# Chapter 5: Sampling for Water Quality

# Sampling for Water Quality

## Introduction

The objective of a sampling program is to obtain measurements for analytes you are interested in. The project design document (see Chapter 4) should provide all the information you need to know about where and what to sample. Good field practices and the development of a **consistent routine** for sampling, preservation, and analysis make sure sample integrity is maintained. This is especially true when sampling personnel may change.

**A Change in Plans**
It is important to note any changes to approved methods, equipment, preservatives, or analytical procedures. It is also important to note why the changes were required. Before making any changes to procedures you must test the result to make sure the changes do not affect the integrity of the data. For example, if a sampling location is going to be moved, carry out several sampling trips with replicate samples from both the old and new locations so you can find and examine any difference between the two. Relocate the sampling station only when the effect of the change is understood and noted. If you are not in control of the change and it cannot be planned for, then you should compare the data from the new site and that of the old after the change.

## Working with a Laboratory

A certified analytical laboratory, carefully selected at the beginning of the project, can provide valuable advice. It can also provide some of the materials and equipment you will need to collect the samples.

Only a laboratory currently accredited and certified to analyze the parameter you are interested in should be used. This is important in order to produce high quality data that can be compared. These labs use specific procedures to provide quality data. Using the same lab for the length of the project reduces one possible source of variation in the results.

In order for procedures to be reliable, you must follow specific collection, preservation and storage requirements. Contact the lab before the sampling date to ask for sample bottles and to get information about the sampling procedures required, sample storage and delivery.

Whenever possible, clean sample bottles should be obtained from the laboratory. The laboratory will send you the bottles they require for each specific sample collection. There are various bottle shapes and sizes made from a variety of materials, depending on the analysis to be performed. The cost of the bottles is included in the price for doing the analysis. The bottles will have been thoroughly cleaned and will be ready for use. Labs run quality control checks to evaluate the bottle preparation procedures. The lab can also provide travel blanks and travel spiked blanks to accompany the samples on the field trip. (More details about this are provided later in the chapter.)

Labs can supply bottles that are treated with preservatives as required by the analysis. They will also provide a statement of the risks linked to these preservatives to ensure that you handle them safely. Alternatively, the lab can provide bulk quantities of preservative, or vials that contain the specific quantity of preservative for a single sample. The method used will depend on the laboratory you are working with, your comfort in handling preservatives which are frequently hazardous (e.g., acids or bases) and logistical difficulties in shipping hazardous goods.

The laboratory will ship bottles with chain of custody or sample submission forms (see below). The bottles will be shipped in an appropriate container such as a cooler with ice packs and with packing material to return the samples in.

It is essential to obtain detailed instructions from the laboratory about things such as rinsing the bottle with the sample, how full to fill a sample bottle for a specific parameter (some require an air space and some do not), and proper preservation techniques. You can ask for a copy of these procedures from the certified lab.

Unless you have the proper equipment and facilities to wash the bottles, order all required bottles from the certified laboratory. However, if you must use your own sample bottles, choose bottles, caps and liners that are free of contamination and suitable for the water quality parameter you are analyzing. They must be cleaned using standardized procedures to make sure the samples are the right quality. The kind of bottle or container you choose depends on what analysis is required. It is very important that the right kind of container is used. For example, samples should not be exposed to certain types of metal containers if an analysis for trace metals is being done. The requirements for the size and shape of bottle are constantly changing. These specifications also vary between different laboratories. Check with a certified laboratory for the latest up-to-date information on recommended container and washing procedures.

## Sample Submission Forms

All samples must be recorded on a **field sample sheet** or **chain of custody form**. Forms used by Environment Canada in the NWT and Nunavut are shown in Figure 5.1 (Field Sample Sheet) and 5.2 (Sample Submission Form). These forms are used to record the possession, handling and analysis of the sample. These and similar forms used by other agencies can include details about the sample collection, events during transportation of the sample, and conditions at the sampling site, including weather observations. This record, depending on its purpose, can be kept from the time the sample is taken to the time analytical data are reported. Such records show who had custody or possession of the sample and where it was at any given time. The forms also provide the laboratory with information on the nature of the sample: when it was collected, for what purpose and under what conditions. All of this information is needed to check if sample integrity was maintained. If possible, these forms should be checked by a co-worker for completeness and accuracy.

Field sample sheets and chain of custody/sample submission forms are the first line of communication with the laboratory. Be sure to fill out any submission sheet in a neat, complete, and orderly manner, and keep it clean and dry. Fill out as much information as possible before leaving on the field trip. This will help to organize the trip, ensure all bottles have been packed, and allow more time in the field to enter information about significant field conditions and events. Enter comprehensive notes on the field sheet describing conditions at the time of sampling (e.g., information about whether the water level is rising or falling, plant growth, ice conditions, possible sources of contamination). It is also a good idea to maintain a log of the sampling trip identifying relevant information that does not fit onto the sample submission sheets. This material will be useful when you or someone else is inspecting the data.

A chain of custody/sample submission form is used if the project is being carried out for a legal reason (e.g., compliance monitoring). This form is critical to the validity or soundness of the project and makes sure that the sample has not been tampered with. It also makes sure that only authorized personnel handle samples, and that proper field sampling techniques for the program are used. All transfers of samples are noted on the form. Transfer procedures are also described to make sure samples are properly protected and preserved. Any changes in sampling or sample storage should be noted on the chain of custody form. The information recorded on the form should be kept on file for the project.

Figure 5.1. Environment Canada Prairie and Northern Region's Field Sample Sheet.

Environment Canada
Prairie and Northern Region

Field Sample Sheet

PROJECT Description: ______ DATE: ______
LOCATION Number: ______ SAMPLED BY: ______
Narrative: ______ Time Zone: ______
Air Temp( °C): ______ Cloud Cover (%): ______ Wind: ______ Precip: ______
Water Depth (m): ______ Ice Thickness (m): ______ % Ice cover: ______ Snow cover (cm): ______

SAMPLE Type: ______ Method: ______ Frequency: ______/YR

WATER Temp( °C): ______ pH: ______ Spec.Cond (@25 °C) ______ Cond. ______@______°C

COMMENTS: ______

TAIGA ENVIRONMENTAL LABORATORY

| Container | Schema | Parameters | Preservation | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Project | | | | |
| | | | | Time | | | | |
| 1L | | Phys/Nutr | Cool to 4 °C | | | | | |
| 500 mL | | Phys/Nutr | Cool to 4 °C | | | | | |
| 500 mL opaque | | Cyanide | 2mL 35% NaOH; Cool | | | | | |
| 500 mL | | Bacti | Cool to 4 °C | | | | | |

Date Shipped: Via:

NATIONAL LABORATORY for ENVIRONMENTAL TESTING

| Container | Schema | Parameters | Preservation | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Project | | | | |
| | | | | Time | | | | |
| 500 mL | 2/3/4/5/6/7/21 | Major Ions | Cool to 4 °C | | | | | |
| 125 mL | 31 | Total Metals | Cool to 4 °C | | | | | |
| 125 mL | 32 | Dissolved Metals | Filter; Cool to 4°C | | | | | |
| 250 mL | 33 | Dissolved As Se | Cool to 4 °C | | | | | |
| 1L Glass | 61/62 | Organics | Cool to 4 °C | | | | | |

Date Shipped: Via:

| | | | | |
|---|---|---|---|---|
| TEL Sample # | | | | |
| EC Sample # | | | | |

WHITE COPY – ACCOMPANY SAMPLES YELLOW COPY – AHSD YELLOWKNIFE PINK COPY – FIELD OFFICE

Figure 5.2. Environment Canada's Sample Submission Form.

Environment Canada / Environnement Canada

**SAMPLE SUBMISSION FORM - ENVIRODAT/MISCELLANEOUS**
**EXPEDITION D'ECHANTILLONS PRELEVES DANS L'ENVIRONNEMENT**

NATIONAL LABORATORY FOR ENVIRONMENTAL TESTING
LABORATOIRE NATIONAL DES ESSAIS ENVIRONNEMENTAUX

| | | | |
|---|---|---|---|
| NLET Project No. - Projet de LNEE | Project Leader- chef de projet | Sample Submitted by- Expediteur | tel No. - No de tel. |
| Date Shipped- Expedie le | Via - Par | Date Rec'd- Recu le | ENVIRODAT submitter ID |

| NLET Sample No. No de LNEE | No. of Ctrs. Nbre de recip | Client Sample No. No de l'echant (max 12 characters) | NLET Schema Name(s) and/or Schema Number(s)- LNEE Schema(s) requises | ENVIRODAT Station ID- Id de la station ENVIRODAT (10 chars.) | Collected- Prevelevement Date (YYYYMMDD) | Time Heure | Zone Fuseau | Remarks- Remarques |
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## Field Trip Preparation

To prepare for a field trip, draw up a list of the types of samples to be collected and the field measurements to be taken. Also make a list of required equipment, supplies and materials, including bottles, extra labels, sampling equipment, sample preservative solutions (if required), travel blanks and travel spiked blanks.

Label all bottles before the sampling starts to identify the intended use. Labelling will make sure they are used for the right purpose.
Use permanent markers or special laboratory labels (e.g., peel and stick water-proof labels).

It is a good idea to prepare a checklist of all the items to be taken on the trip. This includes road maps, station location descriptions, field sampling sheets/chain of custody forms, labels, equipment manuals, personal safety equipment, and a tool box. These checklists will vary depending on the season and method of transportation. Table 5.1 and 5.2 show examples of checklists.

*Reagent* - A substance capable of producing a reaction with another, especially when used to detect the presence of other bodies.

Assemble the proper sampling and testing equipment. Make sure that equipment is in good working order and that spare equipment and/or parts are available for field backups. Sampling and testing equipment should be carefully packed for transportation to the field. Check that the clean sample bottles are labelled, that the caps are secure and that the bottles are safely packed for travel, usually in bubble wrap and/or polyethylene foam chips. Make sure that all chemical ***reagents*** and samples prepared by the lab are on hand for the trip and packaged safely, usually in bubble wrap and/or polyethylene foam chips.

Before leaving, write up an itinerary or trip plan that shows the sampling route and where you will be when, according to the sampling schedule. This itinerary should be left with someone who can monitor your progress to confirm that you arrive back on schedule, or who can alert authorities if problems occur.

Table 5.1. List of items recommended for a mobile laboratory. This list should be modified according to individual situations and seasons.

**Samplers:**
Water sample locations (lat/long)
Specialized samplers as required (Kemmerer, Alpha-bottle)
Weighted sampling line
Open bottle grab sampler
Rope or cable
Extra bolt-on weights and bolts

**Preservation:**
Required chemical preservatives
Disposable graduated transfer pipettes
Wash bottle
Pasteur pipettes and suction bulbs
Magnetic stirrer, stir bars, magnet

**Field Filtration:**
Deionized water
Silicon tubing
5% HCl
500 mL wide mouth bottle
Disposable gloves
Vacuum pump
Disposable filter units

**Field Meters:**
Conductivity meter
Kim wipes
Thermometer
Meter chargers, adapters, batteries
pH meter c/w buffers, electrode filling solution, electrode storage solution, ionic strength adjuster
150 mL beaker
Turbidimeter c/w cuvettes, standards
Dissolved oxygen meter
Multi-meter

**Documentation and Shipping:**
Extra field sheets, submission forms
Shipping labels for certified laboratories
Pens, pencils, permanent markers
Bus/plane/courier bills of lading and lot shipment stickers
Zip closure bags
“Deliver on Arrival” labels
Orientation labels
TDG documentation and labels
Cold-packs (frozen)
Insulated box(es) or cooler(s)
Masking tape
Labelling tape
Packing tape
Calculator

**Clothing:**
Rain gear
Rubber gloves with liners
Chest waders with belt and suspenders
Leather work gloves
Winter clothing: parka, mitts, boots, toque, snowmobile suit, snowshoes

**Winter Gear:**
Ice bar
Auger - hand or power type, with extra blades or cutting heads, gasoline, oil, extra spark plug, blade oil

**Miscellaneous:**
Broom and dustpan
Garbage bags
Camera and film
Data book for personal notes
Paper towels
Watch
Meter stick
Wire

**Safety Equipment:**
Satellite phone
GPS, compass, maps
Fluorescent vest
Life jacket c/w whistle
Throw bag
First aid kit
Fire extinguisher
Triangle flares
Eye-wash bottle
500 mL bottle containing baking soda
Bear spray and banger
Rifle, ammunition
Binoculars
First aid and survival manuals

**Survival Kit:**
Candles
Waterproof matches
Lighter
Sterno/butane stove c/w fuel
Metal cup and utensils
High calorie, non-perishable food
Needle and thread
Light rope (0.3 mm x 6 m)
Swiss army knife/uni-tool
Snare wire
Flashlight
Space blanket
Sleeping bag
Flares
Orange plastic bags
Whistle
Signal mirror c/w ground to air code
Sunglasses
Personal medical kit for allergies or medical conditions

Source: MDA Consulting Ltd. (2003).

Table 5.2. List of items to be stored in a field vehicle. This list should be modified for use in boats, planes, and snowmobiles and according to season.

| | |
|---|---|
| Cell/satellite phone with phone list | Booster cables |
| Credit card | Washer fluid |
| Road maps | Gas line antifreeze |
| Transport of Dangerous Goods manifest or exemption permit | Jack and lug wrench |
| Travel log book | Tire chains |
| Tool kit | Motor oil |
| Duct tape | Serpentine belt |
| Wire | "Seal-All" |
| Extension cord | Transmission/Power steering fluid |
| Shovel | Window scraper |
| Axe | Fire extinguisher |

Source: MDA Consulting Ltd. (2003).

## Sample Testing Safety

Please refer to Canada Labour Code Part II, Water Survey Manual and Parks, Water Safety and Work Safety. The following points will help to keep everyone who conducts sample testing safe.

1) Store preservatives in a safe way when travelling to prevent upset and spillage.
2) Handle corrosive chemicals with care. Use proper personal safety equipment: goggles, gloves and lab coat (if applicable).
3) Clean up spills immediately by diluting them with large quantities of water, neutralisation, mopping up and proper disposal.
4) Avoid direct contact of skin, eye or clothing with chemicals. Rinse with large amounts of water if contact occurs.
5) Never pipette reagents by mouth.
6) Make sure adequate ventilation is provided when working with organic solvents or fuming acids. Avoid inhaling vapours.
7) Avoid rough handling of glassware.

**Being Prepared and Staying Safe**

A health and safety plan should be developed as part of the project for the safety of field personnel under various work conditions. The health and safety plan could require training in first aid/CPR, wilderness survival, firearm safety, Workplace Hazardous Materials Information Systems (WHMIS) and Transport of Dangerous Goods (TDG). It may also be a good idea to provide training in whitewater rescue and underwater aircraft escape.

***The following points will help keep everyone involved in collecting of field samples safe:***

1) Before leaving on the trip, check with RCMP, local officials, hunter and trapper associations or others regarding ice conditions at particular sites.
2) Leave your trip itinerary with your supervisor or the RCMP or someone else who can monitor your return.
3) Use proper signs, flares, vehicle warning lights, and safety vests when parking and sampling along roadways.
4) Wear an approved life jacket when sampling from boats or working over ice.
5) Use a wading stick to check for holes and unsafe footing.
6) Use suspenders and a belt on waders outside of other clothing.
7) Attach a safety rope to yourself and to a rigid, stable mooring when wading in unfamiliar areas, especially during high flow periods.
8) Carry an extra change of dry clothing with you.
9) Use an ice bar to determine the thickness and condition of the ice every few steps. Remove overlying snow as you move across the ice.
10) Never drive a vehicle over the ice except where a winter ice road exists, and then do so with caution.
11) Have at least one other person present when working from boats or over ice.
12) Carry bear repellent, bangers or a rifle, depending on the situation.

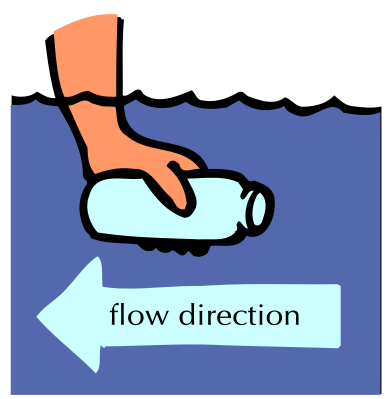
# Field Sampling Techniques and Handling

## How to Obtain a Water Sample

Water samples are usually taken by wading into the water or from a boat during open water seasons, or through the ice. Samples can also be taken from docks, bridges or the floats of an airplane. Some water samples are analyzed in the field at the same time they are collected, while others are collected for later analysis in a laboratory. Try to take samples from the same location each time the site is monitored, regardless of whether it is open water or ice covered. The use of a global positioning system (GPS) to identify geographic co-ordinates will make sure that the sampling site is precisely located. Note any change from the chosen location, along with the reason for the location change.

Samples near the surface can be taken by holding the collection bottle and lowering it into the water until covered, following standard procedures. This hand-held method of sampling, commonly called 'grab sampling', is the simplest way of collecting a water sample. The sample bottle should be held as show in Figure 5.3.

Figure 5.3. The technique for hand-held filling of water sample bottles.




*Depth-integrated sample* - A composite sample made up of water from different depths. It differs from a grab sample which is taken from only one depth. When taking a depth-integrated sample, the bottle should be lowered close to the bottom before it is raised. It should just become completely filled as it reaches the surface.

For larger, deeper river systems, use a weighted sampling device (Figure 5.4). The size of the weight required will depend on the current at the sampling point. It is important to keep the sampler vertical rather than allowing it to drift downstream. Weighted samplers are available in stainless steel or polyvinyl chloride (PVC).

When sampling rivers, a 2L sample bottle is used with the weighted sampler to collect a ***depth-integrated sample***. The actual sample bottles are filled from the larger bottle. A depth-integrated sample is taken by lowering the sample bottle to near the bottom and raising it at a constant rate so that the bottle is filled just before it breaks the surface.

For lakes, it is usually best to get both surface and subsurface water samples. Discrete depth samplers are used to collect water samples collected from below the surface. The most common sampler of this type is the Alpha water sampler (Figure 5.5). Most of these are horizontal samplers, although they are also available as vertical samplers. They are made of PVC or acrylic. A Kemmerer water sampler may be more suitable for use through ice (Figure 5.6). These can also be used in larger river systems. They are available in stainless steel or acrylic.

Figure 5.4. The stainless steel sampling iron is an example of a weighted sampling device. The sampling iron may also be painted with epoxy paint to reduce sources of metal contamination. Source: MDA Consulting Ltd. (2003)

Figure 5.5. The Alpha horizontal discrete depth sampler. Source: MDA Consulting Ltd. (2003)

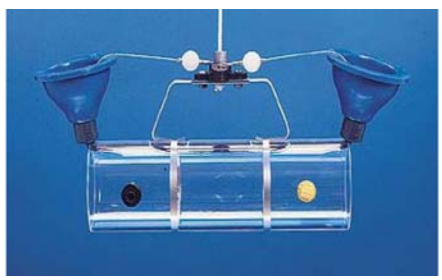


Figure 5.6. The Kemmerer discrete depth sampler capable of operation to depths of 180 m. Source: MDA Consulting Ltd. (2003)

**Isokinetic Samplers**

Isokinetic samplers are designed to continuously collect a representative water sample. They were developed to collect highly representative suspended sediment samples in rivers. An important feature of this type of sampler is that the speed of water approaching and entering the intake does not change. These types of samplers are not usually used for water quality sampling because of the need to clean them between each sample to reduce contamination. The samplers themselves are also a source of contamination because they are constructed of metal.

***No matter how the sample is taken or for what reason, the following guidelines should be used:***

- Before sample collection, rinse all sampling equipment (if appropriate) in the body of water to be sampled.
- Dispose of all rinse water downstream of the site, or in such a way that it does not contaminate or disturb the site to be sampled.
- Start sampling in areas of lowest contamination, followed by areas of highest contamination. This reduces the potential for ***cross contamination*** of samples.
- Be sure not to touch the cap liner, or the inside of the bottles. Touching may result in contamination of the sample.
- Remove all jewellery and watches. Roll up sleeves to avoid sample contamination, or wear gauntlet gloves.
- Don't smoke while taking or handling the samples.
- During sampling by hand don't use insect repellent, as this may cause sample contamination.

*Cross contamination* - The spreading of contaminants such as trace metals, nutrients, germs, bacteria and/or disease by carrying them from one sample to another.

*Courtesy of: Doug Halliwell*

**Rinsing Bottles with Sample Water**

Under most circumstances, bottles should be rinsed three times with the bottle mouth facing upstream. Rinse with the sample water before filling with the water to be kept for analysis. **Do not** rinse bottles that contain preservatives. **Do not** rinse bottles being used for bacteria, cyanide and synthetic organic compounds.

**Rinsing Bottles at Freezing Temperatures**

If the air temperature is below freezing, the rinse water will freeze to the surface of the bottle. **Do not rinse under these circumstances.** It is not effective and may do more harm than good.

**New Thinking about Bottle Washing**

Recent studies have indicated that properly cleaned bottles do not need to be rinsed first with the water being sampled. According to the International Organization for Standardization (ISO), rinse the sample containers only if the laboratory instructions specifically say so. Otherwise, keep the caps on the sample bottles until it is time to use them.

### *Sampling while Wading*

Rivers and streams can be sampled by wading into the water. This kind of sampling does not work in lakes, because a sample taken near the shore will not be representative of the lake system. Sampling while wading will probably involve carrying bottles to and from shore several times.

***When collecting water samples while wading:***

- Wear chest waders, with a belt and suspenders, and a life jacket.
- Disturb the riverbed as little as possible to avoid contaminating the sample with sediment.
- Explore the streambed for large obstacles or holes if you don't know the stream to be sampled or if the streambed changes at times. Wade carefully into the stream with a wading stick and safety line. Once you are certain that it is safe, sampling can begin.
- Be aware of large ice pans that could knock you off balance or trap you. Also be aware of ice formation on rocks and other surfaces.

Occupational Safety and Health (OSH) Committees from federal government departments such as Environment Canada also have their own Task Hazard Analyses. Titles include “Wading Operations”, “Travelling Over Ice” and “All Small Boat Operations”. Task Hazard Analyses may be useful in preparing health and safety plans for specific projects.

***Follow the procedures outlined below to collect the samples.*** All samples must be taken while **facing upstream.** This will make sure that neither your body nor your actions can affect the water being sampled (e.g., by disturbing the bottom material of sediment and biota).

1) Hold the bottle near its base and remove the bottle cap.
2) Plunge the bottle, neck downward, below the surface to a depth of about 20 cm.
3) Immediately turn the bottle until the neck points slightly upwards with the mouth directed into the current (see Figure 5.3).
4) Hold the bottle facing upstream at arm’s length while it fills.
5) If conditions permit and it is appropriate, rinse all required bottles three times, following steps 1 through 4, before filling with the sample.
6) Fill all bottles with the sample water to approximately 0.5cm from the top, or as instructed by the laboratory. This allows the water to expand and/or also allows for the addition of preservatives.
7) Cap each bottle immediately after filling and place in a cooler or backpack.
8) Preserve and complete field analyses, as required, either on shore or as soon as possible.
9) Tape the lids closed on all the sample bottles so that they do not accidentally come off. Carefully re-pack the bottles so that they do not break during transport.

### *Sampling through Ice*

Samples can be collected through the ice from both lakes and rivers at any depth. If the ice is not too thick on a river, it is possible to reach down through a hole in the ice and get a sample by hand or with the help of a sampling pole and attached container. If a sample from a greater depth is needed, use a weighted sampler. For safety reasons, any work on ice and/or in cold weather should be carried out by at least two people.

The sample site should be directly over the main flow channel of the river or stream, or over the deepest part of the lake. Ideally, this location would be the same one sampled during the open water period.

***When collecting water samples through the ice:***

- Wear an approved flotation or survival suit when working on ice over deep or swift water.
- Use an ice bar to test the thickness and condition of the ice to make sure that it is safe to work on it. River ice can be thin even in the Arctic if there is adequate current or warm groundwater inflow. (See Table 5.3 for a general guide to ice thickness safety.)
- Carry a couple of large nails to help in pulling yourself back onto the ice if you fall through.
- Remove overlying snow from the ice surface to provide a clean work area. An area about 1.2 metres square should be large enough.
- Drill or chop a hole through the ice, big enough for the sampler or any other equipment that will be used.
- Clear the area of ice chips, snow, slush and any substances such as grease or gasoline that could contaminate the site.

Table 5.3. General guidelines for ice strength (clear blue ice).

| | Required Ice Thickness (mm)[1] | | | |
|---|---|---|---|---|
| **Load** | **Continuous Travel** | | **Stationary Load** | |
| | Lake | River | Lake | River |
| 1 person on foot | 50 | 60 | 75 | 90 |
| Group, single file | 80 | 90 | 120 | 135 |
| Passenger car (2000 kg) | 180 | 210 | 300 | 350 |
| Light truck (2500 kg) | 200 | 230 | 340 | 390 |
| Medium truck (3500 kg) | 260 | 300 | 425 | 500 |

[1]Effective thickness = Thickness (clear ice) + ½ Thickness (white ice)
Where water lies between layers, use only the depth of the top layer of ice. Under thawing temperatures where average air temperature exceeds zero degrees Celsius, increase the required thickness by 20%.
Source: Alberta Occupational Health and Safety (1990).

***Procedures for taking water samples through the ice are outlined below.***

*In shallow rivers, with water depths less than 50 cm* - The sample may be collected by hand (grab sample) if the ice thickness allows. Dip and fill the bottles directly from the hole (see the method outlined above for taking samples while wading).

*In deeper rivers, with water depths more than 50 cm* - The sample must be collected using the proper weighted sampling device (see Figure 5.4).

1) Lower a clean, opened 2L bottle in a weighted sampler (with 2 to 3 kilograms of extra weight added) to the desired depth. If you are sampling in a current, the weight should be enough to reduce the sampler's downstream drift.
2) Lower the bottle into the river at a rate that will give a depth-integrated sample.
3) Don't let the sampler come in contact with the streambed. This may stir up bottom sediments and contaminate the water sample.
4) Raise the filled bottle from the river and use the water to rinse it, if conditions permit. If the temperature is below freezing you will not be able to rinse the bottles.
5) Repeat steps 1 through 4 until the bottle is re-filled.
6) Rinse the other bottles with the water from the 2L bottle. Swirl the 2L bottle between rinses so that each rinsed bottle receives a representative sample rinse. Leave enough water in the 2L bottle to rinse out any sediment that may have sunk to its bottom.

7) Repeat as needed to rinse out all the bottles required. One-litre bottles may be rinsed from the 2L bottle.
8) Fill bottles of 1L volume or greater by returning each one to the sampler and lowering it into the river at a rate that gives a vertically integrated sample.
9) Fill all bottles smaller than 1L from the water in the 2L bottle. Swirl the 2L bottle before filling other bottles so each container receives a representative sample and so that sediment does not settle in the 2L bottle.
10) Return to the place where preservation and field analysis of the samples will be carried out.
11) Tape the lids closed on all the sample bottles so that they do not accidentally come off. Carefully re-pack the bottles so that they do not break during transport.

*In lakes* **-** The sample must be collected using the proper weighted sampling device (see Figure 5.4). It is not necessary to rinse these samplers as sinking through the water is usually enough. It is better to take lake samples from a number of depths instead of using the depth-integrated sampling that is done in rivers. Lake samples are usually taken one to two meters below the surface and one to two meters above the bottom. The surface sample should be taken first. The same techniques are used for bottle rinsing and handling as those for deep rivers (see above). Always take care to avoid disturbing the sediments when the bottom or deep sample is collected.

### *Sampling from a Boat*

Water samples can be taken from both lakes and rivers using a boat. Usually a sixteen-foot aluminum boat or a twelve-foot inflatable boat with 10 to 20 horsepower motors is used. Refer to the operating manual for information about the motor.

Life jackets must be worn while working from boats, as well as rubber boots/waders and rain gear. Two paddles, a bailer and an anchor must be on board. Chest waders should be worn on the **outside** of other clothing.

In moving water, always sample from the upstream side to prevent contamination of the sample from gas or oil. Grab samples can be collected while the boat is anchored or drifting along mid-channel. When using a weighted sampler in rivers or lakes, you can either anchor or keep the boat running, depending on the circumstances. For example, if there is a danger of ice floes, **do not** anchor the boat and keep the engine running to make sure that the boat can be moved out of danger. Follow the same sampling procedures as those given in the section above on sampling through ice.

**Boating Safely**

Be aware of other boat traffic and natural hazards. All power-driven vessels must yield the right of way to those not operating under power, such as canoes. For more information about boating regulations and safe practices, go to Transport Canada's Office of Boating Safety at www.tc.gc.ca/BoatingSafety/menu.htm.

## Working from the Floats of an Aircraft

Examining water quality in remote lakes and rivers often involves flying into the site and sampling from the aircraft. Follow the same sampling procedures as you would if you were using a boat. Wear a survival suit or life jacket and waterproof chest-waders that will keep you afloat if you fall into the water. In addition, you should tie yourself to the aircraft for extra security. Straddle the floats whenever possible. The rear door of fixed-wing aircraft (e.g., the Cessna 206, with its long, broad tail section) should be tied open. This makes it easier to move the sampling equipment and bottles between the floats and the tail section of the aircraft where the samples are usually stored.

Direct or headphone communication with the pilot is essential. The pilot may need to communicate the difficulty of keeping the aircraft stable on the water, or the fact that wind, wave or fog conditions are making it too dangerous to continue with the sampling. It is much safer to have a third person to help with communication between the sampler and the pilot. A third person is also very useful to help with sample collection. Relatively busy “air traffic” in popular lakes (e.g., Rabbitkettle Lake in Nahanni NPR) may mean additional safety risks, forcing workers to work quickly and efficiently.

If you are carrying out many tasks on a large, windy lake, with a large aircraft on floats, you may have to measure a GPS location when you begin your work and when you finish. An aircraft can drift a substantial distance even when many anchors are used.

## Field Measurements

There are a number of water quality measurements that can be taken in the field. The most common of these are temperature, conductivity, pH, turbidity, dissolved oxygen (DO) and water clarity. (See Chapter 3 for more information about these and other parameters.) It is very important to record measurements as soon as possible after they are taken.

Instruments designed to be used in the field are available to measure these parameters or features individually. Multi-meters that can measure more than one parameter at the same time are also available. Depending on the circumstances, measurements are taken by lowering the instrument probe directly into the water body or into a collected sample. Any probe should be triple-rinsed with the sample to be tested.

Other types of instruments can be left in place to monitor water parameters over time. The manufacturer of the field instruments will provide detailed instructions for their use.

The proper maintenance and calibration of instruments is a very important part of any water quality program. The instruments must be in good working condition in order to get accurate results. Field personnel must understand the calibration and use of any instrument they are using in the field.

**Beyond Grab-sampling - Wolf Creek Research Basin**

Water quality monitoring programs usually use grab sampling – fill the bottle and then analyze the water in a laboratory. This is the approach that this manual describes. Grab sampling gives you a snapshot of the water quality at one time. Of course you can repeat the sampling to get a series of snapshots.

Usually the focus of grab sampling is looking at averages, or at whether the level of something in the water exceeds a guideline. Another approach to sampling is to measure water quality parameters at frequent intervals using electronic recording systems that are left in the lake or stream. Available technology now makes this quite affordable and reliable.

In 1999 scientists at the Wolf Creek Research Basin, a mountain watershed near Whitehorse, Yukon, wanted to examine how water quality of the stream changes with weather conditions over the ice-free period. To do this, they installed electronic sensors in the stream. These sensors measured seven water parameters, including temperature, pH and dissolved oxygen, at 15-minute intervals. The results were recorded on a battery-operated data logger and accessed by cellular phone link through a modem. The entire process operated automatically.

Of course this produced a huge amount of data, and statistical techniques had to be developed to make sense of it.

From this study researchers were able to examine the water quality over the daily and seasonal cycle. The study helped them to describe how water in a mountain stream is influenced by snow-melt, by summer heating of surrounding soils, and by groundwater. This approach to water quality monitoring is best-suited to studies that are aimed at understanding dynamic processes and relationships.

**Maintenance and Calibration of Instruments**

The manual provided by the manufacturer for each instrument gives general maintenance and calibration instructions. Check instrument calibration before setting out for field sampling, and daily while it is being used. Doing another check when you return from field sampling will give another test of its accuracy. All instrument maintenance and calibrations should be recorded in a logbook or on designated spreadsheets.

Any maintenance or calibration, including confirmation of calibration range, time, date and person who conducted the work, should be noted.

All field meters and analytic instruments should be stored according to the manufacturer's recommendations when not in use.

### *Temperature*

The temperature of the water you are sampling is an important first measurement. Water temperature affects many different chemical, physical and biological parameters (see below). In most cases, it is appropriate to standardize variables affected by temperature to a standard laboratory temperature of 25°C.

Temperature measurements must be taken in the field immediately upon obtaining a sample or preferably *in-situ*, by means of automated temperature probes.

### *Conductivity*

Conductivity (also referred to as conductance and specific conductivity) is the measure of the capacity of water to conduct electrical current per unit distance (expressed as microsiemens per centimetre or µsie/cm). It is measured with a conductivity meter. The conductivity of water is temperature dependent. Conductivity probes usually include a temperature probe so that the conductivity reading can be standardized. Some conductivity meters automatically compensate for temperature. If not, the meter reading must be corrected to 25°C before reporting the conductivity.

New conductivity meters may use different types of probes. Follow the manufacturer's instructions for use. Conductivity meters are also available for "pure water" (i.e., conductivity from 0 – 100 µsie/cm) and for high conductivity waters (100 – 1000 µsie/cm). The sampling circumstances may need both ranges.

**The conductivity measurement must be performed before the pH measurement** because the sample may become contaminated by the potassium chloride in the pH electrode.

***The procedure for measuring conductivity is as follows:***

1) Shake the field sample. Rinse the conductivity cell with the shaken sample by pouring a small amount of the sample into the end of the cell and over the outside of the cell.
2) Insert the cell into the water sample and move it up and down to release any air bubbles trapped in the cell. It is important that the side vent holes remain under the surface of the sample.
3) Measure the conductivity of the sample.
4) Record this value beside the temperature of the sample on the field sheet and indicate if the meter does not automatically compensate for temperature.

Be sure to rinse the conductivity cell with deionized water before storage. Store the cell according to the manufacturer's instructions.
Some manufacturers recommend wet storage. Other cells must be stored dry.

### *pH*

pH should be measured after the conductivity measurement. pH is measured using a pH meter.

***The procedure for measuring pH is as follows:***

1) Adjust the temperature reading (if needed) to the temperature of the field sample.
2) Shake the sample and rinse the electrode with sample.
3) Place the electrode in the sample.
4) Select pH measurement mode.
5) Swirl the sample and measure the pH. Allow sufficient time for the meter to stabilize.

Be sure to rinse the electrode with deionized water before storage. Store the electrode in a potassium chloride (KCl) storage solution according to the manufacturer's instructions. pH electrode sensors should be kept wet with sample water or tap water, and not in a standard solution, at all times during storage.

### *Turbidity*

Turbidity is a measure of the amount of solid material in suspension (i.e., not dissolved) in the water. It is measured by a turbidimeter. This instrument measures the transmission of light through water across a fixed distance. The lower the light intensity, the greater the turbidity of the water. Some field multi-meters allow for turbidity measurement in the field, as long as the meter is properly calibrated for turbidity.

***The procedure for measuring turbidity is as follows:***

1) Fill a ***cuvette*** with shaken field sample to the line marked on the cuvette.
2) Dry the cuvette with a clean, lint-free, laboratory-grade paper towel.
3) Place the cuvette, with the orientation mark facing forward, in the chamber. Note: Handle the cuvette with care and do not touch the area of the cuvette below the line. Keep the cuvettes absolutely clean.
4) Measure the turbidity of the sample.

*Cuvette* - A small often transparent laboratory tube.

Rinse the cuvette with deionized water before storage.

### *Dissolved Oxygen*

Dissolved oxygen (DO) is commonly measured *in situ* or immediately after sampling. The samples will change after collection because of ongoing oxygen demand or consumption in the sample container, so they must be measured as soon as possible.

Numerous portable DO meters are available. DO can also be measured using multi-meter DO sensors that have appropriate membranes and are properly calibrated. The meters measure the level of dissolved oxygen in both milligrams per litre and percent of oxygen saturation. Follow the manufacturer's instructions for measuring DO, calibrating the meter and keeping the probe clean.

### *Water Clarity*

Water clarity is measured using a Secchi disc. This round, flat disc has alternating black and white quadrants or quarter-circles. When lowered into a lake it gives a visual measure of the water clarity. The depth at which a Secchi disc disappears shows the level of suspended particulate matter and algal growth in the lake.

The Secchi disc is likely the oldest water quality assessment tool still in common use. It was developed by Angelo Secchi, a Jesuit priest. In 1865, he made the first measurements of ocean transparency and colour using several weighted discs of different colours.

Water clarity measurements are made by lowering the Secchi disc slowly into the water (Figure 5.7). This is usually done from the shaded side of a boat. The depth at which the disc disappears is recorded. The rope holding the disc is marked at intervals to allow direct depth readings. Once the disc disappears, it is lowered for approximately another meter and then raised. The depth at which it first appears is recorded. The Secchi disc reading is the average of the two values recorded. The higher the Secchi disc reading, the clearer the lake. The depth at which the Secchi disc disappears or appears may vary from observer to observer and from day to day due to light conditions.

Figure 5.7. Photo showing use of a Secchi disc.
Source: MDA Consulting Ltd. (2003)

### *Bacterial Sample Collection*

Extra care must be taken to obtain representative samples for determining if bacteria are present. Because bacterial samples are time-sensitive, it may not be possible to ship them to a laboratory for analysis. This means that local culturing and counting methods may need to be developed. Look for specific advice from local laboratories or health or environmental personnel about the best method to use.
Some community drinking water utilities carry out their own bacterial analysis on a routine basis. They may be able to help by providing analytical support to the project.

A mobile bacteriological water quality kit can be purchased from suppliers for just under $10,000. It can be used to analyze total coliform, fecal coliform, *E. coli*, and fecal streptococci. It comes with two incubators that can plug into vehicle cigarette lighters, a binocular microscope, petri dishes, squared filter paper, media, filtration equipment, sterilizing alcohol and flame.

Water samples for bacterial analysis are collected using the techniques described above. For example, in a shallow river, the 'grab sampling' method may be used. In deep water, collection is usually done using a weighted bottle holder.

**Take Caution to Avoid Contamination**

Contacting the sample with your hands will cause contamination of the sample. Wear disposable latex or nitex gloves.

In all cases, water samples collected for bacterial analysis must be preserved immediately after they are taken. To preserve samples, use 1.0 mL of 10% solution of sodium thiosulfate per 1L sample bottle. Or, if bottles are supplied with preservative, collect water samples in a clean bottle and transfer them directly to the analysis bottle. Leave an air space to make it easier to mix the sample with the preservative. Cap the bottle securely. To avoid any contamination of the sample, wear rubber gloves, dust masks, face masks and lab coats.

Samples should be kept out of light. Chill samples in ice between collection and filtration, but do not allow them to freeze. **Start the bacteriological analysis within one hour of getting the sample**, if possible, but not more than six hours after. This timeframe is important to prevent loss of bacteria in the sample. The process needs at least 24 hours of incubation. Colonies of bacteria can only be counted 24 hours after filtering and the start of incubation at proper temperatures.

When collecting bacterial samples from a large lake or reservoir, the 'grab sampling' method may be used. ***When sampling from rivers or streams, the following techniques should be used:***

*In shallow water*

- Collect the samples from a single point near the centre of flow in the stream.
- Face upstream holding the sample container near the base.
- Lower the bottle vertically under the water with the mouth directed towards the current.

Source: MDA Consulting Ltd. (2003)

*In deep water*

- Collect the samples from a bridge or boat using a weighted holder.
- To prevent sample contamination, first rinse the holder under the water without the bottle.
- Insert the bottle into the holder and lower the sample bottle under the water near the centre of the stream flow. Hold the collector vertically with the mouth directed toward the current. Hold the collector still to sample from one vertical point during collection.
- Leave an air space in the bottle to help mixing of the contents.

## Field Quality Control Samples

Quality control (QC) is an important component of any water quality program. The number, type and location of samples collected in the field for quality control purposes are decided on as part of program design. QC checks can include ***field replicates***, ***travel blanks*** and ***travel spiked blanks***. They are used to show how accurate and precise the sampling and analysis has been.

The number of sampling bottles and the way they are prepared before the trip depends on the number of QC samples needed. A QC sample should be identified to indicate what it is, but in a way that will not advise the lab doing the analysis. This is called a blind sample. The sites to be used for QC procedures should be written down for the field sampling team.

### *Field Replicates*

Field replicates are extra samples collected in the same place, at the same time, using the same sampling and filtration procedures. It does not mean the physical splitting of one sample into separate portions.
Field replicates are used to check the precision of sampling.

Replicate samples should be taken in sequence (one after the other). Taking three (i.e., triplicate) or four replicates provides more statistical information than the use of only two (i.e., duplicate) samples, but is still cost effective. Replicate samples are all collected and processed at the same time.

A minimum of one set of replicates should be taken at each site during the project. However, the number of replicates often varies greatly.
A general rule of thumb is 10% of the total number of sampling stations for each sampling project. That is, if 10 sites are being sampled, at least one site should be replicated. Stations to be replicated should be chosen from a rotational schedule set up earlier. The raw data from the “parent” sample and from each of the replicate samples should be stored within the database and identified properly. At the start of a study in an unknown area, it may be necessary to have as many as 30% of total samples as QC samples. **Do not store the average or median result of the replicates** unless the database or information system is equipped to deal with both routine and QC samples.

### *Travel Blanks*

A travel blank is a deionized sample of water used to identify contamination or errors in sample collection and analysis. The lab testing the travel blank does not know what it is. Before leaving for the field-sampling trip, prepare one travel blank for each sample to be taken at each QC site.

The number of travel blanks prepared before the trip will depend on the number of QC samples needed. For example, if two QC sampling sites have been chosen and samples are to be collected for total metals, dissolved metals, and ammonia at each site, a minimum of six travel blanks should be prepared before leaving for the field.

Travel blanks are prepared and stored in shipping cartons containing ice packs. This keeps the sample at approximately 4°C during all steps of transport and sample collection.

***Following are the steps for preparing travel blanks:***

1) Use the same types of bottles for the travel blanks that you will use for field sampling.
2) Label each travel blank, identifying the sampling site location and the analysis to be carried out. Use a field code that indicates the sample is a travel blank. A code is used so that the certified lab does not know the sample is part of the QC program.
3) Fill each sample bottle with distilled, deionized water free of all analytes of interest. Leave an air gap of approximately 5cm at the top of the bottle.
4) Preserve the sample as you would for each parameter to be analyzed. For example, travel blanks for ammonia analysis will be preserved in the same way as field samples to be tested for ammonia. (See below for more details about sample preservation.)
5) Cap and shake the travel blank to mix the water with the preservative. Store it in the sample shipping box with ice packs to keep the travel blank at approximately 4°C.
6) Enter the coded travel blank on the sample submission form or chain of custody sheet.
7) When the sampling has been finished at the QC location, open the travel blank and expose it to the atmosphere for the same amount of time as it took to take the field sample.
8) Recap the exposed travel blank and returned it to the shipping container.

### *Travel Spiked Blanks*

A travel spiked blank is used to test the accuracy of the lab's analysis. Spiked blanks are not routinely used in the field, though they are routinely used in labs. These types of blanks contain a known added amount of the analyte being measured. The added amount should increase the concentration in the sample by a predictable amount.
It is best to get spike solutions from the analytical laboratory and analyse them before use to confirm the concentration.

Preparing and handling travel and travel spiked blanks is similar.

***The procedures for using travel spiked blanks are as follows:***

1) Use the same type of bottles for preparing travel spiked blanks that you will use for field sampling.
2) Label each travel spiked blank, identifying the sampling site location and the analysis to be carried out. Use a field code that indicates the sample is a travel spiked blank. A code is used so that the certified lab does not know the sample is part of the QC program.
3) Fill each sample bottle with distilled, deionized water free of all analytes of interest. Leave an air gap of approximately 5 cm at the top of the bottle.
4) Mix the spiked solution and allow it to sit for about one hour before adding the sample preservative.
5) Preserve the sample as you would for each parameter to be analyzed. (See below for more details about sample preservation.)
6) Cap and shake the travel spiked blank to mix the water with the preservative. Store it in the sample shipping box with ice packs to keep the travel blank at approximately 4°C.
7) Enter the coded travel spiked blank on the sample submission form or chain of custody sheet.
8) Do not remove the travel spiked blank from the shipping container. Keep the container closed at all times during the sampling field trip.

If the lab has not supplied spiked bottles, you must spike the solution with the correct volume of concentrated stock solution. Add enough so that the final concentration of analyte is between 5 and 10 times greater than would be expected in a typical field sample at that location. For example, if the concentration of total phosphorous is expected to be 0.017 mg/L, then the total phosphorous concentration in the travel spiked blank for this QC site should be between 0.085 and 0.170 mg/L.

## Sample Preservation

Physical changes and chemical and biochemical reactions may take place in the sample container between the time of sample collection and laboratory analysis. Storing samples in a cool dark shipping container, such as a cooler, helps to minimize this potential problem. However, in some cases, you may have to treat the samples with a preservative before shipping. For example, samples collected to analyze ammonia, dissolved metals, total metals, mercury and sulphides must be preserved with specific solutions.

It is important to use the same routine for the preservation and analysis of samples to make sure of sample integrity. Bottle types and preservation techniques often change, and will vary according to the laboratory or analytical method. **Always be sure to confirm these techniques with the laboratory.** Try to keep the same techniques and bottle types for the length of the project.

Request chemical preservatives from the analytical laboratory so that they can be tested before you use them. They should be transported and added to the sample bottles with care to make sure there is no contamination. In some circumstances, it may be a good idea to get the sample bottles from the laboratory with the preservatives already added. This reduces contact and helps to prevent problems associated with shipping hazardous goods such as acids.

If the sample requires a preservation treatment, collect the sample as above and then transfer the water into the bottle containing the preservative. **Never use a bottle that contains a preservative to collect the sample.** Make sure the sample is not contaminated during the transfer step. If the laboratory has not added the preservatives to the bottles in advance, refer to Table 5.4 for proper preservatives to use.

Some accredited labs may use factory or lab-cleaned bottles that have been developed for one-time use. These bottles no longer require preservatives for dissolved or total metal samples.

Table 5.4. The appropriate volume and concentration of preservative to be used for field samples.

| Parameter | Preservative |
| --- | --- |
| Ammonia | 1 mL 10% $H_2SO_4$ / 125 mL |
| Dissolved Metals | 0.5 mL concentrated $HNO_3$ / 250 mL |
| Total Metals | 2 mL concentrated $HNO_3$ / 1000 mL |
| Mercury | 2 mL concentrated $H_2SO_4$ + 5% $K_2Cr_2O_7$ solution / 100 mL |
| Sulphides | 1 mL 2N Zn Acetate Solution / 500 mL |

Source: MDA Consulting Ltd. (2003).

## Sample Filtering

To find the concentration of dissolved constituents, water samples must be filtered through a 0.45 μm cellulose acetate membrane filter.
All parts of the filtration system must be washed, including the tubing, filter flasks and funnels, unless you are using disposable filter units. These disposable units will reduce sample contamination. Otherwise all filtration equipment must be washed as before leaving for the field and between filtration of each sample. The filtration equipment must be washed between replicate samples as well.

***The following procedures should be used for filtering samples:***

*Immediately before field trips*

- Clean the inside of all tubing by filling it with 5% HCl and allowing it to soak for six hours or more. Then pump approximately 500 mL of deionized water through the tubing.
- Wash filter flasks and funnels with a non-phosphate laboratory detergent (e.g., Liqui-Nox). Rinse these three times with tap water, followed by deionized water four times. Then soak the filter flasks and funnels in a 5% HCl bath overnight. After soaking, rinse four times with tap water followed by deionized water four times.

*Before each filtration*

- Pump approximately 250 mL of deionized water through all tubing.
- Rinse filter flasks and funnels with deionized water three times.

*After each filtration*

- After filtering highly turbid samples, pump about 500 mL of 5% HCl through the tubing, followed by about 200 mL of deionized water.
- Scrub and wash the filter flasks and funnels with 5% HCl. Rinse a lot with deionized water. If no sediment appears to be sticking to the filter unit, this HCl wash may be left out. The filtration equipment must be washed as outlined between sample replicates as well.

***Use the procedure outlined below to filter samples*** for the analysis of dissolved nitrate/nitrite, dissolved and ortho-phosphorus, dissolved iron, manganese and boron, other dissolved metals, and dissolved arsenic and selenium. Samples for dissolved metals, dissolved trace elements, and dissolved nutrients are to be filtered on site immediately after collection. Make sure the filtering unit and tubing have been cleaned according to the standard procedures outlined above.

1) Insert a filter membrane (142 mm diameter, 0.45 µm cellulose acetate) into the funnel, using Teflon-coated or nylon forceps.
2) Pump through about 250 mL of deionized water. Run the pump until the filter is just dry.
3) Filter about 50 mL of sample, letting it run through the filter.
4) Rinse and fill each of the sample bottles with filtrate. Preserve if necessary.
5) Clean filtration unit and tubing. Between sampling sites, store the filter head in a clean plastic bag or container.

## Sample Storage and Shipping

Field samples should be stored at 4°C in a mobile laboratory refrigerator, portable refrigerator, or cooler containing ice packs until they can be transferred to a temporary holding refrigerator or refrigeration facility. This will make sure that they are preserved properly and that there is no loss of sample quality. If refrigeration is not available, field activities and transportation of samples must be planned so that samples are returned quickly to the laboratory.

**Samples should be shipped as soon as possible after collection.** Ship samples in coolers containing enough ice packs to keep the samples at approximately 4°C for the length of the trip. Whenever possible, send samples to the laboratory the same day they were collected.

Each shipping container should contain only those bottles that are to be analyzed or cleaned by the receiving laboratory. All samples must be well sealed and packed, using foam chips or bubble wrap, to prevent spillage or breakage. The laboratory will re-wash all empty bottles. Any dirty bottles that are returned should have their lids on. Rinse old reagent bottles well before returning them.

Be sure to include a copy of the sample field sheet and/or submission form with each shipment. A chain of custody form for the samples, if required, must also be contained in each shipping container.
These forms should be placed inside a sealed plastic bag in the shipping container to protect them in case of leakage or breakage of samples.

Label all shipping containers with the address of the destination and the sender. The address labels should be bordered with red ink to highlight them and taped over with clear tape to protect against scuffing or marking. Label the top of all shipping containers with “OVER 16 KG”, “THIS END UP” or “FRAGILE”, as applicable. “DO NOT FREEZE” labels are also useful. Make sure containers are free of misleading address and warning labels. Multiple containers should be numbered in a series out of a total number (for example “3 of 6”).

If a cooler is being used to ship the samples, make sure the spigot is taped over to prevent leakage. At least one piece of tape should be used over the closure clasp. Coolers should also have secure handles. Any broken handles or sharp projections should be removed.

Proper documentation or handling receipts from the trucking service or airline should be kept on file so that lost or damaged shipments can be traced.

It is very important to follow all *Transport of Dangerous Goods* regulations for packaging, labelling, and documenting sample boxes. Normally, preserved samples are not considered to be dangerous goods because of the very dilute amount of preservative. However, the shipper is responsible for the goods. You should consider becoming a certified shipper of dangerous goods in order to protect yourself and personnel who may be transporting the samples, as well as those receiving them. If you have doubts about any aspect of the regulations, contact your area Transport of Dangerous Goods Trainer or Transport Canada.