Water Quality Field Manual

for the

State Water Project

May 2006

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Foreword

The State Water Project (SWP) water quality monitoring program is an extensive effort, encompassing monthly collection of physical, chemical and biological samples at more than 30 stations in the California, South Bay, and North Bay Aqueducts and project reservoirs. In addition, automated stations at 13 sites monitor water quality continuously and provide real-time data to SWP water contractors.

Staff of the Division of Operations and Maintenance, Environmental Assessment Branch prepares the Water Quality Field Manual. The purpose is to provide a field reference manual, to document water quality sampling methods, and to serve as a means to communicate program changes to water quality staff in Field Divisions.

The manual, first printed in January 1991, has been extensively modified and updated to include changes in field techniques and modifications to the SWP water quality program. Comments about the manual should be directed to the Environmental Assessment Branch.

Introduction

This manual describes methods of field collection and processing water quality samples from the State Water Project (SWP). The aim of the manual is to provide Division of Operations and Maintenance (O&M) personnel with methods and procedures for collecting, handling, and processing samples for the SWP Water Quality Program.

The main objectives of the Water Quality Program are to:

- Assess the relative quality of SWP water by comparing data to Article 19 water quality objectives, Department of Health Services and EPA Drinking Water Standards.
- Document long-term water quality changes in SWP water.
- Provide SWP contractors with real time water quality data to assess water treatment plant operations.
- Provide long-term SWP water quality data to public and private users.
- Identify, monitor, and respond to water quality emergencies and determine impacts to the SWP.
- Assess the influence of hydrological conditions and water operations on SWP water quality.

The following six sections are included in the manual:

Chapter 1 - *Quick Reference Guide*

Summarizes sample collection and field measurement procedures. Table 1 lists sample bottle and preservative requirements for the most common DWR laboratory analyses.

Chapter 2 - *Water Quality Sampling*

Describes field sampling procedures and recommended types of samplers. Tables include the SWP sampling schedule and recommended water samplers.

Chapter 3 - *Field Measurements*

This section discusses field measurements and information on multi-parameter water quality monitors.

Chapter 4 - *Sample Processing*

Describes quality assurance including collection and handling of field blanks. Procedures for field filtering and tables of sample bottles and preservatives are included.

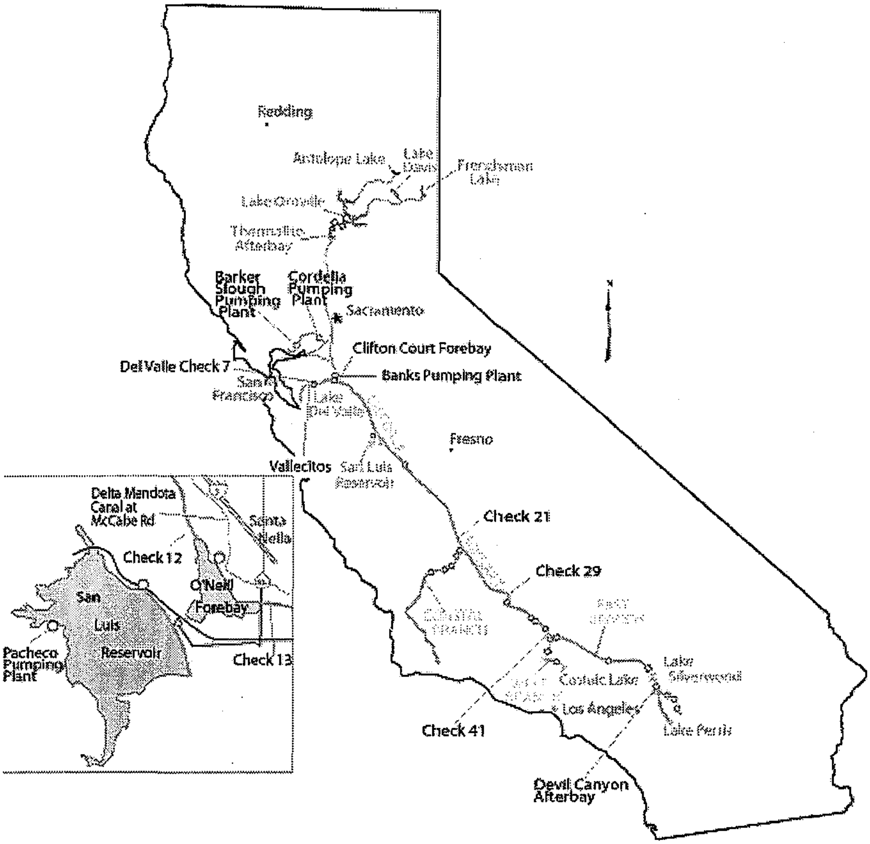
Chapter 5 - *Automated Water Quality Stations*

Information on the automated stations including types of equipment, calibration, maintenance, and data management are presented.

Chapter 6 - *Safety Procedures*

Safety procedures and routines that should be followed during field sampling are addressed.

Figure 1. *Map of the SWP principle monitoring stations*



Chapter One

Quick Reference Guide

Sample Collection

Prior to leaving for field collection

- Create run in FLIMS
- Assemble sampling equipment
- Check all sampling equipment
- Restock chemicals
- Test equipment batteries - carry spares
- Calibrate instruments against standards
- Print FLIMS forms and labels
- Label bottles
- Pack field notebook
- Pack an ice chest with blue ice to keep the collected samples cold

At sampling site

- Collect all required samples **(Table 3)**
- Filter and preserve samples correctly **(Table 7)**
- Collect necessary field blanks and duplicate samples **(Tables 8 and 9)**
- Store samples properly on ice in chest
- Complete forms and field notebook
- Record field measurements

At Bryte Chemical Lab

- Within 24 hours deliver or ship samples, chain-of-custody sheets, and lab forms
- Pick up bottles, distilled water, reference standards and other supplies for next water sampling run

After sampling - at the office

- Check calibration of equipment
- Clean and store field equipment - page 30
- Enter field measurements into FLIMS

Table 1. **Sample Bottle and Preservative Requirements**

Sample Bottle and Preservative Requirements

DWR Code	*Analysis*	***Container***				***Storage and/or Preservation***
		No.	***Type***	***Volume***	***Filter***	
1	Standard Mineral	1 1	Poly Poly	0.5 pt 1.0 qt	yes yes	Acidify (1 mL HNO^3) None
2	Standard Nutrient	1 1	Poly Poly	0.5 pt 0.5 pt	yes yes	Refrigerate (4°C)
3	O & M Misc. Pesticides	1 1	Glass-Amber(s) Glass-Amber(s)	1.0 liter 125 mL	no	Refrigerate (4°C)
4	Chlorinated Pesticides	1	Glass-Amber(s)	1.0 liter	no	Refrigerate (4°C)
5	Nitrogen / Phosphorus Pesticides	1	Glass-Amber(s)	1.0 liter	no	Refrigerate (4°C)
6	Herbicides (chlorinated phenoxy acids)	1	Glass-Amber(s)	1.0 liter	no	Refrigerate (4°C)
7	Volatile Organics	2 1	Glass-amber travel blank	40 mL 40 mL	no no	Refrigerate (4°C) Lab acidified bottle Refrigerate (4°C)
9	Carbamates (EPA 531.1)	1	Glass – clear	125 mL	no	Refrigerate (4°C) Acidified buffer added
*	Phytoplankton	1	Glass	40 mL	no	2 mL Lugol's
56	Suspended Solids (V&S)	1	Poly	1 qt	no	Refrigerate (4°C)
59	Turbidity	1	Poly	1.0 pt [a]	no	Refrigerate (4°C)
66	Total organic carbon	1	Glass-clear(a)	40 mL	no	Refrigerate (4°C) Lab acidified vial
66d	Dissolved organic carbon	1	Glass-clear(a)	40 mL	no	Refrigerate (4°C) Lab acidified vial
68	Project Standard	1 1 1 1	Poly Poly "w" Poly Poly	1.0 qt 1.0 pt 0.5 pt 1.0 pt [a]	yes yes yes no	None Acidify (1 mL HNO^3) Acidify (1 mL HNO^3) None
ASB	Asbestos	1	Glass-clear	1.0 liter	no	Refrigerate – deliver to lab within 48 hrs
T&O	Taste & Odor	1	Glass	40 mL	No	Refrigerate (4°C)

Poly=polyethylene; Poly "w" = acid rinsed Polyethylene

Glass-amber(s) = rinsed with organic solvent;

Glass-clear(a) = with 0.1 mL of pHospHoric acid

[a] ***not required if code 56 submitted.***

**** Code Number Not Specified***

Field Measurements

Oxygen (dissolved) – Page 32
YSI or Hach meters
Units: mg/L
SWP range: 0.0 - 12 mg/L

1. Check the DO meter calibration.

2. Put the DO probe directly in the water or in a container of the water to be measured.

3. Swirl the DO probe if using a YSI meter because the probe consumes oxygen while taking the reading.

4. Record the reading when it stabilizes.

pH - Page 33
Hach Dr-El Engineers Field Kit
Units: pH units
SWP range: ≈ 6.6 - 9.5 units

Calibrate instrument with wide range pH indicator.

Measure pH using 25 mL of raw water.

Acidic = < 7 pH units
Alkaline => 7

Temperature
Units: degrees Celsius (°C)
SWP range: ≈ 10 - 30°C

Field Measurements Continued

Specific Conductance - Page 36

Conductivity meter
Units: µS/cm
SWP range: 100-1600 µS/cm

1. Take measurement directly from water or insert probe into the sample bottle
2. Equilibrate a few minutes before recording the reading

Secchi Depth - Page 44

Secchi Disk, 8-inch diameter
Units: meters
SWP range: 0.1 - 4.0 m

1. Make reading in shaded area.
2. Lower Secchi disk until it disappears.
3. Record depth, then lower an additional few centimeters.
4. Raise Secchi until it reappears, record depth.
5. Average the two readings (#3 & #4), then repeat a second time.
6. Secchi readings can only be taken in calm waters (reservoirs).

Field Measurements Continued

Turbidity -Page 37
Hach 2100P Turbidimeter
Units: NTU
SWP range: <l - l00 NTU

Routine Calibration using Gelex Standards

1. Check instrument with Gelex standards. If the standardization is not within 5% of the established value, calibrate with formazin.
2. Select the automatic range mode using RANGE key.
3. Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicon oil.
4. Place the 0-10 NTU Gelex standard in the compartment. Align the cell diamond with the instrument mark. Close the lid.
5. Press READ. Record value.
6. Repeat steps 3 to 5 for the other Gelex standards (make sure that the vial is oriented properly).
7. Re-assign values to the Gelex standards each time the instrument is calibrated with formazin.

Chapter Two
Water Quality Sampling

Purpose

The goal of field sampling is to obtain samples that are representative of water quality conditions at the time of sampling. It is often difficult to collect a representative sample because water quality in the Aqueduct may change rapidly especially during periods of high pumping. In addition, the numerous steps involved in the sampling process from collection to delivery to the analytical laboratory affect concentrations and forms of some constituents.

Water quality samples are routinely collected at more than 30 stations in the State Water Project **(Table 2)**.

The water quality parameters collected at each station provide important information to meet objectives of the SWP water quality-monitoring program **(Table 3)**.

Water samples must be collected and handled properly to prevent or minimize changes that could affect the concentration of the elements being analyzed. Compounds such as Lugol's solution for phytoplankton and nitric acid for metals (code 68) preserve the samples. Cooling by ice or refrigeration slows down changes in the sample and is another important preservation method.

Sample collection and laboratory analyses are expensive. The quality of the data is directly reflected by the care and attention given to samples in the field. A poorly collected or processed sample can yield inaccurate and misleading information. Important and costly project operation decisions are made based on water quality data. Therefore, water quality sampling is an extremely important task that should be carried out in a conscientious manner and with the greatest possible care.

Table 2. State Water Project Sampling Stations

Station	Type	Mile Post	Description
Oroville Field Division			
LD001000	Reservoir	-	Lake Davis near dam
FR001000	Reservoir	-	Frenchman Lake near dam
AN001000	Reservoir	-	Antelope Lake near dam
OR001000	Reservoir	-	Lake Oroville near dam
◆TA001000	Afterbay	-	Thermalito Afterbay
Delta Field Division			
◆KG000000	Aqueduct	0.00	N. Bay Aqueduct at Barker Slough Pumping Plant
◆KG002111	Aqueduct	21.11	N. Bay Aqueduct at Cordelia Pumping Plant
KA000000	Aqueduct	0.00	Clifton Court Forebay Intake
◆KA000331	Aqueduct	3.31	Harvey O. Banks Pumping Plant
DV000000	Reservoir	-	Lake Del Valle Outlet
DV001000	Reservoir	-	Lake Del Valle at Glory Hole
KB001638	Aqueduct	16.38	S. Bay Aqueduct at Del Valle Check #7
KB002250	Aqueduct	22.50	S. Bay Aqueduct at Vallecitos Turnout
San Luis Field Division			
KA006633	Aqueduct	66.33	Aqueduct at O'Neill Forebay Inlet
◆DMC06716	Aqueduct	67.16	Delta Mendota Canal at McCabe Road
SL001000	Reservoir	-	San Luis Reservoir at Trash Racks
◆SL000000	Reservoir	-	Pacheco Pumping Plant Intake
◆KA007089	Aqueduct	70.89	Aqueduct at O'Neill Forebay Outlet (formerly Check 13)
◆KA017226	Aqueduct	172.26	Aqueduct near Kettleman City – Check 21
San Joaquin Field Division			
KA024454	Aqueduct	244.54	Aqueduct at Check 29
Southern Field Division			
◆KA030341	Aqueduct	303.41	Aqueduct at Check 41
KA040341	Aqueduct	403.41	Aqueduct at Check 66
SI001000	Reservoir	-	Silverwood Lake at dam Outlet
SI002000	Reservoir	-	Silverwood Lake at tunnel Inlet
◆KA041134	Aqueduct	411.34	Aqueduct at Devil Canyon Power Plant Headworks
PE001000	Reservoir	-	Lake Perris at Inlet
PE002000	Reservoir	-	Lake Perris at Outlet
PY001000	Reservoir	-	Pyramid Lake at Tunnel Inlet
CAS00000	Reservoir	-	Castaic Lake Dam Control Building
CA001000	Reservoir	-	Castaic Lake at Inlet
◆CA002000	Reservoir	-	Castaic Lake at Outlet Tower
◆ Principal Water Quality Station			

Table 3. SWP Routine Monitoring Stations

State Water Project Routine Sampling Schedule

Station Name	Station Number	Depth (m)	Project Standard	Nutrients	Pesticides & Herbicides	Organic Carbon, TOC&DOC	UV-254	Suspended Solids, TSS&VSS	Bromide	Taste & Odor (MIB-geosmin)	Phytoplankton	Total & Fecal Coliform	Pathogens EPA 1623	Radiological	Asbestos	Reservoir Profile	Automated Station
Feather River Watershed																	
Antelope Lake	AN001000		A	A													
Frenchman Lake	FR001000		A	A													
Lake Davis	LD001000		A	A													
Lake Oroville	OR001000		M^2	M^2		M^2		M^2									
Thermalito Afterbay	TA001000		M	M				M									
North Bay Aqueduct																	
Barker Slough Pumping Plant	KG000000		M	M	T	M	M	M			M	M	M				#
South Bay Aqueduct																	
Del Valle Check No. 7	KB001632		M	M		M		M		W	M						#
Vallecitos	KB002250		M^1	M^1		M^1		M^1									#
Del Valle C.O.W.	DV000000		M^1	M^1		M^1		M^1		W^1		M^1					#
Del Valle Reservoir	DV001000	0.5		M						M	M	M	M			M	
	DV001000	4	Q	Q		Q		Q		M	M	M					
	DV001000	8								M	M						
San Luis Joint Use Facilities																	
Delta Mendota Canal	DMC06716		M		T	M											
San Luis Res. - Trashracks	SL001000	3	M	M		M				W	M						
Pacheco Pumping Plant	SL000000		M	M		M				W	M						#
O'Neill FB Outlet	KA007089		M	M	T	M	M	M									#
California Aqueduct & Reservoirs																	
Clifton Court Forebay	KA000000		M	M		M		M		W	M						#
H.O. Banks Pumping Plant	KA000331		M	M	T	M	M	M		W	M			Q	Q		#
Check 21	KA017226		M	M	T	M		M							M		#
Check 29	KA024454		M	M	T	M		M									#
Check 41	KA030341		M	M	T	M		M							Q		#
Silverwood Lake	SI001000										W^2					W^2	
	SI002000		Q	M					M		W^2					W^2	
Lake Perris	PE001000										W^2					W^2	
	PE002000		Q	M					M		W^2					W^2	
	PE005000										W^2					W^2	
Devil Canyon Headworks	KA041134		M	M	T	M		M									#
Pyramid Lake	PY001000		Q	M							W^2					W^2	
	PY003000										W^2					W^2	
	PY005000										W^2					W^2	
Castaic Dam Control Bldg	CAS00000																#
Castaic Lake	CA001000										W^2					W^2	
	CA002000		Q	M		M					W^2					W^2	

A=Annually in May
Q=Quarterly (Feb, May, Aug, Nov)
T=Mar, Jun, Sep
M=Monthly (3rd Wednesday)
M^1=Monthly (During Del Valle Releases)
M^2=Monthly (April - November)
W = Weekly
W^1 = Weekly (During Del Valle Releases)
W^2=Weekly (Winter= Bi-monthly)

Sampling Equipment

Water quality parameters measured in the field include dissolved oxygen, pH, temperature, and specific conductance. These parameters can change dramatically before the samples arrive at the laboratory so they need to be accurately measured in the field at the time of collection.

It is important to calibrate field-monitoring equipment according to manufacturer's specifications. Improperly calibrated field equipment can introduce errors. Some parameters such as pH, turbidity, and specific conductance are measured both in the field and laboratory and results are compared.

The equipment used for sample collection should have a minimal impact on the quality of the water being collected. Although difficult to achieve, sampling equipment should not alter the condition of the sample by contamination or physical action, which could affect the laboratory results. For example, certain pesticides can adsorb onto the plastic sides of a sampler or leach compounds into the sample. Metal sampler parts may adsorb or add trace metals and some rubber stoppers used on Van Dorn or Kemmerer samplers may cause trace metal contamination.

* *Disclaimer*

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Types of Samplers

Van Dorn and Kemmerer samplers are the most frequently used water quality samplers **(Figure 2).** The samplers are constructed of a variety of materials including metals: stainless steel, brass, bronze, and nickel-plated brass; and plastics: Teflon®, polyurethane, polycarbonate, acrylic, polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), and silicone rubber.

Metals samplers are durable and do not contain any contaminating organics. One drawback to metal sampler components is the potential of leaching trace metals. Components of plastic samplers may also cause sample contamination. For instance, blue polyurethane used for ring seals on the closing end pieces of old WildCo samplers leach mercury[1] and are unsuitable for trace metal sampling.

Teflon® is an excellent material for sampler construction and suitable for trace metal sampling. It is highly resistant to heat, inert to chemical attack, has poor adsorptive properties, and low leach potential. However, Teflon® samplers usually have a maximum volume of only about I liter. Teflon® equipment is also expensive.

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[1] Glass, G.E. et al. 1990. New sources of mercury contamination in the Great Lakes. Envir. Sci. Technol. 24:1059-1069.

Kemmerer

Kemmerer samplers are also available in a number of different materials. The cylinder walls may be constructed of Teflon®, Stainless Steel (304 or 316), clear acrylic, brass, or polyurethane.

Van Dorn

Van Dorn samplers have several advantages over the Kemmerer and are the recommended sampler for use in the SWP:

1. End stoppers do not interfere with water movement through the sampler
2. No metal rod contacts the sample water
3. Several samplers can be tripped with the same messenger (weight) for multiple depths sampling in a reservoir.

Several different types of construction materials are used for the walls, end seals, and closing tubing. Samplers constructed with blue end seals and black polyurethane closing tubing should not be used for trace metal and organics sampling. Sampler walls should be constructed of either PVC or acrylic. End seals should be made of white polyurethane with amber latex closing tubing or with silicone end seals.

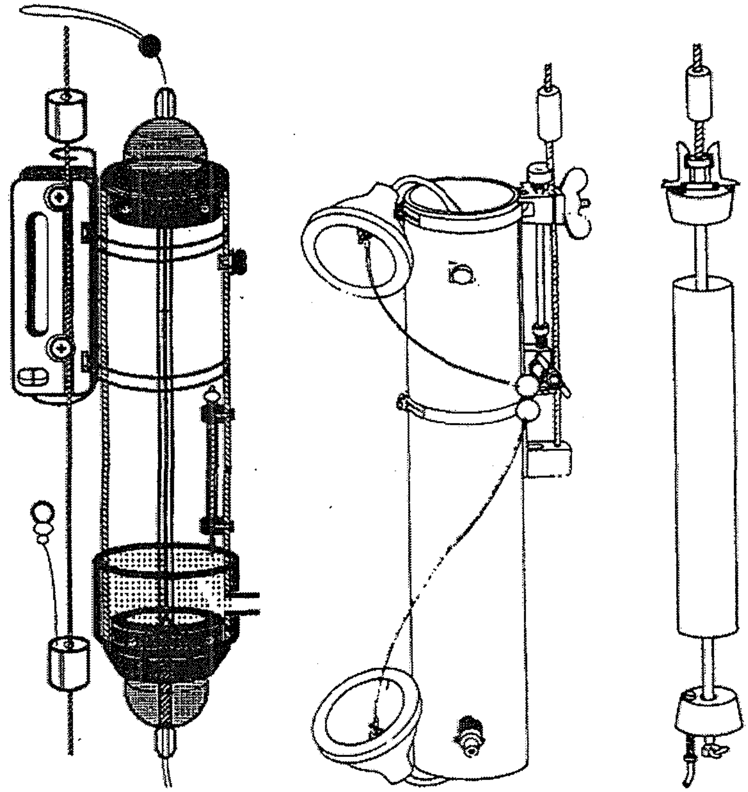


Figure 2. ***Samplers***
Aquatic Research Instruments (left), WildCo (middle), and Kemmerer sampler (right)

Bailers

Bailers are designed for sampling groundwater from wells. The small diameter of the bailer allows passage inside well casings. Larger volumes up to 3.3 liters are available in stainless steel. However, because of the small diameter (3 inches) and long length, bailers are not easy to use for surface water sampling in flowing waters.

San Luis Field Division staff tested the Teflon® bailer in June 1993 and found it awkward to use because of its long length. Since it lacks a closing mechanism, sampling at discrete depths is not possible. Bailers are not recommended for sampling except for ground water collected from wells.

Buckets, Jugs and Sample Bottles

Under certain conditions, buckets can be used to collect water samples. Shortcomings of buckets are that discrete point subsurface sampling is not possible. In addition, surface materials may be collected during sampling and may not be representative of the sample. After sampling, the opening should be covered to prevent air-born materials such as dust from blowing into the bucket and contaminating the sample.

A clean plastic gallon jug or sample bottle may be used to collect surface samples in some situations. The container can be held below the water and filled without collecting contaminates in the surface film. Care must be taken to only use clean containers.

Automated Station Circulation System

At water quality sampling stations that have automated stations, samples can be collected from the circulation system. A hose bib provides pressurized water for filtering samples minutes of purging should be done prior to sampling.

Recommendations

The best way to collect samples is from the automated station circulating system. If needed, best samplers for both trace metal and organics sampling are constructed of polycarbonate, Acrylic or Teflon with no metal parts in contact with the water sample **(Table 4)**. End seals are constructed of silicone or Teflon. End seals constructed of blue or black urethane should not be used because of the possibility of sample contamination. Silicone surgical grade tubing is recommended for sampling equipment used to collect organics and trace metals samples.

For Van Dorn samplers, the Aquatic Research Instruments discrete point sampler and WildCo Beta Plus sampler are recommended **(Figure 2)**.

These recommended samplers can be used for both trace metal and organic sampling. No metal comes in contact with the sample. The samplers allow collection at discrete depths in the water column.

Table 4. **Recommended Water Samplers**

Sampler				Recommend-ations
Van Dorn	*Walls*	End Seals	Tubing	
Aquatic Research Inst.	PCA	PE - silicone	Latex-amber	++
Discrete point sampler				
WildCo Beta Plus ^{tm}	AC	PU – blue	Latex-amber	+
1100 series	PVC	PU – blue	Latex-amber	+
Kemmerer	*Walls*	End Seals	Center Rod	
WildCo Kemmerer Bottles	AC	PU	PVC	+
1200 series	SS304	white/blue Silicone	SS304	++
Bailers	Body	Caps		
WildCo Bailer	SS316	Silicone		++
1280 series				
Buckets	Walls			
	PVC			+
	SS304			+
	SS316			+
Legend	*Abbreviations*			
++ = best	AC	Acrylic	PE	Polyethylene (rigid)
+ = acceptable	PVC	Polyvinyl chloride	SS304	Stainless Steel 304
	PU	Polyurethane	SS316	Stainless Steel 316
	PCA	Polycarbonate		

Sampler Quality Assurance

Procedure

1. Rinse the sampler thoroughly with water after returning from sampling to remove possible contaminants.

2. For a more thorough cleaning of the sampler, first use an alkaline lab detergent, then rinse with a mild acid solution (3% HCL or HNO,) to remove traces of the detergent.

3. Allow the sampler to air dry before storing.

4. *If sampler is stored wet, there is a possibility of mildew, mold, or plastic surface deterioration.*

5. Kemmerer end seals should not be fully closed during storage. The sampler should be stored with the end seals slightly open to prevent damage.

6. Periodically check marked lines for stretching or shrinking. Lines should be measured from the center of vertical samplers.

7. Store the samplers in a clean dark cupboard to avoid contamination and damage from the sun.

8. Check flexible tubing before use for cracks and wear. It is much easier to replace tubing than watch you sampler caps fall to the bottom of the aqueduct or reservoir.

Field Notebook

A field notebook is an important piece of equipment and should always be taken into the field. It is the original document for recording field data and is used as a back up for FLIMS forms.

The following information should be logged in a notebook when water quality samples are collected:

- Station location
- Station number
- Date
- Time
- Sample depth
- Flow
- Sampler's name
- Sample number and lab analysis code number
- Field measurements: including dissolved oxygen EC, pH, temperature, and turbidity.
- Weather
- Secchi depth (lake stations)
- Unusual conditions and other observations

Addresses

Aquatic Research Instruments
P.O. Box 98
218 Main Street
Hope, Idaho 83836

Phone: (800) 320-9482
FAX: (208) 264-5263
E-Mail: hydrobio@aol.com
Website: www.aquaticresearch.com

Wildlife Supply Company (WildCo)
95 Botsford Place
Buffalo NY 14216

Phone: 800-799-8301
FAX: 800-799-8115
E-Mail: goto@wildco.com
Website: www.wildco.com

Chapter Three

Field Measurements

General Considerations

The objective of field measurements is to provide data that closely represents conditions in the aquatic environment at the time of the measurement.

The work area used for sample handling and measurements in the field should be clean. When a truck tailgate is used as a table, it should be covered with white laboratory liners cut to size and taped securely or clean plastic trashcan liners.

Field measurements such as dissolved oxygen, specific conductance or conductivity (EC), pH, Secchi depth (lake sites only), temperature, and turbidity should be made in the field.

Preventive Maintenance of Equipment

After each use rinse all probes with distilled or deionized water.

Change dissolved oxygen probe membranes monthly or whenever readings are erratic and calibration is not maintained. Remove the old electrolyte and add new each time the membrane is changed. Check for air bubbles under the membrane. Tap the probe gently to dislodge bubbles that may be in the body of the probe.

pH probes are kept clean and stored by soaking in commercially available storage solution or pH 4 solution. **Do not use DI water**.

Routine maintenance procedures prescribed in equipment manual should be followed.

Warranties and service contracts should be maintained for major equipment.

Instruments should periodically be sent to the manufacturer for servicing and re-calibration.

Field Chemical Analysis Kits

Kits are available from several venders for field analysis of dissolved oxygen, pH, alkalinity, chloride, and turbidity. Prepared quantities of standard dry reagents (powder pillows) are used or fixed quantities of liquid reagents are dispensed with digital titrators for ease of analysis.

Kits are acceptable for the analyses previously listed, but have limitations which restrict more extensive usage.

These limitations include:

- Generally lower accuracy and precision than laboratory measurements.

- Quality assurance procedures used in the analytical laboratory are not employed for Hach field analyses.

- Results may be influenced (interference) by other chemicals in water that could cause erroneous results.

Do not use kits for field analysis of metals (selenium, mercury, molybdenum) or organic compounds. These analyses should be conducted in a certified analytical laboratory. Under some circumstances, kits can also be used for measuring copper, iron, and manganese.

Dissolved Oxygen

The measurement of dissolved oxygen (DO) is a useful indicator of water quality. Dissolved oxygen in surface waters is derived from the air and from oxygen given off by algae and other aquatic plants during photosynthesis.

Oxygen solubility in water is affected by temperature, pressure (or elevation), and to a lesser degree salinity. The lower the temperature or elevation the more oxygen can stay in solution. At higher temperatures, solubility of oxygen declines.

The most common method for taking field DO measurements is the YSI dissolved oxygen meter, Hach Luminescent Dissolved Oxygen meter (LDO), or Hydrolab Multiparameter monitors. When properly maintained and calibrated, these meters can accurately measure DO and are the preferred method for field DO readings.

The Winkler titration method for determining DO is a very accurate way of measuring DO. It is also fairly laborious to perform. If a DO meter is not available, the Winkler method can be used.

pH (Hydrogen Ion Concentration, Acid-Base)

The pH of a solution is the measure of the hydrogen ion activity and is the logarithm of the reciprocal of the hydrogen ion concentration. It is a very useful measure of water quality and reflects biological or chemical changes in natural water, as well as pollution. A high pH (>8.5) may indicate high levels of algal photosynthesis.

Solutions having a pH less than 7 are described as acidic; solutions with a pH more than 7 are described as basic or alkaline. The pH should be measured in the field immediately after a sample is collected. Chemical, physical, and biological reactions may cause the pH of a water sample to change significantly even minutes after sample collection.

Diurnal Changes in pH

pH usually increases during the day when plant photosynthesis utilizes CO_2 (a weak acid). The degree of pH shift depends on the buffer capacity (alkalinity/acidity) of the water. During the evening, CO_2 is added to the water by plant respiration and the pH will generally decrease

The expected range in the SWP is 6.6 to 9.5

Procedures

There are several methods to measure pH that vary widely in accuracy and precision. Since there are a wide variety of pH meters available, it is important to become thoroughly familiar with the instruction manual provided by the meter's manufacturer.

pH Method - continued

a. Colorimetric

Hach Chemical Company has available a DR-EL Engineers Field Kit for testing for pH. The procedure, outlined in the Hach "Methods Manual" is as follows:

(I) Measure a 25 mL sample using a graduated cylinder and put contents into the bottle provided with the kit. Insert the sample in the opening in the top of the kit and zero the instrument. For frosted bottles, face the clear side with lettering toward the light path.

(2) Add 1 mL of wide range pH indicator solution and swirl to mix. Replace the sample in the instrument. Read pH on the meter scale.

b. pH Meter

(I) Two buffers are needed to calibrate the pH meter. Select buffers of 4 and 7 if the expected pH is less than 7. Use pH- 7 and 10 buffers when the expected pH is greater than 7. The pH buffers must be the same temperature as the sample (within a few degrees).

(2) Remove the plastic protective cap from the electrode prior to calibration and measurement.

(3) Remove the filling plug on refillable electrodes prior to use (usually a rubber plug or sliding sleeve).

(4) Rinse the electrodes with distilled water and dry with soft paper.

pH Method - continued

(5) Set the function switch to pH and adjust the pH meter to the pH of the buffer solution. First calibrate with the pH 7 buffer and secondly with the pH 4 or 10. Rinse the electrode with distilled water and blot dry.

(6) Immerse the electrode in the sample, measure the temperature, and adjust the compensator.

(7) Set the function switch to pH and gently swirl the sample until the pH meter reading stabilizes.

(8) Measurement of pH are reported in pH units and reported to the nearest 0.1 unit.

(9) Read the pH value of the sample and record. Rinse the electrode with distilled water, and store electrode as recommended by the manufacturer.

Specific Conductance (EC)

Conductance is the capacity of water to conduct an electrical current. Specific conductance is the conductance measured at 25°C. Conductivity values increase with temperature at a rate of approximately 1.9% per °C.

The types and quantities of dissolved substances in water determine the specific conductance of water. Conductance is commonly used as an indirect measure of salinity or mineralization of water. Conductance values can also be used to estimate concentrations of bromide, sodium, chloride, total hardness, and other minerals.

Specific conductance of water may change significantly with time because of pollution, precipitation, adsorption, ion exchange, oxidation, and reduction. Therefore, it is important to measure specific conductance or (EC) in the field.

Expected range in SWP = 100-1600 µS/cm.

Procedure

1. Calibrate the conductivity meter with a known conductivity relative to KCl and following the manufacturer's instructions.
2. Place calibrated probe in sample and agitate to move the solution over the probe.
3. Record the reading after the meter has stabilized.

Turbidity Measurements

Suspended matter such as silt, clay, finely divided organic and inorganic matter, soluble colored organic compounds, algae and other microorganisms causes turbidity in water. It is an expression of the optical property of light to be scattered at a 90° angle and absorbed by particulates in the water rather than being transmitted in a straight line.

Turbidity is measured by a nephelometer or a nephelometric turbidimeter. Units are expressed as nephelometric turbidity units (NTUs).

There are two main types of turbidimeters, ratio and non-ratio. A ratio turbidimeter compensates for the *color* of turbidity using multiple detectors. As a result, the ratio turbidimeter will generally read higher than a non-ratio on samples that are colored from dissolved substances and have turbidity greater than about 40 NTU.

Expected range in SWP = <1 to 75 NTU

Standards

There are two types of standards, primary and secondary, used to calibrate a nephelometric turbidimeter. Secondary standards are sealed and usually supplied with the instrument. Since secondary standards will change over time because of deterioration and other factors, primary standards are used to calibrate secondary standards. Primary standards can be prepared with formazin or prepared polymer standards can be purchased directly from Advanced Polymer Systems. Polymer standards using polymer bead require no preparation or dilution.

Hach recommends the use of Formazin but the Department of Health Services (DHS) does not require it.

Standards Continued

An alternative standard is available from Hach called StablCal. However, it is not currently DHS approved for drinking water compliance. StablCal are dilutions of formazin primary standard prepared by a proprietary method that makes low concentrations stable for two years. (See Hach 1998 Catalog, page 206). No refrigeration is necessary and StablCal standards are available in sealed vials that can be used directly on the 2100P. Bulk standards in 500 mL volumes are also available. The response is similar to formazin standard over the entire measurement range. StablCal standards are available in kits with <0.1, 20, 100 and 800 NTU ampules. Mark the expiration date on the standards when they are received and replace them as needed.

Hach 2100A

Several types of nephelometers are used on the SWP; the Hach 2100P (Ratio) and the non-ratio 2100A, 1720C, Surface Scatter 6 and Turner model C4Q-100.

Procedure:

1. The turbidimeter must be warmed up for at least half hour. For bench units the life of the bulb will be prolonged if the instrument is not turned off after each use or at the end of the day.

2. Calibrate the unit using the secondary standards provided with the instrument.

    - Zero the instrument by placing the focusing template into the cell holder.

    - Press the 1.0 range and adjust the zero knob.

    - Insert the secondary standard into the cell holder.

        - Place the light shield over it.

Hach 2100A Continued

- Press the 10.0 range and adjust the span knob to correspond to the NTU value you are using.
- The instrument is ready for turbidity measurements.

3. Thoroughly clean a cuvette (tube) with distilled water.
4. Mix the sample by inverting several times.
5. Rinse the tube twice with sample.
6. Pour the sample down the side of a tilted cuvette to reduce air bubbles that can distort readings.
7. Place the tube in the cell holder. It is important to place each sample in the same position. Mark a spot on the meter and one on each bottle, then aligning the two marks.
8. Place the light shield over it and depress one of the range buttons, 1.0, 10.0 or 100.0.
9. Record the reading.

Note: *A thin layer of silicon oil applied to each cell with a soft, lint free cloth will help minimize the effect of scratches on the cell. Cloth and oil should be purchased from Hach. Cloth must be kept in a sealed bag to keep it clean.*

Hach 2100A Continued

Calibration and Maintenance

The 2l00P is a ratio turbidimeter. Calibration should be done at least monthly using formazin, the primary standard for turbidity. The instruments electronic and optical design provides long-term stability and minimizes the need for frequent calibration.

The 2l00P does not require standardization before every measurement. Prior to use, turbidimeter calibration should be checked against the appropriate Gelex standards. Gelex standards should be aligned properly (the diamond aligns with the orientation mark).

If the standardization is not within 5% of the previous established value, the 2100P should be calibrated with formazin primary standard.

Formazin solutions

Use Hach StablCal standards.
Part No.26594-05 contains
4 standards of <0.1,20, 100, and 800 NTU.

Routine Calibration using Gelex Standards

1. Calibrate the 2100P with formazin (next section).
2. Select the automatic range mode using RANGE key.
3. Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicon oil.
4. Place the 0-10 NTU Gelex standard in the compartment Align the cell diamond with the instrument mark. Close the lid.
5. Press READ. Record value.

Hach 2100A Continued

6. Repeat steps 3 to 5 for the other Gelex standards (make sure that the vial is oriented properly).

7. A re-assign value to the Gelex standards each time the instrument is calibrated with formazin.

Hach 2100P

Calibration using formazin of StablCal

1. Rinse a sample cell several times with dilution water and fill to the line (about 15 mL) or use the <0.1 NTU StablCal ampule.

2. Insert the sample cell and align the orientation mark on the cell with the one on the cell compartment. Close the lid and press **I/O**.

3. Press **CAL**. To get a numerical display press → (right arrow)

4. Press **READ**. The instrument will count from 60 to 0. Read the blank and use it to calculate the correction factor for 20 NTU blank. Remove the sample cell from the compartment.

5. The display will show S1 with the 1 flashing and '"20 NTU". Insert a 20 NTU standard into instrument with the marks aligned properly. Close the lid.

6. Press **Read**. The instrument will count from 60 to 0. Measure the turbidity .The instrument will increment to the next standard. Remove the sample cell from the compartment

2100P Continued

7. The display will show S2 with the 2 flashing and 100 NTU or the value of the last standard. Insert a 100 NTU standard into the compartment Check that the marks on the cell and compartment are aligned.

8. Press **READ**. The instrument will count from 60 to 0. Measure the turbidity and store the value. Remove the cell from the compartment.

9. The display will show S3 with the 3 flashing and 800 NTU or the value of the S3 standard. Insert the S3 standard and with proper orientation into the instrument. Close the lid.

10. Press **READ**. The instrument will again count from 60 to 0. Remove the cell from the compartment.

11. Press **CAL** to accept the calibration (the instrument will automatically return to the measurement mode).

Turbidity Quality Control

1. Keep cuvettes clean and free of dust and scratches. Use a weak acid for cleaning. Fingerprints can affect the turbidity reading, so avoid them on areas where light passes through the cuvette.

2. Use the same cuvette for the standard and the sample when calibrating the primary standards (unless it becomes scratched).

3. Check that the cuvette index mark is aligned properly before making a reading.

4. Turn on the turbidimeter at least 30 minutes prior to measurements.

5. Samples or standards that are cold may cause condensation on the cuvette and affect the readings.

6. Replace expired standards!

7. ***Care should be used when handling formazin. The is toxic and a known carcinogen. Formazin waste should be disposed of properly.***

Secchi Depth

Secchi depth is an index of water clarity and is affected by suspended organic and inorganic matter. Secchi depth is measured with a Secchi disk, first developed by P.A. Secchi in 1865 for a Vatican financed Mediterranean oceanographic expedition.

The disk is attached to a line and lowered into the water until it is no longer visible. The measured distance at that point is the Secchi depth. Secchi depth is a common water quality tool used to indicate the general increase or decrease in plankton and silt concentration. The shallower the disk depth is, the greater the algal or silt concentration.

Expected SWP range = 0.1- 4.0 m

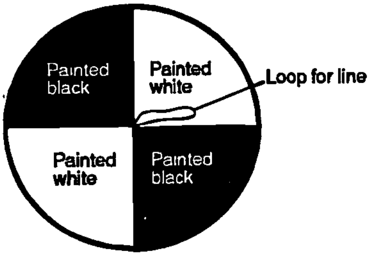


Figure 3. The standard Secchi disk
8-inch diameter circular metal or Plexiglas disk with black and white alternating quarter panels. The disk has a loop or metal eye in the center for attachment to a marked tape or rope.

Secchi Depth -continued

Procedure

1. Slowly lower the disk into the water until it disappears from view. Note this depth.

2. Lower the disk several centimeters.

3. Raise the disk back up until it is visible again and note the depth. Take another reading and average with the first reading.

4. When possible, measurement should be made where the surface water is **shaded**.

Multiparameter Water Quality Monitors

Multiparameter water quality monitors are available from a number of manufactures including Hydrolab, In-Situ, and YSI **(Table 5)**. These instruments can be equipped to measure temperature, dissolved oxygen, specific conductance, pH, depth, oxidation-reduction potential and turbidity. The instruments facilitate reservoir limnological profiles since the probes can be lowered to depths up to 100 meters for quick and accurate measurements.

Advantages of this equipment include:

- Quick and accurate field measurements especially during lake and reservoir profiles.

- Minimizes time in the field.

- Portable Data logging capabilities allow direct entry of data into a computer.

Disadvantages include:

- High initial cost

- Requires regular maintenance and calibration.

Multiparameter Water Quality Monitors -continued

The instruments consist of a surface unit for displaying or storing data, a submersible unit with multiple probes for measuring various parameters, and an underwater cable connecting the two units. Rechargeable batteries supply power, which may be internal or contained in a separate battery case.

Calibration

Sensors should re-calibrated prior to a sampling run. The temperature probe on most units cannot re-calibrated in the field.

Manufacturer's instructions should be followed for specific calibration procedures. In addition, follow the routine maintenance procedures outlined in the instruction manual for each model. These units will need to be sent to the manufacture periodically for maintenance and re-calibration.

Table 5. Multiparameter Water Quality Monitors

Company	**Instruments**	**Address**
Hydrolab	Surveyer 4A DataSonde 4A MiniSInde 4A Hydras 3 Quanta	P.O. Box 389 Loveland, CO 80539-0389 Tele: 800-949-3766 www.hydrolab.com/
Eureka	Manta Amphibian	9715-A Burnet Road Suite 400-A Austin, TX 78758 Tele: 512.302.4333 www.eurekaenvironmental.com
In-Situ	Troll 9000	221 East Lincoln Ave. Fort Collins, CO 80524 Tele: 970-498-1500 www.in-situ.com/
YSI	600 and 6000 series	1725 Brannum Lane Yellow Springs, OH 45387 800.897-4151 www.ysi.com

Reservoir Limnological Profile

Limnological conditions in lakes and reservoirs are rarely uniform from the surface to bottom. Therefore, it is necessary to take a number of measurements at different depths in the water column to measure vertical differences.

The vertical differences are due primarily to changes in the density of water with temperature. At 39 °F (4°C), water is at its maximum density. Warm water, being less dense than cold water, will "float" closer to the surface in a layer known as the **epilimnion (Figure 7)**. Below this layer, a zone exists called the **metalimnion** where water temperature decreases rapidly. The thermocline is a narrow strata of water within the metalimnion where water temperature decrease is maximum with respect to depth. The bottom waters or **hypolimnion** are uniform in temperature and do not freely mix with the warmer upper waters until thermal stratification breaks down in late fall or early winter. The density property of water affects many physical and chemical processes in water.

A vertical profile in a reservoir is useful for a number of reasons. Operations criteria and general water quality can be established. Also, the extent of thermal stratification can be used to predict lake over turn and possible water quality problems when deeper waters are mixed with surface waters.

When profiling a reservoir, a sufficient number of depths should be sampled to determine the main strata in the lake (epilimnion, metalimnion, and hypolimnion). Generally, sampling intervals of one meter are needed where large temperature changes occur with depth. In strata of uniform water temperature, two to five meter intervals are sufficient to characterize the thermal structure of the reservoir.

Addresses

Advanced Polymer
Systems 3676 Haven Avenue
Redwood City, CA 94063

Phone: 800 827-9283

Hydrolab Corporation
P.O. Box 389
Loveland, CO 80539-0389

Phone: 800-949-3766
Fax 970-461-3921
E-Mail: sales@hydrolab.com
http://www.hydrolab.com/

Hach Company
World Headquarters
P. 0. Box 389
Loveland, CO 80539

Phone: 800-227-4224
Fax: 970-669-2932
http://www.hach.com/

Eureka
9715-A Burnet Road Suite 400-A
Austin, TX 78758

Phone: 512-302-4333
http://www.eurekaenvironmental.com

In-Situ
221 East Lincoln Ave.
Fort Collins, CO 80524

Phone: 970-498-1500
http://www.in-situ.com/

YSI
1725 Brannum Lane
Yellow Springs, OH 45387

Phone: 800.897-4151
http://www.ysi.com

Chapter Four

Sample Processing

Sampling Locations

The water quality operations plan for the SWP was initially developed in 1970 by Metcalf and Eddy Engineers (known as the M&E Report). SWP sampling locations on the aqueducts and reservoirs were established to provide of monitoring network that was representative of different conditions in the project. Periodic revisions in sampling locations and parameters are made by the Water Quality Section and the Field Divisions based on requests by the water contractors, or by a need to more accurately measure water quality within a specific reach or section of the SWP.

Aqueduct Sites

Surface samples are usually collected from the aqueduct at a depth of about 3 feet (1 meter). Record the depth accurately on the FLIMS form.

Samples should not be collected from the surface film, which would not be a representative sample. The sample should be taken in free moving water to avoid the sludge and film associated with the walls and bottom of the aqueduct. The exact sample location should be indicated in field notes and on FLIMS lab analysis sheets.

Samples should not be collected from areas that could be contaminated from external environmental sources near the aqueduct, such as crop dusting, dead fish or animals, bird droppings, and dusty wind conditions. Pesticide and herbicide samples could be particularly affected by nearby crop dusting.

Unusual aqueduct conditions should be noted on the laboratory analysis sheet. If there are questions about the sample, call the Water Quality Section or Bryte Lab before submitting it for analysis.

Reservoir Sites

Water quality samples or lake profiles should be taken from established reservoir stations marked by an anchored buoy or identified by a prominent landmark. This location should be verified using a GPS. Surface samples should be collected at about 3-feet (1-meter) depth. Reservoir elevations can be included as a note and entered into FLIMS in the "Sample Description" field. Do not collect surface samples from the surface film. Unusual reservoir conditions should also be noted.

Sample Type

Most water quality samples collected from the SWP are grab or *discrete* samples. That is, they are a single sample from one place and point in time.

Other types of samples can be collected that integrate a number of individual samples into a composite sample. Composite samples are useful if the target parameter is expected to change in concentration in either time or space (depth). Automatic samplers such as those made by ISCO and Manning are available to collect individual samples at specific time intervals and composite them into one sample.

Normally, a single grab sample will be used for ongoing assessment of water quality conditions; however, on some occasions, composite samples may be required.

Automated water quality stations provide composite samples by averaging a series of twelve discrete readings collected at five-minute intervals.

Sample Bottle and Water Requirements

Sample bottles are sized to provide an adequate volume of sample and reserve for laboratory analysis. Bottle materials must be non-reactive with the water sample. Glass or polyethylene bottles are used for all SWP water samples.

Glass is used for most pesticides or organics since some of the constituent compounds can adsorb onto polyethylene. Requirements for each type of analysis in terms of bottle volume and type, preservative, filtering requirements, and holding times are presented in **Table 5**. The FLIMS paperwork and labels will also reflect the bottles needed for the requested analysis.

Gloves worn during sample processing should be powder free vinyl. Latex gloves could contaminate samples with zinc (Bill Nickels, Bryte Lab).

When a sampling run is set up in FLIMS a list of the proper number and type of containers is created for each group of analytes selected, as well as correct sample handling and preservation methods. Follow all of the directions printed on the container labels.

Table 6. Sample Bottles, Preservatives and Holding Times

Code	Analysis	No	Size	Container	Filter	Preserv-ative	Hold Time
1	Standard Mineral 32-34, 39,41, 54,58 27-29	1 1	1 qt 0.5 pt	poly poly	yes yes	None 1 mL HNO_3	7 days
2	Standard Nutrient 40,43,45,46,48	1 1	0.5 pt 0.5 pt	poly poly	yes no	Cool 4 °C Cool 4 °C	28 days
3	O&M Misc. Pesticides Sulfur pest. & glyphosate	1 1	1 L [a] 125mL	glass-clear (s) glass-clear (s)	no no	Cool 4 °C Cool 4 °C	7 days
4	Chlorinated Pesticides	1	1 L [a]	glass-clear (s)	no	Cool 4 °C	7 days
5	Nitrogen/Phosphorus Pesticides	1	1 L [a]	glass-clear (s)	no	Cool 4 °C	7 days
6	Herbicides(chlor. phenoxy acid)	1	1 L [a]	glass-clear (s)	no	Cool 4 °C	7 days
7	Volatile Organics (Incl. MTBE)	3 1	40 mL trip blank	Glass-amber	no	Cool 4 °C	14 days
8	THMFP	4	40 mL	Glass-amber	no	Cool 4 °C	14 days
9	Carbamates (531.1)	1	125 mL	glass-clear	yes	Cool 4 °C	28 days
*	*Unassigned*						
11	Arsenic	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
12	Barium	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
13	Cadmium	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
14	Strontium	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
15	Chromium (all valences)	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
16	Copper	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
17	Iron	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
18	Aluminum	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
19	Lead	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
20	Manganese	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
21	Mercury	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	28 days
22	Nickel	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
23	Selenium	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
24	Silver	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
25	Zinc	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
26	Molybdenum	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
27	Calcium	1	1 pt	poly	yes	1 mL HNO_3	6 months
28	Magnesium	1	1 pt	poly	yes	1 mL HNO_3	6 months
29	Sodium	1	1 pt	poly	yes	1 mL HNO_3	6 months
30	Potassium	1	1 pt	poly	yes	1 mL HNO_3	6 months
31	Lithium	1	1 pt	poly-acid rinse	yes	1 mL HNO_3	6 months
32	Alkalinity	1	1 pt	poly	yes	None	14 days
33	Sulfate	1	1 pt	poly	yes	None	28 days
34	Chloride	1	1 pt	poly	yes	None	28 days
35	Fluroide	1	1 pt	poly	yes	None	28 days
36	Bromide	1	1 pt	poly	yes	None	28 days
37	*Unassigned*						
38	Silica	1	1 pt	poly	yes	Cool 4 °C	28 days
39	Boron	1	1 pt	poly	yes	None	6 months
40	Nitrate+Nitrite	1	1 pt	poly	yes	Cool 4 °C	28 days
41	Nitrate	1	1 pt	poly	yes	Cool 4 °C	28 days

Code	Analysis	No	Size	Container	Filter	Preserv-ative	Hold Time
42	Nitrite	1	1 pt	poly	yes	Cool 4 °C	28 days
43	Ammonia	1	1 pt	poly	yes	Cool 4 °C	28 days
44	Organic N (requires 43)	1	1 pt	poly	yes	Cool 4 °C	28 days
45	Ammonia & organic N	1	1 pt	poly	no	Cool 4 °C	28 days
46	Dis. Orthophosphate	1	1 pt	poly	yes	Cool 4 °C	45 days
47	*Unassigned*						
48	Total Phosphorus	1	1 pt	poly	no	Cool 4 °C	28 days
49	*Unassigned*						
50	*Unassigned*						
51	*Unassigned*						
52	*Unassigned*						
53	MBAS	1	1 qt	glass-clear	no	Cool 4 °C	48 hours
54	Dissolved Solids (TDS)	1	1 pt	poly	yes	Cool 4 °C	7 days
55	Suspended Solids	1	1 pt	poly	no	Cool 4 °C	7 days
56	Volatile & Suspended Solids	1	1 pt	poly	no	Cool 4 °C	7 days
57	Settleable Solids, m\L	1	0.5 gal	poly	no	Cool 4 °C	7 days
58	Specific Conductance (EC)	1	1 pt	poly	no	Cool 4 °C	28 days
59	Turbidity	1	1 pt	poly	no	Cool 4 °C	48 hours
60	*Unassigned*						
61	Color (requires) pH	1	1 pt	poly	no	Cool 4 °C	48 hours
62	PH	1	0.5 pt	poly	no	Cool 4 °C	1 hour
63	*Unassigned*						
64	Biochemical Oxygen Demand	1	1 qt	poly	no	Cool 4 °C	48 hours
65	Biochemical Oxygen Demand (wastewater)	1	1 qt	poly	no	Cool 4 °C	48 hours
66	Total Organic Carbon	1a	40 mL	glass-clear	no	Cool 4 °C	28 days
66D	Dis. Organic Carbon	1a	40 mL	glass-clear	yes	Cool 4 °C	28 days
67	Tannin & Ligands	1	0.5 pt	poly	no	Cool 4 °C	
68	Project Standard 11-13, 15-21, 23-25, 27-29, 32-36, 39, 41, 54, 58, 59	1 1 1 1	0.5 pt 1 pt 1pt 1qt	poly poly poly acid rinse poly	yes no yes yes	1 mL HNO_3 Cool 4 °C 1 mL HNO_3 Cool 4 °C	48 hours
69	Project Partial 27,28,29, 2,33, 34, 39, 41, 54, 58	1 1	8 oz 1qt	poly poly	yes yes	1 mL HNO_3 Cool 4 °C	7 days
70	Membrane Filtration						
71	Total metal Prep						
72	UVA (requires pH)	1	0.5 pt	poly	yes	Cool 4 °C	72 hours
ASB	Asbestos	1	1 liter	glass-clear	no	Cool 4 °C	48 hours
PHY	Phytoplankton	1	100 mL	glass-amber	no	2 ml Lugol's	60 months
T&O	Taste & Odor	1	40 mL	glass-clear	No	Cool 4 °C	14 days

[a] bottle supplied by lab which contains acid preservative

Filtering

A water sample should be filtered immediately after collection to minimize sample degradation in the bottle. Filtering the sample in the field is generally preferred unless the sample can be returned to the office within an hour and filtered.

Water samples are filtered to remove suspended particles from the water while the filtrate (dissolved portion) passes through to a collecting vessel. A 0.45 μ pore size filter is used which is the size that separates suspended from dissolved particles. Filtering is important since a number of chemical analyses are aimed at measuring dissolved concentrations.

Filter Cartridges

Disposable cartridge filters are easy to use and will reduce processing contamination **(Figure 4)**.

Materials

- Gelman 12176 filter
- Ring stand with clamp
- Pump

Procedure

1. Place the outlet of the sampling pump tubing over the inlet fitting of the filter. The flow label on the filter should point away from the pump. Make sure that the fitting is inserted far enough to avoid leakage around the seal. Tubing should be securely connected to the hose barbs (use a hose clamp if necessary).

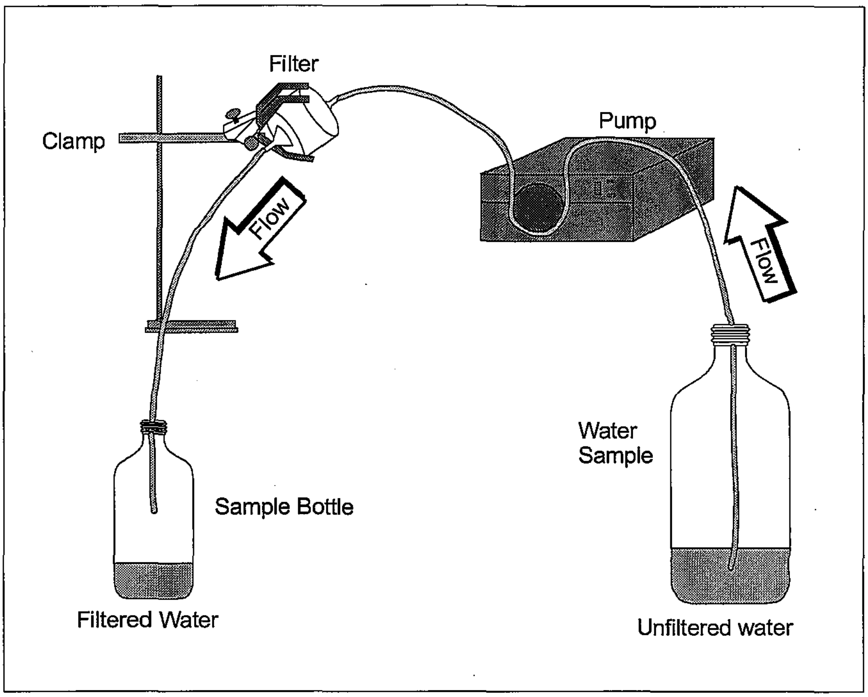
Filtering -continued

2. Hold the filter so that the outlet is directed upward and start the pump. Once air has been purged, attach the filter to a stand in a sideways position so that the filtrate streams horizontally.

3. Flush the cartridge with 500 mL of sample.

Note: *Te filter cartridge should not be used at more than one station to avoid the possibility of cross contamination between sampling sites. This is especially important when sampling sources such as floodwaters, point source discharges, or acid mine drainage.*

Figure 4. **Cartridge filtering apparatus.**



Sample Handling and Transportation

Sample handling and transportation are dependent upon the analysis requested, sample preservation, and travel time to the laboratory. If in doubt, it is best to deliver samples to the lab within 24 hours.

Generally, samples should be delivered to the lab within 24 hrs of collection or shipped by overnight courier service. Ship samples in an ice chest or Styrofoam container. This provides insulation and containment in case of breakage or spillage. Ship samples that require chilling, such as pesticides and other volatile organics, packed in plenty of blue ice or ice.

Remember that it is possible to introduce contamination during transportation and handling. To reduce this risk keep samples in an ice chest away from possible contaminants as soon as the samples are taken. If a sample is taken from a location that might have a high concentration of an analyte, keep it separate from the rest of the samples. Placing samples in ziploc bags can be used as an additional barrier to contamination.

Sample Preservation

Samples are preserved in the field to prevent degradation of the constituents. Typical preservation techniques include cooling the sample, adding acid, or Lugol's solution for phytoplankton. Specific requirements for the field preservation of samples are in **Table 6**, and general considerations are listed below by category:

1. **Metals -** Fixed with 1 mL of nitric (HNO_3) acid to pH<2. Samples are preserved for 6 months.

2. **Nutrients -** Refrigerate or chill to 4 °C and deliver to the laboratory within 24 hours. If delivery to the laboratory within 24 hours is not possible, freeze the samples immediately after collection and keep them frozen until delivery to the laboratory.

3. **Pesticides** - Refrigerate or chill to 4°C and store in a dark location, deliver to lab within 24 hours. Pesticides do not store well and will degrade in light.

4. **Bacteria -Total and fecal coliform** Refrigerate or chill to 4°C and deliver to the lab within 24 hours. Do not add preservatives.

5. **Taste and Odor- MIB and Geosmin** Refrigerate or chill to 4°C and ship to Metropolitan Water District's Laboratory by overnight express mail within 24 hours to:

   MWD
   700 Moreno Avenue
   LaVerne, CA 91750

Sample Preservation General Notes

If in doubt about any sample, it is best to keep the samples chilled in the dark and deliver them to the lab as quickly as possible (within 24 hours). For samples that have a short holding time, coordinate with the lab so they can have the time and staff available the process the samples within the holding time.

Sample Quality Control Data

Quality control during collection, processing, and transportation is an integral part of the SWP water quality program. Quality control procedures are used to assess potential sampling and analytical bias as a result of sample contamination. The quality of the data collected and the validity of any interpretation cannot be evaluated without quality control data.

Two types of samples are used to test sample procedures; blanks and duplicate or replicate samples. Blanks come in three types; trip or blanks, and equipment blanks.

Travel Blanks

Vials or bottles filled with specially prepared water that accompany the sample through all steps of collection and transportation are called travel blanks. These blanks are handled, stored, and treated the same as collected samples. Bryte laboratory prepares and provides these blanks.

Travel blanks are returned to the laboratory and analyzed with the collected sample for the same constituents to determine contamination. Travel blanks accompany VOA samples since contamination from auto exhaust vapors, cleaning chemicals or gasoline could enter the sample vial during collection and transport.

Field Blanks

A field blank is a sample bottle filled with laboratory checked deionized/purified water that is processed in the field, handled the same, and analyzed for the same constituents as the collected sample. The proper preparation of field blanks will ensure that laboratory results reflect actual water quality conditions.

Table 7. Field Blank Sample Requirements

		Bottle				
Code	**Analysis**	**No.**	**Type**	**Volume**	**Filter**	**Preservative**
68	Project Standard	1	Poly "w"	1 pt	Yes	1mL HNO_3
		1	Poly "w"	1 pt	No	1mL HNO_3
7	Purgeable Organics	1	Glass (a)	40 mL	No	Cool 4°C
	Include travel blank from lab					
2	Nutrients	1	Poly	0.5 pt	Yes	Cool 4°C
		1	Poly	0.5 pt	No	Cool 4°C
	[a] Dissolved Trace Metals	1	Poly "w"	1 pt	Yes	1mL HNO_3
		1	Poly "w"	1 pt	No	1mL HNO_3

Poly= polyethylene; Poly "w" = acid rinsed polyethylene; Glass (a) = amber VOA

[a] Taken only for codes 11-26 when code 68 is not collected

Table 8. Stations Recommended for Blank Sampling

	Field Division				
Month	**Oroville**	**Delta**	**San Luis**	**San Joaquin**	**Southern**
Jan	TA001000	KA000331	KA007089	KA024454	KA030341
Feb	-	KG000000	KA017226	-	KA040341
March	OR001000	DV000000	SL001000	-	SI002000
April	-	KA000331	DMC06716	KA024454	PE002000
May	LD001000	KB001632	SL000000	-	KA041134
June	TA001000	KG000000	KA007089	-	KA030341
July	-	DV000000	KA017226	KA024454	KA040341
August	OR001000	KB001632	SL001000	-	CA002000
September	-	KA000331	DMC06716	-	PE002000
October	TA001000	KG000000	KA007089	KA024454	KA030341
November	OR001000	KB001632	KA017226	-	KA040341
December	-	DV000000	SL001000	-	PY001000

Field Blanks -continued

Field blanks are routinely analyzed for trace metals since their low detection limits can pick up low levels of contamination from dust, surface materials, etc.

Field blanks are used to determine if any steps during sample collection, processing, or transportation altered the concentration of the target constituent. Specifically, field blanks demonstrate that:

1. Equipment cleaning protocols adequately remove residual contamination from previous use.
2. Sampling and sample processing procedures do not result in contamination.
3. Equipment handling and transport between periods of sample collection do not introduce contamination.

One set of field blanks should be collected for each sampling event or run (regular monthly, quarterly, annual or special samples) and type of analysis **(Table 7).** Field blanks should be collected at one selected station, as recommended in **Table 8**. Alternative stations are acceptable if selected randomly. Do not use the same station every month for the field blank.

Field blank bottles must be supplied by the laboratory conducting the analysis and be identical to the collected sample in terms of bottle type and preservative

Field Blanks -continued

Fresh deionized/purified (DI) water used in the field blank must be obtained from Bryte Chemical Laboratory. **Commercial distilled water purchased from a store should not be used.** The DI water used should be:

1. Picked up from Bryte Lab every time field blanks are collected, or
2. Taken from unopened supply previously obtained from Bryte Lab.

Procedure

Pour the DI water into the sampler-Kemmerer, Van Dorn bottle, or collection bucket.

Allow the DI water to remain in the sampler for about the same time period as the field sample.

Filtered Blanks - process the DI water from the sampler through the filtering apparatus and into the blank bottle.

Unfiltered Blanks - transfer the DI water from the sampler directly into the blank bottle.

If sampling from an auto-station circulation system, pour unfiltered DI water directly into the bottle and use tubing and clean filter for filtered sample.

Equipment Blanks

Equipment blanks are used to isolate a contamination problem and are only collected to resolve where the contamination is occurring in the sampling process. An equipment blank is collected by rinsing the collecting equipment with DI water and sampling the rinsate. Do not collect equipment blanks unless specifically directed to do so.

Split Replicate Samples

Replicates are produced by splitting a single volume of water into two samples (one primary and one duplicate). Split replicates allow assessment of sources of variability from sample processing, handling, and analysis that can be controlled by field and laboratory procedures. The split replicate assumes that the two sub samples of the collected sample contain equal constituent levels and any variability in the analytical results is the result of errors introduced during handling and laboratory analysis and not caused by short-term environmental fluctuations.

Replicates should be collected by each Field Division at the stations and frequency presented in **Table 9**. The stations are the same as those used for blank sampling (**Table 8**) except that the frequency is reduced. Split replicate samples should be collected annually by Oroville and San Joaquin and bi-monthly in Delta, San Luis, and Southern Field Divisions.

Asbestos monitoring uses split samples because of the high variances in the analytical techniques and the sample environment.

Table 9. Collection frequency and locations for quality control samples.

	Field Division				
Month	**Oroville**	**Delta**	**San Luis**	**San Joaquin**	**Southern**
Jan	-	-		-	
Feb	-	KG000000	KA017226	-	KA040341
March	-	-		-	
April	-	KA000331	DMC06716	-	PE002000
May	-	-		-	
June	TA001000	KG000000	KA007089	-	KA030341
July	-	-		KA024454	
August	-	KB001632	SL001000	-	CA002000
September	-	-		-	
October	-	KG000000	KA007089	-	KA030341
November	-	-		-	
December	-	DV000000	SL001000	-	PY001000

Organic Sampling

Volatile organics samples are compounds with high vapor pressures. Air bubbles in the samples must be avoided because the compounds may volatilize into the bubbles and escape when the container is opened in the laboratory.

Volatile Organic Analysis (VOA)

Forty mL VOA bottles **(Figure 5)** are made of borosilicate glass with a plastic cap with a hole in the center. The Teflon side of the plastic septum inside the cap should be in contact with the sample.

VOA's should be filled to the top with no headspace (air space). The septum allows expansion of the bottle's contents and prevents the container from breaking.

Fill the VOA until a convex meniscus is formed. Carefully place the cap and septum on the vial without trapping any air bubbles. Screw on the cap tightly.

Notes

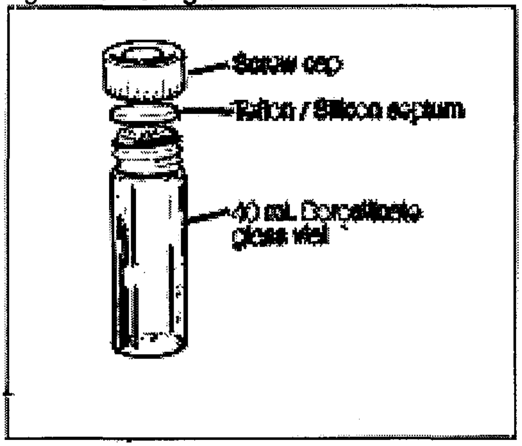
The Teflon side of the septum (the shiny side) should contact the sample.

Do not touch the Teflon side of the septum.

Check for bubbles after screwing on the lid by turning the container over and tapping the bottle. If bubbles are present, remove the lid and top off the vial and re-cap the container.

Volatile Organic Analysis Continued

*Figure 5. **VOA glass vial***



VOA Quality Assurance

Two types of QA samples are utilized during organics monitoring:

Travel or Trip blank
Filled travel blanks should be obtained from Bryte Lab. The travel blank should not be re-opened and should accompany the samples at all times. One travel blank is needed for each group of samples.

Field blank
Fill 2 vials with organic free water during each sampling day. Organic free water is available at Bryte Laboratory.

MIB and geosmin

Two common taste-and-odor causing substances produced by blue-green algae are geosmin and MIB (methylisoborneol). These compounds can be detected by sensitive individuals in the range of 5 ng/L (MIB) and 10 ng/L geosmin and may result in complaints from water consumers.

Samples are collected in 40 mL glass VOA vials. Analysis is done using solid phase micro-extraction (SPME) with results reported in ng/L. Samples should be refrigerated and delivered to the laboratory within 24 hours of collection. The holding time is 48 hours.

Bryte Chemical Laboratory is not equipped to conduct CLSA analysis so arrangements must be made with a contract laboratory prior to sampling. Metropolitan Water District's Water Quality Laboratory in LaVerne analyzes samples for MIB and geosmin for DWR.

These compounds do not pose a health hazard. Taste and odor compounds are a concern because they cause a lack of consumer confidence in the quality of the drinking water provided to the consumers by the water contractors.

Giardia and Cryptosporidium

The pathogenic protozoa's *Giardia* and *Cryptosporidium* in water supplies are responsible for Cryptosporidiosis outbreaks of diarrhea or gastroenteritis. Animals and humans may serve as sources of the protozoa. Possible pathways of contamination in the Aqueduct are runoff from cattle grazing and other surface drainage from surrounding watersheds, or from human waste contamination from swimmers in drinking water sources such as reservoirs, as well as inflow from the delta.

A 10-liter unfiltered sample is needed for a Giardia and Cryptosporidium sample. These samples are not processed by Bryte Laboratory and will need to be sent to a contract laboratory.

Method 1623: Cryptosporidium *and* Giardia *in Water by Filtration/IMS/FA is utilized (EPA 821-R-01-025). Details are available at: http://www.epa.gov/nerlcwww/1623ap01.pdf.*

Water Treatment Plant Sampling

The requirements for collection of bacteriological samples at water treatment plants and within their distribution systems are determined by the Department of Health Services regulations. These guidelines must be followed exactly to be in compliance.

Routine Sampling

Sample collection within treated water distribution system.

1. A Presence/Absence Coliform Test (SM 9221-D) for Total Coliform should be collected at all predetermined TREATED water sample sites. In addition, chlorine residual sample must be collected. This is to prove that there is a trace amount of chlorine within the distribution system.
2. Any lab contract should state that anytime the lab finds a positive result indicating the presence of Coliform that they automatically use the rest of the sample to determine the presence of Fecal Coliform and e-coli.

Sample collection of raw water used at water treatment plant.

1. At the raw water collection site, Total Coliform, Fecal Coliform, and e-coli are collected and analyzed using the multiple tube fermentation method (SM 9221-B) for analysis. At the raw water site, the number of coliforms present is used to make operational changes at the treatment plant.

Repeat Sampling

If a routine sample is Total Coliform positive, collect repeat samples within 24 hours of being notified of the positive result.

1. The repeat sample set must include 3 samples for each Total Coliform positive sample.

    a) The repeat sample set must include the site where the original Total Coliform positive sample was taken. The other two samples should include one sample upstream and one sample downstream of the original Total Coliform positive sample site.

2. The repeat samples must be analyzed for Total and Fecal Coliform and e-coli using the multiple tube fermentation method (SM 9221-B).

3. If any of the repeat samples are positive, collect and analyze additional sets of repeat samples. This shall be repeated until no coliforms are detected in one complete repeat sample set.

4. The Department of Health Services must be notified within 24 hours of a positive result.

Bacteriological Collection Procedure

1. If the faucet has an aerator or strainer, remove it first.

2. Adjust the water flow to a slow, even stream. Allow the water to run about 5 to 6 minutes to assure the water is flowing from the water main, not the building plumbing.

3. Collect a sample for chlorine residual analysis. Using the DPD colorimetric test kit, analyze for residual chlorine, and record the results.

4. The bacteria sample container provided by the laboratory is sterilized and contains a solution of sodium thiosulfate to neutralize any residual chlorine that may be present in the sample. Therefore, do not rinse or overfill the container, touch inner surfaces, or otherwise tamper with the container.

5. When collecting the water sample, hold the cap with the inside pointing down to avoid contamination from airborne bacteria. Do not put the cap down. Hold the bottle near the bottom to avoid contamination from your fingers. Do not touch the inside of the cap or top rim of the bottle.

6. Fill the bottle just to the fill line or shoulder of the bottle. You must collect at least 100 mL of water or the sample cannot be analyzed. Be sure there is airspace above the water in the bottle to allow for mixing before analysis.

Bacteriological Collection Procedure Continued

7. The collected samples must reach the laboratory in time for analysis to begin the same day it was collected. The time elapsing between collection and examination should not exceed 24 hours for the results to be valid. The collected samples must be transported using an iced cooler to at least 4 °C.

Calibration Standards

Standards are samples with a known chemical concentration that are used to calibrate analytical or monitoring equipment

Reference standards are an integral component of quality control. While standards are used routinely in the analytical laboratory, they are also used to calibrate water quality field equipment to assure the instruments accuracy.

Automated water quality field equipment, such as Hydrolab, Foxboro, Hach and Turner turbidimeters require regular calibration. The manufacturers' instructions for calibration and standardization should be closely followed.

To assure that calibrations standards are accurate they need to be prepared from fresh chemicals. When new standards are purchase or prepared write the date on the container in waterproof ink as well as the expiration date. Whenever using the standard be sure that the expiration date has not been exceeded. Place orders for new standards before the old ones expire.

Use good laboratory technique to keep from contaminating the standards. If a chemical standard may have been compromised by contamination, replace it.

FLIMS

All samples are processed and tracked through Bryte Lab by a computerized application known as FLIMS. FLIMS stands for **F**ield and **L**aboratory **I**nformation **M**anagement **S**ystem. FLIMS was developed in house by DWR to manage sample collection information, field data, and laboratory data produced by Bryte Labs. Samples sent to external laboratories can be entered in to FLIMS when creating a sample run, but the final analysis information is not tracked by FLIMS.

Each DWR office that routinely collects samples needs to have a local copy of FLIMS. If your office does not have a local copy of FLIMS or you need training in its use, contact Bryte Laboratory.

FLIMS automates many steps that were previously done by hand. FLIMS allows field staff to generate analytical requests, prepare container labels and chain of custody sheets, record field measurements, and integrate Quality Control samples.

FLIMS has a complete user's guide incorporated into the application. Refer to this guide for specific questions. Below is a discussion of points of particular importance to O&M sampling and data analysis.

FLIMS: Continued

To utilize FLIMS properly it is important to carefully enter default information. These default settings can be changed in individual run templates or sample plans. Important default settings:

- **Mail Contact**: Larry Joyce, O&M Headquarters, Sacramento
- **Station type**: typically use “State Water Project” for aqueduct and reservoir samples in the SWP.
- **Field Measurement Group**: For most sampling sites include water temperature, EC, Turbidity, dissolved oxygen and pH
- **Depth**: Surface samples are taken at 1.0 meters.
- **User Projects**: Routine-monitoring samples will use the “SWP” designation.
- **Water Data Library Fate**: All typical monitoring samples should be set to 3000, viewable by all. Atypical samples should be 1000.
- **Map Datum**: Since all stations will be identified using GPS set this parameter to “WGS84”.

FLIMS Continued

When setting up run templates and individual samples keep the following in mind:

- Unless there is some kind of emergency, the priority should be "5".
- WDL fate should be changed to 1000 if the sample is an atypical sample i.e. samples taken during a copper treatment.
- Sample matrix for most samples is "natural water" and is "purified water" for blanks.
- Be sure to change the sample depth if the sample is not going to be a surface sample (1 meter).
- The sample description box can be used to indicate any additional information that might help identify this sample. If a sample is drawn in an emergency situation and the station information is incomplete or incorrect, this is the place to note the problems.
- Sample Purpose is typically either "normal sample', "sample blank" or "replicate sample". If a sample is atypical use "experimental sample" for the sample purpose. Examples of atypical samples would include: copper treatments, floodwater inflows, chemical spills. Using this code allows the data to be easily separated out when filling data requests for data users outside of DWR.
- Do not forget to enter field measurements into FLIMS within a week of sampling.

New Station Codes in FLIMS

If a sample is collected from a location without an existing code a new code will need to be created. To create a new station code the latitude and longitude is needed so fix the location using a GPS. FLIMS has automated creating new station codes to follow the station naming conventions, below is a summary of water body abbreviations. Properly assigning new station codes is critical. Ask for help from the Database Manager or FLIMS personnel at Bryte if you have problems or questions.

KA	California Aqueduct
KB	South Bay Aqueduct
KC	Coastal Branch
KD	West Branch
KE	Interim North Bay Aqueduct
KF	Peripheral Canal
KG	North Bay Aqueduct
KH	Power Canal
GKA	Groundwater pump-ins
DKA	Drainage into aqueduct
AN	Antelope Lake
BE	Bethany Reservoir
CA	Castaic Lake
DV	Lake Del Valle
FR	Frenchman Lake
LD	Lake Davis
LB	Los Banos Creek Detention Reservoir
LP	Little Panoche Creek Detention Reservoir
ON	O'Neill Forebay
OR	Lake Oroville
PE	Lake Perris
PR	Patterson Reservoir
PY	Pyramid Lake
QU	Quail Lake
SI	Silverwood Lake
TA	Thermalito Afterbay
TF	Thermalito Forebay
TP	Thermalito Diversion Pool

Addresses

Filter Cartridges -vendors
Gelman Model 12176

Gelman Lab
600 South Wagner Road
Ann Arbor, MI 48103-9019

800-521-1520

VWR Scientific
PO Box 7900
San Francisco, CA 94120

Phone: 800-841-0617

Baxter - Healthcare Corporation
Scientific Products Division
PO Box 5011
Hayward, CA 94540-5011

Phone: 800-234-5277

EMSL
1720 South Amphlett Blvd
Suite 130
San Mateo, CA 94402

Phone: 415-570-5401
Fax: 415-570-5402

Chapter Five

Automated Water Quality Stations

Purpose

Continuous remote monitoring is becoming increasing important to SWP operations. Data provided by the automated stations, and confirmed by the monthly water quality-monitoring program, is collected hourly, and summarized weekly. Automated stations are currently installed at 15 locations in the SWP. Stations are equipped to measure specific conductance, temperature, turbidity, fluorescence, UVA, and pH. The configuration of each station is shown in **Table 10**. Data are stored as hourly averages on microprocessor-based data loggers. Computer and telephone modem can access stored data remotely.

The main purposes of the automated water quality stations are:

1. To provide *real time* water quality data accessible to water users by through a modem link.

2. To provide continuous measurements of water quality conditions in the Aqueduct

3. To provide *near real time* data to all users via the Internet during normal business days through daily updates.

Specific conductance, measured at all automated stations, can be used to estimate salinity and concentrations of sodium, chloride, hardness, bromide, and total dissolved solids.

Table 10. Automated Water Quality Stations

Station	Description	Start Date	EC	Temp	Turbidity	Fuorometry	pH	UVA
KG000000	Barker Sl PP	3-89	F	F	HH		H	
KG002111	Cordelia PP	5-89	F	F	HH			
DV000000	Del Valle Outlet	4-96	F	F	HH	TD	H	
KB001638	Del Valle Check	6-94	F	F	HH	AM	H	
KB002250	Vallecitos	8-01	F	F	HH		H	
KA000000	Clifton Court Inlet	3-88	F	F	HH	TD	H	
KA000331	Banks PP	7-86	F	F	HH	AM	H	TY
SL000000	Pacheco PP	7-89	F	F	HH	TD		
KA007089	O'Neill Forebay Outlet	1-90	F	F	HH		ED	TY
KA017226	Check 21	5-90	F	F	HH			
KA024454	Check 29	7-89	F	F	HH			
KA030341	Check 41	12-88	H	H	HH		H	
KA040341	Check 66		H	H	HH			
KA041134	Devil Canyon Headworks	10-95	H	H	HH		H	
	Devil Canyon Second Afterbay			H				
CAS00000	Castaic Lake Outlet	1-92	H	H	HH		H	

F = Foxboro
H = Hanna
HH = Hach
AM = Algae Monitor
TD = Turner Designs
TY = Tytronics
ED = Electrochemical Devices

Data Use

Real-time data such as pH, conductivity, and turbidity are important parameters to SWP contractors. The quality of raw water affects the effort needed to produce quality drinking water. These parameters are measured in raw water to determine the amount of coagulant, disinfectant, and acid needed in the drinking water treatment process.

SWP contractors prefer to know the quality of aqueduct water before it reaches the intake of their water treatment plants. The network of automated stations in the North Bay, South Bay, and California aqueducts allows an instantaneous check of conditions upstream of the water treatment plant intakes. Furthermore, automated stations can measure the day-to-day influence of aqueduct inflows such as drain inlets, groundwater pump-ins, and reservoir releases.

Maintenance

Because the configuration and equipment installed at any given automated station can vary between station and field division, maintenance, calibration, and troubleshooting procedures will not be detailed here.

Instead, generalized procedures currently used by the field divisions will be described. Procedures specific to each meter should be obtained from the original equipment operations manual.

Problems that cause incorrect data to be collected are:

- Biofouling of intake tubes or photo cells
- Inoperative pumps
- Clogging of intake tubes
- Equipment failure
- Electrical or telecommunications problems

Maintenance Continued

Automated stations should be visited at least weekly for calibration and maintenance. Upon arrival, values should be recorded in the station's logbook. Meter components in contact with water (like probes and flow-through cells) should be cleaned.

The exception is the Tytronics UV 254 cell, which rarely needs cleaning because water flowing through the cell is filtered to 0.45 micron.

Automated station adjustments for conductivity and turbidity are usually done by comparison with a calibrated portable meter. The automated station meter readouts are adjusted to match that of the portable meter. The general rule of thumb for most parameters is to obtain an automated station reading that is within 10 percent of actual conditions. The final automated station and portable readouts are recorded in the logbook.

For pH, use a 2 point calibration with a combination of pH 7 and 10 or pH 7 and 4 solutions. Probes are rinsed with D.I. water between calibration solutions. The final automated station and the portable readouts are recorded in the logbook.

The readout of the Tytronics UV 254 meter is compared to the bench top UV254 meter that has been zeroed and filled with environmental water filtered through a Gelman 0.45-micron filter. If the readouts are within 10 percent of each other, nothing more needs to be done. If not, zero the Tytronics with DI water then calibrate with the 0.162 standard provided by Bryte Lab. The final readouts are recorded in the logbook.

Data Loggers

Data loggers record the automated station meters' outputs. The two brands used are Datatakers (Southern Field Division) and Campbell Scientific (all others). Loggers are set up to take readings every 5 minutes and record them as a 1-hour average. The logger data from each station is downloaded almost daily by via modem. The data is processed and reviewed for any potential errors and uploaded to CDEC for permanent storage and public access. A backup copy of the raw data is also available at the field division.

Mandatory Settings

All data loggers must have the output file fields in the following order: date, time, EC, temperature, turbidity, pH, fluorometer, and UVA. If the station does not have one of the listed sensors, skip it and continue with this order. For Campbell data loggers the array ID must be set to 210 for the hourly averages. If the field division chooses to log other data or other time averages, use another array ID designation.

Storing data for non-standard sensors that are not calibrated properly or more frequent time intervals than the standard 1-hour average take up memory on the logger that can be used for more valuable data. Additionally, these data can make the down load time via modem much longer affecting every one who collects data from the station. Plan your data storage programs carefully.

Chapter Six

Safety Procedures

O&M's Safety Rules Manual (May, 2001) should be followed for general safety rules. Section 6 of that manual is devoted to waterways and includes safety information applicable when working around water. The following information is specific to water quality sampling.

General Precautions

Be aware of the following during sampling:

- Loose railings
- Electrical outlets
- Automatic gate movements if station is on control deck
- Low overhangs
- Wet, slippery, concrete decks
- Tripping hazards such as bolts and other protruding objects
- Biting insects such as bees, wasps, black widow spiders, and chiggers
- Rattle snakes

Reservoir Sampling

There are Departmental rules that apply when sampling from a boat. Prior to using a boat for field sampling, an employee must attend the Department's Boat Safety Training class and be trained in CPR and first aid.

These guidelines should be followed when sampling from a boat:

- At least two people should be in the boat.
- Life jackets must be worn and extra flotation devices should be carried aboard.
- A fully charged fire extinguisher must be carried in all powerboats.

Other Concerns

- A non-swimmer should not sample from a boat under any circumstances.
- Do not use a boat that is too small for the job.
- Do not go out in foul weather, rough water, or extremely windy conditions.
- Do not overload the boat and take care to evenly distribute loads in the boat.
- Move carefully in the boat.
- Check the motor operation prior to sampling for proper operation. Carry an extra prop and tools.
- Check all fuel levels before leaving the dock and throughout the trip if necessary.
- Check that all equipment is loaded and working before leaving the dock or shore.
- Use a mechanical winch when lifting heavy equipment over the side of the boat. Extra care should be taken when lifting heavy loads from a small boat.
- Be familiar with and follow all California Boating Laws and U.S. Coast Guard Boating Rules and Regulations.
- Carry a portable two-way radio or cellular telephone.

Chemicals

Chemicals that are potentially hazardous are sometimes used to preserve water quality samples. Fortunately, most of the chemicals are not toxic. When using acids or other potentially hazardous chemicals, wear eye protection, gloves and carry appropriate first aid supplies.

All individuals coming in contact with chemicals must read and understand the Material Safety Data Sheets (MSDS) for each chemical.

Each office must have a clearly labeled binder of current MSDS for all chemicals in use available to all employees. Each time an employee comes in contact with a new chemical he must review the MSDS for that chemical. Supervisors will keep written records of the date that each employee reviewed the MSDS for each chemical.

To insure a safe work environment, properly label all chemical containers. The label must include the following: the name of the chemical, the concentration of the chemical, when it was prepared or opened, who prepared or opened it, and the hazard level of the chemical.

Most chemicals cannot be disposed of in the trash or down the drain. Use proper disposal methods as described by your field division's hazardous materials coordinator.

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