DQM Information Paper 2.1.1
Collection of Water Samples

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1.0 About this Information Paper

This Information Paper (IP) is a new type of guidance, part of the Water Sampling Folder in the Clean Water Team's Guidance Compendium and part of the Data Quality Management (DQM) system. The purpose of this paper is to provide information that may help the user select a water sampling method that is appropriate to his/her water body and access situation. Examples of potential uses for water samples include: field measurements (temperature, dissolved oxygen, pH, etc.); analyses of chemical constituents; suspended sediment determinations; bacterial indicator counts; biota identification and enumeration (phytoplankton, zooplankton, microorganisms populations and functional groups, etc.), and other assessments. The IP features a "method menu" table with a description of some of the available methods, their applications, and their limitations. This IP also provides general practical advice based on The Clean Water Team's (CWT) experience in using these methods. The reader is then referred to the Standard Operation Procedures (SOPs) for step-by-step instructions for each specific procedure.

2.0 Selecting a Method to Collect Water Samples

Table 2.1.1-1 provides a "methods menu" that includes several options to choose from. It is intended to help the user plan the sampling activities in a given Waterbody based on the anticipated access and/or flow conditions, safety concerns, and objectives of the Project.

3.0 Principles of Water Sampling Methods

Water samples can be collected in one of four ways:

- Directly – a hand-held sampling container is dipped in the water and gets filled (water gets in while air gets out of the same opening). The rate of filling depends on the size of the opening. For extended reach, the sampling container can be attached to a pole or a rope and is extended away from the user.
- Displacement, or replacement of air with water - a sampling apparatus that has an intake opening separate from the air outlet is lowered into the water column, water comes in through the intake (which is usually equipped with a pipe leading into the container) and air escapes through the separate hole in the ceiling or the wall of the container. Examples: Kemmerer sampling apparatus, Isokinetic Sampler
- Trapping – a cylindrical apparatus is sent into the water column while open on both ends, and a "messenger" that travels down the line causes it to close and trap the portion of the water column it held. Examples: Nansen bottle, Van Dorn sampler.
- Pumping – water is drawn from the desired location by being "sucked" through a tubing, using a pump of some sort, into a container.

Table 2.1.1-1 Access to Different Types of Waterbodies and Available Sampling Devices

Type of access	Activity or Device	Volume (liter)	Discrete depths	Creeks/Rivers	Ponds/Lakes	Ocean	Surf zone	Mudflats /Wetlands	Notes
Direct	wading		Yes, directly	Approach from downstream, note safety issues	Not recommended (sediment resuspension)	Can't do	From shore out	Careful!	1, 2
Direct	dipping containers from bank		no	does not avoid scum, mud at water edge	does not avoid scum, mud at water edge	Can't do	Can't do	Can't do	
Device from bank or bridge	throwing bucket & rope	5-10	no	Not recommended for rapid currents	Very useful for large samples, does not avoid scum, mud at water edge		Can't do	Can't do	2
Device from bank or bridge	Extending pole and beaker	0.5-1	no	Avoids water edge, allows control	Avoids water edge, allows control				2
Apparatus from bank (with pole or pole & rope) or from bridge (with rope)	Kemmerer, Isokinetic Sampler Van Dorn, Nansen, Syringe pump Inverted bicycle pump Electric pump	0.5 0.5-1 1 0.5-1 0.1-0.2 0.5-2 0.5 -20	yes	Kem, VanD, Nans are not recommended in rapid currents; Isokinetic & pumps OK in current and good for depth integration	All useful except the Isokinetic Sampler				2,3
Boat (direct or with apparatus)	Variable		Enables, with apparatus	Carefully	Very useful	Very useful	Can't do	High tide only	2

Notes
1. Wading often requires specialized gear such as hip waders, chest waders, or "mud floats" (small inflated inner-tube under platform with straps to hold boot)
2. A sampling apparatus is defined here as a gadget that allows for collection of water from a desired depth (Kemmerer, Van Dorn, syringe, inverted bicycle pump). Bucket plus rope and pole plus beaker are referred to as "Devices". The major difference is about the way water is taken in.
3. Most sampling apparati allow for depth-integrated sampling, but getting a representative sample requires knowledge of depth and control over the speed of moving the apparatus up and down the water column.

4.0 Monitoring tips

4.1 How clean is "clean"?

It is very important to decontaminate beakers, buckets, and all other devices used to fetch the water from the source and transfer it into the (dedicated, pre-cleaned) sample container that eventually gets shipped away from the source for analysis. Cleaning sampling devices should be done before and after each trip as well as between samples. Thorough cleaning, herewith referred to as, "decontamination" can be done with Alconox (a detergent that does not leave residues on utensils) followed by a thorough rinse with tap water and then with deionized water. In some cases, it is not necessary to decontaminate between samples taken on the same trip in the same waterbody.

Whenever possible, any sample collection efforts for non-sterile purposes should include rinsing of devices and container in sample water. Devices, apparati, and containers should be rinsed three times with sample water, taking care to dispose the rinse water away from the sampling location, prior to collection of the sample that will be shipped to a laboratory or analyzed in the field.

The user is encouraged to seek specific advice on disinfecting bucket, beaker, etc. if used to collect a water sample aseptically and then transfer it into a sterile sample container (e.g., for Coliform counts). Generally, it is recommended to collect samples for bacteria directly into a sterile sample container.

4.2 Never get separated from your pole

The telescopic pole is a very useful companion to any sampling effort: as a handle for a sampling device, as a rigid length measurement device, as a probe holder, and as a third leg to support operators climbing steep and slippery banks! A pole and beaker sampling device allows collection of samples away from the scum and mud sometimes found at the water edge. When you cannot wade in or collect a sample from a bridge and you need to collect a sample from the bank, a pole and beaker is crucial for the collection of a representative sample. A pole is essential for extending instrument probes (that are mounted on long cables) into the desired location in the river if you are standing on the bank - you just cannot do it without a pole because the probe falls to the bottom. Moreover, in slow-moving waters the dissolved oxygen (DO) electrodes without stirrers require rapid movement; a pole can enable this while a cable cannot. Another good use of a pole is for a sterile sampling container that can be attached to the pole using a clip, a steel loop, or a Velcro "harness".

4.3 Lines and Poles: How deep is the intake?

Rigid poles with marks at given length intervals are very useful for getting to a known depth even if there is flow. When sampling from a bank, the pole can be inserted at an angle and the length of pole submersion can be recorded; if the angle is also recorded, the actual intake depth can be calculated using simple triangulation.

Lines that carry marks at given length intervals, and are used to bring a sampling intake or a probe to a desired depth, should always be made of ropes or cables that do not stretch (Note: Oceanic research vessels have steel cables, cranes, reels, and distance counters that tell the researchers how deep the end of the line is. For citizen monitors, marked lines are probably the best option. Length intervals marks are applied to lines either directly (with a permanent marker on the line itself) or by attachment of an adhesive tape, as a small cylinder on the line or as a "flags" made of masking tape or duct tape that extends outwards. **The most prevalent source of error in depth documentation is the line!**

When using direct marks, make sure somebody is counting them carefully as the sampler goes down, and think about attaching temporal clips or fasteners to mark your depth on the line so you don't lose it while working at a given depth. Some folks use two or more marker loops to denote 10s or 100s (e.g., of feet), others make a knot or two on the line to achieve the same effect. Knots are not appropriate if the line is to be used to deploy a water trapping device that gets triggered by a "messenger"; which is essentially a heavy cylinder sent down the line (see Section 3 above)

Use adhesive tape markers only if you can assure that they do not slide on the line. Braided ropes may allow you to insert a tape between the different strands of the rope. The good thing about flags is that you can write numbers on them, even in large font! Again, flagged line are not appropriate if the line is to be used to deploy a water trapping device that gets triggered by a messenger because you cannot send a messenger down a flagged line.

Marking length intervals on lines, whether on flags or just around the line itself, is often color coded. LaMotte sells their lines with meters marked in red, and 50 cm intervals marked in black; CWT has adopted the same code and adds 10 cm intervals in blue. Green is not recommended for this purpose – it is hard to see. Obviously, lines that need to be marked directly cannot be made of dark material.

Lines and poles used for depth measurements are Instruments, and can be described by DQM tools in the same way as other Instruments. For example, the accuracy and precision of the Secchi disk depends on the line, and the description of the line features (e.g., range and resolution) are an integral part of the Instrument description (in the "INSTRUMETH" table of the DQM Project File). Lines and poles are said to be "calibrated" when initially marked. If you mark a new line yourself, remember that the tape measure used for marking is a Standard (with features recorded in the STANDARDS table of the DQM Project File) and that your action can be documents in the CALIBRATION AND ACCURACY CHECKS table of the DQM Project

File. All marked lines and poles do require periodic Accuracy Checks, preferably with a certified measuring tape, and the CALIBRATION AND ACCURACY CHECKS table of the DQM Project File provides placeholders for these records as well (see SOP-9.2.1.2 for further details and instructions).

4.4 Comments related to specific Sampling Principles

Direct - Beakers (mounted on poles) and buckets (tied to ropes) are used for direct sampling. They are cheap, easy to assemble and use, always handy, and provide extended reach that allows sampling away from marginal waters. They are totally essential in quiet waters when one needs to collect a representative sample away from the edge. However, catching some surface scum, if present, is inevitable.

Displacement – Various Sampling Apparati with intake tube for water and exit hole for air are available, e.g. the LaMotte Sampling Bottle. The shape and position of the intake is crucial to representativeness. Isokinetic sampling devices have a intake nozzle that "sees" the particles in the water in the same way that they flow by because the current continuously "pushes" a representative stream into a compositing bottle (= sample container). The device can be moved up and down the water column from above to collect a depth-integrated sample. There are hand-held samplers small enough to be mounted on a pole, and heavier units that usually require a cable with a reel or a pulley and are deployed from a crane. Caution: Isokinetic sampling devices keep collecting water even after they are full, and this may cause further accumulation of heavier particles - creating a bias in their representation.

Trapping – The Nansen bottle is a water trapping device that has two plugs, one at each end of a cylinder. The orientation of the cylinder, whether horizontal or vertical, is crucial to representativeness. Vertical orientation creates less disturbance (than horizontally-oriented cylinder) as the cylinder is lowered through the water column, and has a better potential to "slice its way" and capture the water layer that is actually present at that depth. In other words, the vertical orientation allows for cleaner depth profiles.

Pumping – Peristaltic Pumps are one example of sampling devices that use tubes to bring water from the desired spot in the water. The efficiency of catching particulate matter in a representative way using pumps depends on the tubing diameter, the flow rate inside the tubing, and the vertical distance, or "head", that the sample has to travel up the tubing. The orientation of the tubing end, or intake, can be detrimental to representativeness. In flowing systems, having the end directed towards the current mimics the isokinetic nozzle in some ways (but is fundamentally different regarding the force that makes the water go into the device). In depth profile sampling (ponds, lakes, ocean), it is recommended to position the intake sideways (either with a rigid "L" or an inverted "T" attached to the end of the tubing); this has a better potential to capture the water layer that is actually present at that depth. Another issue is the ability of the pump to 'suck in' a representative sample or particulates or organisms. Studies show that, in some situations, sampler pumps did not collect sand and other heavy particles during storm event

flows. Pumps usually cannot catch copepods due to their natural response to run away from a current, and only some cladocerans (slower moving organisms) can be caught.

5.0 Sources and Resources

This IP is an integral part of the Data Quality Management (DQM) System implemented by the Clean Water Team, the Citizen Monitoring Program of the California State Water Resources Control Board.

For an electronic copy, to find many more CWT guidance documents, or to find the contact information for your Regional CWT Coordinator, visit our website at www.swrcb.ca.gov/nps/volunteer.html

If you wish to cite this IP in other texts you can use "CWT 2004" and reference it as follows: "Clean Water Team (CWT) 2004. Collection of Water Samples, IP-2.1.1 in: The Clean Water Team Guidance Compendium for Watershed Monitoring and Assessment, Version 2.0. Division of Water Quality, California State Water Resources Control Board (SWRCB), Sacramento, CA."

Available SOPs (2004 Compendium)

- SOP-2.1.1.2 Kemmerer and VanDorn bottles-
- SOP-2.1.1.3 Syringe Pump Apparatus-