.
- The technician will stand in a position that least affects the velocity of the water passing the current meter. That position is usually obtained by facing upstream with the arm fully extended. The technician will stand at about a 45-degree angle downstream from the wading rod. The wading rod is held in a vertical position with the meter parallel to the direction of flow. Avoid standing in the water if feet and legs occupy a significantly large percentage of a narrow cross section. For narrow streams, it is often possible to stand astride the stream.
- Start the digital counter. After 40 seconds, stop the counter. Note that the counter reports velocity.
- If using the headset rather than the digital counter, start the stopwatch and begin counting clicks. The first click is counted as zero.
- After at least 40 seconds have passed, stop the stopwatch. Record number of seconds and number of revolutions (clicks) on the same line of the note as the depth was recorded.
- Determine velocity as a function of elapsed time and number of revolutions from the velocity chart. Record velocity next to the other values for this station.

- Proceed to the next station. Record the distance from the initial point to the station. Repeat measurements of depth and velocity. Continue in this manner across the stream.
- After recording the distance measurement at the last station, record the time at which the ending edge of water is reached as "LEW (or REW) FINISH 1330."
- Note velocity and depth at the edge of water as zero.
- Evaluate and record the following: Flow characteristics, weather conditions, air temperature, water temperature, observer(s), type of meter, and remarks.

5.1.2.6 Discharge Calculations

A current meter measurement is the summation of the products of the subsection areas of the stream cross section and their respective average velocities. The formula

$$Q = \Sigma(va)$$

represents the computation, where Q is the total discharge, v is the corresponding mean velocity of flow normal to the subsection, and a is an individual subsection area. The summation of the discharges for all the subsections is the total discharge of the stream. An example of the measurement is shown in Figure 4.4-5. Refer to Figure 4.4-4, discharge measurement notes. The order for calculating discharge is:

- Use the distances from initial point to compute width for each section. The first width is computed by subtracting the first distance from the second distance, and dividing this quantity by two. The second width will

be the quantity of difference between the third distance and the first distance, divided by two. For each subsequent width, subtract the distance on the line above the line you are calculating from the distance on the line below the line you are calculating, and divide this quantity by two. This procedure is carried out for each line until you reach the final width calculation. This is calculated as the quantity of the difference between the final distance and the second-to-the-last distance, divided by two.

- Subsequent calculations may be performed on a calculator. As values are calculated, the user records values for each subsection and total values for width, area, and discharge.
- Upon return to the base lab, submit the field data to the site supervisor who will check the calculations.

5.1.3 Control Structures

Control structures such as weirs and flumes can be used to determine discharge. These structures have regular dimensions that allow for a consistent relationship between water level and discharge. A few Parshall flumes are in operational condition exist at RFP, and more are to be installed. This section describes use of Parshall flumes to measure discharge. With the exception of small v-notch weirs in pipes in and near the sewage treatment plant, no weirs are known to be in operation at RFP; therefore, this section provides general guidelines for the use of weirs in measuring discharges. Should weirs be installed at RFP, addenda to this SOP will be prepared to describe the use of the specific type of weir in discharge measurement.

5.1.3.1 Introduction

5.1.3.1.1 Weirs. Weirs are classified under the general categories of (1) broad crested, or (2) sharp crested. Discharge over a broad-crested weir takes the form:

$$Q = CLH^{3/2},$$

where Q is the discharge, L is the crest length, and H is the depth of water over the crest of the weir. Values for the coefficient C are given in hydraulic handbooks. While the exponent for H listed here is applicable to many weirs, hydraulic handbooks should be consulted to find the correct exponent for the weir being used.

Sharp crested weirs are constructed in a variety of shapes, but the most common are V-notch, rectangular, and Cipolletti.

5.1.3.1.2 Flumes. A calibrated constriction placed in a stream channel changes the level of the water in or near the constriction. Flumes are constructed so that a restriction in the channel causes the water to accelerate, producing a corresponding change (drop) in the water level.

When the physical dimensions of the flume constriction are known, discharge through the constriction may be determined from measurement of depth. Refer to Subsection 5.1.3.6.2 for a description of discharge measurement for Parshall flumes.

Typical flumes consist of three sections:

- A converging section to accelerate the approaching flow.
- A throat section, whose width is used to designate flume size.
- A diverging section, designed to ensure that the level downstream is lower than the level in the converging section.

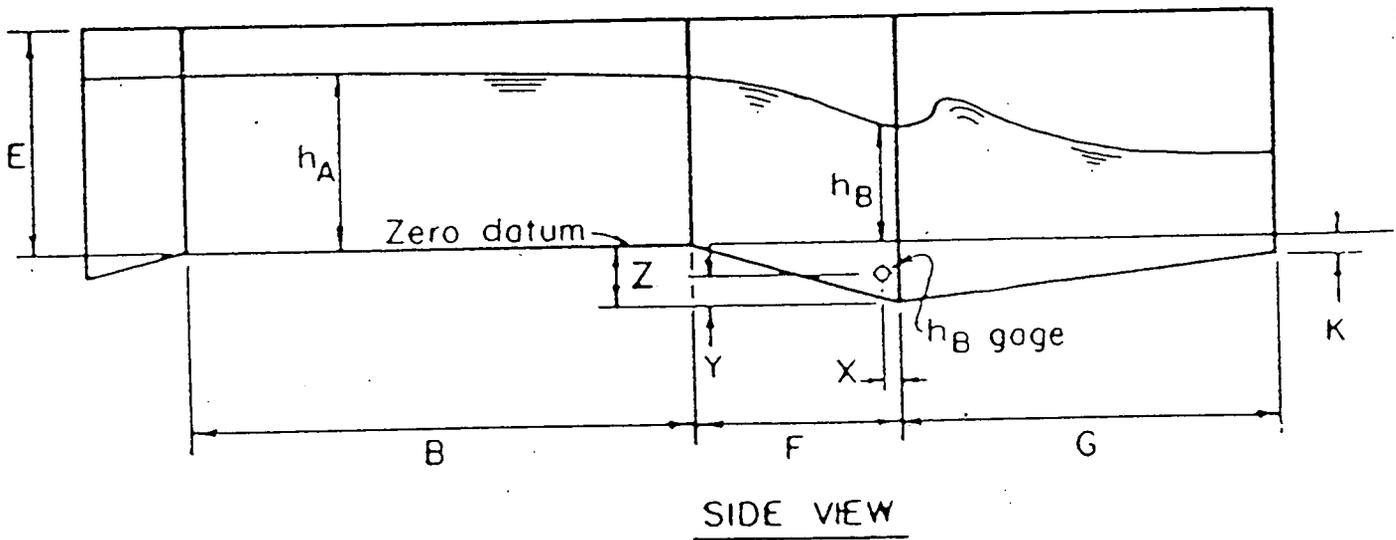
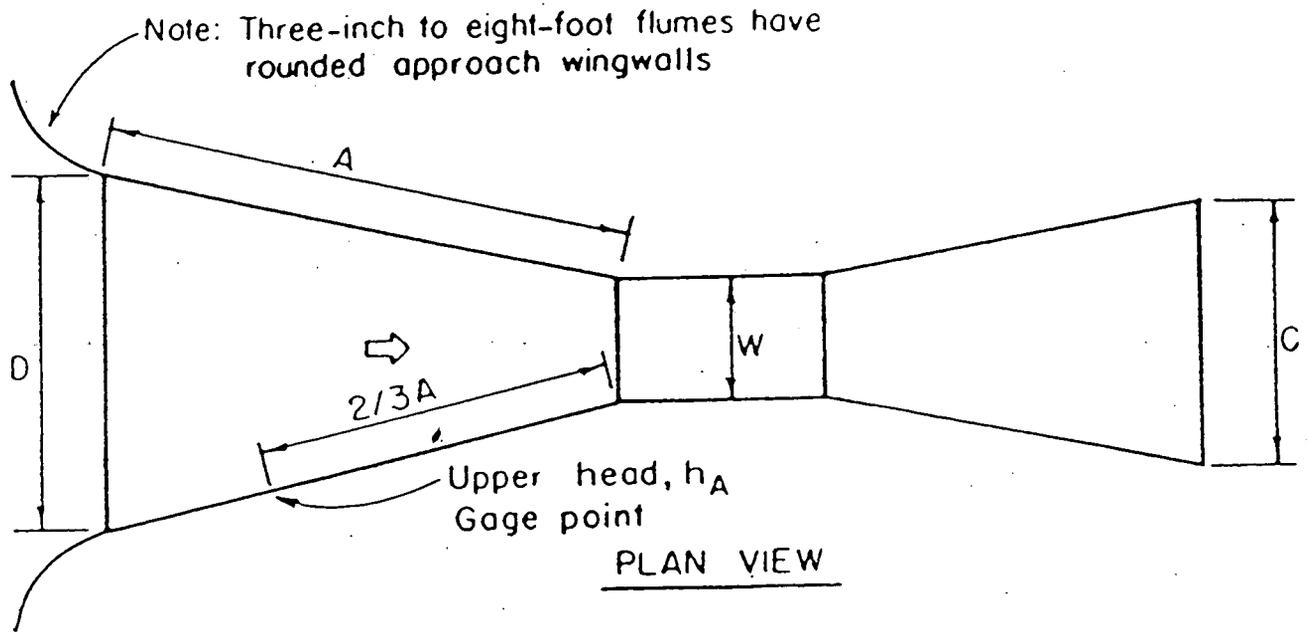
The stage of a stream is the height of the water surface above an established elevation. Stage is usually expressed in feet. The Parshall flume consists of a converging section with a level floor, a throat section with a downward sloping floor, and a diverging section with an upward sloping floor (see Figure 4.4-6). The principal feature of the Parshall flume (developed by R. Parshall in 1922) is an approach reach having converging sidewalls and a level floor, the downstream end of which is a critical depth cross section. The primary stage measurement is made in the approach reach at some standard distance upstream from the critical-depth cross section.

Table 4.4-3 gives the dimensions for various sizes of flumes. The flumes are designated by the width (w) of the throat. Flumes having throat widths from 3 inches (in.) to 8 feet (ft) have a rounded entrance whose floor slope is 25 percent. Smaller and larger flumes do not have that feature.

5.1.3.2 Required Measurement Conditions

5.1.3.2.1 Weirs. For weir formulas to give accurate values of discharge, the upstream face of the weir must be vertical and at right angles to the channel, and the crest of the weir must be horizontal. In addition, atmospheric pressure should be maintained under the nappe, and the approach channel should be straight and unobstructed. The head, h , should be measured far enough upstream from the weir to avoid the affect of curvature of the water surface near the weir.

5.1.3.2.2 Flumes. Ideally, flow rate through a flume may be determined by measurements at a single point some distance downstream from the inlet and above the throat.



FROM: U.S.E.P.A. ENGINEERING SUPPORT BRANCH STANDARD OPERATING PROCEDURES AND QUALITY ASSURANCE MANUAL

Job No. : 4011-455
Prepared by : M.R.R.
Date : 2/18/91

CONFIGURATION AND DESCRIPTIVE NOMENCLATURE FOR PARSHALL FLUMES
 Figure 4.4-6

Table 4.4-3 - Dimensions and Capacities of all Sizes of Standard Parshall Flumes

[For sizes 1 ft to 8 ft, $A = W/2 + 4$. For all sizes, h_1 is located a distance of $2/3 A$ from crest; distance is converging wall length, not axial.]

Size: Throat width W	Widths		Axial Lengths			Wall Depth in Con- verging Section E	Vertical distance below crest		Con- verging wall length A	h_1 dist. upstream from crest	Gage Points		Free Flow Capacities	
	Upstream end D	Down- stream end C	Con- verging Section B	Throat Section F	Diverging Section G		Dip at Throat Z	Lower end of flume K			X	Y	Min.	Max.
inches	feet	feet	feet	feet	feet	feet	feet	feet	feet	feet	feet	feet	ft ³ /s	ft ³ /5s
1	0.549	0.305	1.17	0.250	0.67	0.5-0.75	0.094	0.062	1.19	0.79	0.026	0.042	0.005	0.15
2	.700	.443	1.33	.375	.83	0.50-0.83	.141	.073	1.36	.91	.052	.083	.01	.30
3	.849	.583	1.50	.500	1.00	1.00-2.00	.188	.083	1.53	1.02	.083	.125	.03	1.90
6	1.30	1.29	2.00	1.00	2.00	2.0	.375	.25	2.36	1.36	.167	.25	.05	3.90
9	1.88	1.25	2.83	1.00	1.50	2.5	.375	.25	2.88	1.93	.167	.25	.09	8.90
feet														
1.0	2.77	2.00	4.41	2.0	3.0	3.0	.75	.25	4.50	3.00	.167	.25	.11	16.1
1.5	3.36	2.50	4.66	2.0	3.0	3.0	.75	.25	4.75	3.17	.167	.25	.15	24.6
2.0	3.96	3.00	4.91	2.0	3.0	3.0	.75	.25	5.00	3.33	.167	.25	.42	33.1
3.0	5.16	4.00	5.40	2.0	3.0	3.0	.75	.25	5.50	3.67	.167	.25	.61	50.4
4.0	6.35	5.00	5.88	2.0	3.0	3.0	.75	.25	6.00	4.00	.167	.25	1.30	67.9
5.0	7.55	6.00	6.38	2.0	3.0	3.0	.75	.25	6.50	4.33	.167	.25	1.60	85.6
6.0	8.75	7.00	6.86	2.0	3.0	3.0	.75	.25	7.0	4.67	.167	.25	2.60	103.5
7.0	9.95	8.00	7.35	2.0	3.0	3.0	.75	.25	7.5	5.00	.167	.25	3.00	121.4
8.0	11.15	9.00	7.84	2.0	3.0	3.0	.75	.25	8.0	5.33	.167	.25	3.50	139.5
10	15.60	12.00	14.0	3.0	6.0	4.0	1.12	.50	9.0	6.00			6	300
12	18.40	14.67	16.0	3.0	8.0	5.0	1.12	.50	10.0	6.67			8	520
15	25.0	18.33	25.0	4.0	10.0	6.0	1.50	.75	11.5	7.67			8	900
20	30.0	24.00	25.0	6.0	12.0	7.0	2.25	1.00	14.0	9.33			10	1340
25	35.0	29.33	25.0	6.0	13.0	7.0	2.25	1.00	16.5	11.00			15	1660
30	40.4	34.67	26.0	6.0	14.0	7.0	2.25	1.00	19.0	12.67			15	1990
40	50.8	45.33	27.0	6.0	16.0	7.0	2.25	1.00	24.0	16.00			20	2640
50	60.8	56.67	27.0	6.0	20.0	7.0	2.25	1.00	29.0	19.33			25	3280

Note: Flume sizes 3 inches through 8 feet have approach aprons rising at a 1:4 slope and the following entrance roundings: 3 through 9 inches, radius = 1.33 feet; 1 through 3 feet, radius = 1.67 feet; 4 through 8 feet, radius = 2.00 feet.

From: Measurement and Computation of Streamflow: Volume 2. Computation of Discharge. Geological Survey WSP 2175.

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5.1.3.3 Equipment

The following equipment will be needed:

- Current meter
- Carpenter's level
- Framing square
- Measuring tapes
- Staff gauge

5.1.3.4 Maintenance and Calibration Procedures

5.1.3.4.1 Weirs. All weirs will be inspected to determine that they provide a uniform influent flow distribution and that they are placed squarely across the channel. Corrosion of the crest of a sharp-edged weir or damage by floating debris may alter the weir coefficient. If a broad-crested weir is to be used for measurement purposes, its shape must conform to one for which coefficients have been established by testing. The equations and tables found in hydraulics references that are used to compute the flow over weirs apply only to free-flow conditions. When the water level downstream from a weir rises above the level of the weir crest, the weir crest is said to be submerged. Formulas have been developed for flow over submerged weirs, but under such conditions accurate flow measurement is not possible because surface disturbances downstream from the weir make it difficult to measure the depth of submergence.

5.1.3.4.2 Flumes. All flumes will be inspected to determine that entrance conditions provide a uniform influent flow distribution, the converging throat section is level, and that the throat section walls are vertical. The flume will be closely examined to determine that it

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is discharging freely. Any problems observed during the inspection will be noted and reported to the field manager.

5.1.3.5 Procedures

5.1.3.5.1 Overview. In accordance with SOP 4.1, Surface Water Data Collection Activities, the field crew will determine possible flow conditions based on past activities at the site before going to the field data site. Upon arrival at the site, the field technicians will evaluate the flow conditions to verify the appropriate method for flow measurement. If the flow conditions meet those outlined in Subsection 5.1.3.2, then the technicians will observe and use judgment in approximating the flow volume and will perform a measurement based on use of the control structure.

5.1.3.5.2 Steps to be Followed in Measuring Discharge

- Remove any material that may have accumulated in the flume or on the weir.
- If the station includes a chart recorder, inspect the strip chart on the recorder to verify that it is operating.
- Note any deterioration of the station; report these conditions to the field manager at the conclusion of daily data collection activities.
- Measure and record the throat width to the nearest 1/100 of an inch.
- Use the staff gage to measure and record the gage height to the nearest 0.02 foot.

- Calculate discharge as described in Subsection 5.1.3.6.
- Record the calculated discharge.
- Record the time and date of the site visit.

5.1.3.6 Discharge Calculations

5.1.3.6.1 Weirs. Equations are derived for weirs of specific geometry which relate static head to discharge. Weirs are generally classified into two general categories: (1) broad crested, and (2) sharp crested.

A set of weir tables is necessary for calculating flows. The weir tables are specific to the type of weir. If weirs are established at RFP, tables specific to the weirs will become an addendum to this SOP.

5.1.3.6.2 Flumes. A set of flume tables is necessary for calculating flows. The flume tables are specific to the type of flume. If flumes other than Parshall flumes are installed at RFP, tables specific to the flumes will become an addendum to this SOP. For Parshall Flumes refer to Table 4.4-4, Free-Flow Discharge-Parshall Flume, cfs. Based on the gage height (head, H, in feet) and the throat width of the flume (size of flume, W), the discharge is read directly from Table 4.4-4.

Note that approximate values of discharge for heads other than those shown may be found by direct interpolation in the table.

Table 4.4-4
 Free Flow Discharge — Parshall Flume, cfs

Head, H, Feet	Size of Flume, H'											
	3"	6"	9"	1'0"	1'6"	2'0"	3'0"	4'0"	5'0"	6'0"	7'0"	8'0"
0.1	0.028	0.05	0.09	—	—	—	—	—	—	—	—	—
0.2	0.082	0.16	0.26	0.35	0.51	0.66	0.97	1.26	—	—	—	—
0.3	0.154	0.31	0.49	0.64	0.94	1.24	1.82	2.39	2.96	3.52	4.08	4.62
0.4	0.241	0.48	0.76	0.99	1.47	1.93	2.86	3.77	4.68	5.57	6.46	7.34
0.5	0.339	0.69	1.06	1.39	2.06	2.73	4.05	5.36	6.66	7.94	9.23	10.51
0.6	0.450	0.92	1.40	1.84	2.73	3.62	5.39	7.15	8.89	10.63	12.36	14.08
0.7	0.571	1.17	1.78	2.33	3.46	4.60	6.86	9.11	11.36	13.59	15.82	18.04
0.8	0.702	1.45	2.18	2.85	4.26	5.66	8.46	11.25	14.04	16.81	19.59	22.36
0.9	0.843	1.74	2.61	3.41	5.10	6.80	10.17	13.55	16.92	20.29	23.66	27.02
1.0	0.992	2.06	3.07	4.00	6.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00
1.1	—	2.40	3.55	4.62	6.95	9.27	13.93	18.60	23.26	27.94	32.62	37.30
1.2	—	2.75	4.06	5.28	7.94	10.61	15.96	21.33	26.71	32.10	37.50	42.89
1.3	—	—	4.59	5.96	8.99	12.01	18.10	24.21	30.33	36.47	42.62	48.78
1.4	—	—	5.14	6.68	10.10	13.48	20.32	27.21	34.11	41.05	47.99	54.95
1.5	—	—	—	7.41	11.20	15.00	22.64	30.34	38.06	45.82	53.59	61.40
1.6	—	—	—	8.18	12.40	16.58	25.05	33.59	42.17	50.79	59.42	68.10
1.7	—	—	—	8.97	13.60	18.21	27.55	36.96	46.43	55.95	65.48	75.08
1.8	—	—	—	9.79	14.80	19.90	30.13	40.45	50.83	61.29	71.75	82.29
1.9	—	—	—	10.62	16.10	21.63	32.79	44.05	55.39	66.81	78.24	89.76
2.0	—	—	—	11.49	17.40	23.43	35.53	47.77	60.08	72.50	84.94	97.48
2.1	—	—	—	12.37	18.80	25.27	38.35	51.59	64.92	78.37	91.84	105.40
2.2	—	—	—	13.28	20.20	27.15	41.25	55.52	69.90	84.41	98.94	113.60
2.3	—	—	—	14.21	21.60	29.09	44.22	59.56	75.01	90.61	106.20	122.00
2.4	—	—	—	15.16	23.00	31.09	47.27	63.69	80.25	96.97	113.70	130.70
2.5	—	—	—	16.13	24.60	33.11	50.39	67.93	85.62	103.50	121.40	139.50

NOTE: Approximate values of flow for heads other than those shown may be found by direct interpolation in the table.

From: Groundwater and Wells, Second Edition, 1986

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6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA) and quality control (QC) activities will be accomplished according to applicable project plans as well as quality requirements in this SOP.

7.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Collection Form (Form 4.1A). Use of these forms is described in SOP 4.1, Surface Water Data Collection Activities. Data required by this SOP includes flow measurement device calibration information and field flow measurement data.

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SEDIMENT SAMPLING

Approved By:

J. A. Langmuir

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2.0PURPOSE AND SCOPE

This SOP describes procedures that will be used at the Rocky Flats Plant (RFP) to collect bed material samples from streams, ditches, ponds, and samples of fluviially deposited materials in dry areas that meet acceptable standards of accuracy, precision, comparability, representativeness, and completeness.

The methods defined in this SOP are inappropriate for sediment collection when water levels approach or overtop stream banks. The methods contained herein assume that field personnel can safely wade a stream, sample from the shore of a stream, sample from the shore of a pond, or maneuver a small boat in a pond. During sediment sampling operations, the proper personal protective equipment (PPE) will be worn, as described in the Health and Safety Plan (HSP).

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel sampling sediments will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual. EPA. Region IV. Environmental Services Division. April 1986.

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Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. Environmental Protection Agency. October 1988.

Guy, Harold P. Techniques of Water-Resources Investigations of the United States Geological Survey. Book 3: Applications of Hydraulics; Chapter C1, "Fluvial Sediment Concepts." U.S. Government Printing Office, Washington, D.C. 1978.

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National Handbook of Recommended Methods for Water-Data Acquisition. Department of the Interior. Office of Water Data Coordination. Geological Survey. 1977.

----- Techniques of Water-Resources Investigations of the United States Geological Survey. Book 5: Laboratory Analysis; Chapter C1, "Laboratory Theory and Methods for Sediment Analysis." U.S. Government Printing Office, Washington, D.C. 1973.

The Environmental Survey Manual, Appendices E, F, G, H, I, J, and K. Department of Energy. Office of Environmental Audit. August 1987.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced in this SOP are:

- SOP 4.1, Surface Water Data Collection Activities

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- **SOP 1.3, General Equipment Decontamination**
- **SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples**

5.0 METHODS

5.1 INTRODUCTION

The sampling methods described in this SOP are used to collect bed material samples for the chemical analysis of contaminants which may be contained within the upper layers of the streambeds or adsorbed onto the surface of streambed materials on the Rocky Flats Plant (RFP) property. The uppermost sediments in ponds may also be collected by methods discussed in this SOP for similar chemical analyses.

Sediments range in size from cobbles and boulders to fine silt. Table 4.6-1 shows a list of the common scale of particle sizes for sediments and serves as a reference for field personnel to understand the terms used in describing sediments in this SOP.

The field technicians will evaluate the site based on conditions and particle sizes and will record site conditions and particle sizes in the field logbook or on the Sediment Sample Collection Form included in this document. This will be performed prior to sample collection. (see Table 4.6-1).

TABLE 4.6-1 -- RECOMMENDED SCALE OF SIZES BY CLASSES FOR SEDIMENT ANALYSIS

Tyler Sieve No.	U.S. Standard Sieve No. ¹	Class Name	Metric Units				Phi Value ¹ (ϕ)	English Units (feet)	
			(millimeters)		(micrometers)				
(1)	(2)	(3)	(4)		(5)		(7)		
		Boulders	> 256					> 0.840	
(²)	(²)	Large cobbles	256	- 128			-8	0.840	-0.420
(²)	(²)	Small cobbles	128	- 64			-7	0.420	-0.210
(²)	(²)	Very coarse gravel	64	- 32			-6	0.210	-0.105
(²)	(²)	Coarse gravel	32	- 16			-5	0.105	-0.0525
(²)	(²)	Medium gravel	16	- 8.0			-4	0.0525	-0.0262
2.5	(²)	Fine gravel	8.0	- 4.0			-3	0.0262	-0.0131
5	5	Very fine gravel	4.0	- 2.0			-2	0.0131	-0.00656
9	10	Very coarse sand	2.0	- 1.0	2000	-1000	-1	0.00656	-0.00328
16	18	Coarse sand	1.0	- 0.50	1000	- 500	0	0.00328	-0.00164
32	35	Medium sand	0.50	- 0.25	500	- 250	+1	0.00164	-0.000820
60	60	Fine sand	0.25	- 0.125	250	- 125	+2	0.000820	-0.000410
115	120	Very fine sand	0.125	- 0.062	125	- 62	+3	0.000410	-0.000205
250	230	Coarse silt	0.062	- 0.031	62	- 31	+4	0.000205	-0.000103
		Medium silt	0.031	- 0.016	31	- 16	+5	0.000103	-0.0000512
		Fine silt	0.016	- 0.008	16	- 8	+6	0.0000512	-0.0000256
		Very fine silt	0.008	- 0.004	8	- 4	+7	0.0000256	-0.0000128
		Course clay	0.004	- 0.0020	4	- 2	+8		
		Medium clay	0.0020	- 0.0010	2	- 1	+9		
		Fine clay	0.0010	- 0.0005	1	- 0.5	+10		
		Very fine clay	0.0005	- 0.00024	0.5	- 0.24	+11		

¹ For maximum size of the given class.

² Sieve openings are marked in inches and millimeters.

[This table is reprinted from Techniques of Water-Resources Investigations of the United States Geological Survey.]

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5.2 EQUIPMENT

The following equipment items may be used for bed material sampling operations:

- Decontamination equipment
- Boat
- Dredge, core sampler, or sludge sampler
- Sampler core tubes composed of stainless steel, Teflon[®], or other chemically inert material
- Sample core liner caps
- Stainless steel, Teflon[®]-coated or glass scoop or spoon
- Teflon[®] tape
- Extension rods and connecting clamps
- Mixing pan
- Sieve
- Sample containers
- Sample transportation coolers

5.3 CRITERIA FOR SELECTION OF SAMPLING METHODS AND EQUIPMENT

The selection of sediment sampling devices and methods for their use are dependent on the objectives of the sampling study and other factors. Bed materials are being collected for the purpose of determining the presence, concentrations, and distribution of contaminants associated with these materials at the RFP. Composite samples will be collected to meet these objectives. In addition, information regarding the highest expected concentrations of some contaminants, specifically volatile organic compounds (VOCs), is desired.

The physical characteristics of the sediment site to be sampled are important factors in the selection of sampling devices and methods. These characteristics include:

- Grain size of bed materials
- Presence of water
- Type of water body
- Presence of organic material, rocks, or debris
- Accessibility to sampling location

Silts and clays generally possess the highest concentrations of contaminants. Therefore, areas of the finest grained sediments will be visually identified and used for the collection of VOCs. A core or sludge sampler will be used for VOC collection when water is present to help prevent disturbance of the samples. Check valves in these devices prevent washout during recovery. When collecting VOCs in dry sediments, an attempt should be made to use a core sampler; however, a scoop may be used.

When fine grained materials are underlain by coarse materials, penetration of underlying sediments by corers or sludge samplers may be prevented. If this field condition exists, the sludge sampler, with its butterfly valve segment removed, may be inserted into the bed materials at an angle. This method will retain water which overlies the bed material.

When collecting composite samples of stream bed materials, collection of sub-samples (aliquots) will be performed at points along cross-sections of streams. More than one cross-section may be used to provide sufficient sample material. Samplers should move slightly upstream to collect additional aliquots along cross-sections to avoid impacting sample quality. Core or sludge samplers should be used for this purpose. However, if penetration of sediments is not possible, a dredge (clam-shell) sampler may be used. If data objectives require that only the uppermost sediments be

sampled, core samples may be partially taken at one point. The remainder of the composite may be taken at subsequent points along the cross-section.

When collecting composite samples of pond bed material, the preferred sampling strategy is to collect several aliquots from either randomly selected points or systematic grids at a sampling location. If sample points are randomly selected, they may be located near the center of the pond. If the location cannot be sampled without requiring the sampler to wade into the pond, the site should be sampled from a boat or with a dredge sampler. Extensions to the sampling devices may be required.

Organic material, rocks, or debris may be present in collected samples. These materials should be removed by sieving samples with a large screen sieve. Care should be taken in the selection of stream cross-sections and pond sampling grids to avoid collection of these materials.

5.4 SAMPLING PROCEDURES

Prior to sampling, initiate field notes regarding site conditions, sample team personnel, site identification, date, and sample identification. These items will be recorded on the Sediment Sample Collection Form found in Section 8.0, Documentation.

5.4.1 General Sampling Procedures

Typical steps to be followed in collecting any sediments are:

1. Select the appropriate sampling method and equipment to be used.
2. Decontaminate all sampling equipment.

3. Place all sampling equipment on plastic sheeting near the sampling location.
4. Collect samples.
 - 4a. The core sampler or the sludge sampler will be used to collect the top 2 inches of bed materials for VOC analysis. To collect a VOC sample, push the tapered end of the core sampler into the bed material. This can be facilitated by dropping the top weight onto the sampler shaft, if using a piston-type sampler. The sampler should be pushed in far enough to fill the 2-inch core liner. Enclose the sample in the corer, per manufacturer's instructions, and retract the corer from the sediments. Remove the core liner and seal as follows:
 - Place Teflon•• tape over the ends of the tube
 - Place liner caps securely over the Teflon•• tape
 - 4b. Non-sieved samples for grain size analysis will be taken with a core sampler or a sludge sampler. The method is the same as for VOC samples, however a full 6-inch core will be collected. Three 2-inch core liners will be used. This sample will be collected directly adjacent to the VOC sample location, in visually similar materials. Core will be sealed as described in 4a.
 - 4c. Composite samples for the remaining analytes described in the project work plan will be collected and placed in a mixing pan. Refer to specific procedures found later in this section for composite sample collection methods.
5. Proceed to the sampling equipment location and then sieve the sample found in the mixing pan as described in Subsection 5.4.4, Sieving.

6. Mix the sample as described in Subsection 5.4.5, Mixing.
7. Fill sample containers for the remaining analytes. If liquid is present, attempt to maintain the proportion of solid to water that exists in the mixture while filling the sample containers, as discussed in Subsection 5.4.5, Mixing.
8. As each container is filled, carefully wipe the upper edges of the container with a paper towel so that sediments are removed from the threads and mouth of the jar. This is done to ensure that a tight seal exists after the container is closed.
9. After all sample containers have been filled, place the remaining sediment samples in a waste container.
10. Decontaminate the sample containers by:
 - 10a. Rinsing the outside of the containers with distilled water.
 - 10b. Drying the outside of the containers with a paper towel.
11. Store all sample containers on ice in coolers for transportation.
12. Complete records of sample collection as described in SOP 4.1, Surface Water Data Collection Site Plan.
13. Decontaminate equipment as described in SOP 1.3, General Equipment Decontamination.
14. Perform personal decontamination as required by the HSP.

5.4.2 Sample Collection Using a Dredge, Core Sampler, or Sludge Sampler in Streams

Refer to Subsection 5.3, Criteria for Selection of Sampling Methods and Equipment for instruction regarding stream bed material sampling.

VOC and non-sieved, grain size analysis samples will be collected and sealed as described in Subsection 5.4.1, General Sampling Procedures.

The procedure for collecting streambed materials for other types of analyses using sampling devices described in Subsection 5.3, is as follows:

1. After determining the sampling point or points in the stream, either wade to the sampling point or place the proper number of extensions on the sampler to reach the proper point in the stream.
2. If wading, be sure to hold the sampling device upstream from yourself (facing into the oncoming current).
3. Slowly lower the sampling device to the stream bottom.
4. After the sampling device reaches the bottom of the stream, penetrate bed materials with the sampling device, and follow the manufacturer's instructions for enclosing the sample in the device.
5. Slowly raise the sampling device.
6. Empty the contents of the sampling device into the mixing pan. If more than one point is being sampled in order to obtain several aliquots to produce a composite

sample, proceed to the next sampling point and collect additional samples, as described in Steps (3) through (5). When practical, aliquots comprising a given composite should be approximately equal volume. A beaker or similar device may be used to measure the aliquots before they are placed in the mixing pan. This is done to avoid biasing the sample in favor of any grid points.

7. Repeat Steps (3) through (6) until sufficient bed materials, as required by the project work plan, have been collected.
8. If sieving is required, sieve the materials as described in Subsection 5.4.4, Sieving.
9. Mix the sample material. Use the mixing procedure described in Subsection 5.4.5, Mixing.
10. Begin filling sample containers for the remaining analytes described in the project work plan.
11. As each container is filled, carefully wipe the upper edges of the container with a paper towel so that sediments are removed from the threads and mouth of the jar. This is done to ensure that a tight seal exists after the container is closed. Attempt to maintain the proportion of water to solids that exists in the mixing pan while filling containers, as discussed in Subsection 5.4.5, Mixing.
12. After all sample containers have been filled, place the remaining sediment samples in a waste container.

13. Decontaminate the sample containers by:
 - 13a. Rinsing the outside of the containers with distilled water.
 - 13b. Drying the outside of the containers with a paper towel.
14. Store all sample containers on ice in coolers for transportation.
15. Complete records of sample collection as described in SOP 4.1, Surface Water Data Collection Site Plan.
16. Decontaminate equipment as described in SOP 1.3, General Equipment Decontamination.
17. Perform personal decontamination as required by the HSP.

5.4.3 Sample Collection Using a Dredge, Core Sampler, or Sludge Sampler in a Pond

Two approaches for collecting bed materials are provided in Subsections 5.4.3.1 and 5.4.3.2. One approach is to attach a sampling device to an extension rod or cable, and to use this device while standing on the shore of the pond to collect a sample or multiple samples for compositing of bed material from the bottom of the pond. This approach will be used when the dimensions of the pond do not exceed approximately 30 feet in diameter or 3 feet in depth.

If the pond dimensions exceed these measurements, then the second sampling approach, namely sampling from a boat, as described in Subsection 5.4.3.2, will be employed. The field crew will row to the sample collection point or points in the pond and collect a sample of bed material in a

dredge, core sampler, or sludge sampler, as determined in Subsection 5.3, Criteria for Selection of Sampling Methods and Equipment.

5.4.3.1 Sediment Sampling From the Shore of the Pond

Ponds with dimensions not exceeding approximately 30 feet in diameter and 3 feet in depth will be sampled from the shore. The steps to be followed in obtaining bed material samples from these ponds are similar to sampling a stream from the shore of the stream. Refer to Subsection 5.4.1 for guidance in general procedural steps to be followed in collection of bed material samples from the shore of a pond. Refer to Subsection 5.3, Criteria for Selection of Sampling Methods and Equipment, for further instruction in collecting samples.

An important distinction between stream sampling and pond sampling is that in the case of sampling from a pond, due to the stagnant flow conditions in ponds, sampling personnel must not wade into the pond in order to obtain samples, because wading could agitate the bottom sediments and interfere with the collection of useful samples.

5.4.3.2 Sediment Sampling From a Boat

Refer to Subsection 5.3 for instruction in the selection of sampling methods and equipment.

Ponds with dimensions in excess of approximately 30 feet in diameter and 3 feet in depth will be sampled from a boat. The steps to be followed in obtaining bed material samples from these types of ponds is as follows:

1. Decontaminate the boat, anchor, and all sampling equipment in accordance with the procedures described in SOP 1.3, General Equipment Decontamination.

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2. Arrange decontaminated sampling equipment, sample mixing tray, sample containers, and sample cooler on plastic sheeting inside the boat.
3. Carefully launch the boat. Two samplers then enter the boat. A third crew member remains on shore.
4. Row the boat to the first sampling point in the pond.
5. Anchor the boat.
6. Slowly lower the sampling device over the side of the boat.
7. Refer to Subsection 5.4.1. Perform Steps (4) through (14) to complete sampling operations.

5.4.4 Sieving

If required by the project workplan, sieve the material in the mixing pan. The object of sieving is to eliminate those particles greater in diameter than a particular, desired grain size.

A number 10 mesh sieve should be used to remove all particles larger than 2 millimeters in diameter. If present, cobbles, large pebbles and/or pieces of vegetation should be removed from the sample. This is done by pre-sieving with a number 8 sieve. Record and perform sieving as follows:

- Size and type of sieve (for example: 12-inch diameter brass with stainless-steel mesh)
- Mesh size of sieve (for example: number 10 sieve)
- Sieve the entire volume of collected sediments

- Collect sieved sediments in mixing pan

5.4.5 Mixing

Sediments collected for analyses of constituents other than VOCs and the non-sieved grain size samples will be thoroughly mixed before the samples are placed into the sample containers. In addition, the samples may be sieved prior to mixing, as discussed in Subsection 5.4.4, Sieving. The sediment will be removed from the sampling device and placed in a glass container, Teflon-coated stainless steel pan, or a stainless steel pan then mixed using a stainless steel or Teflon-coated stainless steel spoon or a stainless steel scoop. The sediment will be scraped from the sides, corners, and bottom of the pan, rolled to the center of the pan, and mixed.

The sample is then to be quartered and moved to the four corners of the mixing pan. Each quarter of the sample will then be mixed individually. Each quarter is then rolled to the center of the container, and the entire sample is mixed together. This procedure will be continued to ensure that all parts of the sample are mixed as well as possible, and that the sample is as homogeneous as possible before being placed in the sample containers. Mixed samples are then placed in sample containers.

If water is present in the sample mixture that is obtained by use of a sludge or core sampler, then an attempt will be made to preserve the water-to-solid ratio by including the water as part of the sample. This will be done by following these measures:

- (1) Use the stainless steel scoop to place scoops full of sample/water mixture into each jar.
- (2) Remix the sample/water mixture remaining in the mixing pan after each scoop of material is placed in a sample jar.

- (3) Fill each sample container only partially. Then, beginning with the first container, add additional sample to each container. Continue in this manner until all containers have been filled. This approach is used to evenly distribute the liquid into the various sample containers, while endeavoring to maintain the solid-to-liquid ratio present in the samples collected in the core or sludge sampler.
- (4) If the mixture is high in liquid content, the mixture may be poured into a stainless steel beaker in order to more efficiently transfer the mixture into sample containers. Continued mixing with a spoon will be provided to maintain homogeneity of the sample mixture during filling of sample bottles, as discussed in (3) above.

5.4.6 Sampling Dry Sediments

Sampling personnel will be required to wear level C personal protective equipment (including a respirator) in order to perform sampling of dry sediments. Refer to the Health and Safety Plan for a description of procedures and equipment.

For the case of sampling dry sediments, procedures are as follows:

- Collect samples for analysis for VOCs in the core sampler or sludge sampler. Follow the steps outlined in Subsection 5.4.1, Step (4a). If unable to collect sufficient sample material with the core samples, use the stainless steel scoop.
- Collect samples for non-sieved grain size analysis in the core samples. If unable to collect sufficient sample material with the core samples, use the stainless steel scoop. Follow the procedure outlined in Subsection 5.4.1, Step (4b).

- Collect dry samples from discrete points by use of the stainless steel scoop. Place the samples into the mixing pan. Continue collection until sufficient materials have been obtained. Follow Steps (8) through (17) in Subsection 5.4.1 to complete sampling.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP.

QC samples for sediment sampling fall into four categories:

- Duplicate
- Equipment rinsate
- Field blank
- Trip blank (or rinsate only)

SOP No. 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. The Quality Assurance Project Plan (QAPjP) specifies QC sampling frequencies.

Sample collection procedures for duplicate samples will be the same as those described in Section 5.0. These samples are intended to be as close to exact replicates of the original samples as possible. They are obtained immediately adjacent to the planned samples that they are intended to duplicate.

A rinsate sample from sampling equipment is intended to check for potential contamination of the sample by the sampling equipment. For the bed material sampling operation, a rinsate sample will

be collected from sampling equipment with any liners in place before the sampling equipment is used. Sampling equipment will be rinsed with approximately 3 liters of distilled water which will be collected in a decontaminated stainless steel bowl. A decontaminated glass or stainless steel beaker will be used to dip the water from the bowl and fill the sample bottles. The rinsate samples will be analyzed for the same parameters as the bed material samples.

Field blank and trip blank samples are containers filled with clean water that are handled and transported the same as the other samples to check for potential cross-contamination resulting from field handling and transportation procedures.

7.0 WASTE MANAGEMENT

Sampling sites associated with environmental restoration at RFP fall into two characterizations: potentially contaminated and not potentially contaminated. At sediment sampling stations which have not been verified as background locations, waste materials will be handled in accordance with, SOP 1.10 Receiving, Labeling and Handling Waste Containers.

Sediment stations which have been identified as not potentially contaminated, waste materials will be handled in accordance with:

- SOP 1.6, Handling of Personal Protective Equipment
- SOP 1.7, Handling of Decontamination Water and Wash Water
- SOP 1.9, Handling of Residual Samples

8.0 DOCUMENTATION

Information required by this SOP will be documented on the Sediment Sample Collection Form (Form 4.6A).

SEDIMENT SAMPLE COLLECTION FORM

Sample Team Leader : _____
Sample Team Member : _____
Sample Team Member : _____
Sample Team Member : _____

Sample No : _____
Collection Date : _____
Collection Time : _____
Location Code : _____

North or Y : _____ East or X: _____

Site Identification : _____
Sampling Conditions : Stream Pond Dry
Sampling Device : Scoop Dredge Cover Other: _____
Sampled from : Shore Stream Boat Cross-section Dry Area
Composite (Y/N) : _____
Sieved (Y/N) Sieve Size: No.: _____ Sieve Material: frame _____ screen _____
Collection Method : _____
Prepared By : _____

Headspace Reading : _____ ppm
Volumes Collected : _____ Units: _____

Comments: _____

Matrix: _____
Request for Analysis No: _____
Chain of Custody No.: _____
Ship Date: _____

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Approved By:

COLLECTION OF TAP
WATER SAMPLES

J. W. Langman

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used for the Rocky Flats Environmental Restoration Program and is applicable to the collection of water samples from all taps and valves that provide for the free flow of water when the valve is in the open position. This SOP also describes personnel responsibilities and qualifications, sample collection and preservation procedures, quality assurance/quality control (QA/QC) and documentation requirements that will be used for field data collection activities in order to attain acceptable standards of accuracy, comparability, representativeness, and completeness.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health & Safety Plan. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

A Compendium of Superfund Field Operations Methods. EPA/540/p-87/001. December 1987.

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DOE 1987: The Environmental Survey Manual. DOE/EH-0053, Volumes 1-4. August 1987.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. October 1988.

RCRA Facility Investigation Guidance. EPA. Interim Final. May 1989.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are:

- SOP 1.3, General Equipment Decontamination
- SOP 1.7, Handling of Decontamination Water and Wash Water
- SOP 1.11, Field Communications
- SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP 1.14, Data Base Management
- SOP 2.5, Measurement for Groundwater Field Parameters
- SOP 4.2, Field Measurement of Surface Water Field Parameters

5.0 METHODS

Collection of representative tap water samples through grab sampling of taps, valves, or faucets requires that a reliable SOP be written and implemented. A number of factors may need consideration. For instance, the presence or absence of a holding tank will have an effect on values and stabilization times for parameters such as volatile constituents, pH, and temperature. The following procedure will be utilized to collect samples from taps, valves, or faucets:

- Upon arrival at the site, complete the tap water sampling log sheet down to the section on purging.
- Gloves will be worn by the sampler at all times during the sample collection. To avoid contaminating the sample, the inside of the cap and the sample bottle must not be touched with the fingers nor allowed to touch the tap or ground. In order to avoid dislodging particles in the faucet, it is important that the tap's stream flow not be adjusted during sampling.
- The sample is to be collected from the first accessible point at the sampling site. All sampling must be done prior to any filtration or other treatment. If the tap contains an aerator or strainer, it should be removed.
- Remove all hoses or any other attachments from the tap to be sampled. If the tap is located in an area where the discharge cannot be allowed to flow onto the ground, the hose may remain attached to the tap throughout the 10-minute purge; however, before sampling, the hose must be removed and the tap purged for an additional 2 minutes before sampling. Leaving the hose attached during purging should be avoided if possible.
- If bacteriological samples are to be collected, the tap will be heated with a flame from a lighter or burner for 15 seconds before beginning purging.
- Purge the line by adjusting the cold water side of the tap to provide a smooth-flowing water stream at a moderate pressure that prevents splashing, and record the time that the purging was initiated on the tap water sampling log sheet. Ideally, if volatile organic compounds (VOC) samples are to be collected, the flow rate should not exceed 100 ml/min. However, the primary consideration will be

to provide a smooth flowing water stream at a moderate pressure that will minimize aeration of the sample.

- Estimate the rate of purging by measuring the volume collected in a 250 ml to 1-liter graduated cylinder depending on flow rate, over a 15- to 30-second period. The collection period will be timed with a stopwatch. The volume collected in liters will be divided by the time in seconds and then multiplied by 60 seconds per minute to yield the evacuation rate in liters per minute. Record this information on the tap water sampling log sheet.
- Allow the water to purge for at least 10 minutes before collecting the first sample to ensure that the sample will be free of any rust or residue that may be in the tap. If not free of rust and residue after 10 minutes, continue to purge until the water is visibly clear or until field parameters have stabilized. Record the completion time of purging, the total duration of the purging event and calculate and record the estimated volume of water purged by following the equation given on the tap water collection log sheet.
- When sampling water from a groundwater well, measure the pH, temperature, and conductivity of the water a minimum of three times during purging to determine if measured parameters are stable at the time of sampling, by following SOP 4.2, Field Measurement of Surface Water Field Parameters. Record these values as well as the time the sample was taken for each set of readings on the tap water collection log sheet. Measurements will be a minimum of 2 minutes apart. Field parameters will be considered stable when two consecutive readings for pH, conductivity, and temperature taken at least two minutes apart, differ by less than 10 percent.

- Record any unusual observations about the water during purging, such as color or odor; record the time that purging is completed, and record the length of the purge cycle.
- During purging, check for the presence of total residual chlorine by following procedures in SOP 4.2, Field Measurement of Surface Water Field Parameters.
- Collect the sample at the same flow rate as the purge flow rate by removing the cap of the specified container and placing the container under the tap until it is full. Hold the bottle in one hand and the cap in the other, right side up (threads down), while collecting the sample. If the cap liner or septum has a tendency to fall out of the cap, the cap and liner/septum should be placed on a sheet of plastic with the thread side down.
- Collect the samples in the order specified in Table 4.7-1. Sampling at each site will be specific to the needs and requirements for that site as determined by the site supervisor. The full set of parameters listed in Table 4.7-1 will not always be collected at each site and additional parameters may be required in some instances.
- After collecting the sample, replace the cap, place the bottle in a plastic bag, and store in a cooler at 4 degrees Celsius.
- Turn off the water supply and replace any aerators, strainers, hoses, or other attachments that were removed.
- Complete all chain-of-custody forms and documentation at the time the samples are collected.

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TABLE 4.7-1
SAMPLE PARAMETERS AND ORDER OF FIELD COLLECTION

TCL VOAs
TCL BNAs
Pesticides/PCBs
TAL Metals (dissolved)^(a)
Nitrate/Nitrite as N
Major Ions^(a), TSS, TDS
Cyanide
Radionuclides - Total^(a)
Tritium

^a See Table 2 for individual analytes.

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Sample containers will be precleaned or purchased precleaned before use in the field. All containers, preservatives, and holding times will conform to EPA requirements as listed in Table 4.7-2. Additional information on containers, preservatives, and holding times may be found in SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

Subsequent to sampling, all samples will be placed in sample coolers. The temperature inside the cooler will be cooled to 4°C. This temperature will be maintained by adding blue ice and sealed in plastic bags.

6.0 DECONTAMINATION

Equipment will be decontaminated after use at each site. Procedures for decontamination are set forth in SOP 1.3, General Equipment Decontamination.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

QA samples for tap water sampling fall into four categories:

- Duplicate
- Matrix spike
- Matrix spike duplicate
- Field blank

SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. Applicable project plans specify QA sample frequencies.

TABLE 4.7-2
CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

Parameter	Container	Preservative	Holding Time (Days)
TCL VOA	2 glass 40-ml vial w/Teflon [®] -lined	Approx. 10 mg	7 days
		Na ₂ S ₂ O ₃ ^(a) HCL to pH <2.0	14 days
TCL BNA	Glass-Amber/2 x 1 L	4°C	7 days to extraction
		Na ₂ S ₂ O ₃ ^(a)	40 days after extraction
Pesticides/PCB	Glass-Amber/2 x 1 L	4°C	7 days to extraction
			40 days after extraction
TAL Metals (dissolved) ^(b)	Polyethylene/1 x 1 L	Filter ^(c) ; HNO ₃ to pH <2; 4°C	180 ^(d)
TAL Metals (total)	Polyethylene/1 x 1 L	HNO ₃ to pH <2; 4°C	180 ^(d)

^(a) Should only be added if measurable (greater than 0.2 ppm) residual chloride is present.

^(b) TAL metals are Al, Sb, As, Ba, Be, Cd, Ca, Cr (total), Co, Cu, Fe, Pb, Mg, Hg, Ni, K, Se, Ag, Na, Tl, V, and Zn. Additional parameters to be analyzed are Cs, Li, Mo, Sn, and Sr.

^(c) A 0.45-micron filtering apparatus will be used.

^(d) Holding time for mercury is 28 days.

^(e) The requested major ions are CO₃, HCO₃, F, Cl, SO₄, and PO₄.

^(f) Holding times for the requested major ions are as follows: CO₃ and HCO₃, 14 days; Cl, F, SO₄, 28 days; and PO₄, 48 hours.

^(g) TDS (Total Dissolved Solids) and TSS (Total Suspended Solids) will be collected in the same sample container as the Major Ion analysis.

^(h) Radionuclides are gross alpha and beta; PU-239; Pu-240; Am-241; U-233, 234, 235, and 238; Sr-90; Cs-137; Ra-226; and Ra-228.

⁽ⁱ⁾ Radiation screening samples are analyzed by an on-site EG&G lab and are typically analyzed within 24 hours of collection.

TABLE 4.7-2
CONTAINERS, PRESERVATIVES, AND HOLDING TIMES
(Continued)

<u>Parameter</u>	<u>Container</u>	<u>Preservative</u>	<u>Holding Time (Days)</u>
Cyanide	Polyethylene/1 x 1 L	NaOH to pH > 12; 4°C; 0.6 grams ascorbic acid ^(a)	14 days
Major Ions ^(e)	Polyethylene/1 x 1 L	4°C	See footnote (f)
Nitrate + Nitrate as N	Polyethylene/100 ml	H ₂ SO ₄ to pH < 2; 4°C	28 days
TSS and TDS ^(g)		4°C	7 days
Radionuclides ^(h)			
Total	Polyethylene/3 x 3.79 L HNO ₃ to pH < 2		180 days
Tritium	Glass/100 ml	None Required	180 days
Radiation			
Screen	Plastic/250 ml	None Required	Not Applicable (i)

^(a) Should only be added if measurable (greater than 0.2 ppm) residual chloride is present.

^(b) TAL metals are Al, Sb, As, Ba, Be, Cd, Ca, Cr (total), Co, Cu, Fe, Pb, Mg, Hg, Ni, K, Se, Ag, Na, Tl, V, and Zn. Additional parameters to be analyzed are Cs, Li, Mo, Sn, and Sr.

^(c) A 0.45-micron filtering apparatus will be used.

^(d) Holding time for mercury is 28 days.

^(e) The requested major ions are CO₃, HCO₃, F, Cl, SO₄, and PO₄.

^(f) Holding times for the requested major ions are as follows: CO₃ and HCO₃, 14 days; Cl, F, SO₄, 28 days; and PO₄, 48 hours.

^(g) TDS (Total Dissolved Solids) and TSS (Total Suspended Solids) will be collected in the same sample container as the Major Ion analysis.

^(h) Radionuclides are gross alpha and beta; Pu-239; Pu-240; Am-241; U-233, 234, 235, and 238; Sr-90; Cs-137; Ra-226; and Ra-228.

⁽ⁱ⁾ Radiation screening samples are analyzed by an on-site EG&G lab and are typically analyzed within 24 hours of collection.

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Sample collection procedures will be the same as those described in Section 5.0 of this SOP for duplicate, matrix spike, and duplicate matrix spike samples. These samples are intended to be as close to exact replicates of the original samples as possible. They are obtained immediately adjacent to the planned samples they are intended to duplicate.

Field blank samples are containers filled with clean water that are handled and transported the same as the other samples to check for potential cross-contamination resulting from field handling and transportation procedures.

8.0 DOCUMENTATION

Proper chain of custody and documentation will be maintained at all times by following SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples and SOP 1.13, Chain of Custody. A permanent record of the implementation of this SOP will be kept by documenting field observations and data on the tap water sampling log sheet (Form 4.7A and 4.7B). Observations and data will be recorded with black waterproof ink. Field logbooks will be utilized to summarize the daily field activities and to document project information not required by the field forms.

ROCKY FLATS PLANT
ENVIRONMENTAL RESTORATION PROGRAM
TAP WATER SAMPLING LOG SHEET

Site ID Number: _____

Date: ____/____/____

Location: _____

WATER USE

SINGLE FAMILY

MULTIPLE FAMILY

LIVESTOCK

COMMERCIAL

OTHER (SPECIFY) _____

WATER SOURCE

PUBLIC WATER SUPPLY

GROUNDWATER WELL

OTHER (SPECIFY) _____

PURGING

START TIME: _____

COMPLETION TIME: _____

DURATION OF PURGE: _____

PURGE RATE: __ (VOLUME-L) X ____ (TIME-SECONDS + 60) = __ LITERS/MINUTE

ESTIMATED VOLUME PURGED: _____

PURGE RATE: _____ (L/MIN) X DURATION _____ (MIN) = _____ LITERS

ROCKY FLATS PLANT
ENVIRONMENTAL RESTORATION PROGRAM
TAP WATER SAMPLING LOG SHEET

FIELD MEASUREMENTS DURING PURGING

Volume Purged (liters)	Temp (°C)	Specific Conductance (μ S/cm)	pH	Time	Water Description
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OBSERVATIONS

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TITLE:
POND SAMPLING

Approved By:

J. W. Langmeyer

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2.0 PURPOSE AND SCOPE

This SOP describes procedures that will be used to collect water samples from ponds at Rocky Flats Plant (RFP) and to measure field parameters on surface water collected from these ponds. Specifically, this SOP describes methods to be used for pond sampling and for measurement of surface water field parameters in water from ponds that will be used for field data collection and documentation to attain acceptable standards of accuracy, precision, comparability, representativeness, and completeness.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel active in obtaining pond water samples or measuring field parameters of pond waters will be hydrologists, hydrogeologists, geologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under the supervision of another qualified person.

3.1 NOTIFICATION AND LOGISTICS

The Site Supervisor will be responsible for determining the necessary notifications and authorizations required to (1) coordinate sampling activities with interested parties and (2) address access and security concerns for specific sampling sites.

Sampling of detention ponds may be necessary prior to the periodic need to discharge water from each pond. EG&G will notify the Department of Energy (DOE) three days prior to any pre-discharge sampling event. At least 48 hours prior to the intended time of sampling, DOE will contact the interested parties of the Colorado Department of Health (CDH), the City of Broomfield, and the City of Westminster so that they will have an opportunity to receive split samples. Access to the site must be coordinated with Mr. Mark Van Der Puy, DOE Environmental

Monitoring Branch Chief, at (303) 966-2473, or his designated representative, prior to entering the plant buffer zone.

Note: RFP access and control procedures are subject to future change. Contractors will be notified of any such changes by an EG&G contact. The Site Supervisor will be responsible for notifying sampling personnel of these changes.

3.2 POND SAMPLING TEAMS

If pond sampling is to be performed from a boat, pond sampling teams will consist of three people for each pond. If pond sampling is to be performed from the shore of a pond, then only two people are required as members of the sampling team. In either event, one of the team members will be designated by the Site Supervisor or by the EG&G representative to be the team leader. When pond sampling takes place from a boat, two team members will work out of the boat, while the third team member remains on shore.

All team members will obtain and prepare the sampling and data collection equipment as described in SOP 4.1, Surface Water Data Collection Activities, decontaminate the equipment as detailed in SOP 1.3, General Equipment Decontamination, and transport the equipment to the field site. The two crew members in the boat will perform the majority of the data collection and sampling activities. The third person on the shore will be responsible for the following:

- Assist in locating proper sampling points
- Monitor all sampling activities
- Perform emergency response activities as detailed in the Health and Safety Plan (HSP)
- Measure field parameters

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Drowning is a danger for a person suited in protective equipment because the weight of protective equipment increases the person's weight and impairs swimming ability. Therefore, the HSP should be consulted prior to data collection activities at any pond to determine the appropriate level of protection required for site activities at the pond.

4.0 REFERENCES

4.1 SOURCE REFERENCES

A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. December 1987.

Detention Pond Sampling Plan. Draft. Environmental Management and Assessment Division. Rocky Flats Plant. February 1990

Energy, Safety, and Health Directive. DOE 5400.1. November 9, 1988.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. EPA/540/G-89/004 October 1988.

RCRA Facility Investigation Guidance. Interim Final. May 1989.

The Environmental Survey Manual. Appendixes E, F, G, H, I, J, and K. DOE/EH-0053/Vol. 4 of 4. August 1987.

4.2 INTERNAL REFERENCES

SOP 1.3, General Equipment Decontamination

SOP 1.6, Handling of Personal Protective Equipment

- SOP 1.7, Handling of Decontamination Water and Wash Water
- SOP 1.9, Handling of Residual Core and Laboratory Samples
- SOP 1.12, Rocky Flats Plant Access and Control
- SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP 2.6, Groundwater Sampling
- SOP 4.1, Surface Water Data Collection Activities
- SOP 4.2, Field Measurement of Surface Water Parameters

5.0 METHODS

5.1 SELECTION OF SAMPLING METHODS AND LOCATIONS

As described in the introduction to this SOP, different field conditions will impact the type of sampling methodology that may be used. Ponds in which the entire surface area is frozen may be sampled only from shore. Further, high winds prevent the use of a boat on any pond. The site safety officer will make the judgement of when to cease sampling efforts in the event of high winds.

When sampling frozen ponds, boats will be used to provide safety in the event that the ice breaks. The boat will be anchored with two anchors, with one end at the shore of the pond. Sampling will be performed off the other end of the boat, approximately 12-15 feet from shore. An auger will be used to drill a hole through the ice. The remaining steps in the sampling process are the same as described in Subsection 5.5.2.1, Sampling From a Boat.

Certain parameters will be measured in ponds at each sampling event to determine if stratification and/or a lack of mixing of water exists in the ponds. Stratification of water layers in ponds is usually caused by water temperature differences. Cooler, denser water lies beneath warmer water. Subsection 5.4.1, Field Parameter Measurements, describes measurement of a dissolved oxygen

(DO) and temperature profile which will be used to identify stratified layers or a lack of mixing. The results of this profile will be used to determine sampling methodology.

Generally, vertical composites or non-composited samples will be collected from a boat at the deepest point in ponds. If requested, samples may be collected from randomly selected points in ponds. Additionally, field parameter measurements from multiple points in ponds may be performed if requested. Refer to SOP 4.2 for a description of field parameter measurements.

Specific sampling cases may need to be considered if data collection objectives are not met by these methods, or if interested parties request deviations from these sampling guidelines. One such deviation, which is the collection of split samples with the CDH, is described in Subsection 5.5.2.3, Collecting Split Samples. Such specific requests will be considered on a case-by-case basis.

5.2 SAMPLE CONTAINERS, PRESERVATION, AND HANDLING

In general, sample containers used for pond sampling may be prepared and handled as described in SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. However, in the case of collecting composite samples directly into the containers, advance container preparation detailed in Subsection 5.3.1 will be required.

5.2.1 Preparation of Sample Bottles to be Used for Composite Samples

Composite sample container preparation is as follows:

- Prepare a complete set of reference bottles to be kept in the base lab in the following manner: for each sample bottle size, accurately divide the bottle into volumetric thirds by using a graduated cylinder, potable water, and a permanent marker.

- Use the reference set of bottles: divide sample bottles into volumetric thirds by marking each bottle at the volumetric third points and use the reference bottles as guides.

5.3 EQUIPMENT

All sampling equipment that is neither dedicated nor disposable will be constructed of inert organic materials or of stainless steel. The specific equipment items to be used for pond sampling are listed in Subsections 5.4.1 and 5.4.2.

Equipment used in boats to collect samples or measure field parameters will be organized to prevent the interaction of clean equipment with used equipment, sample water, or wastes. As much as possible, equipment that does not float will be attached to a flotation device or to the boat to prevent loss. Instruments that can be damaged by water will be stored in water-tight containers when not in use.

Depending on the type of sampling being performed, it may be required that field parameter measurement equipment be in the boat for in-situ field parameter measurements, as discussed in Subsection 5.5.1.

For most pond sampling events, the following devices are to be used in addition to some or all of the usual surface water sampling equipment listed in SOP 4.1, Surface Water Data Collection Site Plan:

- Discrete zone sampling device
- Peristaltic pump and tubing composed of inert material
- Depth measuring devices

5.3.1 Field Parameter Measuring Equipment

Equipment described in SOP 4.2, Field Measurement of Surface Water Parameters, may be used in measuring field parameters in ponds. Exception to the methods listed in SOP 4.2 are listed in this section.

5.3.2 Hydrolab Multi-Parameter Measuring Instrument

The Hydrolab Multi-Parameter Measuring Instrument, or similar multi-parameter instruments, may be used for measuring pH, temperature, conductivity, dissolved oxygen, redox potential, depth, and salinity. This instrument enables field measurement and graphic display of vertical field parameter profiles as they are measured in a pond. The Operation and Maintenance Manual will be followed when operating or calibrating the instrument.

5.4 PROCEDURES

This section discusses measurement of field parameters and collection of water samples.

5.4.1 Field Parameter Measurements

Field parameters may be measured and recorded as described in SOP No. 4.2, Field Measurement of Surface Water Parameters. If available, a multi-parameter measuring instrument should be used for these measurements, with the exception of alkalinity. Alkalinity will be measured on shore, in accordance with SOP 4.2, Field Measurement of Surface Water Field Parameters.

In addition to the list of parameters described above, a profile of D.O. and temperature measurements will be taken for ponds. These measurements will be taken at 1-foot increments from

a depth of 1 foot to the bottom of the pond. This may be done with the YSI D.O. meter or with a multi-parameter measuring device.

Notify EG&G personnel should any of the following conditions be encountered:

- The difference between maximum and minimum temperature measurements in the profile is $> 5^{\circ}\text{C}$.
- The difference between maximum and minimum D.O. measurements is > 3 mg/l.
- One or more D.O. values is < 3 mg/l, while any other D.O. values in the profile are > 3 mg/l.

These conditions indicate stratification or the lack of mixing in the pond. Once notified of these conditions, EG&G personnel will make the decision of whether or not to composite samples.

If samples are to be composited, refer to Subsection 5.5.2.1, Sampling From a Boat, for sampling procedures. If samples are to remain as discrete samples, refer to Subsection 5.5.2.2, Non-composited Samples.

5.4.2 Water Sampling Procedures

When samples from the approximate center of small ponds can be collected from shore without wading, water samples will be collected from the shore of the pond in accordance with Section 5.3.6, Sampling of Standing Water, of SOP 4.3, Surface Water Sampling. A boat will be used for sampling a large pond or body of water.

5.4.2.1 Sampling From a Boat

The following procedures describe the general activities to be performed when water samples are collected from a boat. Field parameters may be measured in the boat or by a technician on shore.

- Collect Oil and Grease sample by partially immersing sample bottle at pond surface, taking care not to interfere with the movement of the product into the container.

- Water depth will then be measured. A tape measure with a weighted end may be used. Rotate the spool that holds the tape measure until the weighted end hits the pond bottom. The tape should then be grabbed by hand, just above the water surface and lowered again to get a "feel" for where the bottom is located. Repeat this procedure until confident that the tape end just touches the bottom and record the water depth.

- If no multi-parameter sampling device is available, a sample for the measurement of field parameters will be collected using a discrete zone sampler. One type of discrete zone sampler is an extension rod with a clamp that can hold a glass sampling bottle securely. Built into the frame of the rod is another rod with a ball on the top end and a suction cup on the bottom end. To collect a sample, lower the bottle to the proper depth and rotate the ball counterclockwise to remove the bottle lid by suction. Air bubbles will rise to the surface. When bubbles have stopped, rotate the ball clockwise to close the lid. The sample bottle can then be raised and removed from the rod.

- Transfer the sample to an unbreakable sample container without agitating the sample. Deliver the sample container to the technician on shore for performance of field parameter measurements.

- Samples for analysis of all parameters except volatile organic compounds (VOCs), field parameters, and rad screens will be collected by the use of a peristaltic pump. If multi-parameter equipment is used, the grab sample for alkalinity measurement may be collected with the peristaltic pump. If vertically composited samples are required, samples will be prepared as follows:
- A peristaltic pump, equivalent to a Geopump, with an adequate length of Teflon® intake tubing will be used. The intake for the tubing must be attached to a measuring tape so that technicians are certain to collect all samples from the same depth.
- This sampling device will be lowered to 0.5 meters below the water surface. Samples requiring filtration will be collected first by pumping through a disposable inline 0.45-micron filter. Sample containers (except for volatiles and rad screens) will be filled one-third full, capped, and stored in iced coolers. The containers will have been previously marked at one-third increments to permit ease in properly filling to the one-third volumes.
- After the 0.5-meter sample is collected, the discrete zone sampler will be used to collect a sample midway between the water surface and the pond bottom. The collected sample is then carefully poured into a VOC bottle, leaving no headspace. If a VOC bottle is observed to contain bubbles after it is filled, the bottle must be disposed of and replaced with a new bottle for use in sampling.
- The water remaining in the discrete sampler after the VOC sample has been decanted into the VOC bottle is to be used for a rad screen sample (and field parameters, if necessary). Sample bottles partially filled from the 0.5-meter depth will be composited with an equal portion of water collected from the midpoint depth with the peristaltic pump.

- The third and final portion of the composite samples from each location will be collected 0.5 meters above the pond bottom using the same technique described above. Special care will be taken to avoid any disturbance of bottom sediments. Field parameters will be measured at this depth in the manner described above for the 0.5-meter depth.

5.4.2.2 Non-Composite Samples

The procedures for sampling without compositing are the same as in Subsection 5.5.2.1, Sampling From a Boat, with the following exceptions:

- Samples will not be composited.
- Sample bottles will be completely filled at each of the three sampled zones.

This method will require additional sample bottles than called for in general procedures. Arrangements should be made previous to sampling events to provide for use of this method.

5.4.2.3 Collecting Split Samples

CDH may request that sampling be performed from the shore so that CDH personnel may actively participate in sample collection with the surface water sampling teams. Therefore, when collecting split samples in conjunction with CDH, the following guidelines may be employed:

- Sampling will be performed from the shore of the pond.
- The location to be sampled will be designated by CDH.
- CDH and the contractor will perform split sampling in the manner described in the following steps:

1. Large sample bottles will be filled by CDH and the contractor taking turns filling partial bottles:
 - CDH will half-fill a bottle, then the contractor will half-fill a similar bottle.
 - CDH will finish filling their bottle, then the contractor will complete filling their bottle.
2. VOC bottles will be filled in one step, not by half-filling bottles, as described above.
3. CDH will direct the order in which samples are collected.
4. The contractor will measure and record field parameters.

5.4.2.4 Samples for Bacteriological Examination

Samples for bacteriological examination must be collected in bottles properly sterilized and protected against contamination. The preferred method is to scoop up the water with the open bottle just below the surface of the water. This method is usually used when sampling from a boat. While the bottle is open, both the bottle and the stopper must be protected against contamination. A small amount of water should be poured from the bottle after filling to leave an air space for subsequent shaking in the laboratory. The bottle should be closed at once.

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5.5 DECONTAMINATION

Decontamination will be performed before and after all sampling and data collection activities as described in SOPs 1.3, General Equipment Decontamination; No. 1.6, Handling of Personal Protective Equipment; No. 1.7, Handling of Decontamination Water and Wash Water; and No. 1.9, Handling of Residual Core and Laboratory Samples.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP.

The Quality Assurance Project Plan (QAPjP) outlines program-wide quality assurance objectives and identifies organization and responsibilities for attaining those objectives. The QAPjP also defines general QA methods to be implemented on projects. However, each project's Quality Assurance Addendum (QAA) defines project-specific organization and responsibilities, and specific methods and frequencies that will apply to a given project, such as QA audits and QA samples.

QA samples fall into five categories:

- Duplicate
- Matrix spike
- Matrix spike duplicate
- Equipment rinsate
- Field blank

SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. Applicable project plans specify QA sample functions.

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Sample collection procedures will be the same as those described in Subsection 5.5 for duplicate, matrix spike, and duplicate matrix spike samples. Duplicates are obtained immediately after the suite of analytes that they are intended to duplicate have been collected.

A rinsate sample from sampling equipment is intended to check for potential contamination of the sample by the sampling equipment. For the pond sampling operation, a rinsate sample will be collected from sampling equipment with liners in place before the sampling equipment is used. Approximately 3 liters of distilled water will be rinsed over a decontaminated sampler and collected in a large decontaminated stainless steel bowl. A decontaminated glass or stainless steel beaker will be used to dip the water from the bowl and fill the sample bottles. The rinsate samples will be analyzed for the same parameters as the water samples.

Field blank samples are containers filled with clean water that are handled and transported the same as the other samples to check for potential cross-contamination resulting from field handling and transportation procedures.

7.0 DOCUMENTATION

The Surface Water Data Collection Field Notes Form found in SOP 4.1, Surface Water Data Collection Activities, will be used for documentation of pond sampling activities.

Safety Related
Category 1

TITLE:
INDUSTRIAL EFFLUENT
DISCHARGE SAMPLING

Approved By:

J. W. Langmaier

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2.0 PURPOSE AND SCOPE

This SOP describes procedures that will be used at the Rocky Flats Plant. It addresses the current National Pollutant Discharge Elimination System (NPDES) industrial effluent discharges but is applicable to all industrial effluent discharges for the Rocky Flats Plant. The purpose of this procedure is to ensure that the collection of representative samples meet applicable regulations, appropriate sampling protocols, and acceptable field measurement methods so that acceptable standards of accuracy, precision, comparability, representativeness and completeness will be attained.

Under the authority of the NPDES established by section 402 of the Clean Water Act (CWA) (33 U.S.C. 1251, et. seq.), the USEPA and the state of Colorado have promulgated regulations for monitoring liquid effluent discharges. By these authorities the RFP has been issued a permit to discharge to the receiving water of South Walnut Creek, North Walnut Creek, and Woman Creek with control on the conditions and limits under which discharge may take place. Permit No. CO-0001333, issued in November 1984, is in the process of revision due to an NPDES Federal Facilities Compliance Agreement (FCAA) entered into pursuant to Executive Order 12088, 43 Federal Regulation 47707 (1978). In addition, Department of Energy (DOE) order 5400.1, DOE Environmental Safety and Health Directive (11/09/88), specifies that compliance with NPDES requirements are mandatory for DOE operations. The order also states DOE policy "to conduct it's operations in an environmentally safe and sound manner" and requires monitoring of effluent discharges and ambient water quality.

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3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health and Safety Plan. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure.

MCD-51, NPDES Compliance Inspection Manual. USEPA, May 1988

Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. 3rd Edition. USEPA/6000/4/85/013 March 1985

Region VIII USEPA NPDES Acute Test Conditions-Static Renewal Whole Effluent Toxicity.

Code of Federal Regulations. 40 CFR parts 122, 123, 125, 133, and 136

Methods for Chemical Analysis of Water and Waste. USEPA 1979

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DOE Order 5400.1

4.2 INTERNAL REFERENCES

Rocky Flats Plant NPDES Permit No. CO-0001333

Rocky Flats Plant NPDES Federal Facilities Compliance Agreement

Related SOPs cross-reference by this SOP are:

- SOP 1.3, General Equipment Decontamination
- SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP 1.14, Data Base Management
- SOP 4.2, Field Measurements of Surface Water Field Parameters
- SOP 4.3, Surface Water Sampling

5.0 METHODS

5.1 SAMPLE COLLECTION AND PRESERVATION

Collection of representative effluent samples requires that a reliable procedure be developed and implemented. Since each effluent location may have conditions or requirements that make it unique, each location must be evaluated on a site-by-site basis. This SOP addresses criteria for effluent sampling, including sampling necessary to meet the requirements of NPDES Permit No. CO-0001333, as modified by the 1990 NPDES FFCA. Surface Water samples will be collected following SOP 4.3, Surface Water Sampling. Composite samples will be collected with an automatic sampler following manufacturer's instructions for its operation. Sampling sites will be located at the points specified in the field sampling plan and the NPDES permit. Parameters measured in the field will comply with SOP 4.2, Field Measurements of Surface Water Field Parameters.

5.2 SAMPLE CUSTODY, PRESERVATION AND HANDLING

Sample containers used for sampling will be prepared and handled as described in SOP 1.13, Containerizing, Preserving, Handling and Shipping of Soil and Water Samples. Precleaned sample containers will be purchased by EG&G personnel from a commercial laboratory supplier. If not purchased precleaned, the containers will be sanitized according to Contract Laboratory Program (CLP) procedures. Table 1 lists containers, preservatives, and holding times for NPDES samples. These requirements are based on 40 CFR 136 and regulations governing the collection of NPDES samples, which will take precedence over any conflicting information given in other guidance or SOP when collecting NPDES samples.

5.3 GRAB AND COMPOSITE SAMPLING

Samples will be collected as either grab or composite samples, as specified by the NPDES permit, and/or the NPDES FFCA.

Surface water grab samples will be collected as required by SOP 4.3, Surface Water Sampling with attention given to certain parameters, such as oil and grease, which must be collected by sample container immersion, while others may be collected by the "dip and transfer" method. Volatile organics and fecal coliform will be collected by sample container immersion whenever possible. Discrete grab samples will be collected upstream of the point where the sample technician is standing.

To comply with the permit, flow proportional composites will be collected as required. The composites will be collected as described in SOP NPDES.4, River and Ditch Sampling. It is anticipated that some revisions to this SOP or the field sampling plan will be required when a renewal NPDES permit is issued.

TABLE 4.9-1
CONTAINERS, SAMPLE PRESERVATION AND SAMPLE HOLDING TIMES

<u>Parameter</u>	<u>Container</u>	<u>Preservatives</u>	<u>Holding Time</u> <u>(Hrs or Days)</u>
HSL-VOAs	2x40mL vials with teflon lined septum lids	Cool 4°C ^(a) or with HCl to pH < 2	7 days 14 days
Total Organic Carbon (TOC)	125mL - glass bottle	H ₂ SO ₄ to pH < 2	28 days
Biochemical Oxygen Demand ₅ (BOD ₅)	1L-glass ^(b)	Cool 4°C	48 hours
Biochemical Oxygen Demand Carbonaceous ⁵ (CBOD ₅)	1L-glass ^(b)	Cool 4°C	48 hours
Fecal Coliform	500mL-glass (sterile)	Cool 4°C ^(a)	6 hours

^a Add 0.008% Sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine

^b Poly bottles may be substituted if glass are not available

^c Glass bottles may be substituted if polyethylene bottles are not available

^d Holding Time for mercury is 28 days

^e Amount is for Ceriodaphnia and Pimephales promelas test

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TABLE 1 (continued)
CONTAINERS, SAMPLE PRESERVATION AND SAMPLE HOLDING TIMES

<u>Parameter</u>	<u>Container</u>	<u>Preservatives</u>	<u>Holding Time (Hrs or Days)</u>
Oil and Grease	2x1-L-widemouth glass with teflon liner	Cool 4°C; H ₂ SO ₄ to pH < 2	28 days
Solids-Total	500mL-Poly ^(c)	Cool 4°C	7 days
Nitrate/Nitrite (as N)	100mL-Poly	Cool 4°C; H ₂ SO ₄ to pH < 2	28 days
HSL Metals-Total	1L-Poly	HNO ₃ to pH < 2	6 months ^(d)
Chromium-total	1L-Poly	HNO ₃ to pH < 2	6 months
Phosphorus-Total	250mL-glass	Cool 4°C; H ₂ SO ₄ to pH < 2	28 days

- ^a Add 0.008% Sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine
- ^b Poly bottles may be substituted if glass are not available
- ^c Glass bottles may be substituted if polyethylene bottles are not available
- ^d Holding Time for mercury is 28 days
- ^e Amount is for Ceriodaphnia and Pimephales promelas test

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TABLE 1 (continued)

CONTAINERS, SAMPLE PRESERVATION AND SAMPLE HOLDING TIMES

<u>Parameter</u>	<u>Container</u>	<u>Preservatives</u>	<u>Holding Time (Hrs or Days)</u>
Static Bioassay	1 gallon Poly ^(e)	Cool 4°C	48 hours
pH, temperature, Total Residual Chlorine	In-situ; poly, glass or metal container	None	Analyze immediately

- * Add 0.008% Sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) in the presence of residual chlorine
- ^b Poly bottles may be substituted if glass are not available
- ^c Glass bottles may be substituted if polyethylene bottles are not available
- ^d Holding Time for mercury is 28 days
- ^e Amount is for Ceriodaphnia and Pimephales promelas test

A major effort is underway at the RFP to install Parschall flumes and other structures to enable more accurate flow measurements at industrial effluent points, pond discharge locations, and on streams within the RFP boundary. This will also facilitate the collection of representative samples through the use of the automatic flow-proportional composite samplers.

When completed, most samples will be collected by automatic samplers. Until installation of the upgraded network is complete, some locations will require manual compositing of samples proportional to flow.

Manually composited individual grab samples will be thoroughly mixed prior to removing an aliquot to ensure that a representative sample is transferred to a container for analysis. Sample manipulation will be minimized to reduce the possibility of contamination.

5.4 STATIC BIOASSAY

Whole effluent toxicity monitoring will be conducted at several effluent locations as required by the NPDES FFCA. Acute replacement static toxicity tests will be conducted in conformity with "Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms", USEPA 600/4-85/013 (revised March 1985) and the Region VIII USEPA "NPDES Acute Test Conditions - Static Renewal Whole Effluent Toxicity". USEPA Region VIII procedures will take precedence in case of any conflicts.

Acute 48-hour replacement static tests using Ceriodaphnia and acute 96-hour replacement static tests using Pimephales promelas will be conducted from a 2-gallon flow-proportioned composite sample collected for this analysis. Pimephales promelas used in the test will be 5 ± days of age.

6.0 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Quality Assurance (QA) and Quality Control (QC) will be accomplished according to applicable project plans as well as quality requirements presented in this SOP. Additional QA/QC requirements may be added if it is determined they are needed to ensure the quality of the data.

The most common monitoring errors are typically the result of improper sampling, improper preservation, and exceeding sample holding times. Errors of this type will be minimized by the use of this SOP which addresses all of these issues and through the training provided for the technicians.

There are six types of QA/QC samples:

- Duplicate
- Matrix Spike
- Matrix Spike Duplicate
- Rinsate samples
- Trip Blanks
- Split samples

6.1 FIELD DUPLICATES, MATRIX SPIKE AND MATRIX SPIKE DUPLICATE SAMPLES

Field duplicate, matrix spike (MS), and matrix spike duplicate (MSD) samples are independent samples collected from the same source, so they are, to the extent possible, equally representative of the parameter(s) of interest at a given point in time. The MS and MSD are used by the analytical laboratory as a QA/QC check.

6.2 EQUIPMENT RINSATE SAMPLES

Equipment rinsate samples are samples that are obtained by pouring analyte-free distilled water through decontaminated sample collection equipment (dipper, compositing container, pump, etc.) and collecting the rinsate in the appropriate container for chemical analysis. These samples are used to determine the effectiveness of the decontamination procedures.

6.3 TRIP BLANKS

Trip blanks are prepared prior to the sampling event in 40-ml VOA containers and accompany the samples in the cooler throughout the sampling and transportation events. They are packaged and shipped for VOA analysis with the field samples. At no time after their preparation are the sample containers to be opened before they reach the laboratory. Currently trip blanks are not being collected for the NPDES Program since VOA analysis are not currently required by the permit.

6.4 SPLIT SAMPLES

Split samples involve collecting a single sample and dividing the sample into two containers for analysis by separate laboratories. While infrequently employed, split samples are beneficial in identifying problems and discrepancies within the analytical laboratories.

6.5 QA/QC SAMPLE FREQUENCIES

A minimum of one trip blank per shipment per day containing samples for Volatile Organic Analyses will be submitted. Matrix spike and matrix spike duplicate collection frequencies will be determined by the analytical laboratory procedures. Equipment rinsates and sample duplicates

will be collected at a minimum frequency of one per 20 field samples. Split samples should be collected at a frequency of one per 100 samples or at least once each year.

6.6 FIELD INSTRUMENT CALIBRATION

Field instruments will be calibrated in accordance with SOP 4.2, Field Measurement of Surface Water Field Parameters.

7.0 DOCUMENTATION

Proper chain of custody and documentation will be maintained at all times by following SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. A permanent record of the implementation of this SOP will be kept by documenting field observations and data. Observations and data will be recorded on pre-approved field forms that identify the required data entries or in a bound field notebook with consecutively numbered pages. Field logbooks will generally be utilized to summarize the daily field activities and to document project information not required by the field forms.

Permanent ink will be used for all entries in the logbooks and on the field forms. Mistakes will be crossed out with a single line, initialed, and dated. Unused pages or partial pages will be voided by drawing a line through the blank sections and initialing. Any deviation from this SOP requires documentation in the site supervisor's logbook.

The field activity daily log narrative should create a chronological record of the media team's activities, including the time and location of each activity. Any descriptions of problems encountered, personnel contacted, deviations from the SOP, and visitors on site should also be included. The weather conditions, date, signature of the person responsible for entries, and the