Quality Assurance
Technical Document 2

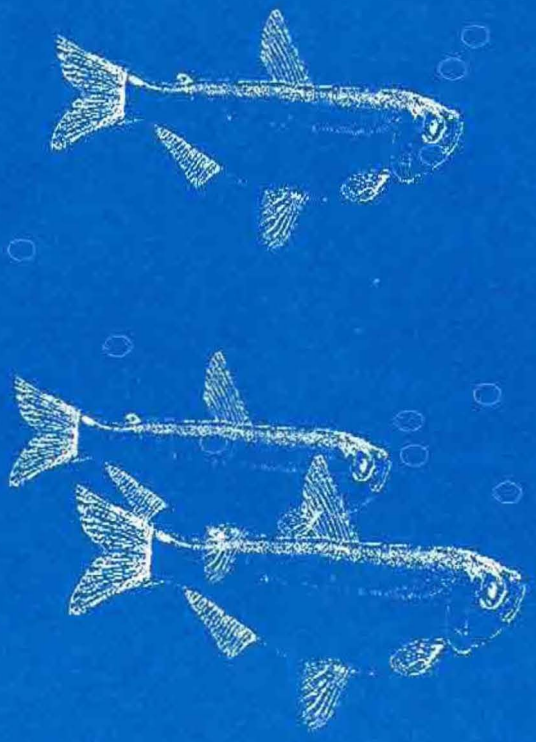
Sampling Manual for Environmental Measurement Projects

April 1994

The Resources Agency State of California Department of Water Resources

Department of Water Resources
Quality Assurance/Quality Control Program

Environmental Assessment



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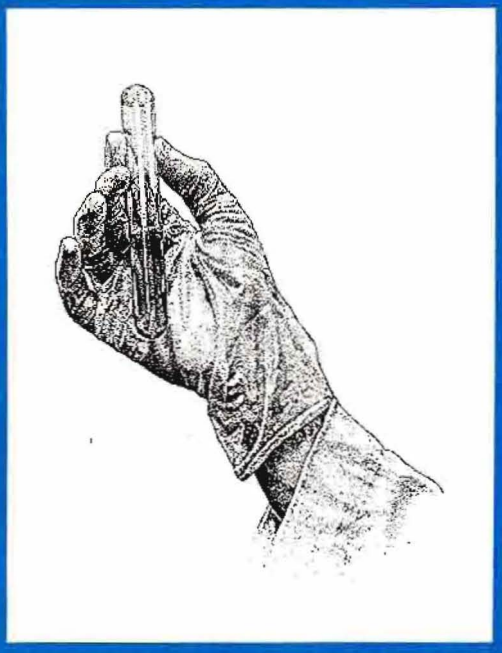

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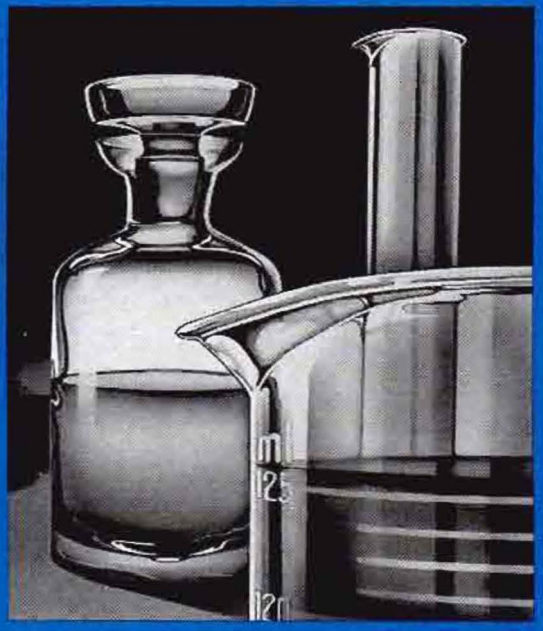

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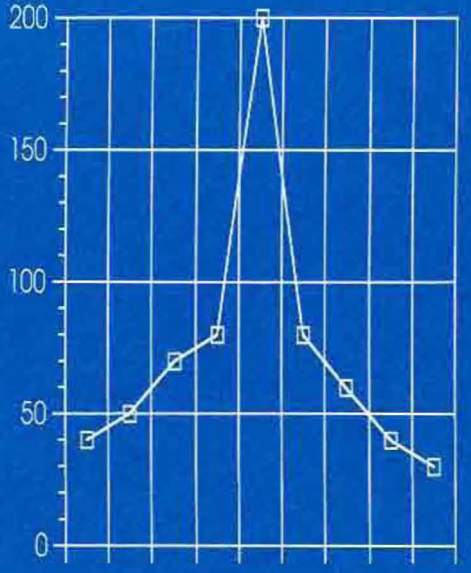

State of California
The Resources Agency
Department of Water Resources
Division of Local Assistance

Sampling Manual for Environmental Measurement Projects

April 1994

Douglas P. Wheeler
Secretary for Resources
The Resources Agency

Pete Wilson
Governor
State of California

David N. Kennedy
Director
Department of Water Resources

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Quality Control Committee

Harlan Proctor
Division of Local Assistance

Gerry Boles
Northern District

Ben Igawa
San Joaquin District

Dick Gage
Delta Field Division

Bruce Agee
Division of Local Assistance

Bellory Fong
Division of Local Assistance

Steve Roberts
Division of Planning

Bob Pierotti
Southern District

Mike Floyd
Central District

George Anderson
Delta Field Division

Dan Peterson
Division of Operations
and Maintenance

Bill Nickels
Division of Local Assistance

Organization

State of California
Pete Wilson, Governor

The Resources Agency
Douglas P. Wheeler, Secretary for Resources

Department of Water Resources
David N. Kennedy, Director

John J. Silveira
Deputy Director

Robert G. Potter
Chief Deputy Director

Carroll M. Hamon
Deputy Director

L. Lucinda Chipponeri
Assistant Director for
Legislation

Susan N. Weber
Chief Counsel

Division of Local Assistance

Carlos Madrid . . . . . Division Chief

Richard Woodard . . . . . Chief, Water Resources Assessment Section

This report was prepared by

Judith Heath . . . . . Program Manager, Quality Assurance/ Control Program, Water Quality Assessment

With the assistance of

William McCune . . . . . Water Resources Engineering Associate, Water Quality Assessment

Nan Singhasemanon . . . . . Environmental Specialist, Water Quality Assessment

Rita Cheng . . . . . Student Assistant, Water Quality Assessment

Jeff Blackwell . . . . . Former Student Assistant, Water Quality Assessment

Tracy Montgomery . . . . . Former Student Assistant, Water Quality Assessment

Lynda Dale Herren . . . . . Supervisor of Technical Publications

Purpose and Scope

This manual is designed and written for California Department of Water Resources Program Managers in charge of environmental measurement projects. It has been extensively reviewed and has received the endorsement of DWR's Quality Control Committee which is comprised of various Division and District representatives.

The purpose of this manual is to document the general sampling procedures used by DWR. The immediate goal is to provide the groundwork for the development of project-specific sampling manuals, provide quality assurance/control procedures for sampling and the necessary information for the development of the data quality objectives. The long-term goal is to standardize sampling equipment and methods so that comparable and reliable data are obtained.

At present, DWR employees use a wide variety of equipment and procedures. The great extent of this variety makes it difficult to provide highly detailed instructions for field sampling procedures in one document. This is why it is highly recommended that Program Managers or their staff develop project-specific sampling manuals unique to their operations. Therefore, the contents of this manual are not intended to cover every sampling procedure for all types of equipment. Rather, it sets forth basic sampling principles which are relatively independent of equipment or methods used. In many cases, detailed descriptions are provided for equipment and procedures which are widely used at DWR. The mention of trade names or brands does not constitute an endorsement by the State of California.

The development of new and improved field techniques is a continuing process. Therefore, this manual will be updated as necessary. A training program is planned in tandem with this manual. For further information, contact Judy Heath of DWR's Quality Assurance/Quality Control Program at (916) 327-1672.

Introduction

Environmental samples should represent the larger "population" from which they are taken. In practice it is seldom possible to collect a completely representative sample, but this is a goal which must be pursued. The sampler must ensure a quality sample by using clean equipment, properly prepared containers, good sampling technique, and proper sample preservation.

The goal of quality assurance in sampling is to identify, measure, and eliminate or minimize errors which contribute uncertainty to the data. For example, blank samples (usually demineralized water free of the parameter of interest) and other quality control samples are used to assess contamination due to sampling procedures. This helps to identify, control and minimize the effects of errors.

The most sophisticated equipment will fail to give good results if the sample is non-representative, contaminated during collection, or improperly preserved or handled. The quality control measures taken by laboratory personnel can account only for errors that occur *after* sample collection and delivery; therefore, sampling procedures must be properly evaluated and planned to minimize sources of error in the sampling process.

Modern environmental sampling requires an extraordinary degree of care. Analytical detection limits are now common in the parts per billion or parts per trillion range. When such small concentrations of materials are being analyzed, a sample can be easily contaminated. A particle of dust or a finger in the sample can cause contamination.

In the final analysis, the sampler is the major controller of the quality of samples. It is an important responsibility to protect the quality of data produced by DWR.

CHAPTER 1

QUALITY ASSURANCE/CONTROL (QA/QC)

The quality of analytical data is critically dependent on the way the sampling is conducted, the manner in which the sample is handled and analyzed and, finally, how the data are handled. Good quality control must be built into the sampling plan from the outset.

Written Procedures

Sampling plans are written protocols and should be included or referenced in the QA Project Plan. The sampling plan incorporated as part of the project plan (or standard operating procedures for sampling) delineates the details on:

- Sampling locations
- Sample type
- Sample frequency
- Number of samples
- Duration of sampling
- Sample volume
- Sample collection methods and holding times
- Equipment to be used for the sample collection
- Sample containers
- Pretreatment of containers
- Type and amount of preservative to be used
- Blanks, duplicates/triplicates, spiked samples, replicates
- Chain of custody procedures
- Any other pertinent matter which will have a bearing on the quality assurance in collecting and handling samples

Guidelines on the above can be found in the DWR publication, *Guidelines for Preparing QA Project Plans.* Although designing for quality assurance takes a little extra time and attention at the outset, this effort will give the best and most valid data in the end.

Where adequate QA/QC practices are employed, the overall costs and total time spent are generally lower and valid data yield is generally higher than in programs where QA/QC practices are inadequate.

Contamination Avoidance

Samples should be safeguarded from analyte loss, tampering, or misidentification. This requires a good sample management system in which all steps are properly taken and documented from the time the sample is collected until the time it is analyzed. The sampler is required to scrupulously follow the sampling program indicated by the Program Manager to ensure reliable data results.

As mentioned previously, every possible precaution should be taken to prevent contamination and ensure reliable data results. Contamination may be introduced during sample collection, handling, storage, or transport to the laboratory.

Common sources of potential sample contamination during sample collection include unclean equipment and apparatus, improper handling of samples (e.g., filtration), improper preservation protocols, an unclean working environment (e.g., roadside dust, smoking), and unclean sample containers. Common sources of contamination from sample transport and storage include use of unclean storage containers, cross-contamination between samples (e.g., volatile organic samples becoming contaminated because of the proximity of other samples), and improper cooling temperatures.

Instrument Care

As an added step toward ensuring good quality data, procedures should be developed for routine testing, maintenance and calibration of the equipment. This manual generally addresses cleaning, maintenance and calibration of measurement equipment, but the manufacturer's instructions should be consulted for more detail. These procedures should establish routine maintenance, testing and calibration intervals, and generate a documentation record system. An example of an "Instrument Maintenance, Calibration and Repair Log" which may be used for this purpose is found in Appendix A.

Audits

Random control checks or audits should be performed to make sure that appropriate sampling guidelines on sample collection, handling, storage, and transportation are followed by the field personnel, and deviations, if any, are rectified. The Program Manager is the primary staff person responsible for conducting audits within the program.

Periodically, field sampling programs will be independently audited by the DWR QA Officer, who will check for clean equipment, preparation area and vehicle conditions, properly maintained field and equipment logs, proper office preparation procedures, proper field sampling and analysis techniques, and completed QA Project Plans. The QA Officer will work with the Program Manager to address any problems encountered.

QA/QC Samples

Analytical field control is performed by incorporating duplicates, blanks, spikes, and known reference standard samples into the collection effort. A description follows:

Field Duplicates

These are second samples collected at the same location, time, and in the same manner as the original sample. Field duplicates are used to assess precision associated with the laboratory and the field collection process. It is recommended that one field duplicate be taken for every ten samples taken, or one field duplicate be taken for each sampling run.

Field duplicates are often presented to a laboratory "blind"; i.e., the laboratory is not made aware that the batch contains replicate samples. This procedure is recommended.

Field Blanks

These are samples of purified water brought to the field, then either filtered or not, before being transported back to the laboratory with the samples. Filtered blanks help to check possible contamination from hoses, housing, filters, and technique. Unfiltered blanks help to check possible contamination from containers and preservatives. The travel blank helps to check diffusion of contaminants into samples which might occur in the process of collecting and transporting samples from the field. Travel blanks are particularly important when volatile chemical analyses are planned.

Samples submitted to the DWR Bryte Chemical Laboratory for nutrients and trace metals analysis should be accompanied with filtered and unfiltered blank samples. The recommended frequency is one set for each field crew run. Preparation is as follows:

Nutrient Blanks. Unfiltered—one eight-ounce plastic bottle filled with blank water (laboratory supplied). Filtered—one eight-ounce plastic bottle filled with blank water supplied by the laboratory, which has been filtered in the field using the normal filtration equipment.

Note: If only *total* nutrient is requested, only the unfiltered blank is necessary.

Trace Metal Blanks. Unfiltered—one 16-ounce acid washed plastic bottle filled with blank water and one milliliter of nitric acid (ampule provided by laboratory). Filtered—one 16-ounce acid washed plastic bottle filled with blank water which has been filtered through the field apparatus, plus one milliliter of nitric acid (ampule provided by laboratory).

Note: If only *total* trace metal analysis is requested, only unfiltered blanks are necessary. Both unfiltered and filtered blanks should be used for dissolved trace metals.

Volatile Blanks. For volatile analysis samples, a pair of travel blanks prepared by the laboratory from organic-free water should accompany each batch of sample vials to the field and back again. These blanks are required to prove that containers were properly cleaned and that no contamination occurred during handling.

Standard Minerals. Blanks are normally not required for standard minerals, since contamination is not usually significant. However, for very low level detection work, such as mineral analysis for rain water, blanks may be necessary. Consult with the QA Officer if you are planning special low level analyses.

Spikes

Spikes are samples "spiked" with a known amount of analyte and analyzed using standard techniques. This analysis produces data on analytical accuracy. Accuracy is a measure of the ability to correctly quantify a known quantity of analyte in a sample, or in other words, to get the correct answer. (Precision is a measure of the ability to get the same answer through repeated measurements of a sample.)

In complex matrices, such as agricultural drainage, waste water, and soils, constituents in the matrix can often interfere with the chemical analysis. Therefore, it is often necessary to prepare "matrix spike" samples to verify that the sample matrix does not interfere with the analyses. If your plan is to sample one of the matrices listed above or other complex matrices, consult with the QA Officer who will assist in determining whether and how spike samples should be incorporated into your sampling plan.

Standard Reference Samples

Standard reference samples are samples specially prepared by agencies such as the National Bureau of Standards, and contain known concentrations of a substance. These samples are submitted by the Program Manager to the laboratory blind; that is, samples do not look any different from the samples collected in the field. They are submitted as a check on performance. The QA Officer can help to obtain these samples for the Program Manager's use. The standard reference samples are used to provide the Program Manager and the laboratory with invaluable accuracy data.

As an "external" quality control check, reference samples can frequently be used to identify systematic, analytical errors which are otherwise unlikely to be observed. Interlaboratory comparisons, in which split samples are analyzed by more than one laboratory, are also valuable external means of detecting systematic errors. The laboratory should run an independent reference sample at least quarterly coinciding with the time samples are analyzed.

Data Quality Assessment

Quality assessment describes those techniques used to assess the quality of the measurement process and the results. The Program Manager needs to examine the data from both the field analysis and the laboratory analysis to determine if it is reliable and meets the objectives of the sampling program. Details for data quality assessment are presented in the DWR draft *Guidelines for Preparing QA Project Plans*. This publication is expected to be available in the winter of 1993. For details contact Judy Heath of DWR's QA/QC Program (916) 327-1672.

CHAPTER 2

FIELD PREPARATION

In general, the Program Manager is responsible for planning or overseeing the planning of the entire monitoring project, including sampling, analysis, data interpretation, and reporting. These plans are documented in the QA Project Plan. The objective of a QA Project Plan is to ensure that the quality of the data collected is reliable and appropriate for the objectives of the monitoring project.

Program Manager responsibilities also include taking precautions to ensure the safety of the employees, ensuring adequate sampling supplies, calibrating and cleaning equipment, as well as completing paperwork accurately, including sample labeling. These responsibilities are frequently delegated to staff.

Before sampling, staff involved in the field trip should have an opportunity to review the QA Project Plan for the project. This document will inform them of the specific procedures they are expected to follow when sampling. Thus, they have an opportunity to discuss any questions about their respective roles, and to clarify the goals of the sampling effort. Moreover, before a Program Manager can even take samples from the field, he or she needs to know where to sample, how many samples are needed, what types of samples are needed, which laboratories to choose, and so on. This is where the necessary task of sampling design comes in. A more thorough discussion of sampling design can be found in Appendix B.

Checklist

One of the most important ways to ensure quality and reduce errors is to develop and use a detailed checklist of activities to be performed in connection with field sampling. The following general checklist can be used.

PREPARATION CHECKLIST

- ☐ Condition and availability of boats, motors, trailers, laboratory vans, pumps, etc.
- ☐ Condition, calibration, cleanliness and availability of sampling and analytical equipment
- ☐ Type and number of sampling containers
- ☐ Container labels
- ☐ Stabilizers, reagents or preservatives for samples (e.g., pH buffers, calibration standards, preservatives, etc.)
- ☐ Field books
- ☐ Laboratory submittal forms including Chain-of-Custody Reports
- ☐ Safety equipment including eye protection, life vests, radios, special clothing, and first aid kit
- ☐ Maps with sampling locations plotted
- ☐ Transportation, shipping and storage requirements of samples before delivery to laboratory
- ☐ Access permission and gate keys obtained
- ☐ Prior notification to laboratory (laboratory must be notified so that they can schedule the workload)
- ☐ Ice chests with ice
- ☐ Sampling schedule—stating the time when each station should be sampled

Equipment Condition

All equipment, including boats, laboratory vans, pumps, etc., should be carefully checked for proper operation prior to the sampling run. Some conditions to look for are broken or cracked components, leaky seals, frayed ropes, loose bolts or screws, blown fuses, inoperative readout devices, batteries with insufficient power, and corroded or dirty electric terminals. Care should be taken when lubricating equipment because lubricants can be a source of sample contamination.

It is a good idea to carry an extra supply of fuses, flashlights, lanterns and any glassware to be used.

Equipment Calibration

Calibrate instruments to comply with manufacturer's or laboratory specifications before *and* after the sampling run. If a post-run calibration indicates significant instrument drift has occurred during the run, data collected by the instrument during the run are generally not usable. Repair or replacement of parts should be considered if readings do not fall within acceptable ranges.

Where calibration is simple, as with the Yellowsprings DO meter, calibration checks should be repeated during the sampling run. Calibration procedures for field measurement equipment, along with methodologies for measurement, are described in Chapter 7.

Instrument calibration log books should be maintained for each instrument documenting its condition, scheduled periodic services, the date, and the individual performing the calibration, maintenance, or repair. Appendix A shows an example calibration log sheet. Calibration log books should be bound volumes with numbered pages, and entries should be made with indelible ink. All permanent record books such as field notebooks should be bound with numbered pages, and entries made with indelible ink.

Equipment Cleanliness

Chemical cleanliness of field sampling equipment and laboratory glassware is important. Generally, chemical cleanliness requires rigorous cleaning with hot water, strong detergents, and more than one rinse. Samples are not representative if contaminated by dirty sampling equipment, containers, or measuring equipment. If available, commercial laboratory dishwashers are a real asset to a field preparation laboratory.

More specific cleaning measures follow:

Glassware Bottles

Typically, glassware should be washed in a strong phosphate-free detergent using hot water, and followed by two rinses with tap water and one rinse with demineralized water. Rinse water poured over chemically clean glassware flows off in a sheet, as opposed to forming droplets.

Plastic Bottles

Plastic bottles which have never been used before, and have been properly stored and protected from contamination, do not need to be cleaned for use as containers for the major minerals. This is because the manufacturer cleans plastic bottles before being sold. They should, however, be rinsed with the sample water before being filled. In cases where trace metal samples will be collected, only laboratory acid-washed bottles should be used. Arrangements can be made with the chemical laboratory for acid cleaning.

Sampler

The sampling device (e.g., stainless steel bucket, Van Dorn, Kemmerer, bailers, augers, ponars, etc.) should be thoroughly cleaned with phosphate-free detergent and steam cleaned, where steam

cleaning equipment is available. All traces of detergent must be removed from the equipment before use to avoid contaminating the sample.

Filtering System

The filtering system should be completely cleaned and tested to ensure proper operation before every trip. The cleaning can be done by placing both the intake and outlet tubes in a container filled with a hot solution of strong detergent, and the pump should be operated for several minutes. This should be followed by a good rinse with tap water. The two tubes should then be placed in a container of 5 percent solution of nitric acid and the pump allowed to operate for several minutes. A quart of demineralized water should be pumped through as a final rinse.

If unusual filter media are used, or if the filtration is being performed for an unusual analysis, the laboratory or QA Officer should be contacted to determine an appropriate cleaning procedure.

Mobile Laboratory

Cleaning the inside of the vehicle or boat, especially the counter area and sinks, is critical for avoiding contamination of samples. Cleaning the floor is also important to avoid dust entering samples, sampling equipment, and reagents. Vehicles should be thoroughly cleaned prior to each sampling run.

Sinks should be tested for proper operation, storage tanks should be completely filled with demineralized water before each sampling run, and any holding tanks should be emptied. Make sure all safety equipment is in place (e.g., eye protection devices and washes, gloves, first-aid kits, etc.).

Smoking in mobile laboratories or while sampling is both a contamination risk and safety hazard, and is prohibited at all times.

Ice Chests

Ice chests and other containers for storage of samples must be kept clean. The DWR Bryte Chemical Laboratory has recommended that blue ice packets not be used because they have the potential to leak which could result in sample contamination. If blue ice packets must be used, care should be taken to keep them in the lower part of the chest. An alternative to blue ice packets would be regular ice. This could be made by filling a plastic bottle about three quarters full and freezing it.

Labeling Sample Containers

Prior to the run, sample containers should be labeled with waterproof ink. Either a gummed label or a label attached to a sample tag must be placed directly on the sample container. Applied labels must be made of material which can withstand immersion in water, and have adhesive which will not cause contamination or cause the label to peel in hot, cold, or wet conditions. The label information should include:

- Laboratory number
- Sample type, either by name or code number (e.g., standard mineral, chlorinated organic pesticides, Code 7, etc.)
- Date sample collected
- Sampling station name or code
- Filtered or unfiltered
- Preservative (acid, formalin, Lugol's Solution, rose bengal stain, etc.)

An example of a container label used by DWR follows:

CQ0858 **11/13/90**
JOHNSONSL
VOA CODE 8
40 ml-filtered

Field Books

A three-ringed binder containing field sheets, laboratory submittal and chain of custody forms, maps, and notes should be carried. The binder should be water resistant. Extra copies of the field sheets, lab submittal, and chain of custody forms should also be available.

A water-resistant field notebook is also recommended. The field notebook may be bound if the study objective is for regulatory purposes or if data may be litigated. Bound or unbound, the notebook should have consecutively numbered pages. Entries to the notebook are made using indelible ink. Field notes should include the sampling site name or description, applicable weather conditions, tide stage, stream flow estimates, waste discharges (when possible), sample cooling temperature, and any other conditions which may affect the interpretation of the monitoring data.

When sampling a station for the first time, the exact location of the sampling site should be described so that the site may be found again for resampling. A standardized method exists to code

wells and define locations on streams, rivers and water bodies. The appropriate personnel within DWR should make these determinations to avoid duplications and confusion. When revisiting a station, maps and photographs of the site should be included in the notebook. The field notes should contain sample times recorded as 24-hour Pacific Standard Time.

As necessary, notes can be transferred from the field notebook for other uses. However, the field notebook remains the Book of Original Entry for any legal purposes.

Laboratory Forms

Examples of these forms are presented in Appendix C. In general, the forms used by DWR are:

- Chemical Laboratory Test Request (DWR 1263)
- Water Analysis (Organic Phosphorous Pesticides)
- Water Analysis (Chlorinated Organic Pesticides)
- Water Analysis (Purgeable Organics)
- Water Analysis (Carbamate Pesticides)
- Water Analysis (Chlorinated Phenoxyacid Herbicides)
- Water Analysis (Miscellaneous Pesticides)
- Phytoplankton Analysis (DWR 3749)
- Water Analysis (Mineral) (DWR 2241a)
- Water Analysis (Miscellaneous) (DWR 2241b)
- Water Analysis (Nutrient) (DWR 2241c)
- Water Analysis (Minor Elements) (DWR 2241d)
- Water Analysis (Supplemental Minor Elements) (DWR 2241e)
- Field Data Collection Sheet (customized to fit need)

Laboratory submittal sheets should also include a Chain of Custody Report if the data will be used for legal purposes. An example of this form is shown in Appendix D. The Chain of Custody Report is important, because it documents how a sample is handled from the time it is collected to the time it is analyzed. The form also tracks the location of the samples. In cases of legal dispute, Chain of Custody Reports are very important evidence. Make sure the following information is recorded on this document:

- The sample collector's name which must be present and legible.
- All required signatures and dates.

- Storage temperature record (backed up by recorded sample storage temperature data from field log).
- Record of transfer of sample responsibility from one person to another.
- Type and manner of sample preservation.
- The receiving date on the laboratory sample documentation which should agree with the appropriate date on the chain of custody document.
- The chain of custody documentation which must not show a break in documented custody.
- The sample ID number which must be recorded for each sample listed on the chain of custody document.

A DWR Bryte Chemical Laboratory Water Analysis Code and Price List form can be found in Appendix E. DWR Bryte Chemical Laboratory and County Codes for Laboratory Submittal Forms are listed in Appendix F.

Safety Equipment

The type of safety equipment to be taken on the run depends on the type of samples to be collected and the forecasted weather conditions. In general, the sampling team should be equipped and trained to use:

- Fire extinguishers
- Eye wash equipment
- Eye protection devices
- First-aid kit, poison oak preventative solution
- Life jackets for boat and off shore sampling
- Tethering ropes for personnel to anchor themselves while sampling over water
- Two-way radios
- Fluorescent colored vests for bridge sampling
- Road markers for warning oncoming traffic
- Rotating yellow light for vehicle roof when vehicle is stopped on or near traveled roadways (check with the Mobile Equipment Office for latest regulations)
- Protective clothing (gloves, hard hats, rain gear, boots, etc.)
- Sunscreen lotion

Maps for Identifying Locations

Maps of the area to be sampled should be carried in the vehicle or boat. These include road maps which have the premarked route, quad maps and nautical charts. Quad and nautical charts are available from DWR, United States Geological Survey, and other agencies.

Access Permission to Sampling Sites

It is DWR policy to obtain written permission before entering private property. The Program Manager is responsible for procuring permission from the property owners (not tenants). A Temporary Entry Permit (form DWR 308) from the Division of Land and Right of Way is in Appendix G. Signatures of property owners as well as necessary information are to be obtained. Signed permits should be sent to the Division of Land and Right of Way for processing and acceptance. Copies of this written permission should be carried by the crew while on the sampling run.

Many sites are accessible only by private roads that have locked gates. In such cases, a gate key is needed from the owner of the property, utility company, or Reclamation District. A DWR lock may already be included in the set of existing locks on these gates. If not, it may be possible to obtain permission to add a DWR lock to the existing set.

Notification to Laboratory

The laboratory should be notified prior to sampling in order to plan for the workload. Notification helps to ensure the samples will be properly handled, stored, and analyzed within the maximum holding times.

CHAPTER 3

SAFETY WARNINGS AND PRECAUTIONS

This discussion highlights safety procedures for field sampling activities. In general, it is advisable to have a partner on all sampling runs. A partner can help in the event of an emergency.

If a situation looks dangerous, it probably is. Exercise caution.

For all field sampling, carry a well-stocked first-aid kit, including a poison oak protective solution. The kit must be located in the vehicle in a readily visible and easily accessible place. The contents of the kit should be inspected before each trip for any necessary replacement. All mobile laboratories must also have an eye wash station.

A two-way radio or a cellular phone should be taken, and all crew members should be able to operate it. Carry a list of emergency phone and radio call numbers. In addition, at least one field person in each run should be trained in cardiopulmonary resuscitation and first aid. All field personnel should know that DWR offers training courses in both CPR and first aid. Although these courses may not be mandatory, they are highly recommended.

In case of an emergency in the Sacramento/San Joaquin Delta, radio Delta Field Division (Delta Control) and explain the emergency. At this time, request that State Police monitor the frequency. Communicate with the State Police (radio unit 408 or 409) and answer all questions.

Hard hats should be worn when sampling near unstable overhead structures.

When working along roads (e.g., sampling from bridges), fluorescent vests should be worn, and road markers should be near the vehicle. A rotary yellow light should be placed on top of the vehicle.

Bridge and Shore Sampling

Often samples will be taken from places where there is a danger of falling into water. For this reason, life jackets should always be worn when working near water.

The person sampling should be tethered with a line fastened to a stable object, such as a vehicle and/or an anchored ladder. For bridge sampling, tethers should not be long enough to

allow the sampler to fall over the edge. Perlon and other types of rock-climbing ropes with a minimum diameter of 9 millimeters are recommended. Tethers must not be tied to belts.

Escape routes should be planned out ahead of time. Do not wade into streams where the water is fast and deep, even with a tether.

When sampling on private property, access must be obtained from the owner (see section on "Access Permission to Sampling Sites" in Chapter 2 and the Temporary Entry Permit form in Appendix G). The owner should be asked to point out any possible safety hazards.

Beware of farm animals, especially cattle and dogs.

Be cautious of oncoming traffic when sampling from bridges, levees, and other traveled roads. If parked on the shoulder of the road, place an orange cone about 20 feet from the rear of the vehicle as a warning to oncoming motorists. All safety equipment must be visible and accessible. Acquire and use a flashing yellow warning light on the top of the vehicle. It is a good idea to have a permanent warning light mounted on vehicles which are continually used for sampling. If the sampling vehicle has no warning light, portable ones are available. Wear highly visible fluorescent vests on the roads and bridges. At least two persons should do this work; one should watch for traffic as the other performs the sampling.

Drive slowly on rough or narrow roadways. Equipment and chemicals in the sampling van or truck should be secure so that there is no damage to them while traveling on rough roads.

Boat Sampling

Boats are often used to sample locations in lakes, reservoirs, rivers, and channels. DWR regulations require the presence of at least two persons in the boat at all times. Moreover, each boat should have a marine radio for use in case of an emergency.

Life jackets must be worn at all times while in the boat.

Extra flotation devices should also be carried. A fully charged fire extinguisher must be carried in all power boats, and there are other legal requirements. The DWR Boat Safety class is required for all personnel involved in this type of field work. Instructors of this class can be consulted to determine current legal requirements for boat safety equipment.

Ground Water Sampling

Many of the safety measures listed under "Bridge and Shore Sampling" also apply to "Ground Water Sampling." The owner of the property where the wells are located must be contacted beforehand for access permission and for advice on the existence of any serious safety hazards (see section on "Access Permission to Sampling Sites" in Chapter 2 and the Temporary Entry Permit form in Appendix G).

Pumps and pump houses often have unique safety hazards.

Pumps are normally operated by 220 or 440 volt power, which is powerful enough to kill. It is best if the owner turns the pump on. Never turn the pump on without permission. Do not touch wiring or equipment in contact with wiring. Watch out for frayed or loose wires.

Use caution around pumps and pump houses to avoid electrocution.

Pump houses harbor spiders, wasps and snakes. Watch where you put your hands and feet.

Some pump motors and diesel engines are extremely loud. Ear protection should be worn in these instances.

Oil and debris are often found around the pump area. Be careful; the ground could be slippery.

Pump structures are often in poor condition and can present hazards from protruding nails and boards that are weak or loose. Large-diameter abandoned wells are dangerous, and caution should be exercised to prevent falling into the well.

Out-of-service or improperly abandoned wells can be hazardous if gases are trapped. Removal of caps, plugs, etc. should be done slowly to bleed off any gases. Do not smoke around wells because of possible explosive gases.

Municipal Waste Water Sampling

Sewage sampling presents specific problems, because of the possible disease-causing nature of the waste. The waste water should be handled with extreme caution.

Before sampling, consult with county health authorities about appropriate vaccination. Up-to-date typhoid and tetanus shots are recommended.

Work with plant personnel to determine where the sample can be properly and safely collected. Plant safety hazards can be pointed out by a plant operator. A hard hat should be worn.

Antiseptic soap and a chlorine solution, made by adding 1 cup of liquid household chlorine bleach to 1 gallon water, should be carried.

Contact with waste water should be avoided. Wear disposable plastic gloves when sampling. Hands should be washed after sampling using antiseptic soap, followed by a chlorine solution rinse. Any equipment used to collect the sample should also be cleaned and sterilized. The outside of sampling containers should be disinfected if waste water has spilled on the outside; however, care should be taken to ensure that the disinfectant does not contaminate the sample.

If sampling through a manhole, special precautions must be taken.

For protection against traffic, a fluorescent vest should be worn and markers should be set up to control traffic.

Do not enter the manhole. Collect the sample by using a pole arrangement with the bottle on the end.

Do not smoke. Gases may explode.

Sampling should not be done alone. If a field person has fallen into a manhole, the other person should not go in immediately to help, but should first alert someone of the situation. Poisonous or explosive gases can be confined to such low-lying and enclosed areas. Any area suspected to contain harmful gases should be ventilated prior to sampling with equipment designed not to contaminate samples. A proper breathing apparatus should also be available. If not careful, the person helping may also be in need of assistance.

A properly calibrated gas detector should be used to warn against low oxygen or poisonous gas conditions.

Industrial Waste Water

Industrial waste water is very often toxic. The following safety procedures should be employed:

Hazards associated with the wastes to be sampled should be known. It is important to work with plant personnel, who should be asked for all possible information on safety hazards.

Request a Material Safety Data Sheet (MSDS) from the plant owner or operator. The MSDS must contain information on how to handle and store the material that is to be sampled. Sampling should not be done without an MSDS.

The instructions listed in the MSDS for sample handling and storage must be followed.

Wear any protective clothing or equipment that is required by the MSDS.

Agricultural Drainage Water

Agricultural drainage water can (but usually does not) contain high concentrations of pesticides and other synthetic organic toxins. Agricultural drains can often be hazardous:

Beware of poorly constructed or broken down walkways and pump platforms (e.g., rotten or missing wood).

Pumps can turn on automatically, so keep yourself and loose articles of clothing away from areas near moving parts, or to which power is applied.

Wear disposable plastic gloves when sampling agricultural water and avoid skin contact with water, sediment, and vegetation. Wash hands thoroughly after sampling.

Take precautions when in slippery areas, or deep mud, or along steep accesses.

Permission to access locked gates and private property must be obtained. Gates must be re-locked after entry.

Beware of hunters, farm animals, spiders, wasps, and snakes. Be wary of areas where crop-dusting is occurring or has occurred. Low-flying planes and posted fields are possible signs which suggest pesticide use. Also look for notices of field re-entry times.

CHAPTER 4

SAMPLE COLLECTION

Site Selection

The study site for sample collection should be selected based on the program objectives, the parameters of interest, and the type of sample needed. Typically, surface water sampling by DWR is performed in lakes and reservoirs, agricultural and urban drains, estuaries and bay waters, waste discharges, streams and Delta channels, and in the federal and State aqueducts. Occasionally, sediment and soil samples are collected from river and stream beds and surface soils.

Sites should be carefully chosen by the Program Manager, based on an appropriate research to characterize site variability. Investigate electronic databases or historical records that have pertinent information on area of interest. The proposed sampling area should then be further surveyed to determine:

- Access to the water, sediment, or soil.
- What permission, if any, is needed for access and sampling.
- Locations of any discharges which could affect the quality of the samples in the proposed area of sampling.
- Presence of safety hazards.
- Locations of upstream tributary streams (in the case of stream monitoring).
- Timing of flooding and ebbing tidal phases.

Following this survey, tentative sampling locations should be chosen, and visited for further evaluation. The proposed sampling site should be transected horizontally and/or vertically as appropriate, and samples taken at various intervals. If results of the sample analysis show that homogeneity exists among the samples, then one may exercise latitude in the choice of sampling location within the cross section.

The composition of flowing waters, such as streams, depends on the flow and may also vary with the depth. Grab samples in a stream should be taken from a depth of about 60 percent of the total stream depth in an area of maximum turbulence. Samples should not be taken from the surface of a water body, because surface phenomena make surface water unrepresentative of the entire water body.

Lakes and reservoirs are often stratified with respect to temperature and, because of this, are not vertically homogeneous. Discharges into lakes and reservoirs often result in one part of the lake being different in quality from another. Likewise, flowing waters are often not homogeneous because of upstream effects such as discharges and tributaries upstream of a sampling point.

Estuarine sampling presents special complexities, due to the effects of the tides. Sampling dates and times may need to work around tidal influences. This is especially true with parameters which are dependent on the specific conductance of the water, which often changes with the tides.

Surface water sampling stations require some sort of numbering because of the spatial variability of water bodies. Fortunately, surface water sampling stations can be numbered by one of three ways. A location on a stream, river or other narrow watercourse, is given a Stream Sampling Station Number. A location on a larger body of water is assigned a Broad Water Body Station Number. For those stations located on the State Water Project, numbering is in accordance with SWP's own numbering system based on mileage. For more detailed explanations of these numbering systems, see Appendix H at the end of this document. A system of numbering ground water wells is also presented later in this chapter.

Sediment and soil samples tend to be very heterogeneous, and because of that, are probably the most complex matrix monitored. Every effort should be made to ensure that representative samples are collected. In flowing water, sampling sites should generally be selected at depositing areas where silt and clay settle out due to low current speeds. Inside bends of rivers and aqueducts provide low velocity conditions for sediment deposition. In addition, sediment is often sampled to determine substrate characteristics of a benthic grab.

In places where homogeneity cannot be achieved, it is often necessary to sample a number of locations and either analyze the samples separately or composite them for a single analysis. Horizontal and/or vertical transects under different flow patterns will help verify sample representativeness under different conditions.

The representativeness of a ground water sample is also important. Knowledge of the physical and chemical characteristics of the aquifer system is desirable but is rarely known. Issues to be considered when samples are taken include time of the year (e.g., before or after the rainy season) and agricultural chemical usage. Purging a well before collecting samples is necessary to make sure that the stagnant water is eliminated. The amount of purged volume will depend on the diameter, depth, and recharge rate of a well.

The job is not finished even after a sampler has managed to collect a sample from a representative location. Samples should then be properly preserved and handled to ensure the integrity of the data results.

The Surface Quality Station Description forms (Appendix I) along with photographs of the location should be filed in a three-ring binder entitled "Sample Stations," which is to be kept in possession of the Program Manager.

Types of Samples

Several types of commonly collected samples to be analyzed by a laboratory are described below. The Program Manager will determine which type is to be collected.

Grab vs. Composite

A grab (or discrete) sample is intended to represent the composition of one specific site at one specific time. A composite sample is a series of discrete samples collected at various points in a cross section, or at different times, which are mixed and treated as one sample. Composite samples give an average composition, but will not give information about variation between individual sample points.

Composites can be made mathematically by analyzing a number of discrete samples and averaging the results. This technique offers the advantages of grab and composite sampling, with the disadvantage of the higher costs of analyzing a number of samples instead of one.

Because of the heterogeneous character of sediments, it is ordinarily necessary to collect a number of samples from a sediment area. Samples may be composited, but this is inappropriate for analysis of volatile compounds, since there can be loss of analyte while mixing samples. Therefore, grab samples are recommended for volatile compounds in sediment. Keep collection equipment washed and cleaned between discrete samples.

Filtered or Unfiltered

Filtration is performed for the purpose of separating particulate matter from a water sample. The filtered water (filtrate) is usually the fraction analyzed. Much of the filtration performed by DWR is done using the 0.45 µm (micron) filter, which is sufficiently small in pore size to remove bacteria and particles greater than 0.45 µm from the water. For the purposes of chemical analyses, constituents in the filtrate solution are considered to be dissolved. Step-by-step procedures for filtering are explained in Chapter 5.

Flow Integrated

Flow integrated samples are composite samples made by combining unequal volumes of discrete samples. The volume of discrete samples added to the composite is dependent on the flow at each sampling point or time. As an example, the need for such sampling occurs in a river or stream that varies in composition across its width and/or depth. Samples are collected from the cross section and mixed in proportion to the flow present at each sampling sector. This type of sampling requires flow measurements to be made at each sampling point.

Collection of flow integrated samples is obviously more complicated than collecting from a single location. However, samples collected in this way are usually quite representative of the water body being measured. In situations where non-homogeneity exists, this technique may be among the only ways of collecting a sample that meets the criterion for representativeness.

Automated

There are numerous automated water quality stations that collect continuous data on the State Water Project. Conductivity monitors are at all sites, and some stations include water quality monitors for other parameters as well as microprocessor-based data loggers. These stations provide continuous or "real time" water quality data on parameters such as specific conductance, fluorescence, turbidity, and temperature. Since these measurements are continuous, more data points are generated, and monthly averages can be computed to more accurately portray water quality conditions than a monthly average of single grab sample data points.

At a number of stations, data can be telemetered to central locations. This data can then be accessed by personal computers. Methods of transfer of records include telephone dial up, direct connection to portable personal computers and physical transport of data memory packs to readers.

Further project specific information about the types of sampling and analytical equipment, methods used and parameters measured in the SWP are presented in *State Water Project Water Quality Field Manual*, January, 1991.

Collection Equipment

The following discussion is intended to familiarize the sampler with the basic types of sampling equipment for surface water and waste water, ground water, sediment and soils, and biological samples.

Persons who are inexperienced in the use of particular equipment are urged to consult with the QA Officer or other knowledgeable persons prior to a final decision on type of equipment to use and manner of sampling to be employed.

A wide range of sampling equipment is available for each matrix (e.g., surface water, ground water, waste water, sediment, soils, etc.). In choosing a sampling device, the scale of the project should be considered. A hand-driven corer may be appropriate for collecting a few shallow soil samples, but the same device would not be a good choice for deep or multiple borings. Likewise, a hand bailer is suitable for removing a few liters from a well, but a bladder pump or submersible electric pump is better for taking larger volumes.

Sampling devices must be made of chemical resistant materials that will not change the quality of the water being sampled. The best sampling devices are usually constructed from one of three materials: Teflon, glass, or stainless steel. These materials have been shown to be the most inert in terms of adsorption or desorption of organic and inorganic compounds. Stainless steel is not usually a problem when sampling for organic compounds, but may contribute trace metals such as chromium, iron, nickel, and molybdenum to inorganic samples. Latex and rubber neoprene tubings should also be avoided, since latex is organic and rubber neoprene may contain trace metals. Instead, medical-grade silicone and Tygon tubing are recommended.

In evaluating a sampling device, consider all of its parts, such as butyl rubber seals which may be small, but could contaminate samples for organic analyses.

Surface and Waste Water Sampling Equipment

As compared to sample collection by use of a dipping device, good water sampling equipment has the major advantages of allowing the sample to be taken at selected depths, and being able to fill multiple containers from the same sample. The use of appropriate sampling equipment is recommended for all surface water sampling. The sampling device should always be totally submersed to prevent surface contaminants from being included in the sample.

Water Sampling Bottles. The most commonly used water sampling bottles are the Van Dorn and the Kemmerer (shown below).

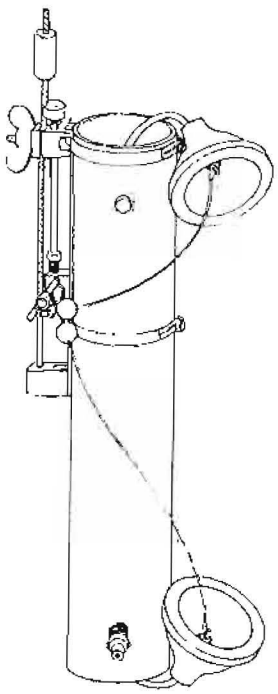


FIGURE 1: Van Dorn Sampler (from *Standard Methods for the Examination of Water and Waste Water*, 1989).

FIGURE 2: Kemmerer Sampler (from *Standard Methods for the Examination of Water and Waste Water,* 1989).

The Van Dorn bottle has several advantages over the Kemmerer:

- No interference from stoppers with water movement through the bottle,
- tripping mechanism is more reliable,
- no metal rod to contact water in the bottle,
- sampling volume can be larger, and
- multiple samples can be tripped with the same weight for depth sampling in a reservoir. However, the Kemmerer sampler constructed of stainless steel with Teflon closures is the preferred choice for sampling organic substances. Brass Kemmerer bottles, on the other hand, are not suitable for collecting water samples that will be analyzed for metals.

Automatic Composite Sampler. This sampler, automatically and unattended, takes samples over a given period of time. The samplers are programmable to enable a wide variety of sample scheduling; either discrete or composite samples can be collected using this equipment.

When unattended equipment is used, be certain to consider equipment security. Assume strangers will encounter your equipment regardless of how remote the location.

ISCO Protective Enclosures. Many pieces of DWR equipment have been stolen, shot, and otherwise damaged or destroyed. Concealment is probably one of the best means of securing unattended equipment. If unattended operations will occur over a period of time, a bullet resistant, well-anchored and locked protective enclosure should be constructed. A picture of ISCO protective enclosure is shown.

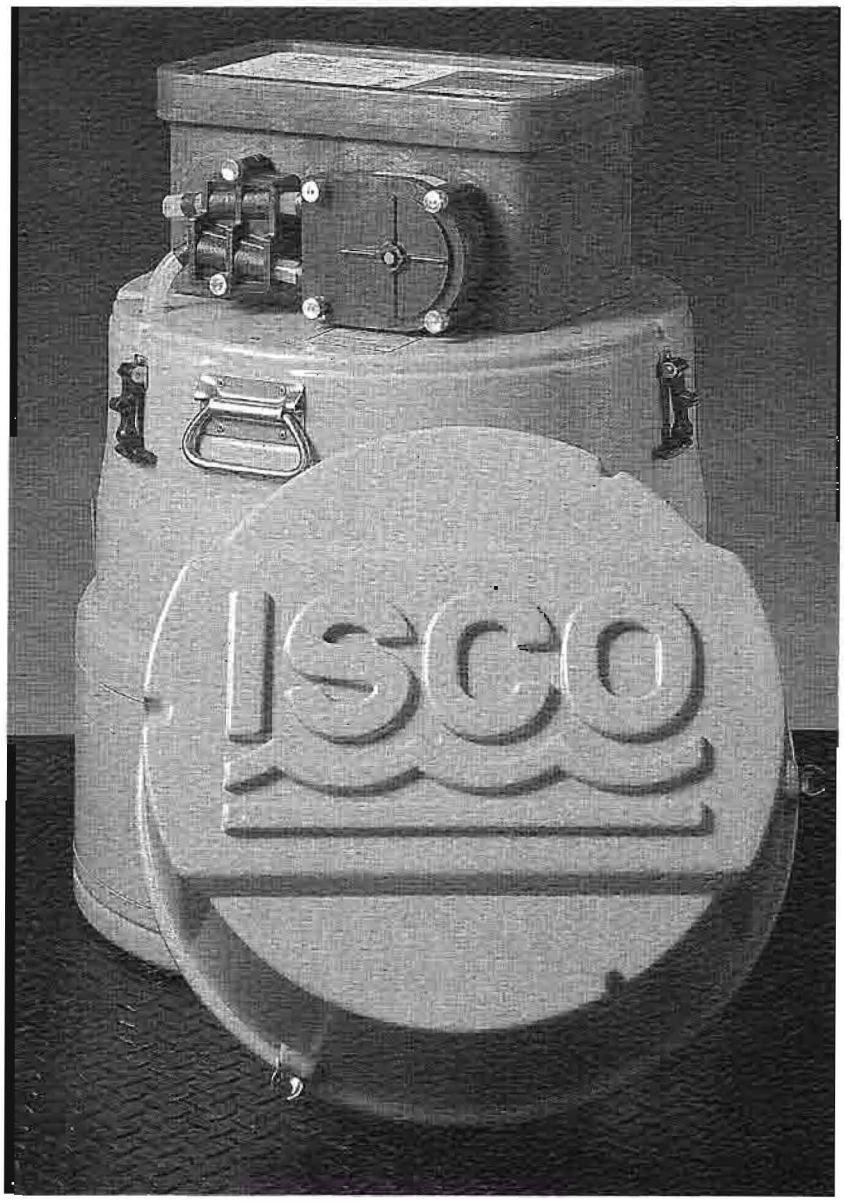


PHOTO 1: ISCO Protective Enclosure (from ISCO).

Bailer. The bailer or bucket for surface water sampling is a device which is usually made of stainless steel. One model has spigots for regulation of flow into sampling bottles and Teflon packing in the valve system. Even though many bailers are constructed of stainless steel, trace metal contamination is still possible. Blanks should be performed in order to assess the amount of trace metal contamination produced by the bailer. Dated stainless steel bailers should be replaced periodically to avoid contamination. Examples of surface water bailers are shown below.

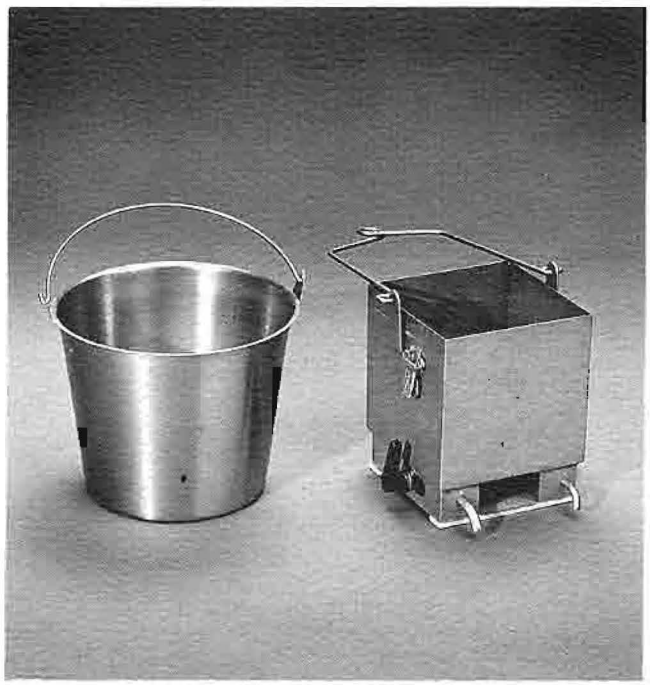


PHOTO 2: DWR Surface Water Bailers.

Procedures for Taking Surface Water Samples:

Start out with properly cleaned sample collection equipment. Pick an area which will give a representative sample. Take a sample where the water is well mixed, e.g., directly downstream from where two sample streams are joined. Excellent sampling points are those below a source of turbulence.

Take a sample at 0.5 to 1 meter below the surface in a stream or channel, or where turbulence is sufficient to keep the water body well mixed.

Collect the sample below the water surface to avoid floating material.

Ground Water Sampling Equipment

Ground water samples are generally taken from wells on which pumps are installed and periodically pumped. In some cases, however, wells which are not active (without operable pumps) will be sampled.

Bailer. A bailer for ground water sampling may be in the form of a weighted bottle, a capped length of pipe on a rope, or some modification thereof, which is lowered and raised generally by hand. It can be constructed from a variety of materials which will ensure that contamination of the sample will not occur. The Teflon bailer is used to collect volatile organic samples in ground water. Bottom-pour bailers, with removal spigots, have been designed so that the least amount of volatile constituents will be lost from the sample collected. A downrigger (a motorized graduated winch) may be attached to the ground water sampling unit and used to lower and raise bailers for sample collection. An example of a ground water bailer is shown below.

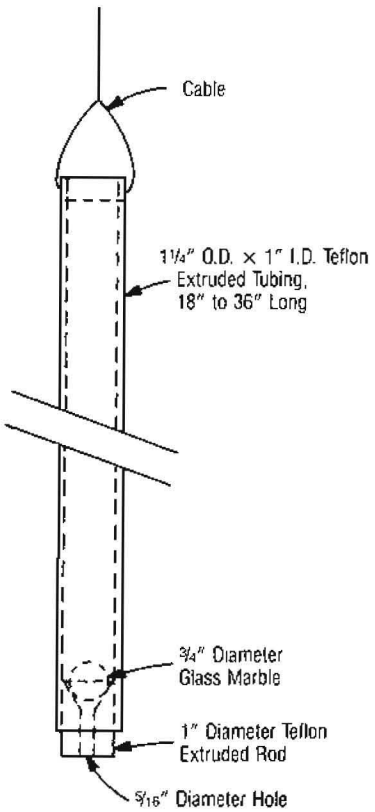


FIGURE 3: Ground Water Bailer (from *EPA 600/4-82-029*, 1982).

Bladder Pump. The bladder pump has a system of check valves used to squeeze a bladder and drive water in an upward direction. Choice of the proper pump is important because pump operation and material may affect the water chemistry of the sample. In small diameter wells and in wells with great depth-to-water, use of a bladder pump or bailer may be the only method to purge and sample the water. A bladder pump is shown below.

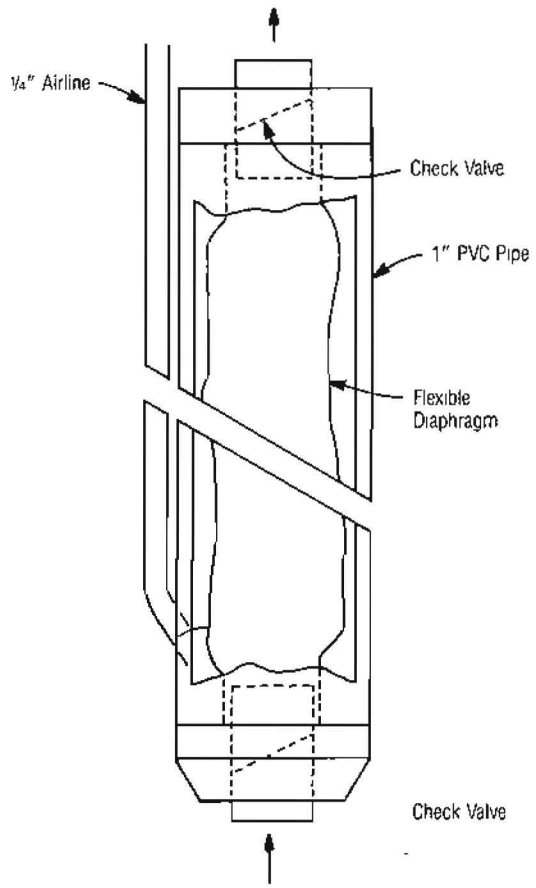


FIGURE 4: Ground Water Bladder Pump (from *EPA 600/4-82-029*, 1982).

Kemmerer Sampler (for low volume wells). This sampler is similar to the Kemmerer Sampler for surface water which was described earlier but can be equipped to operate remotely.

Active wells with operable pumps. The first measurement which needs to be made is the depth to the water inside the well casing. This can be done using a tape, long conductor conductivity-probe, m-scope (a well water level measuring device), or similar equipment. On most wells an access port is

located near the well head. If no way can be found to get a probe or tape into the well, ask the owner for information. The following are some important points to remember:

- In wells with submersible pumps, there is a risk of losing the measuring device and damaging the pump, because the device may become entangled. Caution and judgment should be used before measuring this type of well.

- If the power is on, a probe should not be lowered, because the suction created by the pump may cause the probe to be taken into the pump.

- A probe made of lead may contaminate the well water if lead analyses are desired.

Procedures for Taking Ground Water Samples (Active Wells with Operable Pumps):

First, measure the depth to water. When measuring the depth to water, it is preferable to measure the static, or non-pumping water level. If you must measure a pumping well, indicate in the field notes that the well is pumping. If the well was recently pumping, indicate the length of time since pumping stopped.

If there are other pumping wells nearby that may affect the water level at the well to be measured, state this and give the approximate distance to the pumping wells. It is not always easy to tell if a submersible pump is running. Check the discharge pipe for vibrations with your hand or ear, or check the electric meter to see if the disk is spinning.

If the well has a small access hole, make sure that the probe on the electric tape can be pulled back through the hole. Slowly lower the tape into the well. When the buzzer sounds or light goes on, pull the tape back above the water surface. If buzzer or light remains on, shake the tape until it shuts off and then lower tape again very slowly until buzzer or light goes on again. Repeat this process until consistent results are obtained.

Determine the reference point elevation above the ground surface (see figure below). Carefully select and describe the reference point in the field log book (e.g., if open casing, measure to top of casing at the seam, or to top of casing on the north side, etc.).

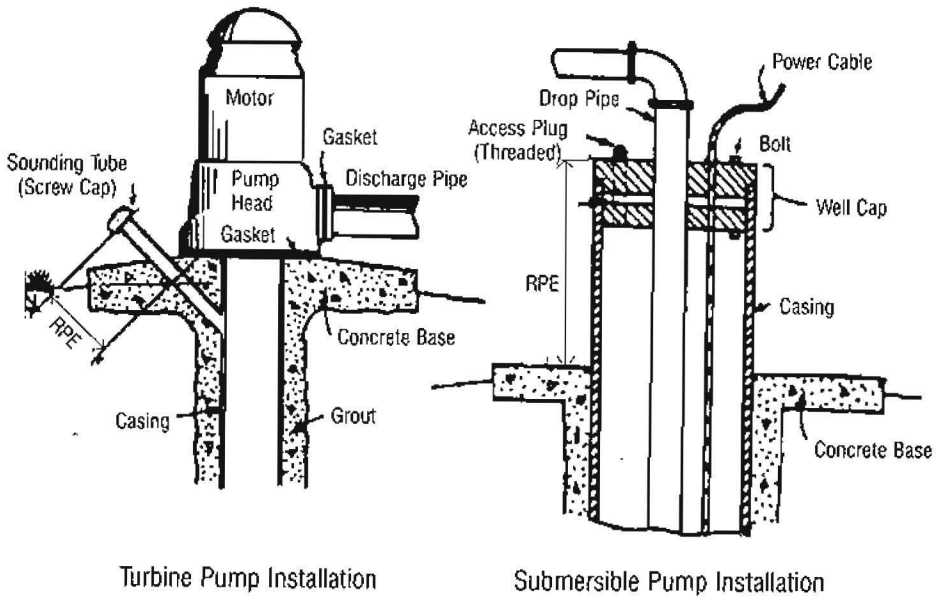


FIGURE 5: Reference Point Elevation (RPE) Measurement.

Carefully describe the well's location using distances from roads, buildings, fences, other wells, etc., in the field log book. Include a sketch map of the location and take a photograph. Also describe the well, type of pump, serial numbers, and type and diameter of casing. If you do not have a Well Completion Report (DWR 188) or have not yet found it, try to obtain a well log from the owner, or information such as perforated sections, date of completion, name of driller, and/or name of landowner at the time of drilling. A Well Completion Report (DWR 188) can be found in Appendix J.

Under the State Well Numbering System, each well receives a State Well Number. This number is assigned by using township, range, section, and 40-acre tract within the section. The 40-acre tracts are lettered and each well within the tract is assigned a sequence number. An example of a state well number is: 03S/04E-36N04-S. The number 03S indicates the township. The range is indicated by 04E. The number 36 indicates section 36. The tract is denoted by the letter N. The number 04 denotes the sequence number, and S signifies the San Bernardino base and meridian. A more graphic explanation of this numbering system can also be found in Appendix J.

To obtain state well numbers, contact the DWR District Office in the area where the well is situated. The following information is necessary in order for the District Office to assign a well number:

A map showing the location of the well,

A description of well location; e.g., address of property, direction and distance to nearest town, road, or canal; its location with respect to existing wells; etc.,

A description of the well; e.g., owner, date of construction, depth of well, etc. A Well Data form (DWR 429) should be used for recording information on each well (Appendix J). Appendix J also contains field variations of this form (DWR 274 and DWR 1213).

A Well Completion Report (DWR 188), Appendix J.

Once the depth to water has been measured or estimated, purging can begin. Purging is the process whereby the stagnant water which has been sitting in the well casing is pumped out so that the water which is sampled is the actual water being drawn in from the aquifer. In order to determine the volume of water and the length of time required to purge, perform the following steps:

Determine the purge volume by using the following formula:

V (volume) $= 3\pi r^2 d$

where: $\pi = 3.1416$
r = radius of the casing (ft)
d (ft) = depth of well–depth of water

Note: With 3, in the equation, being the minimum number of well volumes to be purged assuming that stabilization of properties such as specific conductance, pH, etc. has occurred (*USGS Western Region Field Manual* and SW 846 Vol 2).

Discharge rate is determined by measuring the time required to fill a container of known volume and dividing the volume by the time required which gives the discharge rate.

The time required to purge the well is then given by:

$$\text{Time (minutes)} = \frac{V\ (\text{ft}^3) \times 7.48\ (\text{gallons/ft}^3)}{\text{Discharge rate (gpm)}}$$

Record this information in the field log book.

If the volume of water in the well cannot be determined, purge the well for some period of time; e.g., 30 minutes or until the field parameters (pH, specific conductivity, temperature, etc.) stabilize. Always indicate in the field notebook the length of time for purging. In some cases, water samples will be taken from a tap. If this is so, any water softener, filters, or conditioners should be noted.

Purging a well with a holding tank is best accomplished by turning on more than one spigot in order to keep the pressure in the tank low and the pump running. This process is important because volatile compounds can escape from the water into the existing air space in the pressure tank. The object is to keep the pump going at all times during the purging process.

The spigot(s) closest to the well head should always be used. If the closest spigot is not at or near the well head, then allow for the estimated volume of the delivery system to the spigot used.

The well should be purged for at least the time indicated by the above calculations *and* until the field parameters (pH, specific conductivity, temperature, etc.) have stabilized. These parameters should be measured frequently during the purging process. Purging may not be necessary if sampling is from municipal wells or wells that are used on a continuous basis. Nonetheless, the circumstances in which well sampling occurs should always be documented.

When collecting a sample, keep the container close to the spigot but do not let it touch the spigot. If a garden hose is attached to the spigot, remove it before sampling. Wipe off any dirt, oil, or debris from the spigot before sampling.

When sampling for volatile organics, the analytes can be lost due to turbulence at the spigot. Turbulence is best overcome by inserting a piece of Teflon tubing up into the spigot area and filling the Volatile Organics Analysis bottle with it as the spigot is slowly turned on.

When sampling for coliform bacteria, the delivery pipe of the spigot should be heated with a propane torch (until the water at the lip of the spigot boils, but not to redness) for sterilization prior to sampling.

Wells Without an Operable Pump (Wells Which Are Not Active). The above procedures apply to these wells with the following exceptions:

Procedures for Taking Ground Water Samples (Wells Without a Pump):

The depth is easily measured since snagging a probe on the pump lines is not a problem.

Once the volume needed for purging has been determined, divide that volume by the capacity of the bailer. This gives the number of times which the bailer must be dipped in order to properly purge the system. If several bails are necessary, a winch can be attached to the

downrigger to speed up bailing. Various pumps are also available. The method which is used is dependent on the facilities and equipment available to the sampler.

After the purging is complete, the well may be sampled by use of a sample bottle, Kemmerer sampler, submersible pump, or a bottom emptying bailer. Again be careful not to contaminate the sampling equipment with nearby dirt, oil, or debris. The sample should then be handled as if it were a surface water sample.

Disposal of Purged Well Water—All purged waters should be disposed of in an environmentally safe and aesthetically acceptable manner. Discuss the purging process and disposal of the purged water with the owner or tenant in advance.

If the purged waters are hazardous, then compliance with the California Code of Regulations, Title 22, for disposal of hazardous wastes must be followed. These regulations are too extensive to list in this manual.

The hazard levels of wells could be ascertained by investigating historical data or by performing pilot tests. If hazardous wastes are suspected, discuss the monitoring and disposal requirements with the QA Officer or staff at the California Department of Toxic Substances Control.

Sediment and Soil Collection Equipment

Sediment and soils analyses are difficult and require special efforts to ensure quality. In preparation of a QA Project Plan for sediment sampling, the preparer should contact the QA Officer for advice on incorporating adequate quality control procedures.

Any equipment or devices used for sampling should be carefully cleaned prior to each collection effort to avoid cross-contamination. Every effort should be made to determine the precise location from which a sample has been taken. Positioning may be obtained from landmarks by careful alignment or other established methods.

Trowel or Scoop. These instruments typically can collect soil samples up to 3 inches deep. Stainless steel or polypropylene scoops are preferred, depending on what constituents are to be analyzed and the consistency of the soil.

Shovel. Shallow soil samples can be obtained to a depth of about one foot using a shovel.

Hand Corer or Soil Auger. Soil augers are tools with a hard metal central shaft and sharpened spiral blades. The tool, when rotated clockwise by its wooden T handle, cuts the soil as it moves forward and discharges most of the loose soil upward. A hand corer has a cutting front end that gradually fills the corer with material as it is turned in a clockwise fashion. The auger and corer collect soil samples at depths greater than can be collected by a trowel or shovel. A picture of several sediment corer samplers is shown.

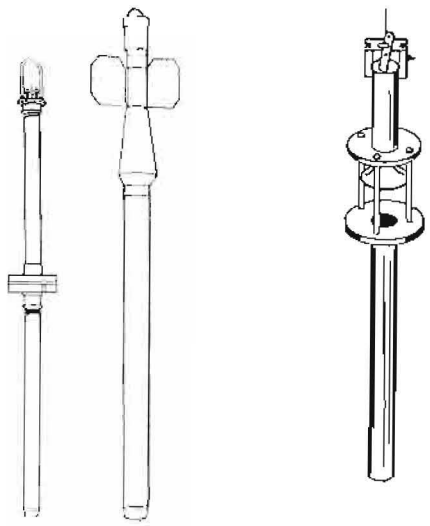


FIGURE 6: Sediment Sampling Corers (from *Standard Methods for the Examination of Water and Wastewater*, 1989).

Ponar Dredge. The side plates of the Ponar dredge prevent washout and shock waves that accompany other such devices. The Ponar dredge is most useful for collecting coarse sand and gravel rather than fine sediments. It is also good for collecting in deeper waters and swift currents. A Ponar dredge is shown below.

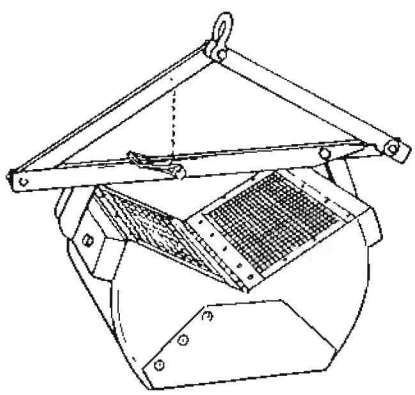


FIGURE 7: Ponar Dredge (from *Standard Methods for the Examination of Water and Wastewater*, 1989).

Petersen Dredge. The Petersen dredge can collect sand, gravel, mud, and clay and gives reasonable quantitative samples for fine sediments when used carefully. The Petersen dredge is less preferred than the Ponar dredge because it is harder to use, particularly in adverse weather conditions. The Petersen dredge may not collect samples in a constant manner between areas because it tends to lose sampled material and is subject to premature tripping. A Petersen dredge is shown below.

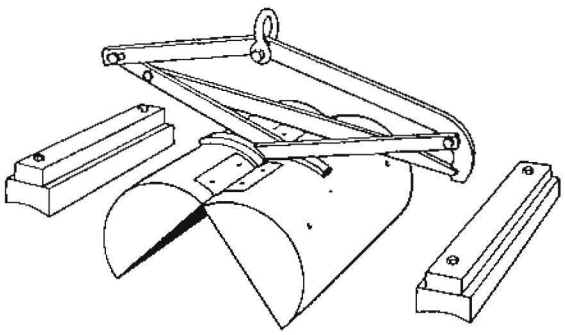


FIGURE 8: Petersen Dredge (from *Standard Methods for the Examination of Water and Wastewater,* 1989).

Ekman Dredge. The Ekman dredge can be used in soft sediments and calm waters. It reduces shock wave, and in finer sediments free of stones, tends to retain material more efficiently than the Ponar or Petersen dredges. This equipment is smaller and lighter than other dredges and can be lowered and retrieved by hand. The Ekman dredge is useful in shallow, sandy or muddy bottom streams and comes in a range of sizes. It is not useful in rough water, or when rocks or vegetation are on the bottom. The jaws can fail to close completely and cause loss of sample. It is also inefficient in deep water or in moderate to strong currents. An Ekman dredge is shown.

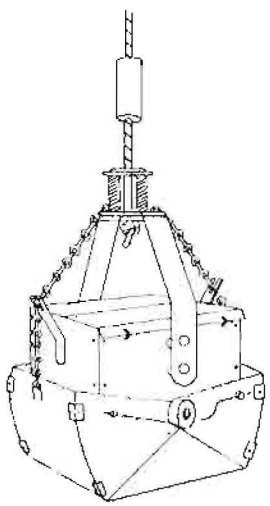


FIGURE 9: Ekman Dredge (from *Standard Methods for the Examination of Water and Wastewater,* 1989).

All dredges require a boat, winch, and suspension cable. The disadvantages of dredges are that the jaws can lock on hard objects causing sample loss, and the tripping mechanism can be a safety hazard to hands. All three types of equipment described above can also be used for collection of benthic samples.

Power-assisted Coring or Drive Samplers (for deeper soils). Depths greater than 3 feet require the use of a drill rig. DWR contracts for drilling beyond 3-foot depths. Many drilling systems use a split-spoon or split-barrel sampler which is driven by a weight through a hollow stem auger.

Collection Equipment for Biological Samples

Benthic Macroinvertebrates. Macroinvertebrates refers to those invertebrates which can be seen with the unaided eye. In freshwater streams, most benthic (bottom dwelling) macroinvertebrates are aquatic insects. They are studied because many are sensitive to pollution, live in the water for over a year, cannot easily escape pollution as some fish can, and are easily collected in many streams and rivers.

For small streams, the equipment recommended by DWR is the Surber Square Foot sampler. For larger streams and lakes, the Ponar, Petersen or Ekman dredge should be used. These dredges are described above. A Surber Square Foot sampler is shown.

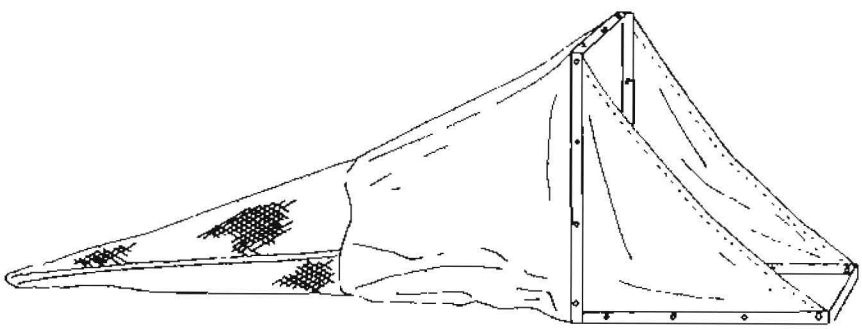
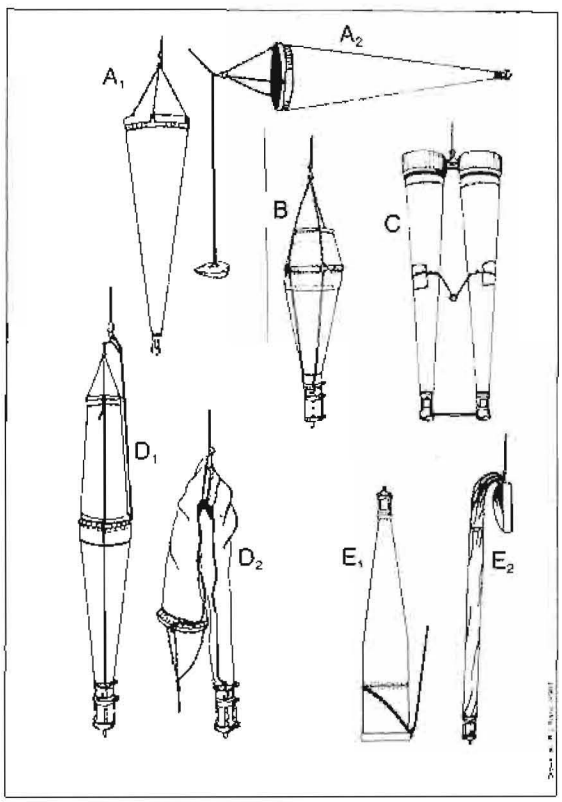


FIGURE 10: Surber Square Foot Sampler (from *Standard Methods for the Examination of Water and Wastewater*, 1989).

Zooplankton. Zooplankton refers to minute animal organisms which swim in a body of water. The species abundance and diversity are related to water quality.

Sampling for zooplankton is done with a net designed to be pulled vertically from a given depth, or horizontally over a given distance. Various zooplankton nets are shown.



A) Conical tow-net (A_1) for vertical tows (A_2) for horizontal tows; B) Wisconsin tow-net, C) Bongo net; D) Wisconsin net fitted with messenger activated closing mechanism (D_1) open (D_2) closed; and E) Free-fall net (E_1) open (E_2) closed.

FIGURE 11: Various Zooplankton Nets (from *Standard Methods for the Examination of Water and Wastewater*, 1989).

The net should be made of #20 or #25 bolting cloth (mesh opening of approximately 65 microns). A collecting cup is attached to the end of the net. The spigot at the end of the cup is used to drain the contents into a sample bottle. Horizontal nets are used to collect horizontally stratified zooplankton and are towed from a boat.

To collect larger zooplankton (Copepods and Cladocerans), Clarke-Bumpus nets are used. Various size mesh nets are used with the Clarke-Bumpus sampler. The net is mounted within a rectangular steel towing frame which includes a flowmeter for measuring the amount of water which has passed through the sampler during a given tow. Submersible pump devices in addition to the net can be used in some cases to collect smaller zooplankton to get a more representative cross-section of the zooplankton community. A Clarke-Bumpus net is shown.

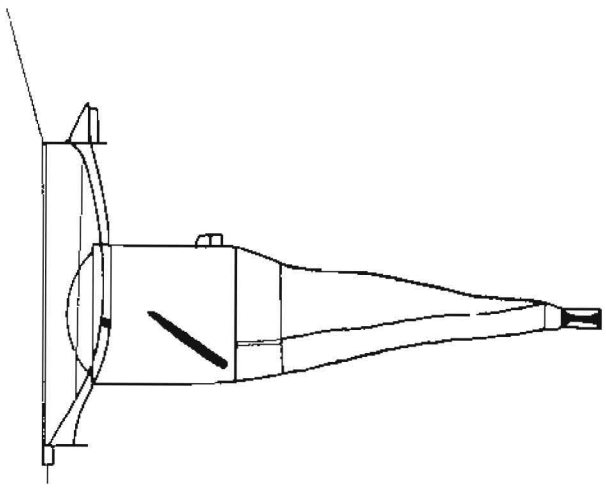


FIGURE 12: Clarke-Bumpus Net (from *Standard Methods for the Examination of Water and Wastewater*, 1989).

Other collection devices include the Van Dorn water bottle and the submersible pump. If AC pumps are not practical, DC pumps can be obtained.

Phytoplankton. Phytoplankton are freely suspended minute plants in a body of water.

Phytoplankton samples are generally taken by a Van Dorn or Kemmerer bottle, but a plankton tow net can be used as well. Plankton tow nets are not suitable for collecting samples from a small or restricted region or in very shallow water. In addition, smaller algae pass through nets.

Submersible pumps can be used to collect samples. The disadvantage is that fragile organisms can be fragmented or destroyed by pumping pressure.

Artificial Periphyton Substrates. There is no general agreement as to the best type of artificial substrate on which to collect periphyton, because all substrates which have been tested have shortcomings. One type is a simple plate of material such as ceramic or clay tile; another consists of glass microscope slides arranged on a supporting device which provides exposure of the slides to the environment. A picture of a periphyton sampler is shown below. The particular sampler shown below has a plexiglass frame supported by two styrofoam floats. The rack holds eight glass microscope slides.

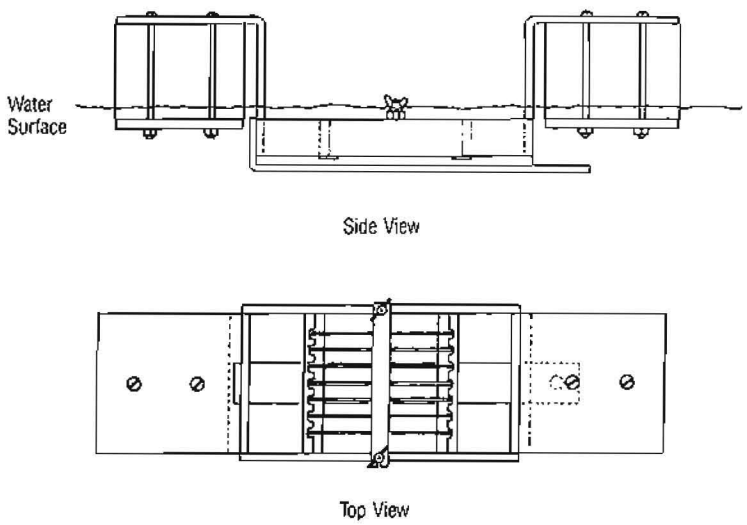


FIGURE 13: Periphyton Sampler (from *EPA 600/4-82-029,* 1982).

Natural substrates may also be used for collecting samples by scraping submerged stones, sticks, pilings, and other available substrates. The removal of sample from rough surfaces presents a problem in using such material.

Fish Eggs and Larvae. DWR uses an egg and larva net mounted on a towing frame with skis. The net is cone-shaped, 76 cm in diameter at the opening and 3 meters long, with a mesh size of 505 microns. The opening of the net when attached to the towing frame is D-shaped. The collecting jar is a plastic, 32-ounce jar screened with 4770 micron mesh bolting cloth. A flow meter could be attached to the net if the flow volume is to be determined. An egg and larva net is shown.

PHOTOGRAPH PROVIDED BY ENVIRONMENTAL SERVICES OFFICE, DWR

PHOTO 3: Fish Egg and Larvae Net.

Bacterial Samples (fecal and total coliform). The direct use of the sample container is generally preferred when collecting bacterial samples. A picture of the technique used for direct sample collection in flowing water using a sample container is shown.

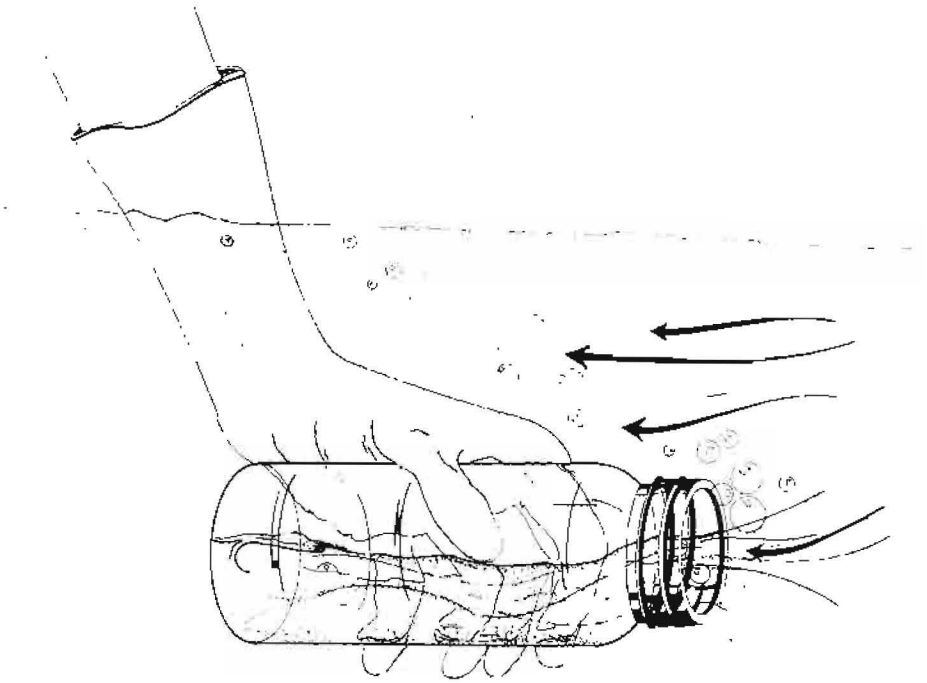


FIGURE 14: Direct Collection Using a Sample Container (from *EPA 600/4-82-029*, 1982).

CHAPTER 5

GENERAL SAMPLE PROCESSING

The requirements for sample containers, sample volume, preservation methods and holding times for organics, inorganics, biological samples and other miscellaneous parameters are listed in Tables I through VII starting on page 52. These requirements are from the Environmental Protection Agency (40 Code of Federal Regulations, Chapter 1, 7/1/90 edition) and *Soil Sampling Quality Assurance User's Guide*, 2nd ed., EPA, March 1989. The laboratory can provide additional information about meeting these minimum requirements.

Container and Sample Volume Requirements

It is important to use the appropriate sample container for the parameter to be measured. Improper containers can introduce contaminants and cause other errors which make the data useless. Problems caused by improper containers may include chemicals leaching from the container into the sample, waterborne constituents clinging to the sides of improper containers and reducing the concentration in the sample, and containers with improper seals allowing volatile compounds in the sample to escape.

Sample containers may be obtained from the laboratory or they may be purchased. Containers which require special washing or the addition of preservatives must be obtained from the laboratory.

Appropriate volumes of samples must be collected to ensure that the required detection limits can be met and that any necessary sample re-analysis can be performed. Required volumes of samples are listed in Tables I through IV. Contact the laboratory for further information on volume requirements for soil and sediment samples.

Unless otherwise specified, sample containers should be filled only to the neck. Leaving head-space in unchilled samples is necessary in glass containers to avoid rupture from thermal expansion of the water. Containers can also rupture if the sample is frozen.

Filtration

In many instances it is desirable to know the concentration of a substance which is dissolved in water as well as the amount of the substance which is suspended. By filtering the water, the suspended matter is removed, but the dissolved material passes through the filter and can be collected as a sample.

Equipment

The equipment that is commonly used by DWR is a filter stand that supports a 142 mm diameter filter. Water is supplied to the stand by a peristaltic pump equipped with surgical grade silicon tubing. Those stands made of stainless steel should be used only for samples which are not to be analyzed for metals. A picture of the filtration equipment is shown below.

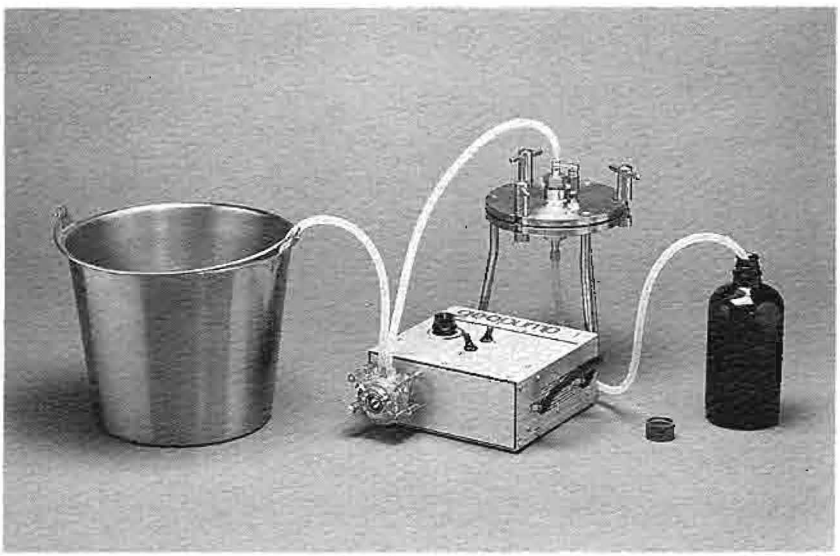


PHOTO 4: Filtering Apparatus.

Consult the QA Officer or the laboratory regarding the possibility of contaminating organic samples when using membrane filters and/or plastic filter stands.

Procedures:

Using clean forceps (tweezers) place the supporting screen on the base of the filtering device. If there is a difference in the two sides of the screen, be sure the side facing upward is in agreement with the manufacturing instructions.

Using the forceps, place a membrane filter (0.45 µm pore size) on top of the screen. A filtering device with a second screen should be placed on top of the filter. An alternative to using forceps would be using protective or separating papers from the filter container. Either way, care must be taken to not touch and contaminate the filter paper.

Place the top plate of the filtering device in the proper position and firmly fasten the screw clamps.

Place the intake tube in a bottle of demineralized water, turn on the pump and open the air vent valve. Lift the air valve side of the device to let the internal air escape. Close the valve when the device has filled with water.

After a quart or more of the demineralized water has been flushed through the system, remove the intake tube from the bottle and pump as much water as possible out of the system.

Shake any remaining water from the intake tube and place it in the sample water. Pump a half pint or more of the sample through the system discarding the water that is discharged.

Sample containers which have not been specially cleaned by the laboratory or by the manufacturer and which do not contain any preservative should be rinsed thoroughly with clean demineralized water. These containers should then be rinsed with the filtered water using about 10 percent of the total volume of each container.

After rinsing the appropriate containers for the samples scheduled to be collected, the containers should be filled with the filtered sample. Air space should be included or excluded in accordance with the instructions for collecting each type of sample.

Immediately after each use, remove the filter from the stand and flush the filtering system with demineralized water.

Between field trips, the filter assembly should be cleaned by circulating a hot solution of a strong detergent through the system. This can be done by placing both the intake and discharge tubes in a container of the solution and operating the peristaltic pump for at least 10 minutes.

The assembly should then be thoroughly flushed with tap water followed by a thorough flush with demineralized water. The apparatus should be allowed to dry and then be stored in a plastic bag.

Preservation

The purpose of preservation is to help retard chemical and biological changes that occur after the sample is taken. Some changes that may occur are volatilization of the constituent, adsorption of metal onto the surfaces of the containers, chemical reactions, and decomposition of organic material. The requirements for preservatives and preservation methods are listed in Tables I through VII.

One of the most important preservation techniques is cooling, and one of the most common problems in sample preservation is a lack of adequate cooling. Cube ice is preferred to blue ice by DWR's Bryte Chemical Laboratory because it cools more efficiently, the samples are more completely surrounded by the cooling medium and blue ice packets may leak and contaminate the samples. A problem which sometimes results from the use of ice is that water from the melted ice may loosen the labels from the sample containers.

Proper cooling temperatures must be achieved and maintained (see Tables I through VII for cooling temperatures). To do this, a bottle of tap water may be placed in the ice chest with the samples, and the temperature of the tap water can be measured. The tap water container should be the same size as the largest sample to be collected, and the temperature of the test bottle should be recorded on a field sheet (Appendix K).

For many types of samples the laboratory provides containers with the correct preservative in them, and for other samples, it provides the preservatives and any necessary instructions. A preservative that is added in the field should be added immediately upon collection or just after filtration. If feasible, the laboratory should be encouraged to provide the preservatives already in the sample container so that the field crew does not have to handle them.

Sample preservation media, such as acids, formalin, or stains, should be fresh and uncontaminated. Smaller containers or other objects should not be dipped into a stock solution of preservative. Instead, the stock solution should be poured into another container (any unused preservative removed should not be put back into the stock container). These procedures will help prevent the stock solution from becoming contaminated.

Limit exposure to both the formalin fumes and to the formalin solution. Make sure the working area is well ventilated.

Nitric acid is the preservative used for most minor elements and common metals (sodium, calcium, and magnesium); however, Chromium VI samples are preserved by cooling to 4°C. The laboratory provides the acid in ampules of 2 mm. The neck of the ampule should be broken with the implement made for that purpose. The ampules are poorly designed, however, and the acid must be jolted out.

Care should be taken when acidifying any sample. Disposable gloves and goggles should be used when acidifying samples.

Sample containers which contain preservatives should not be rinsed and should not be filled to overflowing. These containers are well cleaned at the laboratory prior to introduction of the preservative. Preservatives are usually toxic and/or potentially injurious so care should be taken in handling them by wearing gloves and goggles. Also, field personnel should be familiar with the location of and the use of the eye flush kit. Hands should be washed after preservatives are handled.

Holding Times for Samples

The holding time is the maximum time a sample can be stored after collection before analysis is begun without significantly affecting the results. Holding times vary depending on the parameter, preservation technique, and analytical methodology. Maximum holding times are usually specified by EPA, and must be considered when scheduling sampling trips. Delivery times should be coordinated with the laboratory. Maximum holding times are listed in Tables I through VII.

Transportation, Shipping and Storage of Samples

For many samples, transportation to the laboratory must begin as soon as possible to avoid degradation of the constituents to be analyzed. For example, the recommended maximum transport time for coliform samples is only 6 hours. Prior to and upon arrival at the laboratory, samples have to be refrigerated. They should then be analyzed within 2 hours of arrival. The time elapsing between collection and examination may be longer, but cannot exceed 24 hours.

Samples to be shipped which must remain cold should be thoroughly chilled prior to packing. Blue ice in non-leaking containers is convenient for keeping samples cooled during shipment. Dry ice should not be used with samples which would be altered by freezing (e.g., precipitation of solids), and it should not be used with samples in containers which could rupture (especially glass). However, nutrient samples are sometimes frozen and chlorophyll filters are always frozen.

Special chests are made for dry ice, since dry ice can cause cracking and splitting of the plastic lining inside regular ice chests. These chests are thick (1-1/2 to 2 inches) foam containers covered by heavy paperboard. The lid is secured to the chest with cloth fabric straps.

Well-insulated ice chests with a tough plastic outer cover are best for shipping samples. When any sample is to be shipped by common carrier or sent through the U. S. Postal Service, it must comply with the Department of Transportation's Hazardous Materials Regulations (*49 Code of Federal Regulations* Part 172). Since these regulations are quite extensive, the Quality Assurance Officer should be consulted when shipment is contemplated.

Samples should not be stored in the proximity of agents which can contaminate the samples. For instance, samples for volatile organics analyses should not be stored near solvents. In most instances, samples should be stored in an ice chest or a refrigerator. This not only keeps them chilled, it also protects them from constituent changes which may occur in the presence of light. Samples should not be exposed to direct sunlight, and they should be delivered to the laboratory with a minimum of agitation.

Note: These tables are consistent with Bryte Chemical Laboratory's recommendations; however, consult your contract laboratory for specific recommendations.

TABLE I

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR ORGANICS IN WATER SAMPLES

Parameter	Container	Volume Required (mL)	Preservation	Maximum Holding Time
Pesticides	1.3 L glass jug	1000	(2 mL H_2SO_4, pH<2) for herbicides 4°C for all pesticides	Extraction w/in 7 days; analyzed w/in 40 days
Volatile Organic Compounds	Amber glass vial w/Teflon-silicone septa & screw cap	40 (no air space)	4°C, 2 drops HCl (1:1)	14 days
Trihalomethane Formation Potential (THMFP)	Amber glass vial w/Teflon-silicone septa & screw cap	40 (no air space)	0.45 µm filtered 4°C	14 days after quenching
Oil and Grease	Wide mouth glass jar, Teflon lined cap	1000	H_2SO_4, pH<2, 4°C	28 days
Total Organic Carbon	Glass vial w/Teflon-silicone septa & screw cap	40	H_3PO_4, pH<2, 4°C	28 days

Note: Check with laboratory; may need more than one container for quality control samples.

Source: 40 *Code of Federal Regulations* part 136 (7/90); *Methods for Chemical Analysis of Water and Wastes*, EPA- 600/4-79-020 (Revised March 1983).

TABLE II

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR INORGANICS IN WATER SAMPLES

Parameter	Container	Volume Required (mL)	Preservation[3]	Maximum Holding Time[1]
Bromide	Poly or glass	50 (Bryte Lab) 100 (EPA)	None required	28 days
Chloride	Poly or glass	50	None required	28 days
Fluoride	16 oz poly	300 (EPA) 100 (Bryte)	None required	28 days
Iodide	Poly or glass	100	Cool to 4°C	24 hours
Cyanide	Poly	500	Cool to 4°C NaOH to pH<12 0.6 g ascorbic acid	14 days
Silica	8 oz poly	50	Cool to 4°C	28 days
Sulfate	Poly or glass	50	Cool to 4°C	28 days
Boron	Poly	100	None required	6 months
Ammonia[2]	Poly or glass	400	Cool to 4°C H_2SO_4 to pH<2	28 days
Nitrite[2]	Poly or glass	50	Cool to 4°C	48 hours
Nitrate[2]	Poly or glass	100	Cool to 4°C	48 hours
Nitrate-Nitrite[2]	Poly or glass	100	Cool to 4°C H_2SO_4 to pH<2	28 days
Organic Nitrogen[2]	Poly or glass	500	Cool to 4°C H_2SO_4 to pH<2	28 days
Orthophosphate, Dissolved[2]	Poly or glass	50	Filter on site Cool to 4°C	48 hours
Hydrolyzable Phosphate[2]	Poly or glass	50	Cool to 4°C H_2SO_4 to pH<2	28 days
Total Phosphate[2]	Poly or glass	50	Cool to 4°C H_2SO_4 to pH<2	28 days
Total Dissolved Phosphate[2]	Poly or glass	50	Filter on site Cool to 4°C H_2SO_4 to pH<2	24 hours
Standard Mineral	Qt. poly 8 oz poly	960 100	0.45 µm filtered 0.45 µm filtered HNO_3, pH<2	See note[1] 6 months
Standard Nutrient	8 oz poly 8 oz poly	100 100	4°C unfiltered Freeze unfiltered	48 hours 3 months
Total Metals	16 oz poly	480	HNO_3 to pH<2	6 months
Dissolved Metals	16 oz poly	480	HNO_3 to pH<2 0.45 µm filtered	6 months
Suspended Metals	Poly	200	Filter on site	6 months
Chromium VI	Glass or poly	200	Cool, 4°C	24 hours
Total Mercury	16 oz poly	480	HNO_3 to pH<2	28 days
Dissolved Mercury	16 oz poly	480	Filter; HNO_3 to pH<2	28 days

[1]Unstable samples such as municipal and industrial wastes, hot springs, etc., require immediate attention.
[2]DWR's Bryte Chemical Laboratory can freeze these samples within 48 hours and extend the holding time to 3 months
[3]Do not freeze agricultural waste or highly saline waters for dissolved samples
poly = polyethylene; glass = borosilicate clear glass (amber glass will be specially noted)

Source 40 *Code of Federal Regulations* part 136 (7/90); *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020 (Revised March 1983).

TABLE III

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR BIOLOGICAL SAMPLES

Parameter	Container	Volume Required (mL)	Preservation	Maximum Holding Time
Zooplankton	Glass or poly	60	5% Formalin w/rose bengal dye	12 months
Phytoplankton	Glass	60	2 mL Lugols solution	12 months
Bacteria—(fecal and total coliform)	Sterilized glass bottles, or pre-sterilized plastic "whirlpak" bags	>100 mL	Cool to 4°C	6 hours[3]
Benthos	Wide-mouth glass or poly	Quart or larger, 50% sample, 50% preservatives	10% buffered formalin or 70%-80% ethanol	2-3 weeks[2]
Chlorophyll			Store filter in dark and freeze	30 days

[1]Both preservatives can be used, but one may be preferred over the other depending on the type of organisms collected. At DWR, buffered formalin with the addition of rose bengal dye is most commonly used.
[2]After 2-3 weeks, fresh preservatives are added for permanent storage
[3]Ideally, the maximum transport time should be 6 hours. Upon receipt in the laboratory, it should be refrigerated and processed within 2 hours. Realistically, however, the time elapsing between collection and examination may be longer, but should not exceed 24 hours.

Sources: 40 *Code of Federal Regulations* part 136 (7/90); *Methods for Chemical Analysis of Water and Wastes.* EPA- 600/4-79-020 (Revised March 1983). Benthos data taken from EPA's document: *Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters*, EPA/600/4-90/030 (November 1990).

TABLE IV

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR MISCELLANEOUS PARAMETERS IN WATER SAMPLES

Parameter	Container	Volume Required (mL)	Preservation	Maximum Holding Time
Color	16 oz poly	480	4°C	48 hours
Suspended Solids	16 oz poly	480	4°C	14 days
Volatile Suspended Solids	16 oz poly	480	4°C	14 days
Oil and Grease	Wide-mouth, solvent washed glass jar	1000	1 ml H_2SO_4 and cool to 4°C	28 days
Ultraviolet Absorption	Poly or glass	50	4°C	48 hours

Source: 40 *Code of Federal Regulations* part 136 (7/90); *Methods for Chemical Analysis of Water and Wastes,* EPA- 600/4-79-020 (Revised March 1983).

TABLE V

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR MISCELLANEOUS IN SOIL AND SEDIMENT SAMPLES

Parameter	Container	Preservation	Maximum Holding Time
Acidity	Poly or glass	Cool, 4°C	14 days
Alkalinity	Poly or glass	Cool, 4°C	28 days
Ammonia	Poly or glass	Cool, 4°C	28 days
Cyanide	Poly or glass	Cool, 4°C	28 days
Sulfate	Poly or glass	Cool, 4°C	28 days
Sulfite	Poly or glass	Cool, 4°C	48 hours
Nitrate	Poly or glass	Cool, 4°C	48 hours
Nitrate-Nitrite	Poly or glass	Cool, 4°C	28 days
Nitrite	Poly or glass	Cool, 4°C	48 hours
Oil and Grease	Poly or glass	Cool, 4°C	28 days
Organic Carbon	Poly or glass	Cool, 4°C	28 days

Source: *Soil Sampling Quality Assurance User's Guide*, 2nd ed., EPA, March 1989.
Consult laboratory for volume requirement of soil/sediment samples.

TABLE VI

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR METALS IN SOIL AND SEDIMENT SAMPLES

Parameter	Container	Preservation	Maximum Holding Time
Chromium VI	Poly or glass	Cool, 4°C	48 hours
Mercury	Poly or glass	Cool, 4°C	28 days
Metals except above	Poly or glass	Cool, 4°C	6 months

Source: *Soil Sampling Quality Assurance User's Guide*, 2nd ed., EPA, March 1989.
Consult laboratory for volume requirement of soil/sediment samples.

TABLE VII

CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES FOR ORGANIC COMPOUNDS IN SOIL AND SEDIMENT SAMPLES

Parameter	Container	Preservation	Maximum Holding Time
Extractibles (including phthalates, nitrosamines, organo-chlorine pesticides, PCB's, nitroaromatics, isophorone, polynuclear aromatic hydrocarbons, haloethers, chlorinated hydrocarbons and TCDD)	Glass, Teflon-lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)
Extractables (phenols)	Glass, Teflon-lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)
Purgeables (halocarbons and aromatics)	Glass, Teflon-lined septum	Cool, 4°C	14 days
Purgeables (acrolein and acrylonitrate)	Glass, Teflon-lined septum	Cool, 4°C	3 days
Orthophosphate	Poly or glass	Cool, 4°C	48 hours
Pesticides	Glass, Teflon-lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)
Phenols	Poly or glass	Cool, 4°C	28 days
Phosphorus	Glass	Cool, 4°C	48 hours
Phosphorus, total	Poly or glass	Cool, 4°C	28 days
Chlorinated organic compounds	Glass, Teflon-lined cap	Cool, 4°C	7 days (until extraction) 30 days (after extraction)

Source: *Soil Sampling Quality Assurance User's Guide*, 2nd ed., EPA, March 1989.
Consult laboratory for volume requirement of soil/sediment samples.

CHAPTER 6

SAMPLE PROCESSING FOR SPECIFIC PARAMETERS

This chapter discusses specific procedures for collecting and processing samples for organic, inorganic, biological, radionuclide and miscellaneous analyses.

Included in the organic category are volatile, semi-volatile, non-volatile, biochemical oxygen demand, chemical oxygen demand, total and dissolved organic carbon, and oil and grease. Acute toxicity bioassay may also be collected and analyzed. Samples for inorganics analyses include standard mineral, trace metals, minor elements, and asbestos.

Biological analyses include phytoplankton, zooplankton, benthic organisms, chlorophyll, and bacteria (total and fecal coliform). Miscellaneous parameters sampled and analyzed include color, suspended solids and ultraviolet absorption.

Organic Samples

Volatile

Volatile compounds have high vapor pressures and low water solubility. Most organic solvents are volatile. Care must be taken to avoid trapping air bubbles in these samples because the compounds may volatilize into the air bubble and escape when the container is opened in the laboratory.

Containers for Volatile Organic Analysis. Samples taken from sampling equipment are placed in specially cleaned 40-milliliter Volatile Organic Analysis (VOA) containers. The VOAs are screw-top borosilicate glass containers with plastic caps that have a hole in the center. Inside the cap is a removable plastic septum, one side of which is lined with Teflon. The Teflon-lined side should be in contact with the sample. This cap allows sample containers to be filled to the top with no headspace since the septum permits thermal expansion and, thus, prevents the container from bursting. Appropriate VOAs are provided in ready-to-use condition by the laboratory.

Solid or sediment samples for analysis of volatiles are collected in wide-mouthed glass jars which are specially cleaned with adhesive-free Teflon-lined caps. A commonly used jar size is a half-pint (235 ml). The jars should be packed tightly to reduce air space.

A picture of a VOA glass vial is shown below.

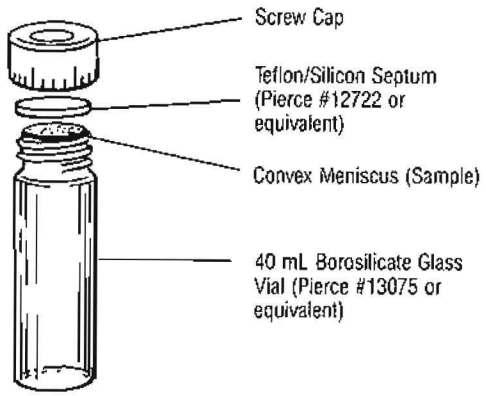


FIGURE 15: VOA Glass Vial (from *EPA 600/4-82-029,* 1982).

Procedures to Collect Volatile Organics:

Do not touch the Teflon liner or lip of the vial. Unpowdered, disposable gloves should be worn during the sampling to protect the sample.

If possible, the VOAs should be filled with the water from a sampler equipped with a release valve to control flow. Turn on the valve and release the water onto the inner sides of the VOA bottle being careful not to cause any bubbles. Fill the VOA until it is overtopped with a convex meniscus. Carefully place the cap and septum over the mouth of the vial, being careful to avoid trapping bubbles in the sample. Only one side of the plastic septum is Teflon coated, and that side should be in contact with the water. Do not touch the Teflon side of the septum. The lid should be screwed on firmly.

Check for bubbles by inverting the vial and tapping it lightly; then hold the vial up to the light and look for bubbles. If any bubbles appear, the sample must be discarded and the container refilled repeating the above procedure.

Inspect the samples thoroughly for particulate matter. This matter may contain bacteria which will rapidly degrade volatile organics. If visible matter cannot be avoided, shorten the holding times to a minimum and inform the laboratory that you have particulate matter in the sample, requesting expedited analysis.

Isolate samples from potential sources of contamination (including other samples and the necessary travel blanks) by placing them in individual plastic bags. The samples should be placed in an ice chest and padded to prevent breakage. Cube ice should be used to cool the samples to 4°C, but the VOAs should be kept separate from the melt water. Dry ice should not be used because of its capacity to freeze and burst sample containers. Samples for volatile analyses should be transported to the laboratory immediately.

Semi-volatile

In general, these organics are identified as having medium to low solubility and low vapor pressure. An example of a semi-volatile is chlordane, a pesticide.

Containers for Semi-volatiles. Semi-volatile samples are collected in 1.3-liter amber glass jars with Teflon liners in the cap or a swatch of Teflon sheeting beneath the cap. The jar can be used to collect the sample directly from the water source or from a water sampler.

Procedures to Collect Semi-volatile Organics:

For samples collected directly from a surface water source, immerse the uncapped sample bottle to a depth several inches below the water surface. Slant the bottle with the opening pointed upstream. Hold the bottle near its bottom so that water that comes in contact with the hand does not enter the bottle. Fill the container completely so that there is no airspace.

Non-volatile

Non-volatile compounds have very low vapor pressures. An example of a non-volatile is lignin.

Containers for Non-volatiles. Non-volatile organics are collected in one-liter amber glass bottles which are equipped with caps lined with Teflon.

Procedures to Collect Non-volatile Organics:

See the procedures for collecting semi-volatiles.

Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is a measure of the quantity of dissolved oxygen consumed by bacteria in the aerobic oxidation of organic matter in water. The test is conducted for a specified time—commonly five days.

Containers for BOD. A polyethylene half-gallon bottle is a good choice for collecting the sample since a liter of sample is needed for the analysis.

Procedures to Collect BOD Samples:

BOD samples can be collected with either a Van Dorn or Kemmerer sampler or directly in the bottle. The sample volume should be a little more than 1 liter.

Transport and store the samples in an ice chest chilled with cube ice. The samples must be delivered within 24 hours.

Make a dissolved oxygen measurement and record the value on the field sheet and on the laboratory analysis sheet. Analytic procedures for determining dissolved oxygen are presented in Chapter 7.

Note that BOD samples are accepted by DWR's Bryte laboratory on Monday, Wednesday and Friday with notification.

Chemical Oxygen Demand

The chemical oxygen demand (COD) is used as a measure of the oxygen equivalent of the organic material in a sample that is susceptible to oxidation by a strong chemical oxidant. The COD can be empirically related to the biochemical oxygen demand for samples from specific sources.

Container for COD. Collect samples in a one-pint polyethylene bottle.

Procedures to Collect COD Samples:

Procedures 1 through 3 for BOD (above) apply.

If more than a 24-hour delay will occur before analysis, preserve sample by acidification to pH $\leq$2 using concentrated sulfuric acid provided by the laboratory.

Total and/or Dissolved Organic Carbon

The total and dissolved organic carbon tests determine the carbonaceous material in water. These tests are typically used for determining the concentration of organic carbon in water that comes from a variety of natural, domestic, agricultural, and industrial sources.

Containers for Organic Carbon Analyses. Organic carbon samples should be collected in specially-cleaned 40 milliliter vials which can be obtained from the laboratory. The vials contain 1 milliliter of phosphoric acid as a preservative. Care must be taken to avoid loss of the preservative, and the vials should not be filled to overflowing.

Procedures to Collect Organic Carbon Samples:

Total organic carbon samples are collected from a sampler, as discussed previously.

Dissolved organic carbon samples are filtered through a 0.45 µm silver membrane filter, which can be obtained from DWR's Bryte Chemical Laboratory. Deviations from this method should be documented because other filter materials may interfere with the analysis. This is especially true when the dissolved organic content is low.

When using membrane filters, special care should be taken to thoroughly rinse the filter with demineralized water and at least a half-pint of the sample water before collecting the DOC sample. The 40 milliliter VOA should be filled from the filter apparatus discharge tubing.

If the particulate and dissolved forms of organic carbon need to be differentiated, a filtered and an unfiltered sample may be collected.

Chill the samples at <4°C and protect from sunlight. Deliver to the laboratory within 24 hours of collection.

Oil and Grease

Oil and grease analyses determine the cumulative concentrations of soaps, fats, waxes, and oils. When oil and grease are discharged in waste water, they frequently cause surface films and shoreline deposits, and they are often harmful to aquatic organisms.

Containers for Oil and Grease. Samples for determining oil and grease should be collected directly in a wide-mouth glass jar which has been cleaned and rinsed with a solvent to remove any contaminants. Plastic containers should not be used as oil and grease will adhere to the plastic.

Procedures to Collect Oil and Grease Samples:

Collect samples directly in the sample bottle. Do not rinse the sample bottles with the sample water prior to filling.

When analysis cannot be done immediately, samples should be preserved with concentrated sulfuric acid to a PH <2. This preservation method will maintain the integrity of the extractable substances for up to 28 days without any other preservation technique. Samples should not be preserved with chloroform or sodium benzoate. Ask the laboratory to add the preservative to the containers prior to field runs.

Leave an air space above the liquid in the sample bottle to facilitate handling during analysis.

Inorganic Samples

Standard Minerals

DWR's Bryte Chemical Laboratory has grouped the analysis of a number of common minerals into a class designated as "Standard Mineral." Included in this group are: Calcium (Ca), magnesium (Mg), total hardness, sodium (Na), potassium (K), total alkalinity (as $CaCO_3$), chloride (Cl), sulfate (SO_4), nitrate (NO_3), boron (B), total dissolved solids (TDS), and specific conductance at 25°C. Nitrate (NO_3) measurement results are given in terms of "order of magnitude." This is because accurate levels of nitrogen as NO_3 are difficult to obtain due to the cycling of nitrogen to other forms.

Results for these analyses are reported on a DWR laboratory analysis sheet labeled Water Analysis (Mineral) (see Appendix C). Turbidity is also reported on this analysis sheet.

Containers for Standard Minerals. The sample for the metals in the "Standard Mineral" are collected in an 8-ounce polyethylene bottle. Space should be left in the neck of the bottle for the addition of nitric acid from one ampule. A quart bottle of filtered water should also be collected for the analysis of the anions, but this sample should not be acidified.

Procedures to Collect Standard Minerals:

With the exception of turbidity, samples for all of the above analyses are filtered through a 0.45 µm membrane filter.

The turbidity sample should not be filtered and is collected from the sampling device in a pint polyethylene bottle.

Trace Metals and Minor Elements

Metals and other minor elements are frequently collected by DWR. The two most common groups of metal measurements are total metals and dissolved metals. Total metals refers to the "total concentration" of metals in a sample; that is, dissolved plus suspended metals. Suspended metals are the quantities of metals which would be removed by filtration.

The suspended metal fraction is usually determined by calculating the difference between total and dissolved metal concentrations, as reflected in the filtered and unfiltered sample analyses.

Containers for Trace Metals and Minor Elements. Water samples for metals and minor element analysis are collected in 16-ounce polyethylene acid washed bottles. Sample containers are supplied by DWR's Bryte Chemical Laboratory. Acid washed containers from the laboratory are identified by a "W" on the cap and bottom of the bottle.

Soil samples for metal analyses are generally collected in 16-ounce, acid-washed, wide-mouth glass jars with Teflon-lined caps and do not need to be fixed with nitric acid. Samples used for determining silver should be stored in light proof containers.

Procedures to Collect Trace Metals and Minor Elements:

Samples for total metals should be collected without filtration in an acid-washed polyethylene pint bottle. Enough space should be left in the bottle for acidification.

Goggles and disposable gloves should be worn when acidifying samples. Carefully break the top off an ampule of nitric acid and empty the contents into the sample bottle. Do not dip the tip of the acid vial into the sample to dispense the acid. This could cause contamination.

Use caution when handling acids. In addition to wearing gloves and protective eye gear, an eyewash device and an acid neutralizing kit should be carried on field runs where acidification is scheduled.

Dissolved metal samples should be filtered through a membrane filter with a 0.45-µm pore size. The stainless steel filter stands should not be used to filter metal samples because of the possibility of contaminating the sample.

Dissolved metal samples are collected in the same containers and acidified in the same way as total metal samples.

Asbestos

Asbestos in water occurs naturally. EPA has proposed a drinking water standard of 7.1 million fibers per liter where fiber length is greater than 10 microns. Although levels in some areas where DWR monitors water quality have exceeded this limit, asbestos is rather easily removed in the drinking water treatment process, thus bringing the water into compliance with the drinking water standard.

Containers for Asbestos. Asbestos samples are generally collected in glass or polyethylene bottles. Polypropylene bottles are not used, due to the potential for particulates to be released into the sample. While the size of the bottle may vary greatly between laboratories, EPA recommends two one-liter bottles: the first for analysis, and the second for storage and verification of data. These containers should be obtained from the laboratory that is performing the analysis, since they need to be specially washed.

Procedures to Collect Asbestos Samples:

Collect the sample with a surface water sampler.

Rinse and fill the sample container.

Keep sample chilled (not frozen) and in the dark in order to minimize algal and bacterial growth. The sample should be sent by air express (e.g., Federal Express) to the contract laboratory within 24 hours of collection.

Biological Samples

Macroinvertebrates

Macroinvertebrates refers to those invertebrates retained on a U.S. Standard No. 30 sieve. They are visible to the unaided eye. These organisms are studied because many are sensitive to pollution, live in the water for over a year, cannot easily escape pollution as some fish can, and are easily collected in many streams, rivers and estuaries.

Containers for Macroinvertebrates. Benthic macroinvertebrates are placed and stored in wide-mouthed quart or gallon high-density polyethylene jars. Use of larger jars makes it possible to minimize field processing.

Procedures to Collect Macroinvertebrate Samples Using a Surber Square Foot Sampler:

The site selected should have sufficient flow to wash the organisms into the net. The depth of the water should be less than the height of the net portion of the sampler and no more than knee depth of the person doing the sampling. This type of sampling should not be performed where the current is fast enough to pose a hazard to the person sampling. Take safety precautions. For example, make sure you work with a partner, use a lifeline, etc.

In flowing waters, stand in the current facing downstream. Place the net or screen in the stream so that the net is located downstream of the sampled area.

With your hands, carefully dislodge invertebrates from the defined square foot of stream bottom and allow the stream flow to carry them into the net. An object for prying the larger rocks loose may be helpful.

A common problem in using the Surber Square Foot Sampler is that organisms may wash under and around the sampler. The inherent variability in samples collected by this method indicates a strong need for quality control procedures to quantify the variability.

Take two or three subsamples from each riffle area and composite them or take discrete samples if it is important to determine the variability between samples.

Transfer the collected sample into a shallow white pan, and using tweezers and a hand lens or low power microscope, pick out the organisms from the detritus and place the sorted organisms in a mixture of 10 percent buffered-formalin solution and rose bengal dye. Sorting organisms is best done in a well-ventilated enclosed area rather than in the field.

A minimum of about 100 organisms per sample is desirable. When samples contain large amounts of fine sediment, wash the sediment through a #30 sieve and preserve the sample material remaining on the sieve.

Limit exposure to both the formalin fumes and to the formalin solution. Make sure the working area is well ventilated.

Store benthic macroinvertebrates in an adequately sized wide-mouthed, high-density polyethylene jar and label the container.

Fill out the field book with information regarding estimates of depth and flow. Note the type of stream bottom. Stream flow can be measured using a flow meter, or calculation from a hydrograph. An estimate of the flow can be made based on current velocity and cross section area if neither of the above methods are possible.

Take the next sample by working upstream so that dislodged material from one sample does not interfere with collection of the next.

Send samples to the lab for analysis as soon as practical. The requested analysis of the sample should include some estimate of total biomass present as well as identification and enumeration of the individual organisms.

Note the following: 1) Most commercially available formalin is slightly acidic, but can be neutralized by the addition of calcium carbonate; 2) when using formalin, some of the delicate organisms are lost. Long-term preservation using this technique is generally done only to preserve specimens of unusual organisms which can be effectively kept by this technique.

Procedures to Collect Macroinvertebrates Using a Ponar, Petersen or Ekman Dredge:

The contents of each grab sample are brought to the surface with the dredge and placed in a large plastic bucket or tub. Water is used to create a slurry, which is poured into a U.S. Standard #30 mesh screen (0.595 mm openings).

Take 3 to 5 replicate samples to be statistically significant.

If possible, the samples should be subjected to a fine spray of water to remove as much substrate as possible. Any large pieces of debris or rocks should be removed by hand.

The material remaining on the screen should be washed into an adequately sized high-density polyethylene jar and preserved with a formalin solution containing rose bengal dye. When using a full strength (37 percent) formalin solution, enough solution should be placed in the water in the jar to make up one fourth of the total volume.

Limit exposure to both formalin fumes and formalin solution. Make sure the working area is well ventilated.

Zooplankton

Zooplankton are minute animal organisms which may live anywhere in the water column. The species abundance and diversity are related to water quality. Zooplankton are also a good measure of the available food supply for higher aquatic organisms.

Containers for Zooplankton. Zooplankton samples are placed and stored in wide-mouthed, 6-ounce to 12-ounce glass jars.

Procedures to Collect Zooplankton Samples Using a Zooplankton Net (vertical tow):

Lower the net made from No. 20 silk bolting cloth to the desired depth. This is usually a depth just above the bottom or just above the anoxic zone, if such a zone exists.

Retrieve the net at a rate of 0.5 to 1.0 meters per second.

Once the net is out of the water, pour water on the outside of the net to wash the organisms from the inner net surface into the collecting cup at the vertex of the net.

Drain the contents of the collecting cup into a sample bottle of suitable size; e.g., 1 pint to 1/2 gallon. For the purpose of identification, a few drops of rose bengal stain should be added. After a few minutes, an amount of neutral formalin equal to slightly more than 5 percent of the original volume of water should be added. If a lengthy storage time is anticipated, the container should be made of high-density polyethylene.

Limit exposure to formalin fumes.
Work in a well-ventilated area.

Properly label bottles and store them so that breakage will not occur.

On the field data sheet, include information of the depth of tow, mesh size, diameter of the net opening, and the retrieval time. These figures are necessary for calculation of the approximate volume of water sampled.

Procedures to Collect Zooplankton Samples Using a Zooplankton Net (horizontal tow):

There are many complications involved in horizontal tows. Choice of a desired tow depth is difficult, but achieving the chosen tow depth is even more difficult. One method of making a horizontal tow is presented below.

A buoy should be set and the net should be attached to the buoy. The tow line should then be reeled out as the boat moves away from the buoy (markings on the tow rope provide a measure of the distance); then set the anchor. The boat should then be set and the net can be towed by hand from the starting buoy to the boat using a steady pull, sufficient to keep the net at the desired tow depth. Horizontal net tows are usually made at a depth where a zone of heavier zooplankton concentration is anticipated.

Other collection and preservation procedures are the same as above.

Procedures to Collect Zooplankton Samples Using a Van Dorn Water Bottle:

This method should be used only where there are moderate to heavy concentrations of zooplankton.

Pick up 3 to 5 liters with the Van Dorn and keep the entire sample.

Other procedures for containers and preservation techniques are the same as above.

Procedures to Collect Zooplankton Samples Using a Submersible Pump:

Lower the pump to the desired depth and pump water through a #20 plankton net. The pump should be rated so that the volume pumped can be determined. Submersible pumps are used to pump sample water aboard some of the DWR's boats.

Other procedures for containers and preservation techniques are the same as above.

Eggs and Larvae

DWR collects eggs and larvae samples to determine the density of fish species (particularly striped bass) entrained by State Water Project and Central Valley Project pumps.

Containers for Eggs and Larvae. Eggs and larvae samples can be stored in a wide-mouthed, 1-quart polypropylene jar.

Procedures to Collect Eggs and Larvae:

Collect samples by making ten-minute inclined tows using an egg and larva net. If heavy algal blooms are present, tows should be made for only five minutes to reduce net clogging. The angle of the towing cable should be approximately 71 degrees.

A flowmeter is used to estimate water flow through the net. The flow data is subsequently used to compute cubic meters of water sampled. The flowmeter should be periodically calibrated in a flow tank at different velocities for a specific time.

At the end of each tow, rinse the contents of the net into the collection jar. Add a few drops of rose bengal dye and preserve the samples with a 5% buffered formalin solution.

At the laboratory, samples should be subjected to a strict quality control program. Sampling procedures are described in more detail in *1984 Striped Bass Egg and Larva Study in the Sacramento-San Joaquin Estuary, 1984.*

Phytoplankton

Phytoplankton refers to freely suspended algae (single celled or colonial) living in a body of water.

Containers for Phytoplankton. Phytoplankton samples are placed in 2- or 4-ounce glass containers.

Procedures to Collect Phytoplankton Using a Van Dorn Sampler:

Nearly fill a 2-ounce glass bottle of suitable size containing 2 milliliters of Lugol's solution as a preservative. Do not fill the container completely, since the laboratory analyst needs space to gently agitate the sample before subsampling. A 4-ounce bottle should be used where phytoplankton concentrations are very low, as at Lake Tahoe.

Lugol's solution is capable of preserving phytoplankton in identifiable condition for several months; however, analysis should be performed as soon as possible because some degradation does occur. Samples should be stored out of direct sunlight.

Flagellated organisms, for instance, lose their flagella within a few months of storage and other changes occur which make identification more difficult in some phytoplankton species. Formalin is more damaging to flagellated organisms than Lugol's solution.

Label and store containers to avoid breakage. All samples should be kept in darkness until analyzed.

Record appropriate information on the field sheets.

Periphyton

Periphyton is the algal biomass which attaches itself to solid surfaces. One means of quantifying this biomass in a lake or aqueduct environment is by using artificial substrates such as periphyton plates. These plates are also useful for considering community metabolism as well as biomass.

Bacteria

Bacteria (fecal and total coliform) can enter the waterways from natural soil erosion, the presence of mammals and birds, agricultural and storm runoff carrying wastes, and sewage discharged into the water. Coliform organisms are generally not pathogenic, but are good indicators of the possible presence of pathogenic organisms, and can be more readily monitored than actual pathogens.

Bacterial analyses are the principal tests used to assess the sanitary quality of water and the potential public health risk from waterborne disease. They are used to assure the safety of potable water and water used for recreation and to make sure the water is free from waterborne diseases. Bacterial analyses also are used to determine the effectiveness of water and wastewater treatment and to identify useable water resources and sources of bacterial contamination.

(Normally DWR staff are involved in bacterial testing only to the extent of collecting water samples and sending them to the State and county health laboratories using instructions, containers, and techniques specified by the health laboratory.)

Containers for Bacterial Samples. The containers for bacterial samples are sterilized 4-ounce plastic bottles, or sterilized plastic "Whirlpak" bags.

Procedures to Collect Bacterial Samples:

Obtain sampling containers from the analytical laboratory. Containers do not need to be fixed with thiosulfate unless chlorinated treated sewage is being sampled. **Do not rinse the container.**

In open water, sample by holding the sample container near its base and plunging neck downward below the surface. Turn the bottle until the neck points slightly upward and against the current. If there is no current, create one by moving the bottle in the direction away from your body (see Figure #14, Ch. 4, page 45). Also, in a moving stream, the sample should be taken upstream of the sampler or sampling boat. Remember to wear sterile rubber gloves when sampling directly with a container.

Leave enough space (about one-half inch) to allow mixing of the sample by the laboratory analyst.

Label the bottles and place them on ice. If the samples are held more than six hours before analyses, the holding time should be reported along with the data. The samples should be maintained at 4°C between the field and the laboratory.

A record of the sample holding temperature should be made in the field log. If there are any unusual events (changes in temperature, etc.) during transportation, they should be recorded so that they may be considered in evaluating the data.

Filtration Methods for Bacterial Samples:

Membrane filtration techniques exist for incubating filter residues for bacterial analyses. Since all bacterial samples collected by DWR are analyzed by governmental health laboratories, information on these techniques should be obtained from the laboratory doing the analysis.

Techniques exist for analyzing filter membranes for organisms such as algae. These techniques are not often employed by DWR staff. If the need arises for use of such a technique, consult with the QA Officer or other knowledgeable persons while the project is being planned.

Radionuclide Samples

Radionuclides are radioactive atoms that break down to release energy (radioactivity). Contamination of water by radionuclides is caused primarily by natural sources. Natural radionuclides are of concern because of their potential health effects (e.g., cancer) and their widespread occurrence.

Radon

Containers for Radon. Samples for radon analysis are collected in 4-ounce glass prescription sample bottles and caps. Keep sample bottles in a cool place.

Procedures to Collect Radon Samples:

Purge the well for at least 15 minutes until the pH, temperature and specific conductance stabilize to obtain a representative sample.

At the sampling point, attach Tygon tubing to port, faucet, tap, etc., using an appropriate adapter as necessary. Place the delivery end at the bottom of a bucket and slowly run the water into the bucket to rinse. Then allow the water to fill and overflow the bucket for the remainder of the sampling.

Remove the prescription bottle cap. With the bottle in an upright position, carefully submerge the bottle and the cap. Avoid agitating the water and minimize creation of bubbles. With the bottle underwater, insert the end of the tubing into the bottle and allow the water to exchange to assure a fresh sample. Remove the tubing, and cap the bottle tightly while it is still immersed under the water.

After removing the capped bottle from the bucket, invert the bottle and check to see if any bubbles are present. If bubbles are present, empty the bottle and re-sample beginning with Step 3. Collect at least two separate samples from the same sampling bucket.

Wipe bottles thoroughly and attach an identification label to each dry bottle. Note carefully the time and date of collection in field notebook and on laboratory submittal sheets.

Uranium, Radium and Gross Alpha

Containers for Uranium, Radium and Gross Alpha Samples. Plastic (polyethylene) containers are preferred over glass containers. Cubitainers, which can be used for shipping, are recommended. Containers should hold ½ gallon to 1 gallon.

Procedures to Collect Uranium, Radium and Gross Alpha Samples:

Purge the well for 15 to 30 minutes to stabilize conditions and obtain a representative sample. Sample directly into container.

Add 2 ml of HNO_3 per liter of water for preservation, which is 8 ml HNO_3 per gallon of water.

Note day and time of collection in field notebook and on laboratory submittal sheet.

Miscellaneous Samples

Solids

The term "solids" refers to settleable solids, total dissolved solids, and total suspended solids.

Containers for Solids. A 16-ounce polyethylene bottle is the preferred container.

Procedures to Collect Solids Samples:

Use a water sampler such as the Van Dorn Bottle, Kemmerer, etc., to collect the sample water.

Fill a 16-ounce bottle with water from the sampler.

Label containers and store in an ice chest at 4°C in order to slow any microbial breakdown of the solids present. Solids samples are impractical to preserve, so transportation to the lab should be as rapid as possible.

Alkalinity

Alkalinity of water is its acid-neutralizing capacity.

Containers for Alkalinity. Samples should be collected in 16-ounce polyethylene containers.

Procedures to Collect Alkalinity Samples:

Use a water sampler such as the Van Dorn Bottle, Kemmerer, etc., to collect the sample water.

Transfer samples to a 16-ounce bottle. No preservation is necessary.

Store containers in the ice chest at 4°C and transport as soon as practical. The maximum holding time for alkalinity samples is 14 days.

Record appropriate information on field sheets.

Ultraviolet Absorbance

Dissolved organic carbon, total organic carbon, and trihalomethane precursors may be estimated using ultraviolet absorbance.

Containers for UVA Analysis. Samples should be collected in 8-ounce polyethylene bottles.

Procedures to Collect UVA Samples:

Use a water sampler such as the Van Dorn Bottle, Kemmerer, etc., to collect the sample water.

Filter samples into the 8-ounce bottle.

Label containers and store them in an ice chest at 4°C. The UVA samples should be transported to the laboratory within 24 hours.

CHAPTER 7

FIELD ANALYSES

Field analyses are performed when immediate results are necessary or for those parameters that can significantly change in a grab sample, such as temperature, pH, and dissolved oxygen and turbidity. Field observations should be made to enhance data interpretation; e.g., cloud cover, wind speed and direction, unusual odors, air temperature, etc. Field analyses conducted by DWR staff include pH, dissolved oxygen, specific conductance, fluorometry, Secchi depth, light transmissivity, and turbidity. Some of these parameters, such as pH and specific conductance are often measured again in the laboratory for comparison purposes, but good field measurements are very important because parameters such as pH change and do not reflect field conditions when taken in the laboratory.

The type of instrument, support equipment, and reagent used for analyses will depend on the parameter to be analyzed and the objectives of the study. A monitoring equipment survey was conducted at the DWR on May 16, 1990. Results of the survey indicate which instruments are in wide use. These results are mentioned in each of the respective sections below. As stated in "Purpose and Scope," the mention of trade names does not signify product endorsement by the State of California.

Equipment used for field analyses should be maintained and calibrated on a routine basis. Before going to the field, equipment should be checked, chemicals restocked, batteries tested and replaced or recharged, equipment calibrated and the calibration results recorded, and field books set up according to the sampling trip(s) planned. Extra batteries, fuses, sample cuvettes, and other glassware should also be carried.

For the purpose of measurement consistency, the same type of equipment should be used within the project. Different types of equipment give readings which may not be comparable.

Field Analysis Procedures

Temperature

Purpose. Temperature is related to many of the physical, biological, and chemical characteristics of a stream or water body. For example, temperature affects the solubility of oxygen in water and the rate of biological activities of bacteria, algae, and other aquatic organisms.

Equipment. Temperature measurement is often possible using instruments designed primarily to measure another parameter such as dissolved oxygen, specific conductance, or pH. Based on survey results, the YSI Model 33 is the instrument most commonly used within DWR to measure temperature. This instrument, which measures both specific conductance and temperature, is pictured below.

PHOTO 5: Multi-parameter Instrument with Electrical Conductivity and Temperature Probes (from YSI Inc.).

Instruments which measure temperature along with pH or dissolved oxygen are also satisfactory for use in measuring temperature. A good American Society of Testing and Materials certified mercury thermometer is also satisfactory for making temperature measurements, but it should not be placed in a bucket from which water will be taken for laboratory analysis.

If a Yellowsprings conductivity meter equipped with a temperature probe is used, care should be taken to completely immerse the temperature sensor which is located at the top of the conductivity/ temperature probe. Whenever possible, temperature should be measured at the source, not in the sample container.

Cleaning and Maintenance. In general, the temperature probe should be stored in a pint bottle of demineralized water in order to avoid buildup of deposits.

Calibration. Occasionally the temperature reading should be compared to the value obtained by an American Society for Testing and Materials calibrated standard mercury thermometer. Temperature differences should be less than 1°C. DWR's Bryte Chemical Laboratory or the QA Officer can assist in acquiring a suitable calibration thermometer.

Measurement Procedure for Taking Temperature Reading:

At the water source, position the top of the probe a few inches below the surface. Move the probe through the water for a period of time sufficient to get a constant reading.

Often it is not practical to take the temperature reading at the water source, in which case, the same technique applies if a subsample of the water is taken.

Report the data to two significant figures of degrees Celsius.

pH

Purpose. The pH value of water, on a scale of 0 to 14, is a measure of the hydrogen ion (H^+) concentration. If water contains more H^+ than OH^- ions, the water is acidic with a pH less than 7. If water contains more OH^- ions than H^+ ions, water is basic with a pH greater than 7. A difference of one pH unit is a tenfold difference in the hydrogen ion concentration.

The pH value is important because at extremely high or low pH values, the water is unsuitable for most aquatic organisms, and certain species are very sensitive to small changes in pH. Furthermore, acidic conditions can cause trace metals to dissolve and become available for accumulation in the food chain. The pH measurement should be taken soon after sample collection.

Equipment. The pH of a sample is usually determined with an electronic meter which uses a glass electrode in combination with a reference electrode. In some instances, a combination electrode may be used instead. Based on survey results, the type of instruments used in DWR to measure pH are the Beckman and Cole-Parmer meters. These meters internally correct for temperature. A picture of a Beckman pH meter is shown below.

PHOTO 6: Beckman pH Meter.

Less accurate, but often more reliable colorimetric pH methods are available as a backup to electrometric pH measuring equipment. Based on survey results, the two most common pH colorimetric methods are the Hach Kit method and the Hellige color comparator. Field crews should carry a backup colorimetric kit, with fresh indicator solutions. Use of a colorimeter to make a reading should be noted in the log. In general, the limitations of using the colorimetric procedures include the slightly lower accuracy and precision of the results. When reagents are fresh, however, the method has a degree of reliability not usually found in the electronic meters.

Cleaning and Calibration. Most of the pH meters used in the field can be automatically calibrated. Calibration against two standard buffers which bracket the expected pH of the waters to be sampled (e.g., pH 4 and 10) should be performed during preparation for the field trip on each sampling day. The electrode should first be thoroughly rinsed with a previously used portion of buffer before placing it in the fresh buffer. After a Beckman pH meter has been standardized with the first buffer, no other operations should be attempted until the standardization with the second buffer has been completed.

After the pH meter has been standardized with both buffer solutions, the electrode should be thoroughly rinsed by swirling it in a cup of demineralized water. The swirling rinse should last one to two minutes. After the rinsing is completed, the cup should be emptied and refilled with fresh demineralized water. The electrode should then be replaced in the cup and transported to the first sampling station in the cup. The electrode should be rinsed two times in the sample water by swirling before measuring the pH in a third portion of the sample.

Buffer replacements are available through the laboratory, equipment manufacturers, or supply houses. The pH electrodes should also be checked for electrolyte levels and internal crystallization.

The probe should be stored in a special solution for electrode storage or in a pH buffer of 4. These mixtures will allow for ion exchange between the storage solution and the pH probe's electrode filling solution.

Measurement Procedures to Collect pH Samples:

If practical, a pH measurement taken directly in the water body is preferred. Care should be taken not to immerse the probe completely in the sample water, since this will cause cross contamination of the sample water and the electrode filling solution.

Immerse the electrodes in a small container of the sample water. Use of a stirring bar to ensure sufficient sample movement across the electrode is desirable; otherwise, move the probe around in the sample until the instrument readout stabilizes.

Record the pH reading to tenths of a pH unit. Most water samples fall in the range of 6.5 to 8.5.

Dissolved Oxygen

Purpose. Dissolved oxygen is essential for the maintenance of healthy water bodies. Most aquatic plants and animals need oxygen dissolved in the water for survival. Sudden and gradual depletions of dissolved oxygen can cause major shifts in the kinds and diversity of aquatic organisms. Variations in dissolved oxygen readings occur with algal concentrations, time, weather, and temperature.

Maximum dissolved oxygen concentrations are typically reached in mid-afternoon when an algal population has had most of the day to produce oxygen through photosynthesis and more than compensate for the oxygen demand from plant respiration and organic decomposition. At night when there is no available sunlight, organisms cease photosynthesis and stop oxygen production. However, respiration continues, resulting in a decrease in oxygen concentrations.

Equipment. Dissolved oxygen is measured primarily by the oxygen electrode meter and/or the modified Winkler method. Based on DWR's survey of monitoring equipment, dissolved oxygen is measured by the YSI Models 50 and 58, the Hach digital titration field kit, and by a DWR-fabricated Winkler method kit. A dissolved oxygen meter and the modified Winkler method titration system are shown below.

PHOTO 7: Dissolved Oxygen Meter (from YSI Inc.).

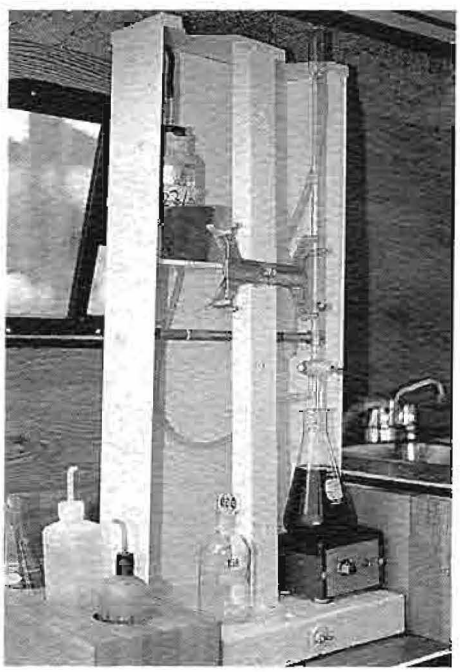


PHOTO 8: Modified Winkler Apparatus.

Cleaning and Maintenance of a DO Meter. Power for the dissolved oxygen meter is supplied by batteries. When it is time to replace the batteries, the meter will usually display a message, such as "LO BAT." A low or weak battery may give erratic readings. The battery terminals should be inspected on a monthly basis and should be cleaned if corroded or covered with a build up of material. The terminals can be cleaned by rubbing them with a pencil eraser (or similar material) to remove the oxide layer.

The oxygen probe should be stored in a container supplied by the manufacturer. A small piece of moist paper towel or sponge should be placed in the container to prevent the electrode from drying out.

The oxygen probe contains a membrane which allows gases to pass to the electrodes. A loose, wrinkled or fouled membrane may give erratic readings. The membrane should be replaced every two to four weeks. There should be no air bubbles under the membrane. The figure below illustrates membrane application. Refer to manufacturer's instruction for the correct procedure for your specific instrument.

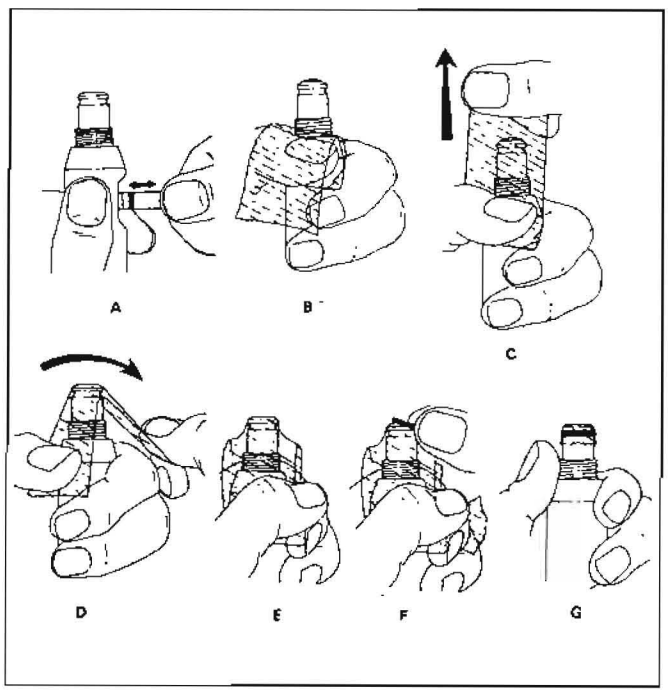


FIGURE 16: Membrane Application (from YSI Inc.).

Calibration of a DO Meter. Dissolved oxygen meters typically need to be warmed up for several minutes (10 to 20) by setting the control knob to "temperature." The dissolved oxygen meters are calibrated by placing the probe in a solution of known oxygen concentration, such as water-saturated air or water of a known oxygen content (mg/L). The controls of the meter should be adjusted to the correct concentration. The instrument should be calibrated daily by the water saturated air method and at least once a month against a modified Winkler kit. Refer to the manufacturer's instructions for details regarding calibration procedures.

Measurement Procedures to Collect Dissolved Oxygen Using a DO Meter:

The probe should be placed in the sample, and the sample should be stirred to obtain continuous movement of the water. The oxygen concentration at the membrane surface is continuously being depleted, and must be stirred to resupply fresh sample water.

Switch the function key to the position appropriate to the desired readout (% or mg/L). Allow a few minutes for the probe to come to the temperature of the sample.

The sample should be stirred until the display has stabilized. Record the stabilized reading.

Record temperature at the time of collection.

Measurement Procedures to Collect Dissolved Oxygen Using the Modified Winkler Method:

The supplies needed for the Modified Winkler technique can be obtained through DWR's Bryte Chemical Laboratory. The reagents are in color-coded (red, white and blue), powder pillow form. The titrating reagent, thiosulfate, is also available from the laboratory. The thiosulfate in a Winkler kit should be replaced if it has been in the kit for one month or more.

Collect the sample in a 300 ml BOD bottle so that the aeration of the water is minimized. Be sure to have extra aliquots of water samples ready in case titration has to be repeated. To avoid bubbles, overflow the bottle with an excess of the water sample. Gently tap bottle with finger to lower water level to top of bottle neck to make room for the powdered chemicals to be added.

Immediately add the contents of the red (manganous sulfate) and white (alkaline iodide-azide) powder pillows to the sample (in that order) being careful not to introduce any air bubbles while doing so. Use the glass stopper to push any remaining chemicals from the lip of the

BOD bottle into the bottle; then drop the stopper into the bottle so that all bubbles are excluded. Hold a finger on the stopper and gently invert the bottle 15 times or so to thoroughly mix the contents. Do not shake the bottle vigorously since this causes a fine floc to be formed which is slow in settling.

Handle the chemicals carefully. They are very caustic. Do not conduct this analysis without wearing plastic gloves and safety glasses and having acid neutralizer and eyewash equipment handy.

Allow the floc (precipitate) to settle until about half of the bottle is clear. Add the contents of the blue powder pillow (sulfamic acid). Place stopper in bottle once again and shake vigorously until all of the granules are dissolved. According to EPA, fixed samples may be stored for up to eight hours in the dark, though immediate analysis is always recommended where feasible. If a large amount of organic material is present, the sample should definitely be analyzed immediately.

Transfer the entire contents to a clean 500 ml Erlenmeyer flask, add a stirring bar and place on a magnetic stirrer or swirl by hand. Begin titrating with 0.037 N thiosulfate solution until a pale straw color appears. Note that thiosulfate standards can be degraded by sun light and other factors. Therefore, thiosulfate standards should be replaced periodically, preferably each month. Standardized solutions can be obtained from the laboratory.

Add about 0.5 ml of starch solution to the flask. (Starch should also be replaced monthly.) This should turn the solution to a dark blue color.

Continue to titrate with thiosulfate, and swirl or stir the flask continuously, until the blue color disappears. One can tell when the end point is approaching, because plumes that are clear will momentarily appear in the solution as the drops fall into the flask. The clear plumes will increase in size and persist longer as the end point approaches. The end point is reached when the solution turns clear and stays clear as long as five seconds or so.

It is easy to over-titrate and add too much thiosulfate to the container. Remember this rule: when a titrated solution changes color, you have already passed the end point. The trick in performing a proper titration is to control the process to the point where the last drop added turns the solution clear. If you over-titrate, you can add a known volume of your water sample so that the solution turns blue again. Then you can retitrate with thiosulfate. Another alternative is to repeat the titration with a new sample.

Take the dissolved oxygen reading off the buret scale in mg/L. This reading does not require any further calculations because the concentration of the thiosulfate solution has been related to the volume of the sample by the laboratory.

Record the temperature at the time of collection.

Specific Conductance

Purpose. Specific conductance is a parameter which is used as a screening device. It can be correlated with the TDS and ionic strength of a solution, and is a good general indicator of the salinity of the water.

Types of Equipment. Many conductivity meters measure temperature as well as specific conductance. Based on the survey results, the types of equipment used in DWR to measure specific conductance are the following: Foxboro, Honeywell, Beckman, YSI Model 33, Orion, Stevens, and Martek. A picture of a conductivity meter which also measures temperature is shown on page 76.

In permanent field installations, inductive conductivity probes are often used, and they are sometimes used on portable field sampling equipment as well. These are identifiable as a donut-shaped coil housed in insulated and waterproof material.

Cleaning and Maintenance. The electrode on the conductivity meter should be periodically cleaned with a soft brush so that algae build up will not affect the readings. The need for replatinizing of electrodes on the conductivity meter is dependent on type and quality of probe used. Replatinizing solutions with directions are available from the major equipment manufacturers. After replatinizing an electrode, the instrument should be recalibrated. Always store the electrode in demineralized water between uses.

The use of inductive conductivity probes is popular in unattended environments, because the probe does not require replatinizing, and because they are relatively unaffected by biological growths and require little cleaning.

Calibration. The conductivity meter should be checked for accuracy and calibrated before and after each sampling run. Calibration standards should be in the range of water being sampled. Standards are available from DWR's Bryte Chemical Laboratory, or can be obtained from the

instrument manufacturer. If the value obtained by reading with the instrument varies greatly from the known value (i.e., ≥5%), then the instrument needs to be evaluated for possible repair.

Most modern conductivity meters used in the field are self-correcting for temperature. That is, all measurements will be corrected to 25°C. If the meter does not have this feature, make the correction manually using instructions that typically accompany the equipment. If more specific directions are needed, see *Standard Methods for the Examination of Water and Wastewater,* 18th Edition, 1992, pp. 2-46.

Measurement Procedures to Collect Specific Conductance Samples Using the Conductivity Meter:

Place sufficient sample in a small, clean bottle to completely immerse the probe. Failure to immerse the probe to the point specified by the manufacturer will give false readings. Make certain that no air is trapped in the probe. Allow time for the probe and sample to reach a stable temperature.

If the instrument does not have automatic temperature correction, take the temperature of the water after the temperature has stabilized and adjust the compensation dial to the correct temperature.

Record the reading in microsiemens per centimeter (µS/cm).

Fluorescence

Purpose. Measurements of chlorophyll fluorescence are often used in the field for immediate detection of the general level of phytoplankton biomass and are also used in such applications as providing early warning of phytoplankton blooms.

The fluorometer is also used to detect rhodamine fluorescence. Rhodamine, a red dye, is frequently used in dye studies since it can be detected down to levels as low as 10 µg/L. Typical applications of dye studies include detection of leakage through earthen levees, and flow mixing studies in complex waterways such as the Delta.

Types of Equipment. Based on the survey results, the most common fluorometer used at DWR is the Turner Designs Model 10. A picture of this instrument is shown.

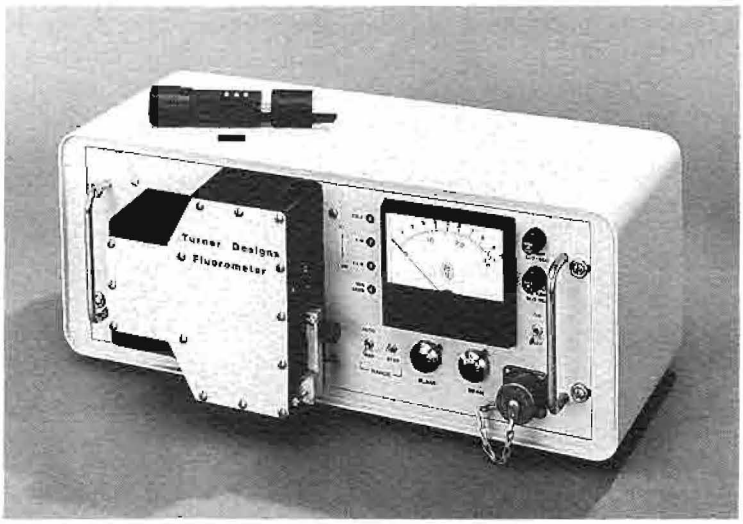


PHOTO 9: Fluorometer (from Turner Designs).

Cleaning and Maintenance. Cuvettes, both discrete and flow-through, should be kept in clean condition. Any buildup of deposits inside either type of cuvette should be removed by washing with a non-abrasive cloth, sponge, or brush. Household chlorine bleach or a laboratory-grade detergent may be used if washing with clean water proves ineffective. The cuvette should be thoroughly rinsed with demineralized water, regardless of which washing agent is used.

In a situation where a nephelometer is in line with a flow-through fluorometer, chlorine bleach must never be flushed through the system. The bleach damages the black nephelometer cuvette and renders it unusable.

Instructions for instrument maintenance should be obtained from the manufacturer's instruction manual.

Calibration. Prior to undertaking any fluorometric measurements, the correct light sources and filters must be installed. For selection of lamps and filters refer to the manufacturer's instruction manual. You may also ask the QA officer for referral to others in DWR who have extensive experience in fluorometer operations.

The fluorometer should be calibrated prior to use. Because of its stability, Rhodamine B stock solutions are often used to calibrate for chlorophyll and rhodamine fluorometric analyses. The instrument may be calibrated to read out in micrograms per liter (μg/L) of Rhodamine B, for which a correlation to chlorophyll *a* exists.

Calibration Procedures:

Obtain Rhodamine B standards from DWR's Bryte Chemical Laboratory with concentrations of 0.5 mg/L and 0.05 mg/L. The standards should be stored in the dark and replaced after six months.

Remove standard solution from storage area; allow the solution to come to room temperature before calibrating the fluorometer.

Turn on the fluorometer and allow it to warm up for at least one hour before conducting calibration.

Use the discrete cuvette holding device for calibration.

Clean cuvettes thoroughly, rinse with demineralized water and allow to dry.

Fill cuvette with demineralized water that has been stored out of the light. Zero the instrument on the x100 setting and the 31.6 range (most sensitive range); use the BLANK knob to perform the adjustment.

Measure temperature of standard solution. Find meter scale setting for corresponding temperature on Table VIII on page 88. Persons generating chlorophyll fluorescence data to be correlated with chlorophyll extract data sometimes use a different table for this purpose. The QA Officer can direct you to persons using the other table.

Fill cuvette with 0.5 mg/L (500 parts per billion) Rhodamine B standard. On the x1 setting, x10 range, set the top scale reading to the value determined in Table VIII.

Check linearity of the instrument by measuring the fluorescence of the 0.05 mg/L standard which should be 1/10 the fluorescence of the 0.5 mg/L standard solution.

The calibration should be recorded, preferably in a bound calibration logbook with numbered pages, using indelible ink.

TABLE VIII

CORRECTION CHART - 0.5 mg/L RHODAMINE B STANDARD SOLUTION[1]

°C	Set Point (x1, x10 Range)	°C	Set Point (x1, x10 Range)
15	5.71	23	4.61
16	5.56	24	4.48
17	5.42	25	4.36
18	5.27	26	4.24
19	5.14	27	4.13
20	5.00	28	4.02
21	4.86	29	3.91
22	4 73	30	3.80

[1]Based on the relationship that Rhodamine B fluorescence changes inversely by 0.027 per degree Celsius change in temperature.

Measurement Procedures for Chlorophyll a Samples:

The fluorometer may be used to make discrete or continuous readings.

For individual readings, the instrument is set up with a discrete sample cuvette holder. The fluorometer should be set to zero using demineralized water in the cuvette. The sample is then placed in the cuvette, and the reading is taken. It is good practice to place the cuvette in the same orientation for each reading. Observe meter reading of the sample on the top meter scale and convert to fluorescence units using the conversions in Table IX on page 89.

For continuous readings, a flow-through sample chamber is installed. An opaque hose or tube is attached to the chamber to supply the sample. Measurements are made while water is pumped through the chamber using a pump which does not introduce excessive air bubbles into the fluorometer chamber. The water sample should enter the chamber from the bottom in order to further reduce bubble formation. Teflon plumbing tape should be used to secure airtight joints and avoid air entrainment in the sampling chamber.

TABLE IX

FLUORESCENCE DATA CONVERSION TO FLUORESCENCE UNITS[1] (Upper Meter Scale Readings)

Range	Range of Fluorescence Units	Conversion Factor
100 x 31.6	0 - 3.16	Reading x .316
100 x 10	0 - 10	" x 1
100 x 3.16	0 - 31.6	" x 3.16
100 x 1 (Min. Sens.)	0 - 100	" x 10
1 x 31.6	0 - 316	" x 31.6
1 x 10	0 - 1000	" x 100
1 x 3.16	0 - 3160	" x 316
1 x 1 (Min. Sens.)	0 - 10,000	" x 1000

[1]The "Fluorescence Unit" (FU) in this table is defined as one ten-thousandth of the full range of the Turner Designs model 10 fluorometer.

Fluorometers are now available that give a direct digital readout so that conversions are not necessary.

Light Penetration

Purpose. The degree of light penetration is important in determining the vertical distribution of plankton in lakes and reservoirs. Water clarity is affected by suspended organic and inorganic matter. The two measures of light penetration are Secchi disk transparency and light transmittance.

Types of Equipment. Light penetration is measured by DWR staff using one of two methods, the Secchi disk or a hydrophotometer. The Secchi disk is a 20 cm diameter circular disk, usually metal, with black and white alternating quarter panels. The disk often has a weight on the bottom and is supported by a steel or metallic tape. A picture of the Secchi disk is shown.

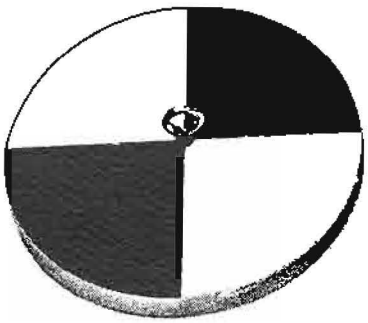


FIGURE 17: Secchi Disk.

Cleaning and Maintenance for the Secchi Disk. The paint on the Secchi disk should be kept in good condition and clean to ensure sharper endpoints.

Measurement Procedures for Light Penetration Using Secchi Disk:

The Secchi disk should be lowered into the water where the surface is calm and shaded since glare and surface movements interfere with the observer's vision.

Lower the disk until the black and white quadrants just become indistinguishable, and record the depth.

Lower the disk a little further, and then retrieve it slowly until the quadrants can just be distinguished again. Record this depth.

Record the Secchi depth as the average of the two readings.

Sunglasses should not be worn while observations are being made. Moreover, the same person should make all the Secchi disk readings to ensure consistency.

A hydrophotometer is a light meter which includes a photocell that can be submersed in water to measure the light transmittance at various depths. Based on survey results, the Martek and the Montedoro-Whitney hydrophotometers are most commonly used in DWR. Most instruments now used produce a readout value which is shown as a percentage of the light intensity at the water surface. Each instrument is different and should be operated according to the instruction manual. A picture of a hydrophotometer is shown.

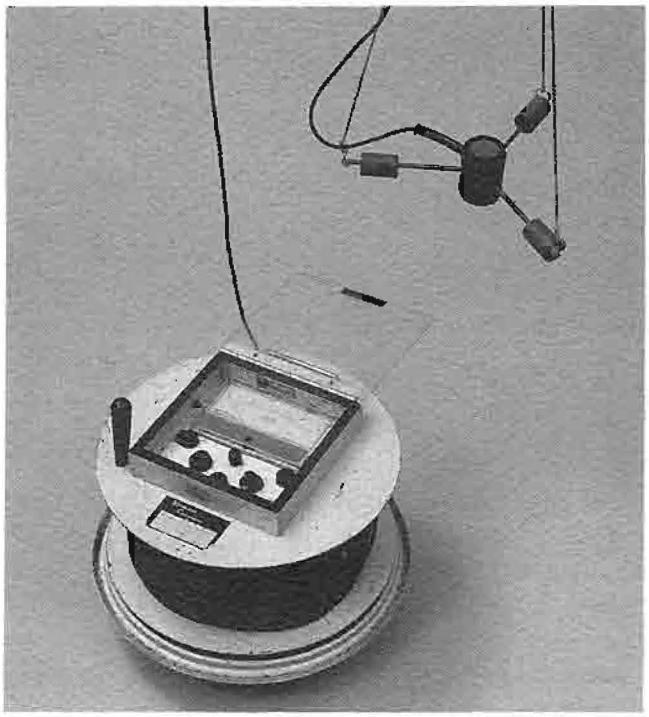


PHOTO 10: Hydrophotometer.

Cleaning and Maintenance for the Hydrophotometer. Cells of the hydrophotometer should be kept clean and any damage encountered should be repaired. Fresh batteries should be installed and spare batteries should be carried. Any special instructions of the manufacturer should be followed.

Calibration. Before going into the field, the hydrophotometer should be calibrated in sunlight. With the photocell away from shadows and reflective objects, turn the instrument on and adjust the meter to 100 percent. Neutral-density filters should then be placed singly and/or in combination on top of the cell in order to reduce the light reaching the cell to some known fraction of the incident light. Plot the photometer readings against the rated values of the single filters or the product of rated values of combinations of filters. The resulting curve can be used to adjust values obtained in the field.

Measurement Procedures for Light Penetration Using the Hydrophotometer:

Support the photocell on the boat in a horizontal position away from any objects producing reflections or shadows.

Turn the instrument on and adjust the meter to 100 percent.

Lower the photocell into the water and take a reading at the depth of 0.5 meter and then take additional readings at 1-meter intervals until the reading reaches about 1%. Two readings should be made which closely bracket 1%. Further readings should be made until the 0.3% light level is reached.

Retrieve the photocell and take another reading as in step 3. For best results, the readings should be made between the hours of 1000 and 1400 Pacific Standard Time, the time when the sun's rays are most nearly perpendicular to the water. The 1% light level is often referred to as the compensation depth where the rate of algae photosynthesis equals the rate of respiration. More recent studies have indicated that the compensation depth may be nearer to the 0.3% light level.

Turbidity

Purpose. Turbidity is a measurement of the clarity of the water. The analysis, frequently done in the laboratory, can also be done satisfactorily in the field with the proper equipment.

Type of Equipment. The most commonly used instrument for measuring turbidity is the nephelometer. Nephelometric turbidimeters measure the amount of right-angled light scatter resulting when a beam of light is passed through a glass cell containing the sample. Based on the survey results, the two types of turbidimeters used by DWR are the Hach 2100A and models produced by Turner Designs. A newer Hach model, the 2100P, is also gaining wider use.

The 2100P produces a superior reading to the 2100A model, especially at high turbidities. The 2100P specifications are not yet standardized in *Standard Methods for the Examination of Water and Wastewater,* 18th edition, 1992, which is published jointly by the American Public Health Association, the American Water Works Association, and the Water Environment Federation. Until *Standard Methods* is updated, the Hach model 2100A readings should be used. The Hach 2100A and 2100P with sample vials (also known as sample cells or cuvettes) are shown below.

PHOTO 11: Hach Nephelometers: (left): 2100A Model (right): 2100P Model (both from Hach Co.).

Cleaning and Maintenance. The sample cells used in a turbidimeter require almost constant cleaning. Wash with detergent and rinse thoroughly. Kimwipes or tissues that will not leave an oil film should be used to dry. Similarly, the cleaning of internal lenses or any transparent parts between the lamp and sample cell should be cleaned with the same material. However, make sure that all lenses are replaced in their original position if they were removed for cleaning. This ensures that the factory focusing of the instrument is not altered.

Calibration. Calibrate the nephelometer by measuring the turbidities of a series of standards obtained from the laboratory. These standards should be replaced at monthly intervals, except in cases when turbidity standards are sealed containers of solutions which are relatively stable and semi-permanent. The calibration should bracket the expected range of the samples to be analyzed. Prepare a curve by plotting the measurements against the stated turbidities of the standards. If there is a significant difference between the measured values and the stated values, future turbidity measurements should be adjusted according to the curve.

Measurement Procedures for Turbidity:

Turn on the turbidimeter and allow it to warm up for 30 minutes.

Agitate the sample as thoroughly as possible without creating a number of small bubbles, and then fill the measuring cell. If air bubbles can be seen in the cell, tap it lightly to jar them loose so they will float to the surface.

All sample cells supplied by Hach are optically matched and have a line scribed on them to help align them correctly in the turbidimeter. Place the cell in the turbidimeter so that the scribed mark on the cell is in line with the line on the nephelometer cell chamber.

Cover the cell with the light shield and depress the button for the highest range. If the reading is less than 40 NTUs, the lowest range possible should be used to determine the turbidity.

If the initial reading is greater than 40 NTUs, the sample must be diluted with demineralized water. After dilution, a turbidity reading should be taken using the lowest range possible. This reading must then be multiplied by the dilution factor to get the correct turbidity value.

For example, if your reading is 15 NTUs and dilution consisted of one part of sample plus four parts of demineralized water, the corrected turbidity would be 15 x (1 + 4) = 75 NTUs.

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APPENDIX A

EXAMPLE

INSTRUMENT MAINTENANCE, CALIBRATION, AND REPAIR LOG

Instrument Maintenance, Calibration, and Repair Log

Name of Instrument:
Manufacturer:
Model #:

DWR Property Code:

Parameter(s) Measured:

Date	Time	Maintenance Performed: (Cleaning, etc.)	Calibration Values					Repairs Made		Sent for service: Date out/ Date returned	Signature of staff
			Standard	Observed			% Difference	Repaired by Staff	Sent in for servicing		

Sample Calculation: % Difference = $\frac{((\text{Standard}*3)-\text{Sum of 3 observed values})}{(\text{Standard}*3)} * 100$

If Standard was 1310 uS/cm (Specific Conductance) and Observed values were 1301, 1309, and 1315 uS/cm, then:

% Difference= $\frac{((1310*3)-(1301+1309+1315)}{(1310*3)} * 100$ = approximately 0.13%

APPENDIX B

SAMPLING DESIGN

APPENDIX B: SAMPLING DESIGN

Every environmental measurement project should have a sampling plan. The purpose is to document procedures to ensure the collection of representative samples. The sampling plan design should depend on the measurement objectives of the program, that is, the data needed, the intended uses, the data users, and the strategy for achieving the objectives. This information, along with considerations to the time frames, resources and the technological constraints of methodology, is used to help develop the data quality objectives. The development of the data quality objectives is a joint reponsibility of the Program Manager, technical staff (both field and laboratory), and the data end-users. A well-prepared sampling plan can contribute greatly to the relative success of a sampling program.

The following provides guidance for designing a sampling plan for an environmental measurement project:

Indicate the measurement objectives and develop data quality objectives (DQOs) for collection of the samples.

Before sampling can occur, the intention or goal of the measurement activity should be established. Some examples of these are:

- to determine if a problem exists
- to monitor site conditions to determine if remedial action is required
- to design and implement remedial measures
- to comply with monitoring regulations
- to determine if monitoring data exceed drinking water standards or water quality criteria

The measurement objectives can be used to help develop the data quality objectives. Data quality objectives are statements which define the level of confidence that is required for the data's end-use. Determining data quality objectives is not within the scope of this document but is discussed in more detail in DWR's *Guidelines for Developing Quality Assurance Project Plans (see Bibliography).*

Specify the past and present information about the site.

The study area should be examined to determine potential sources of contamination and the sampling locations. The examination can include:

- Maps
- Aerial photography
- Interviews with key personnel

- Site visit
- Historical records showing land use and anthropogenic influences (e.g. industrial zones, agricultural, etc.)
- Data previously collected (from routine monitoring or surveillance studies). If no data are available, carry out preliminary sampling of the study area which can aid in selecting the sampling locations. Note that some data are necessary in order to statistically determine the appropriate number of samples to be taken for the environmental measurement project.

Determine what types of samples are needed.

The type of sample collected will depend on the objectives of the environmental measurement project. The following is a description of the type of samples which can be collected:

Grab Samples—Grab samples are discrete aliquots which represent a specific location at a specific point in time. In other words, these samples, collected at a particular time and place can represent only the composition of the source at that time and place. However, when a source is known to be fairly constant in all directions, then the sample can be considered representative. Grab samples give the most information regarding contaminant variability. That is, grab samples collected at intervals and analyzed separately can document the extent, frequency, and duration of variations.

Composite Samples—Composite samples represent the mixing of a number of grab samples and represent an average value. Since compositing involves combining several grab samples, estimation of overall site properties using composites is less expensive than using grabs due to reduced analytical costs. However, compositing does not allow the variability of data to be determined.

Integrated Samples—Integrated samples are mixtures of grab samples collected from different points simultaneously. For example, the need for an integrated sample occurs in a river or stream that varies in composition across its width and depth. To evaluate average composition of total loading, a mixture of samples are collected representing various points in the cross-section in proportion to their relative flows. Knowledge of the volume movement, and composition of the various parts of water being sampled usually is required. The integrated method is preferred over grab samples when the cross-sectional transport characteristics of the site are not adequately understood.

Determine the best sampling approaches.

The aim of any environmental project is to attain the most useable data using the least amount of sampling possible. With this in mind, certain sampling approaches may suit one program better than another since they can effect the quality and usefulness of data produced. The following are three general approaches to sampling:

Judgmental Sampling—This method is based on experience and available information to determine the location which will provide the most representative sample. Judgmental sampling has the highest level of bias compared to the two following techniques, but requires the smallest number of samples. This type of sampling is most efficient when prior history of the sampled site, including previously obtained data, is known.

Systematic Sampling—This technique can be employed by breaking down a sampling area into consistent patterns such as squares, triangles or contours. Such a method allows for more consistent sampling since each sampling site is marked and can be repeatedly sampled. Compared to judgmental sampling, more samples are needed, but the level of bias is less.

Random Sampling—Random sampling depends on the theory of random chance probabilities in order to choose the most representative sample. This process is utilized when numerous sampling locations are available but there is no satisfactory reason for choosing one over another. Compared to the two previous methods, the largest number of samples is needed here to obtain representative data of the parameters being measured. The level of bias, however, is smallest.

These three techniques mentioned are not necessarily mutually exclusive of one another so can be combined if needed. There are three primary combinations of approaches. These are systematic-judgmental, systematic-random, and judgmental-random.

The selection of surface-water sampling sites and ground water sampling sites differ. For surface water, the sampling site should be at or near a gaging station because the data must relate to water quality constituent concentrations in order to compute transport loads and understand water quality characteristics. It should also be in the straight reaches of the channel where the flow is relatively uniform.

For ground water, the sample site will depend to a great extent on a general knowledge of the geometry and hydraulic characteristics of the aquifer(s) being studied. The selection of existing wells should be judged based on knowledge of the depth and length of the screened interval, the casing material, method of construction, data of construction, and method of sealing around the annulus. The selection of sites for new wells should be judged from a knowledge of potential sources of contamination and geometry of the water-bearing zones at risk.

When sampling sediment, all data should be collected at a common cross section or strata. However, consideration may have to be given to all or part of the following, depending on the expected uses of the data:

- measurement of streamflow
- cross-section samples of suspended sediment
- single vertical or pumping sampler suspended-sediment samples

- cross-section bedload samples
- cross-section bed material samples

Select the number of samples.

The number of samples needed for analysis is determined ultimately by the data quality objectives. A relatively simple statistical equation can be used to estimate the number of samples needed. For the following equation to work, however, certain assumptions about the nature of the data must be made. First, the data are assumed to have a normal or Gaussian distribution with data points placed symmetrically around a "true" arithmetic mean. Second, each data point is independent of one another (i.e., no cross-contamination is taking place).

For environmental data with very low concentrations such as in the parts per billion (ppb) or parts per trillion (ppt), however, normal distribution may not exist. In this case, a log-normal distribution is represented, where the logarithms of the concentrations, not the concentration values, follow a Gaussian distribution. Nonetheless, mean values from a normally distributed plot, whether log or arithmetic, can be used in the statistical analysis for number of samples. If data points fail to exhibit either of these two distribution schemes, the investigator should use non-parametric statistics or consult a statistician.

Lastly, before the number of samples can be determined, the investigator needs to decide the limit of confidence and tolerable error that he or she wants. Once these parameters are set, then the minimum number of samples that needs to be taken can be calculated using the following equation (from *Principles of Environmental Analysis, American Chemical Society*, 1983):

$$\text{\# of samples} = \frac{(\text{z factor} \times \text{standard deviation of population})^2}{(\text{tolerable error})^2}$$

"z" factor—The z factor is the number assigned to various confidence level values. This factor is taken from the selection of tables in statistical texts such as the *National Bureau of Standards Handbook*. For example, at the 95 percent confidence level, the z factor is 1.96. Since the investigator selects the level of confidence, the z factor is also indirectly selected. If the sample size is seven or smaller, then the appropriate value of the student's t distribution (also from statistical tables) should be used in place of the z factor in the above equation.

Standard deviation—This is a measure in variability of all data points from the population's mean value. The standard deviation can be calculated using sampling data from a statistical study whether preliminary or historical. This value can be underestimated or overestimated if the calculation is based on an insufficient number of samples in the population (less than seven).

Tolerable error—This is the allowable error placed on the estimate of the population's mean. The higher the tolerable error, the smaller the sample size will be, and vice versa. Tolerable

error values are important to the investigator since they, like the confidence level, can be manipulated to suit the needs of the data quality objectives.

As an example, assume that the sample population has a mean concentration of 1.0 ppm with a standard deviation of 0.5 ppm. The tolerable error in the stated value of the mean at the 95 percent confidence level (which gives a z factor of 1.96) is not to exceed 25 percent. Then,

$$\text{\# of samples} = \frac{(1.96 \times 0.5)^2}{(0.25)^2} = 15.37$$

Given here is only one out of many statistical methods which can be employed to give an estimate of sample numbers. Other methods may involve different variables and functions, but they will also give similar estimates. The appendix in this manual references various statistical approaches.

Select the number of quality control samples.

The number of QC samples to be incorporated into the monitoring activities depends on the particular data quality objectives. QC samples for field operations are important because they can demonstrate that the sample containers, collection and storage procedures have not altered the sample in a way which would adversely affect the analytical results. QC samples commonly used for the field are field spikes, field blanks, and replicates (defined in Chapter 1). Field spikes, however, are not ordinarily used by DWR field crews because of the precise techniques necessary to perform an accurate spike. At DWR, the spiking of the samples usually occurs at the laboratory after the sampling runs.

Field blanks can be used for nutrients, trace metals, standard minerals, and volatile organics each of which require different sample preparations. At DWR, field blanks are required for trace metal analysis.

At least one duplicate and one field blank for each daily field run per field crew should be taken. Depending on the number of environmental samples taken in one day, the percentage of QC samples to environmental samples will differ. More QC samples taken will provide better precision; however, the number of QC samples will be limited by cost and time.

Select the analytical laboratory(s).

In order to ensure reliable data from samples collected in the field, a pre-award performance evaluation of analytical laboratories is needed. This can be done by setting minimum quality assurance requirements which candidate laboratories have to meet.

To begin, the data quality objective of the program should once again be considered. If high data quality is required, then the quality assurance requirements of the program would be more stringent, and vice versa. Next, candidate laboratories should be checked for certification. Both the California Department of Health Services and the United States Environmental Protection Agency have laboratory certification programs. These programs certify that laboratories can meet minimum criteria for analytical procedures, pass an on-site inspection given at least once every

three years, and adequately analyze an annual set of reference samples. Currently, there are certification programs for drinking water, waste water, solid waste, and radioactive materials.

Choosing a laboratory which is certified to perform the analyses required may help ensure that performance is appropriate and adequate, but some non-certified laboratories are also acceptable as well. This is true if a non-certified laboratory is evaluated properly, meets the data quality objectives, and displays the required level of quality assurance and quality control.

A careful examination of the analytical laboratories' QA manual (sometimes known as QA plan) will also aid in the selection process. These manuals should be submitted by candidate laboratories during the "Invitation for Bids/Request for Proposals" process. A complete QA manual should mention and discuss at least the following:

- A reference to the standard operating procedures (SOPs) for all analytical methods
- Documentation of quality control practices for instruments, equipment, supplies, reagents, and analyses to assure that data generated is of acceptable precision and accuracy
- Qualifications of staff
- Adequacy of laboratory facilities
- Preventative maintenance of equipment and instruments
- Sample logging and tracking of standard operating procedures
- Sample storage
- Sample preparation
- Analytical methods
- Laboratory internal quality control
- External quality assurance checks
- Turnaround time of analyses
- Laboratory data reports
- Laboratory forms
- Laboratory safety

Another method which tests the analytical performance of candidate laboratories is the evaluation of performance samples. This also is typically done during the "Invitation for Bids/Request for Proposals" process. Performance evaluation samples contain known concentrations of chemicals in a particular medium such as soil/sediment and water. These performance evaluation samples can be obtained from the DWR QA Officer who maintains an ongoing contract with a laboratory which prepares them.

Various types of performance evaluation samples may be obtained directly from agencies such as the EPA, DHS, U.S. Geological Survey, National Institute of Standards and Technology, the National Research Council of Canada, and some private sector laboratories. The DWR Bryte Chemical Laboratory can also prepare a limited number of organic and inorganic performance evaluation samples (in water) depending on their workload requirements.

The following information is needed along with the performance evaluation samples:

- Laboratory method uncertainty intervals
- Preparation and analytical methods
- Documentation that adequate QA/QC procedures occurred to authenticate the value of the performance evaluation samples

Performance evaluation samples are then distributed to candidate bidders along with the following:

- Sample preparation and analytical methods to be used to analyze the performance evaluation samples. This information is obtained from the preparers of the performance evaluation sample and simply relayed to the bidders.
- A provision that the applicant laboratories will be responsible for all analytical costs for the performance evaluation samples.
- A statement requiring submission to DWR of the results of any quality control measurements taken by the candidate laboratory during analysis of the performance evaluation samples.
- A statement regarding the deadline and location for submittal of results.
- A statement to the effect that any departure from the methods and procedures of the performance evaluation will be sufficient cause to disqualify the bidding laboratory.

The previous information can also be incorporated into the language of the "Invitation for Bids/Request for Proposals."

Overall, the program's Data Quality Objectives, and laboratory's certification status, QA manual, and performance on evaluation samples are the major influences in choosing an appropriate analytical laboratory.

(For more detail on selecting analytical laboratories, see the DWR document *Quality Assurance Guidelines for Analytical Laboratories*, September 1992.)

APPENDIX C

DWR BRYTE LABORATORY

SUBMITTAL FORMS

State of California | DEPARTMENT OF WATER RESOURCES | The Resources Agency

CHEMICAL LABORATORY TEST REQUEST

DATE SUBMITTED		COLLECTOR	PHONE
UNIT & WORK ORDER NUMBER		INVESTIGATION	
ANALYSIS BY	X 1. DWR CHEMICAL LABORATORY	APPROVED	
	2. DEPARTMENT OF HEALTH LABORATORY	RECEIVED (FOR LABORATORY)	DATE RECEIVED
	3. OTHER	BOTTLES RECEIVED	

BOTTLES RECEIVED		
NUMBER	SIZE	TYPE

SPECIAL INSTRUCTIONS

SAMPLER'S NUMBER	LABORATORY NUMBER	ANALYSES	DATE CHARGED					
			MINERAL	NUTRIENT	METAL	MISC.	PESTICIDE	BIO.
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
C								
DWR 1263 (11/79)	PAGE TOTAL							

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER ANALYSIS (NUTRIENT)

D (1) T (2) LAB. NO. (3–8)

CARD

BASIN (9–13) | STATE WELL NO./STATION NO. (14–25) T (26) | YR. MO. DAY (27–32) | TIME (PST) (33–36) | CO. (37–38) | FIELD TEMP. (39–42) U (43)

FIELD EC (44–49) | FIELD PH (.50–52) | DO (53–55) | DISCHARGE (CFS) (56–62) | G.H. (FT.) (63–66) | DEPTH (FT.) (67–69) | SAMPLER (70–73) | LK (78) | CARD CODE (79) 1 | (80)

TYPE OF ANALYSIS: | W.O.

CARD – 2

FIELD CARBON DIOXIDE
CO_2 mg/L (9–11)

FIELD ALKALINITY
as $CaCO_3$
Phen. mg/L (12–14) | Tot. mg/L (15–17)

TURBIDITY
CODE
Candle = C
Hach = A
Hellige = E
Hach Colorimeter = B
Turb. (18–21) | CODE (22) | R (23)

TOTAL AMMONIA _____ ml
as N mg/L (56–62)

TOTAL ORGANIC NITROGEN
_____ ml
as N mg/L (63–69)

TOTAL AMMONIA AND ORGANIC NITROGEN
_____ ml
as N mg/L (70–76)

DISSOLVED NITRITE _____ ml
A _____ C _____
Factor _____
A (sam) _____
as N mg/L (41–47)

DISSOLVED NITRATE _____ ml
as N mg/L (48–55)

DISSOLVED NITRATE AND NITRITE
_____ ml
as N mg/L (24–31)

DISSOLVED AMMONIA _____ ml
as N mg/L (34–40)

CARD 2 (79)

CARD – 3

DISSOLVED ORGANIC NITROGEN
_____ ml
as N mg/L (41–47)

DISSOLVED ORTHOPHOSPHATE
_____ ml
A _____ C _____
Factor _____
A (sam) _____
as P mg/L (9–16)

DISSOLVED ACID HYDROLYZABLE PHOSPHATE
_____ ml
A _____ C _____
Factor _____
A (sam) _____
AP _____ – OP _____
as P mg/L (17–24)

DISSOLVED TOTAL PHOSPHORUS
_____ ml
A _____ C _____
Factor _____
A (sam) _____
as P mg/L (25–32)

TOTAL ORTHOPHOSPHATE
_____ ml
A _____ C _____
Factor _____
A (sam) _____
as P mg/L (48–55)

TOTAL PHOSPHORUS
_____ ml
A _____ C _____
Factor _____
A (sam) _____
as P mg/L (33–40)

LAB. (74–77) OV (78) 3 (79)

OWNER _____
NAME ADDRESS
COPY TO OWNER ☐
CITY ZIP CODE

DETAILED LOCATION _____

POINT OF COLLECTION _____ PPG _____

REF. POINT _____ Cl RESID. _____ COLOR _____

DEPTH TO WATER _____ FT. SECCHI _____ M ODOR _____

DEPTH OF WELL _____ FT. WIND _____ FOAM _____

USE _____ %CLOUD COVER _____

PERF. INTER _____ ALGAE _____ TURBID. _____

REMARKS _____

SAMPLER _____ OF _____

DATE TO LAB. _____

DATE STARTED _____

DATE COMPLETED _____

CHEMIST _____

CHECKED _____

DWR 2241 C (Rev. 8/78)

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

D | T | LAB. NO. (1 | 2 | 3–8)

WATER ANALYSIS (ORGANIC PHOSPHOROUS PESTICIDES)

CARD 1

BASIN (9–13) | STATE WELL NO./STATION NO. (14–25) | T (26) | YR. (27–28) | MO. (29–30) | DAY (31–32) | TIME (PST) (33–36) | CO. (37–38) | FIELD TEMP. (39–42) | U (43)

FIELD EC (44–49) | FIELD PH (50–52) | DO (53–55) | DISCHARGE (CFS) (56–62) | G.H.(FT.) (63–66) | DEPTH (FT.) (67–69) | SAMPLER (70–73) | LK (78) | CARD (79) [1] | (80) CODE DUPE ALL CARDS

TYPE OF ANALYSIS | W.O. NO.

Compound	Storet Code	CAS No.	uq/L
Mevinphos		7786-34-7	
Demeton	39560	8065-48-3	
Naled		300-76-5	
Phorate	39023	298-02-2	
Dimethoate	39009	60-51-5	
Diazinon	39570	333-41-5	
Disulfoton	39010	298-04-4	
Methyl Parathion	39600	298-00-0	
Malathion	39530	121-75-5	
Chlorpyrifos		2921-88-2	
Parathion	39540	56-38-2	
Methidathion		950-37-8	
Profenofos		41198-08-7	
s,s,s-Tributyl Phosphorotrithioate (DEF)	39040	78-48-8	
Ethion	39398	563-12-2	
Carbophenothion (Trithion)	39786	786-19-6	
Phosmet		732-11-6	
Phosalone		2310-17-0	
Azinphosmethyl	39580	86-50-0	

Date to Lab. _____ Date Analyzed _____ Date Completed _____

Chemist _____ QC No. _____ Checked _____

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

D | T | LAB. NO. (1 2 3 8)

WATER ANALYSIS (CHLORINATED ORGANIC PESTICIDES)

CARD 1

BASIN (9 13) | STATE WELL NO./STATION NO. (14 25) | T (26) | YR. (27 32) | MO. | DAY | TIME (PST) (33 36) | CO. (37 38) | FIELD TEMP. (39 42) | U (43)

FIELD EC (44 49) | FIELD PH (50 52) | DO (53 55) | DISCHARGE (CFS) (56 62) | G.W.(FT.) (63 66) | DEPTH (FT.) (67 69) | SAMPLER (70 73) | LK (78) | CARD 1 (79) | CODE DUPE ALL CARDS (80)

TYPE OF ANALYSIS | W.O. NO.

Compound	Storet Code	CAS No.	ug/L
Diuron	39650	330-54-1	
BHC, alpha	39337	319-84-6	
Chlorpropham	81322	101-21-3	
Dichloran	38447	90-30-9	
Simazine	39055	122-34-9	
BHC, gamma	39340	58-89-9	
BHC, beta	39338	319-85-7	
Atrazine	39033	1912-24-9	
PCNB	39029	82-68-8	
BHC, delta	34259	319-86-8	
Chlorothalonil	70314	1897-45-6	
Alachlor	77825	15972-60-8	
Heptachlor	39410	76-44-8	
Thiobencarb	34722	28249-77-6	
Chlorpyrifos	81403	2921-88-2	
Aldrin	39330	309-00-2	
DCPA	39770	1861-32-1	
Captan	39640	133-06-2	
Heptachlor Epoxide	39420	1024-57-3	
Chlordane	39350	57-74-9	
Endosulfan I	34361	959-98-8	
Dieldrin	39380	60-57-1	
DDE	39320	72-55-9	
Endrin	39390	72-20-8	
Endosulfan II	34356	33212-65-9	
Endrin Aldehyde	34366	7421-93-4	
DDD	39310	72-54-8	
Endosulfan Sulfate	34351	1031-07-8	
DDT	39300	50-29-3	
Methoxychlor	39480	72-43-5	
Dicofol	39780	115-32-2	
Toxaphene	39400	8001-35-2	
PCB-1016	34671	12674-11-2	
PCB-1221	39488	11104-28-2	
PCB-1232	39492	11141-16-5	
PCB-1242	39496	53469-21-9	
PCB-1248	39500	12672-29-6	
PCB-1254	39504	11097-69-1	
PCB-1260	39508	11096-82-5	

Date to Lab. _____ Date Analyzed _____ Date Completed _____

Chemist _____ QC No. _____ Checked _____

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

D | T | LAB NO. (1 | 2 | 3–8)

WATER ANALYSIS (PURGEABLE ORGANICS)

BASIN (9–13) | STATE WELL NO./STATION NO. T (14–25 26) | YR MO DAY (27–32) | TIME(PST) (33–36) | CO. (37 38) | FIELD TEMP U (39–42 43)

FIELD EC (44–49) | FIELD PH (50 52) | O.D. (53 55) | DISCHARGE (CFS) (56–62) | G.H. (FT) (63–66) | DEPTH (FT) (67–69) | SAMPLER (70–73) | LK (76) | CARD (79) | CODE (80)

TYPE OF ANALYSIS | W.O.

Compound	Storet Cd.	CAS No.	ug/L
Vinyl Chloride	39175	75-01-4	
Trichlorofluoromethane	34488	75-69-4	
1,1,2-Trichlorotrifluoroethane		76-13-1	
1,1-Dichloroethylene	34501	75-35-4	
trans-1,2-Dichloroethylene	34546	156-60-5	
1,1-Dichloroethane	34496	75-34-3	
cis-1,2-Dichloroethylene	77093	156-59-4	
Chloroform	32106	67-66-3	
1,1,1-Trichloroethane	34506	71-55-6	
Carbon tetrachloride	32102	56-23-5	
Benzene	34030	71-43-2	
1,2-Dichloroethane	34531	107-06-2	
Trichloroethylene	39180	79-01-6	
1,2-Dichloropropane	34541	78-87-5	
Bromodichloromethane	32101	75-27-4	
Toluene	34481	108-88-3	
Chloropicrin	77548	76-06-2	
1,1,2-Trichloroethane	34511	79-00-5	
Tetrachloroethylene	34475	127-18-4	
Dibromochloromethane	32105	124-48-1	
Ethylene dibromide	77651	706-93-4	
Chlorobenzene	34301	108-90-7	
Ethylbenzene	34371	100-41-4	
Xylene(s)	81551	1330-20-7	
Bromoform	32104	75-25-2	
1,3-Dichlorobenzene	34566	541-73-1	
1,4-Dichlorobenzene	34571	106-46-1	
1,2-Dichlorobenzene	34536	95-50-1	
1,2-Dibromo-3-chloropropane	38437	96-12-8	
Cl2 Demand _____ Cl2 Spike _____			

Date to Lab. _____ Date Analyzed _____ Date Completed _____

Chemist _____ QC Number _____ Checked _____

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

D | T | LAB NO. (1 | 2 | 3–8)

WATER ANALYSIS (CARBAMATE PESTICIDES)

CARD 1

BASIN (9–13) | STATE WELL NO./STATION NO. T (14–25, 26) | YR. MO. DAY (27–32) | TIME (PST) (33–36) | CO. (37–38) | FIELD TEMP. U (39–42, 43)

FIELD EC (44–49) | FIELD PH (50–52) | DO (53–55) | DISCHARGE (CFS) (56–62) | G.H.(FT.) (63–66) | DEPTH (FT.) (67–69) | SAMPLER (70–73) | LK CARD (78) | 1 (79) | CODE DUPE ALL CARDS (80)

TYPE OF ANALYSIS | W.O. NO.

Compound	Storet Code	CAS No.	ug/L
Aldicarb Sulfoxide		1646-87-3	
Aldicarb Sulfone		1646-88-4	
Oxamyl		23135-22-0	
Methomyl	39051	16752-77-5	
3-Hydroxycarbofuran		16655-82-6	
Aldicarb		116-06-3	
Carbofuran	81405	1563-66-2	
Carbaryl		63-25-2	
1-Naphthol		90-15-3	
Methiocarb		2032-65-7	

Date to Lab. _____ Date Analyzed _____ Date Completed _____

Chemist _____ QC No. _____ Checked _____

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

D | T | LAB. NO.

WATER ANALYSIS (CHLORINATED PHENOXY ACID HERBICIDES)

CARD 1

BASIN | STATE WELL NO./STATION NO. | T | YR. | MO. | DAY | TIME (PST) | CO. | FIELD TEMP. | U

FIELD EC | FIELD PH | DO | DISCHARGE (CFS) | G.H.(FT.) | DEPTH (FT.) | SAMPLER | LX CARD | CODE DUPE ALL CARDS

TYPE OF ANALYSIS Code 6 | W.O. NO.

Compound	Storet Code	CAS No.	ug/L
Dicamba		1918-00-9	
MCPP		93-65-2	
Pentachlorophenol (PCP)		87-65-2	
Dichlororop		120-36-5	
2,4, - D	39736	94-75-7	
MCPA		94-74-6	
2,4,5 - TP	39760	93-72-1	
2,4,5 - T	39740	93-76-5	
2,4, - DB		94-82-6	

(above includes salts and esters)

Date to Lab _____ Date Analyzed _____ Date Completed _____

Chemist _____ QC No. _____ Checked _____

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER ANALYSIS (MISCELLANEOUS PESTICIDES)

D (1) T (2) LAB. NO. (3–8)

CARD 1

BASIN (9–13) | STATE WELL NO./STATION NO. (14–25) | T (26) | YR. (27–28) | MO. (29–30) | DAY (31–32) | TIME (PST) (33–36) | CO. (37–38) | FIELD TEMP. (39–42) | U (43)

FIELD EC (44–49) | FIELD PH (50–52) | OO (53–55) | DISCHARGE (CFS) (56–62) | G.H.(FT.) (63–66) | DEPTH (FT.) (67–69) | SAMPLER (70–73) | LK CARD (78) | 1 (79) | CODE DUPE ALL CARDS (80)

TYPE OF ANALYSIS: O & M Misc. Pesticides

W.O. NO.:

Compound	Storet Code	CAS No.	ug/L
Acephate		30560-19-1	
Glyphosate		1071-83-6	
Aminomethylphosphonic Acid		1066-51-9	
Proparqite		2312-35-8	
Trifluralin		1582-09-8	
Benfluralin		1861-40-1	

Date to Lab._____ Date Analyzed_____ Date Completed_____

Chemist_____ QC No._____ Checked_____

(11/89)

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

LAB. NO. (1–6)

PHYTOPLANKTON ANALYSIS

STATION NUMBER (7–18) | YR MO DAY (19–24) | TIME (PST) (25–28) | FIELD TEMP U (29–32) | FIELD EC (33–37)

FIELD pH (38–40) | DO (41–43) | FLOW (CMS) (44–48) | SECCHI METERS (49–51) | DEPTH METERS (52–54) | ANALYZED BY (55–56) | MAGNIFICATION (57–59)

NUMBER OF FIELDS READ (60–61) | SETTLING VOLUME (ml) (62–65) | MULTIPLICATION FACTOR (66–69) | PHYTOPLANKTON TOTAL PER ml (70–74) | TOTAL CSU X 10^Y (75–77) | PRESER-VATIVE (78) | CARD 1 (79) | CODE (80)

COLL. BY
COLL. NO.
W.O.
DATE TO LAB.
DATE ANALYZED.

CLASS (1)	GENUS (2–5)	SPECIES (6–9)	SIZE	NUMBER PER ml (10–14)	GROUP (15)	CSU X 10^Y (16–18)	REMARK (19)	CARD CODE (79–80)
								2
								3
								4
								5

ADD. GENERA (1–36)

COMMENTS (37–72)

DWR 3749

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER ANALYSIS (MINERAL)

O | T | LAB NO. (1 2 3–8)

BASIN (9–13) | STATE WELL NO./STATION NO. T (14–25 26) | YR MO DAY (27–32) | TIME(PST) (33–36) | CO. (37 38) | FIELD TEMP U (39–42 43)

FIELD EC (44–49) | FIELD PH (50 52) | D.O. (53 55) | DISCHARGE (CFS) (56–62) | G.H. (FT) (63 66) | DEPTH (FT) (67 69) | SAMPLER (70–73) | LK | CARD | CODE (78 79 80)

TYPE OF ANALYSIS | W.O.

DISSOLVED HARDNESS
____ ml
1 ml = ____ mg $CaCO_3$
as $CaCO_3$ mg/L (9–13)

DISSOLVED CALCIUM
____ ml
1 ml = ____ mg Ca
Ca mg/L (14–19)

DISSOLVED MAGNESIUM
meq/L Hs ____
meq/L Ca ____
meq.L Mg ____
Mg mg/L (20–25)

DISSOLVED SODIUM
dil. ____
% A ____
Curve ____
Na mg/L (26–31)

DISSOLVED POTASSIUM
dil. ____
% A ____
K mg/L (32–36)

DISSOLVED TOTAL ALKALINITY
____ ml 1 ml = ____ mg $CaCO_3$
as $CaCO_3$ (37–40)

pH (45–47)

DISSOLVED SULFATE
____ ml
SO_4 mg/L (48–53)

DISSOLVED CHLORIDE
____ ml
1 ml = ____ mg Cl
Cl mg/L (54–59)

DISSOLVED NITRATE
____ ml
NO_3 mg/L (60–63) (79)

DISSOLVED FLUORIDE
____ ml
F mg/L (9–11)

DISSOLVED BORON
____ ml
A ____ C ____
Factor ____
A (sam) ____
B mg/L (12–16)

CALC. DIS. SOLIDS

TURBIDITY CODE
Candle = C
Bech = A
Hellige = E
Hatch Color-imiter = B
Turb. (17–20) | CODE (21) | R (22)

DISSOLVED SOLIDS
T
____ ml 180 C=a
105 C=s
T.D.S. mg/L (23–28) | T (29)

SPECIFIC CONDUCTANCE 25°C
R (Std) ____
R (sam) ____
Factor ____
Micromohs/cm (30–35)

DISSOLVED SILICA
____ ml
A ____ C ____
Factor ____
A (sam) ____
SiO_2 mg/L (36–38)

Owner ____
Name Address COPY TO OWNER ☐
City Zip Code
Detailed Location ____

____ Hs
____ Ca
____ Mg
____ Na
____ K
meq/L sum

____ Alk
____ SO_4
____ Cl
____ NO_3
____ F
meq/L sum

LAB. (39–42) | OV (43) (79)

DATE TO LAB. ____
DATE STARTED ____
DATE COMPLETED ____
CHEMIST ____
CHECKED ____

REMARKS ____

Sampler ____ of ____

DWR 2241a

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

O (1) T (2) LAB NO. (3–8)

WATER ANALYSIS (MISCELLANEOUS)

BASIN (9–13) | STATE WELL NO./STATION NO. (14–25, 26 T) | YR MO DAY (27–32) | TIME(PST) (33–36) | CO. (37 38) | FIELD TEMP (39–42) U (43)

FIELD EC (44–49) | FIELD PH (50 52) | D.O. (53 55) | DISCHARGE (CFS) (56–62) | G.H. (FT) (63–66) | DEPTH (FT) (67 69) | SAMPLER (70–73) | LK (78) | CARD (79) | CODE (80)

TYPE OF ANALYSIS

W.O.

FIELD RESIDUAL CHLORINE
Cl mg/L (9–12)

METHYLEVE BLUE ACTIVE SUBSTANCES
CODE ABS = A LAS = L
____ ml
A ____ C ____
Factor ____
A(sam) ____
MBAS mg/L (13–16) CODE (17)

OIL AND GREASE
____ ml
O&G mg/L (18–20)

CYANIDE
____ ml
CN mg/L (21–26)

PHENOLS
____ ml
A ____ C ____
Factor ____
A(sam.) ____
as Phenol mg/L (25–31)

SETTEABLE SOLIDS
CODE
____ ml
FIELD = F
LAB = L
ml/L (32 34) CODE (36)
mg/L (36–40)

CHEMICAL OXYGEN DEMAND
____ ml
COD mg/L (41–46)

BIOCHEMICAL OXYGEN DEMAND
Dil ____
Bat. No. ____
Orig ____
Orig.(c) ____
Bat. No. ____
Final ____
Final(c) ____
Diff. ____
Seed ____
Corr. ____
mg/L ____
% Dep. ____
CODE
Thio Factor(O) ____ (F) ____
BOD mg/L (50–54) (55)

SUSPENDED SOLIDS
CODE
____ ml
180°C = 8
105°C = 5
SS mg/L (58–62) (63)
VSS mg/L (64–66)

TANNIN AND LIGNIN
____ ml
as Tannic Acid mg/L (48–49)

COLOR, TRUE
pH (69 71)
Color Units (72–74)

LAB. (75 78) (79)

Owner ____
Name ____ Address ____ COPY TO OWNER ☐
City ____ Zip Code ____
Detailed Location ____

SET UP
Date ____
Time ____
TAKE OFF
Date ____
Time ____

DAY CODE
4 = A
5 = B
6 = C
7 = D
100 = E
OTHER = F

REMARKS ____

TOC VIAL NUMBER(S) ____

Sampler ____ of ____

DATE TO LAB. ____
DATE STARTED ____
DATE COMPLETED ____
CHEMIST ____
CHECKED ____

DWR 2241b

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER ANALYSIS (MINOR ELEMENTS)

D (1) T (2) LAB NO. (3–8)

BASIN (9–13) | STATE WELL NO./STATION NO. T (14–25 26) | YR MO DAY (27–32) | TIME(PST) (33–36) | CO. (37 38) | FIELD TEMP U (39–42 43)

FIELD EC (44–48) | FIELD PH (50 52) | D.O. (53 55) | DISCHARGE (CFS) (56–62) | G.W. (FT) (63–66) | DEPTH (FT) (67–69) | SAMPLER (70–73) | LK (78) | CARD (79) | CODE (80)

TYPE OF ANALYSIS | W.O.

ARSENIC ml A C Factor A(sam) As mg/L D/T (9–15 16)	BARIUM ml A C Factor A(sam) Ba mg/L D/T (17–23 24)	CADMIUM ml A C Factor A(sam) Cd mg/L D/T (25–31 32)	CHROMIUM(all) ml A C Factor A(sam) Cr mg/L D/T (33–39 40)
CHROMIUM(+6) ml A C Factor A(sam) Cr^{+6} mg/L D/T (41–47 48)	COPPER ml A C Factor A(sam) Cu mg/L D/T (49–55 56)	IRON ml A C Factor A(sam) Fe mg/L D/T (57–63 64)	LEAD ml A C Factor A(sam) Pb mg/L D/T (65–71 72 73)
MANGANESE ml A C Factor A(sam) Mn mg/L D/T (9–15 16)	MERCURY ml A C Factor A(sam) Hg mg/L D/T (17–23 24)	SELENIUM ml A C Factor A(sam) Se mg/L D/T (25–31 32)	SILVER ml A C Factor A(sam) Ag mg/L D/T (33–39 40)

LAB (49–52)

(53) (54) (55) (79)

Owner
Name Address COPY TO OWNER
City Zip Code
Detailed Location

ZINC ml
A C
Factor
A(sam)
Zn mg/L D/T (41–47 48)

DATE TO LAB.
DATE STARTED
DATE COMPLETED
CHEMIST
CHECKED

REMARKS

Sampler of

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

O (1) T (2) LAB NO. (3–8)

WATER ANALYSIS (SUPPLEMENTAL MINOR ELEMENTS)

BASIN (9–13) | STATE WELL NO./STATION NO. T (14–25 26) | YR MO DAY (27–32) | TIME(PST) (33–36) | CO. (37 38) | FIELD TEMP U (39–42 43)

FIELD EC (44–49) | FIELD PH (50 52) | D.O. (53 56) | DISCHARGE (CFS) (55–62) | G.H. (FT) (63 66) | DEPTH (FT) (67 69) | SAMPLER (70–73) | LX (75) | CARD (79) | CODE (80)

TYPE OF ANALYSIS | W.O.

ALUMINUM ml A C Factor A(sam) Al mg/L D/T (9–15 16)	ANTIMONY ml A C Factor A(sam) Sb mg/L D/T (17–23 24)	BERYLLIUM ml A C Factor A(sam) Be mg/L D/T (25–31 32)	BISMUTH ml A C Factor A(sam) Bi mg/L D/T (33–39 40)
COBALT ml A C Factor A(sam) Co mg/L D/T (41–47 48)	GALLIUM ml A C Factor A(sam) Ga mg/L D/T (49–55 56)	GERMANIUM ml A C Factor A(sam) Ge mg/L D/T (57–63 64)	LITHIUM ml A C Factor A(sam) Li mg/L D/T (65–71 72 79)
MOLYBDENUM ml A C Factor A(sam) Mo mg/L D/T (9–15 16)	NICKEL ml A C Factor A(sam) Ni mg/L D/T (17–23 24)	STRONTIUM ml A C Factor A(sam) Sr mg/L D/T (25–31 32)	TITANIUM ml A C Factor A(sam) Ti mg/L D/T (33–39 40)

LAB (49–52)
(53) (54) (55) (79)

Owner
Name Address COPY TO OWNER ☐
City Zip Code
Detailed Location

VANADIUM ml
A C
Factor
A(sam)
V mg/L D/T (41–47 48)

DATE TO LAB.
DATE STARTED
DATE COMPLETED
CHEMIST
CHECKED

REMARKS

Sampler of

DEPARTMENT OF WATER RESOURCES
WATER QUALITY SECTION
FIELD DATA COLLECTION SHEET

Run Name: Sampler(s): Sampling Date: / /

EC Meter # _____ Calibrated by ____	pH Meter #____ Probe #____ Calibrated by ____	DO Meter #____ Probe #____ Calibrated by ____

Station Name/Number Lab Codes Req.	Lab No.	Time (PST)	Field Temp	Field EC	Field pH	Field D.O.	TOC Vial#	Misc Comments Locks	Nosuf
Ag Drain on Empire Tract, W.end 8-Mi.Rd. B9V80361299 8 S1,S5	C20122	Typical Range->	26.2 7.3	2546. 0.	7.9 6.1	9.4 0.5	<-Hi <-Lo	NONE	920122
Ag Drain on Empire Tract, W.end 8-Mi.Rd. B9V80361299 8 S1	C20123	Typical Range->	26.2 7.3	2546. 0.	7.9 6.1	9.4 0.5	<-Hi <-Lo	NONE	920123
Ag Drain on Empire Tract, W.end 8-Mi.Rd. B9V80361299 8 S2	C20124	Typical Range->	26.2 7.3	2546. 0.	7.9 6.1	9.4 0.5	<-Hi <-Lo	NONE	920124
Ag Drain on Empire Tract, W.end 8-Mi.Rd. B9V80361299 8 S2	C20125	Typical Range->	26.2 7.3	2546. 0.	7.9 6.1	9.4 0.5	<-Hi <-Lo	NONE	920125
Ag Drain on Empire Tract, W.end 8-Mi.Rd. B9V80361299 8 S3	C20126	Typical Range->	26.2 7.3	2546. 0.	7.9 6.1	9.4 0.5	<-Hi <-Lo	NONE	920126
Ag Drain on Empire Tract, W.end 8-Mi.Rd. B9V80361299 8 S3	C20127	Typical Range->	26.2 7.3	2546. 0.	7.9 6.1	9.4 0.5	<-Hi <-Lo	NONE	920127

NOTE: TAKE 1 EXTRA VIAL FOR TOC DUP ANALYSIS PER RUN FOR BRYTE WHEN DOING TOC ANALYSIS!
NOTE: If Rindge Tr. Combination Changed, contact Jesse Vocque at (209) 957-0256.
S1) THM analyses to be spiked to 60 mg/L Cl2
S2) THM analyses to be spiked to the normal 120 mg/L Cl2
S3) THM analyses to be spiked to 240 mg/L Cl2
S4) THM analyses to be spiked to 120 mg/L Cl2 and BUFFERED
S5) DOC, Br, UVA

APPENDIX D

EXAMPLE

CHAIN OF CUSTODY REPORT

Example

CHAIN OF CUSTODY REPORT

CLIENT:	REPORT TO:	TURNAROUND TIME:		
ADDRESS:				8 HR.
	BILLING TO:	24 HR.	48 HR.	72 HR.
PHONE:		5 DAY	10 DAY	15 DAY
PROJECT NAME/SITE:	PO#/BILLING REFERENCE:			

SAMPLER:	DATE:

SAMPLE ID#/ STATION	SAMPLE DESCRIPTION	NUMBER OF CONT.	TYPE CONT.	SAMPLING TIME/DATE	ANALYSIS REQUESTED										REMARKS	SAMPLE NUMBER

RELINQUISHED BY	DATE	TIME:	RECEIVED BY:	TRAVEL TIME:		
				ON SITE TIME:		
RELINQUISHED BY:	DATE	TIME:	RECEIVED BY:	OTHER:		
				WERE SAMPLES:	YES	NO
RELINQUISHED BY:	DATE	TIME:	RECEIVED IN LAB BY:	PRESERVED ?		
				IN GOOD CONDITION?		

APPENDIX E

DWR BRYTE LABORATORY

WATER ANALYSES CODE AND PRICE LIST

State of California

DEPARTMENT OF WATER RESOURCES

Chemical Laboratory

The Resources Agency

Total $ _____

Date _____

W.O. _____

Unit _____

WATER ANALYSES

Code and Price List

Fiscal Year 1993–94

CODE	TYPE OF ANALYSIS	NO. OF ANAL.	UNIT* PRICE $	CHARGES
	Special and Nonvolume Work	(hr.)	(/hr.)	
1.	Standard Mineral (27-30, 32-4, 39, 41, 54, 58)		135	
2.	Standard Nutrient (40, 43, 45, 46, 48)		95	
3.				
4.	Chlorinated Organic Pesticides		160	
5.	Organic Phosphorous Pesticides		160	
6.	Herbicides (chlorinated phenoxy acid)		240	
7.	Purgeable Organics		240	
8.	Trihalomethane Potential		200	
9.	Carbamates		175	
10.				
11.	Arsenic		43	
12.	Barium		23	
13.	Cadmium		23	
14.	Strontium		13	
15.	Chromium (all valences)		23	
16.	Copper		23	
17.	Iron		23	
18.	Aluminum		23	
19.	Lead		23	

* Volume basis, 12 or more

** Total metal samples are not filtered in the lab and therefore include dissolved, suspended and precipitated metals. Metals not designated Total are filtered in the field or lab and include only dissolved metals. Total Metals Digestion, per sample. Extra charge for Al & Fe, no chg. for As, Hg & Se.

DWR 846 (Rev. 8/93) (1 of 3)

CODE	TYPE OF ANALYSIS	NO. OF ANAL.	UNIT* PRICE $	CHARGES
20.	Manganese		23	
21.	Mercury		43	
22.	Nickel		23	
23.	Selenium		43	
24.	Silver		23	
25.	Zinc		23	
26.	Molybdenum		23	
27.	Calcium		12	
28.	Magnesium		12	
29.	Sodium		12	
30.	Potassium		10	
31.	Lithium		10	
32.	Alkalinity (Total as $CaCO_3$ and pH)		14	
33.	Sulfate		16	
34.	Chloride		11	
35.	Fluoride		18	
36.	Bromide		22	
37.	Iodide			
38.	Silico		11	
39.	Boron		11	
40.	Nitrate plus Nitrite		14	
41.	Nitrate		15	
42.	Nitrite		11	
43.	Ammonia		16	
44.	Organic Nitrogen (requires 43)		28	
45.	Ammonia and Organic Nitrogen		28	
46.	Dissolved Orthophosphate		16	
47.				
48.	Total Phosphorous (not filtered)		28	

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(Form continued on page 130)

(Form continued from page 129)

CODE	TYPE OF ANALYSIS	NO. OF ANAL.	UNIT* PRICE $	CHARGES
49.				
50.				
51.				
52.	Oil and Grease		41	
53.	Methylene Blue Active Substances (surfactant)		40	
54.	Dissolved Solids		14	
55.	Suspended Solids		36	
56.	Suspended and volatile Suspended Solids		40	
57.	Settleable Solids (settleable matter), ml/L		9	
58.	Specific Conductance		8	
59.	Turbidity		9	
60.				
61.	Color ("true")		12	
62.	pH		7	
63.	Chemical Oxygen Demand		38	
64.	Biochemical Oxygen Demand		40	
65.	Biochemical Oxygen Demand (wastewater)		115	
66.	Total Organic Carbon		35	
67.	Tannin and Lignin		14	
68.	Project Std. (11, 15, 16, 17, 19, 20, 23, 25, 27-9, 32-5, 39, 41, 54, 58)		367	
68a.	Project, Additional (12, 13, 18, 21, 24)		135	
69.	Project Partial (27-9, 32-4, 39, 54, 58)		107	
70.	Membrane filtration.		8	
71.	Total Metals Digestion (per sample) **		35	
72.	UVA		12	

APPENDIX F

LABORATORY AND COUNTY CODES FOR LABORATORY SUBMITTAL FORMS

TABLE I LABORATORY CODES					
Code	**Analysis**	**Code**	**Analysis**	**Code**	**Analysis**
1	Standard Mineral (27-30,32-4,39,41,54,58)	25	Zinc	49	Phenol
2	Standard Nutrient (40,43,45,46,48)	26	Molybdenum	50	
3	Purgeable Organics	27	Calcium	51	
4	Chlorinated Organic Pesticides	28	Magnesium	52	Oil and Grease
5	Organic Phosphorous Pesticides	29	Sodium	53	Methylene Blue Active Substances
6	Herbicides	30	Potassium	54	Dissolved Solids
7	Purgeable Organics (GC-MS)	31	Lithium	55	Suspended solids
8	THM Formation Potential	32	Alkalinity	56	Suspended and Volatile Suspended Solids
9	Phytoplankton	33	Sulfate	57	Settleable Solids
10		34	Chloride	58	Specific Conductance
11	Arsenic	35	Fluoride	59	Turbidity
12	Barium	36	Bromide	60	
13	Cadmium	37	Iodide	61	Color
14	Strontium	38	Silica	62	pH
15	Chromium	39	Boron	63	Chemical Oxygen Demand
16	Copper	40	Nitrate plus Nitrite	64	Biochemical Oxygen Demand
17	Iron	41	Nitrate	65	Biochemical Oxygen Demand (Wastewater)
18	Aluminum	42	Nitrite	66	Total Organic Carbon
19	Lead	43	Ammonia	67	Tannin And Lignin
20	Manganese	44	Organic N (requires 43)	68	Project, Standard
21	Mercury	45	Ammonia and Organic N	68a	Project, Additional
22	Nickel	46	Dissolved Orthophosphate	69	Project, Partial
23	Selenium	47		70	Membrane Filtration
24	Silver	48	Total Phosphorous	71	Total Metals Digestion

TABLE II COUNTY CODES			
CODE	**COUNTY**	**CODE**	**COUNTY**
1	ALAMEDA	30	ORANGE
2	ALPINE	31	PLACER
3	AMADOR	32	PLUMAS
4	BUTTE	33	RIVERSIDE
5	CALAVERAS	34	SACRAMENTO
6	COLUSA	35	SAN BENITO
7	CONTRA COSTA	36	SAN BERNARDINO
8	DEL NORTE	37	SAN DIEGO
9	EL DORADO	38	SAN FRANCISCO
10	FRESNO	39	SAN JOAQUIN
11	GLENN	40	SAN LUIS OBISPO
12	HUMBOLDT	41	SAN MATEO
13	IMPERIAL	42	SANTA BARBARA
14	INYO	43	SANTA CLARA
15	KERN	44	SANTA CRUZ
16	KINGS	45	SHASTA
17	LAKE	46	SIERRA
18	LASSEN	47	SISKIYOU
19	LOS ANGELES	48	SOLANO
20	MADERA	49	SONOMA
21	MARIN	50	STANISLAUS
22	MARIPOSA	51	SUTTER
23	MENDOCINO	52	TEHAMA
24	MERCED	53	TRINITY
25	MODOC	54	TULARE
26	MONO	55	TUOLUMNE
27	MONTEREY	56	VENTURA
28	NAPA	57	YOLO
29	NEVADA	58	

APPENDIX G

TEMPORARY ENTRY PERMIT

( ) Exploration

( ) Survey

( ) Construction

District:

Feature:

Parcel No.:

TEMPORARY ENTRY PERMIT

Permission is given to the State of California, Department of Water Resources and its officers, employees, agents and contractors referred to as the State, to enter, with all necessary equipment, upon property in the County of _____, State of California, described as:

for the purpose of

and for such other incidental purposes as may be required, subject to the following provisions:

1. Reasonable precautions will be exercised to avoid damage and protect persons or property.

2. Permittor assumes no liability for loss or damage to property or injuries to or deaths of agents, contractors or employees of the State by reason of the exercise of privileges given under this permit.

3. Nothing in this permit shall preclude Permittor from filing with the State Board of Control a claim(s), for any loss or expense which Permittor or his tenant may suffer caused by or due to exercise by the State of the rights granted by this permit.

4. State agrees to indemnify and hold harmless Permittor from any damage caused by State's activities authorized by this permit. State agrees also to either reimburse Permittor for any damage or destruction to its roads and fences, or other property, occurring by reason of the exercise of rights granted, or to replace or restore said property.

5. This permit expires on _____.

Dated: _____

▶ _____

Permittor ____ Owner ____ Lessee

Acceptance Recommended

_____

_____

_____

Permittor's Address

▶ _____

Land Agent

_____

and Telephone

PERMIT ACCEPTED
State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

By ▶ _____

Chief, Real Estate Branch
Division of Land and Right of Way

DWR 308 (Rev. 9/91)

APPENDIX H

NUMBERING OF SURFACE WATER SAMPLING STATIONS

(From DWR's Bulletin 230-81— Index to Sources of Hydrologic Data)

SURFACE WATER QUALITY STATION INDEX

DWR STATION NAME	DWR STATION NUMBER	AREAL CODE	TOWNSHIP & RANGE	COUNTY	PERIOD OF RECORD	HISTORIC RECORD (NUMBERS OF ANALYSES)						CURRENT RECORD 1971-81 (NUMBERS OF ANALYSES)					
						MIN	NUT	ME	SME	MISC	PEST	MIN	NUT	ME	SME	MISC	PEST

Surface water sampling stations are numbered by one of three systems: by location on a stream or other narrow watercourse, by location on a large body of water, or by location on a feature of the State Water Project. Stations situated on streams are numbered by Stream Sampling Station Number, an extension of the Surface Water Measurement Station Number. Stations situated on a large body of water are assigned a Broad Water Body Station Number. Stations situated on SWP features, which are maintained by the DWR Division of Operations and Maintenance, are numbered in accordance with a system for identification of State Water Project features.

The Stream Sampling Station Number consists of eight characters - a letter and seven digits in the form: A1 2345.67. The first two characters refer to its areal designation (see table below). The next four characters define a station location in relation to other stations in upstream order on a particular stream. The seventh and eighth characters (the final two digits), set off by a decimal point, denote a water quality sampling point located between gaging stations. Where a sampling point is at a stream gaging station, the last two characters are zeros.

A – Sacramento River Area

0 – Sacramento Valley Floor
1 – Pit River
2 – Shasta Lake
3 – Sacramento Valley Westside
4 – Sacramento Valley Northeast
5 – Feather River
6 – Yuba-Bear Rivers
7 – American River
8 – Cache Creek
9 – Putah Creek

B – San Joaquin River Area

0 – San Joaquin Valley Floor
1 – Cosumnes River
2 – Mokelumne-Calaveras River
3 – Stanislaus River
4 – Tuolumne River
5 – Merced River
6 – Fresno-Chowchilla River
7 – San Joaquin River
8 – San Joaquin Valley Westside
9 – Sacramento-San Joaquin

C – Tulare Lake Area

0 – Tulare Lake Valley Floor
1 – Kings River
2 – Kaweah River
3 – Tule River
4 – Green Horn Mountains
5 – Kern River
6 – Tehachapi Mountains
7 – Tulare Lake Basin Westside

D – Central Coastal Area

0 – Santa Cruz
1 – Pajaro-San Benito Rivers
2 – Lower Salinas River
3 – Upper Salinas River
4 – Monterey Coast
5 – San Luis Obispo Coast
6 – Santa Maria-Cuyama
7 – Carrizo Plain
8 – Santa Ynez River
9 – Santa Barbara Coast

E – San Francisco Bay Area

0 – San Francisco Bay
1 – Coast-Marin
2 – Marin-Sonoma
3 – Napa-Solano
4 – East Bay
5 – Alameda Creek
6 – Santa Clara Valley
7 – Bayside-San Mateo
8 – Coast-San Mateo

F – North Coastal Area

0 – Smith River
1 – Lost River-Butte Valley
2 – Shasta-Scott Valleys
3 – Klamath River
4 – Trinity River
5 – Mad River
6 – Eel River
7 – Mattole River
8 – Mendocino
9 – Russian River

G – North Lahontan Area

1 – Surprise Valley
2 – Madeline Plains
3 – Eagle Lake
4 – Susan River
5 – Smoke River
6 – Herlong
7 – Truckee River
8 – Carson River
9 – Walker River

V – South Lahontan Area

0 – Mono Lake
1 – Adobe Valley
2 – Owens River
3 – Cottonwood Creek
4 – Deep Springs
5 – Amargosa River
6 – Ivanpah
7 – Searles Lake
8 – Antelope Valley
9 – Mojave River

W – Colorado River Area

1 – Mojave Desert
2 – Needles-Colorado River
3 – Whitewater River
4 – Carrizo Creek
5 – West Salton Sea
6 – East Salton Sea
7 – Blythe-Yuma-Colorado River
8 – Coyote Wash
9 – Imperial Irrigation District

X – San Diego Area

1 – San Joaquin Creek
2 – Santa Margarita River
3 – San Luis Rey River
4 – San Dieguito River
5 – San Diego River
6 – Sweetwater River
7 – Otay River
8 – Tia Juana River

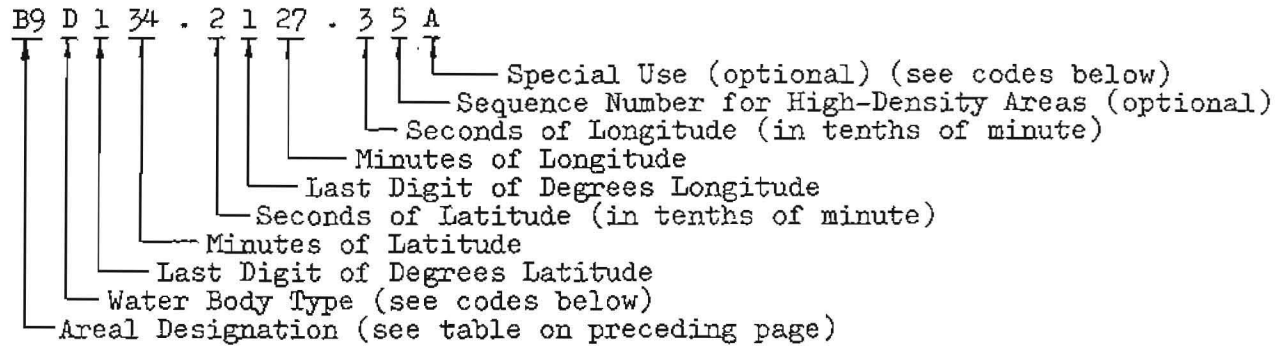
Y – Santa Ana Area

1 – Santa Ana River below Narrows
2 – Chino Creek
3 – Lytle-Cajon Creeks
4 – Warm City Creeks
5 – Santa Ana Headwaters
6 – Santa Ana River above Narrows
7 – San Timoteo Creek
8 – Temescal Wash-Elsinore
9 – San Jacinto River

Z – Los Angeles Area

1 – Ventura River
2 – Lower Santa Clara River
3 – Upper Santa Clara River
4 – Colleguas-Conejo Creeks
5 – Ventura Los Angeles Coastal
6 – Los Angeles River
7 – San Gabriel River above Narrows
8 – San Gabriel River below Narrows

The Broad Water Body Station Number consists of 11 or 13 characters in the form: B9 D 134.2 127.35A.



Water Body Types

B Bay
C Canal
D River delta
L Lake
R Reservoir
V Agricultural drain
X Channel with two-directional flow
Z Sump
E Estuary
S Slough
O Ocean

Special Uses

A Agricultural drainage
I Industrial plant
S Sewage plant

The State Water Project (SWP) Station Number consists of eight characters -- two letters with six digits in the form: AB 0012.34. The first two characters designate a SWP aqueduct or storage facility. The SWP facilities are coded as follows:

Aqueduct

KA California Aqueduct
KC Coastal Branch
KE North Bay Aqueduct
KB South Bay Aqueduct

Storage Facilities

OR Lake Oroville
TF Thermalito Forebay
TA Thermalito Afterbay
TO Thermalito Outlet
LD Lake Davis
FR Frenchman Lake
AN Antelope Lake
DV Lake Del Valle
CC Clifton Court Forebay
BE Bethany Reservoir
ON O'Neill Forebay
SL San Luis Reservoir
PY Pyramid Lake
CA Castaic Lake
QU Quail Lake
TE Tehachapi Afterbay
SI Silverwood Lake
PE Perris Lake

If the feature is an aqueduct, the six digits define the location of the station to the nearest hundredth of a mile along the Aqueduct from its beginning. If the station is situated on a storage facility, the third, fourth, and fifth characters denote the chronological appointment of the station, and the last three characters will always be zeros.

APPENDIX I

SURFACE QUALITY STATION DESCRIPTION

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

SURFACE QUALITY STATION DESCRIPTION

DISTRICT CODE

STREAM STATION NO.

AREAL DESIGN CODE

T/R/SECT.

LATITUDE

LONGITUDE

COUNTY CODE

SWQM STA. NO.

ELEV.

QUAD.

STATION NAME

ALPHA CODE

ROAD LOG

MILEAGE	DESCRIPTION OF ROUTE TO NEXT MILEAGE POINT (INCLUDE LOCKED GATES)

OPERATIONAL FEATURES

ELEV. DERIVED FROM _____ DRAIN. AREA ____ SQ. MI.

AVE. ANNUAL PRECIP.

CHANNEL CHARACTERISTICS:

BOTTOM CHARACTERISTICS:

STREAM FLOW CHARACTERISTICS:

RECORDER: TYPE

SERIAL NO. _____ LOCK NO.

DATE STATION ESTABLISHED

NEAREST GAGE

CHANNEL CROSS SECTION SKETCH

UPSTREAM ACTIVITIES

REGULATION:

DIVERSIONS:

DISCHARGES:

POPULATION:

RELATION OF STREAM TO GROUND WATER:

CONTRIBUTORS TO SILTLOAD:

REMARKS:

LOCATION SKETCH

DWR 2054

APPENDIX J

WELL DATA FORMS & STATE WELL NUMBERING SYSTEM

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

State No. _____

WELL DATA

DISTRICT _____

Owner _____ | State No. _____
Address _____ | Other No. _____
Tenant _____
Address _____

Type of Well: Hydrograph ☐ Key ☐ Index ☐ Semiannual ☐

Location: County _____ Basin _____ No. _____

U.S.G.S. Quad. _____ Quad. No. _____

_____ ¼ _____ ¼ Section _____, Twp. _____, Rge. _____ MD SB H Base & Meridian

Description _____

Reference Point description _____

which is _____ ft. above / below land surface. Ground Elevation _____ ft.

Reference Point Elev. _____ ft. Determined from _____

Well: Use _____ Condition _____ Depth _____ ft.

Casing, size _____ in., perforations _____

Measurements By: DWR ☐ USGS ☐ USBR ☐ County ☐ Irr. Dist. ☐ Water Dist. ☐ Cons. Dist. ☐

Chief Aquifer: Name _____ Depth to Top Aq. _____ Depth to Bot. Aq. _____

Type of Material _____ Perm. Rating _____ Thickness _____

Gravel Packed? Yes ☐ No ☐ Depth to Top Gr. _____ Depth to Bot. Gr. _____

Supp. Aquifer _____ Depth to Top Aq. _____ Depth to Bot. Aq. _____

Driller _____

Date drilled _____ Log, filed _____ open (1) _____ confidential (2) _____

Equipment: Pump, type _____ make _____

Serial No. _____ Size of discharge pipe _____ in.

Power, Kind _____ Make _____

H. P. _____ Motor Serial No. _____

Elec. Meter No. _____ Transformer No. _____

Yield _____ G.P.M. Pumping level _____ ft.

Water Analysis: Min. (1) _____ San. (2) _____ H.M. (3) _____

Water Levels available: Yes (1) _____ No _____

Period of Record: Begin _____ End _____

Collecting Agency: _____

Prod. Rec. (1) _____ Pump Test (2) _____ Yield (3) _____

SKETCH

N

REMARKS

Recorded by: _____

Date _____

DWR 429 (Rev. 4/70)

ORIGINAL
File with DWR

Page ___ of ___
Owner's Well No. _____
Date Work Began _____ , Ended _____
Local Permit Agency _____
Permit No. _____ Permit Date _____

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 425914

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DEPTH TO FIRST WATER _____ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*

TOTAL DEPTH OF BORING _____ (Feet)
TOTAL DEPTH OF COMPLETED WELL _____ (Feet)

WELL OWNER

Name _____
Mailing Address _____
CITY STATE ZIP

WELL LOCATION

Address _____
City _____
County _____
APN Book _____ Page _____ Parcel _____
or
Township _____ Range _____ Section _____
or
Latitude _____ DEG MIN SEC. NORTH Longitude _____ DEG. MIN SEC. WEST

LOCATION SKETCH

NORTH
WEST EAST
SOUTH

Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

___ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
___ Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD _____ FLUID _____

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL _____ (Ft.) & DATE MEASURED _____
ESTIMATED YIELD* _____ (GPM) & TEST TYPE _____
TEST LENGTH _____ (Hrs.) TOTAL DRAWDOWN _____ (Ft.)
* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other _____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME _____
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS CITY STATE ZIP

Signed _____ _____ _____
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV 7-80

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

STATE OF CALIFORNIA
THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

WELL DATA

STATE WELL NUMBER						REG.	BASIN	REFERENCE POINT ELEVATION	AGENCY SUPPLYING DATA
TOWN	RANGE	SEC.	LOT	NO.	BM				

COUNTY	BRANCH	AGENCY WELL NUMBER

NO MEASUREMENT

0. Measurement discontinued
1. Pumping
2. Pump house locked
3. Tape hung up
4. Can't get tape in casing
5. Unable to locate well
6. Well has been destroyed
7. Special
8. Casing leaking or wet
9. Temporarily inaccessible

QUESTIONABLE MEASUREMENT

0. Caved or deepened
1. Pumping
2. Nearby pump operating
3. Casing leaking or wet
4. Pumped recently
5. Air or pressure gauge measurement
6. Other
7. Recharge operation at or nearby well
8. Oil in casing

DATE			N M	Q M	TAPE READING AT R.P.	TAPE READING AT W.S.	R.P. TO W.S.	ELEVATION OF W.S.	OBSERVER — REMARKS
Mo.	Day	Yr.							

DWR 1213

STATE WELL NUMBER						REG.	BASIN	REFERENCE POINT ELEVATION	AGENCY SUPPLYING DATA
TOWN	RANGE	SEC.	LOT	NO.	BM				

COUNTY	BRANCH	AGENCY WELL NUMBER

DATE			N M	Q M	TAPE READING AT R.P.	TAPE READING AT W.S.	R.P. TO W.S.	ELEVATION OF W.S.	OBSERVER — REMARKS
Mo.	Day	Yr.							

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WELL DATA

Monthly ☐ Hyd. ☐ Sampling ☐ Other ☐

Owner..... State No.....

Address..... Other No.....

Tenant..... .....

Address..... .....

Location: County..... Area.....

Region..... Basin.....

USGS Quad..... Quad. No.....

T.....R.....Sec.....Lat....., ... MD SB B&M H

Description.....

.....

.....

.....

SKETCH

.....feet North and.....feet West of SE Sec. Cor.

DWR 274 (REV. 12-64)

DESCRIPTION OF SAMPLING POINT

DESCRIPTION OF REFERENCE POINT

(a).....

....., ... ft. above/below land surface, Date.....

(b).....

....., ... ft. above/below land surface, Date.....

(c).....

....., ... ft. above/below land surface, Date.....

Ref.Pt. Elev.: (a)..... ft.; (b).....ft.; (c).....ft.

Ground Elev.: (a)..... ft ; (b).....ft.; (c).....ft

Determined from: (a).....; (b)..... ; (c).....

DESCRIPTION OF WELL

Use.....Depth.....ft.

Casing: size.....in., perforations.....

.....

Aquifer(s).....

Driller.....

Date drilled..... Log filed: Open ☐, Confidential ☐

DESCRIPTION OF EQUIPMENT

Pump type....., Make.....

Serial No....., Size of discharge pipe.....in.

Motor kind....., Make.....

Horsepower....., Serial No. .....

Elec. Meter No....., Transformer No.....

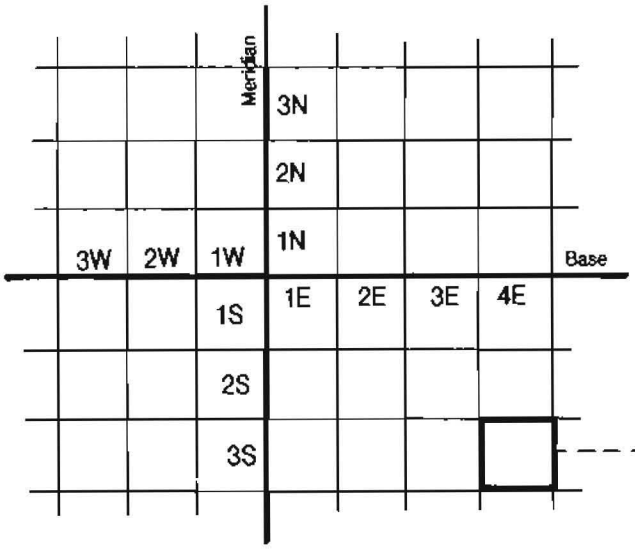
TEST DATA

Agency.....

Date of Test .....19....., Capacity of well.....G P.M.

Static Water Level.....ft., Drawdown.....ft.

STATE WELL NUMBER 03S/04E-36N04S



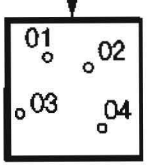
SAN BERNARDINO BASE
AND MERIDIAN
Township and Range
Numbering System

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

TOWNSHIP 03 SOUTH,
RANGE 04 EAST
Section Numbering System

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

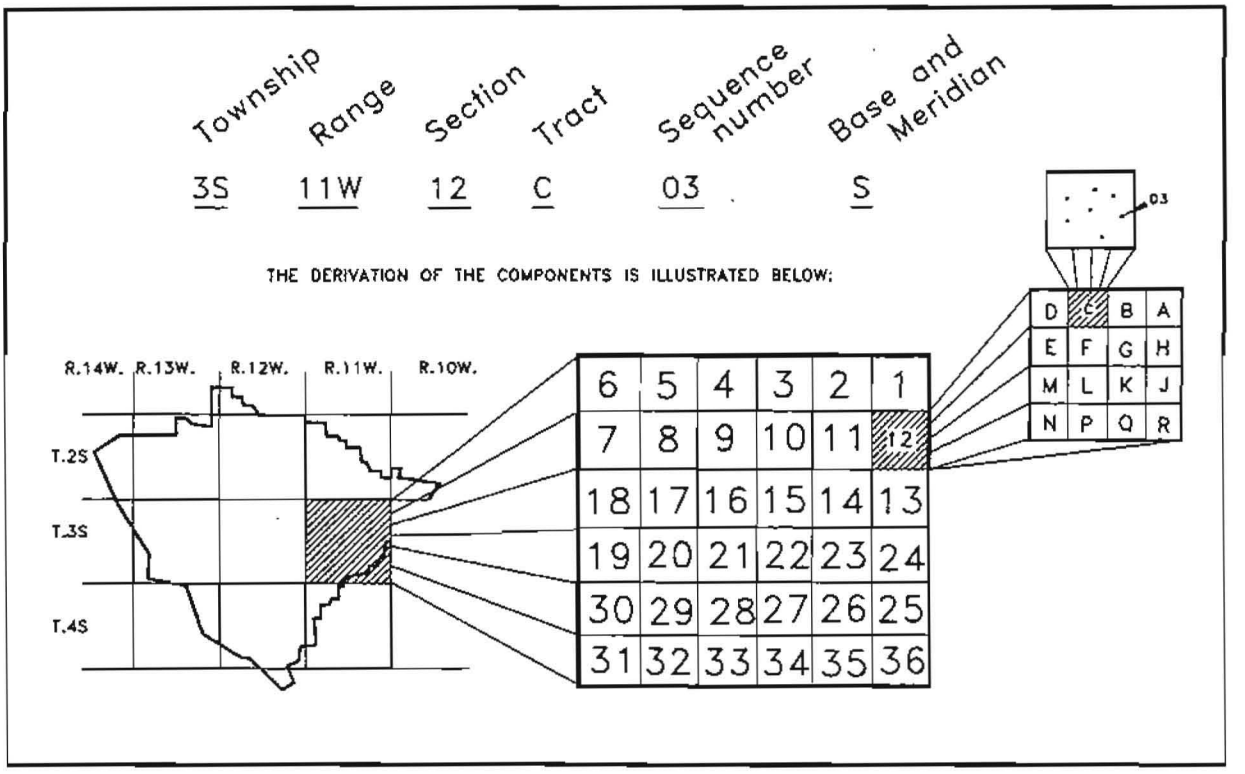
SECTION 36
Tract Numbering System



TRACT "N"
Well Numbering System
and Location

Water Well Identification

State well numbers identifying each water well in the Central Basin are derived from a system based on the U.S. Public Land Survey. Each number consists of township and range designations, a section number, a letter representing the 40-acre tract in which the well is situated, a sequence number indicating the chronological order in which the well number was assigned, and a letter representing the base and meridian. The last letter is frequently omitted from well numbers in a single area beause all wells there share a single base and meridian. The components of Well 3S/11W-12CO3S, for example, are identified below.



SYSTEM FOR WATER WELL IDENTIFICATION

APPENDIX K

EXAMPLE

FIELD LOG BOOK SHEET

Field Log Book Sheet

Sampling Run Name: Samplers: Sampling Date:

Station Name/Number Lab Analysis Codes	Sample ID Number	Time (PST)	Sample Temperature	Specific Conductance	pH	Dissolved Oxygen	Weather Conditions	Tide/Depth/Flow Data	Comments

NOTES:

Ice Chest Number	Transport Temperature°C

Additional copies of this report may be obtained from:

State of California
Department of Water Resources
Bulletins and Reports
P.O. Box 942836
Sacramento, CA 94236-0001
Phone: (916) 653-1097

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