HP Technical Assistance
HYDROLOGY PROJECT

World Bank & Government of The Netherlands funded

Training module # WQ - 13

How to sample surface waters for water quality analysis

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with
HALCROW, TAHAL, CES, ORG & JPS

Table of contents

1. Module context

This module describes procedures for collection of samples from surface waters and their handling. Modules in which prior training is required to complete this module successfully and other available, related modules in this category are listed in the table below.

While designing a training course, the relationship between this module and the others, would be maintained by keeping them close together in the syllabus and place them in a logical sequence. The actual selection of the topics and the depth of training would, of course, depend on the training needs of the participants, i.e. their knowledge level and skills performance upon the start of the course.

No.	Module title	Code	Objectives
1	*Basic water quality concepts*	WQ I-1	• Become familiar with common water quality parameters. • Appreciate important water quality issues.
2	*Basic chemistry concepts*[a]	WQ I-2	• Convert units from one to another • Understand the basic concepts of quantitative chemistry • Report analytical results with the correct number of significant digits
3	*How to prepare standard solutions*[a]	WQ I-4	• Recognise different types of glassware • Use an analytical balance and maintain it. • Prepare standard solutions
4	*How to measure colour, odour and temperature*[a]	WQ 1-5	• Measure natural colours in water samples • Distinguish different types of odours
5	*How to measure the pH of a water sample*[a]	WQ I-7	• Measure the pH of a watersample
6	*How to measure electrical conductivity*[a]	WQ I-9	• Measure electrical conductivity • Appreciate the effect of ion concentration and type on EC value
7	*How to measure dissolved oxygen (DO)*[a]	WQ 1-12	• Measure dissolved oxygen in water samples

a – prerequisite

2. Module profile

Title	:	How to sample surface waters for water quality analysis
Target group	:	HIS function(s): Q1, Q2, Q3, Q5
Duration	:	One session of 60 min
Objectives	:	After the training the participants will be able to*:* • Carry out surface water sampling with necessary precautions
Key concepts	:	• Representative samples • Samplers • Sample preservation
Training methods	:	Lecture and discussion
Training tools required	:	OHS, board
Handouts	:	As provided in this module
Further reading and references	:	Water Quality Monitoring, ed. J. Bartram and R. Balance, UNEP & WHO, E & FN Spon

3. Session plan

No	Activities	Time	Tools
1	***Preparations***		
2	***Introduction***: • Ask the participants to name a surface water source in their area and what should they take with them on a sampling expedition. List on board. • Introduce the lecture topic	10 min	Board OHS
3.	***Sampling site and types of samples*** • Emphasise need for precise definition of site, requirements of a suitable site and representative sample	10 min	OHS
4	***Samplers & sample containers*** • Describe different types of sampling devices and their suitability in different situations • Categorise different types of analyses and corresponding requirements for sample container	15 min	OHS
5	***Sample handling*** • Describe various steps to be taken after drawing of sample in the sampler • Name site analyses to be carried out • Describe perservation procedures for different analyses	15 min	OHS
6	***Conclusion*** • Wrap up by asking difficulties faced in sampling programmes. Discuss possible solutions	10 min	

4. Overhead/flipchart master

OHS format guidelines

Type of text	Style	Setting
Headings:	OHS-Title	Arial 30-36, with bottom border line (not: underline)
Text:	OHS-lev1 OHS-lev2	Arial 24-26, maximum two levels
Case:		Sentence case. Avoid full text in UPPERCASE.
Italics:		Use occasionally and in a consistent way
Listings:	OHS-lev1 OHS-lev1-Numbered	Big bullets. Numbers for definite series of steps. Avoid roman numbers and letters.
Colours:		None, as these get lost in photocopying and some colours do not reproduce at all.
Formulas/Equations	OHS-Equation	Use of a table will ease horizontal alignment over more lines (columns) Use equation editor for advanced formatting only

Sampling of surface waters

- Sampling sites
- Types of sample
- Samplers
- Sample containers
- Sample handling
- Guidelines

Sampling site

- Well defined
- Safe to approach
- Representative of reach
- Bridge
- Boat
- Bank (L or R)
- Wading
- Other

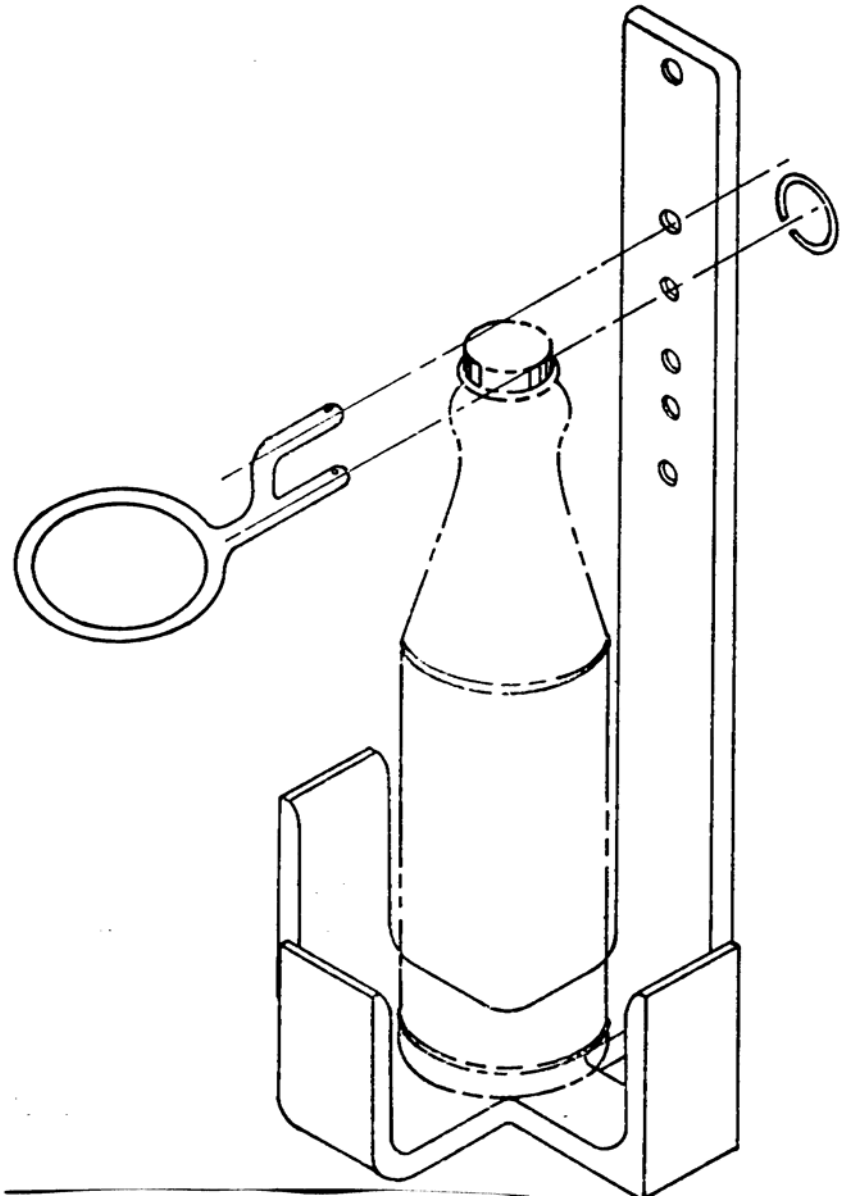
Types of sample

- Grab
  - *rivers are well mixed vertically*
  - *main current*
  - *20 – 30 cm below surface*
- Composite
  - *time based grabs*
  - *time based & flow weighted grabs*
  - *large variations in quality with time*
  - *waste streams, flux studies*

Types of sample

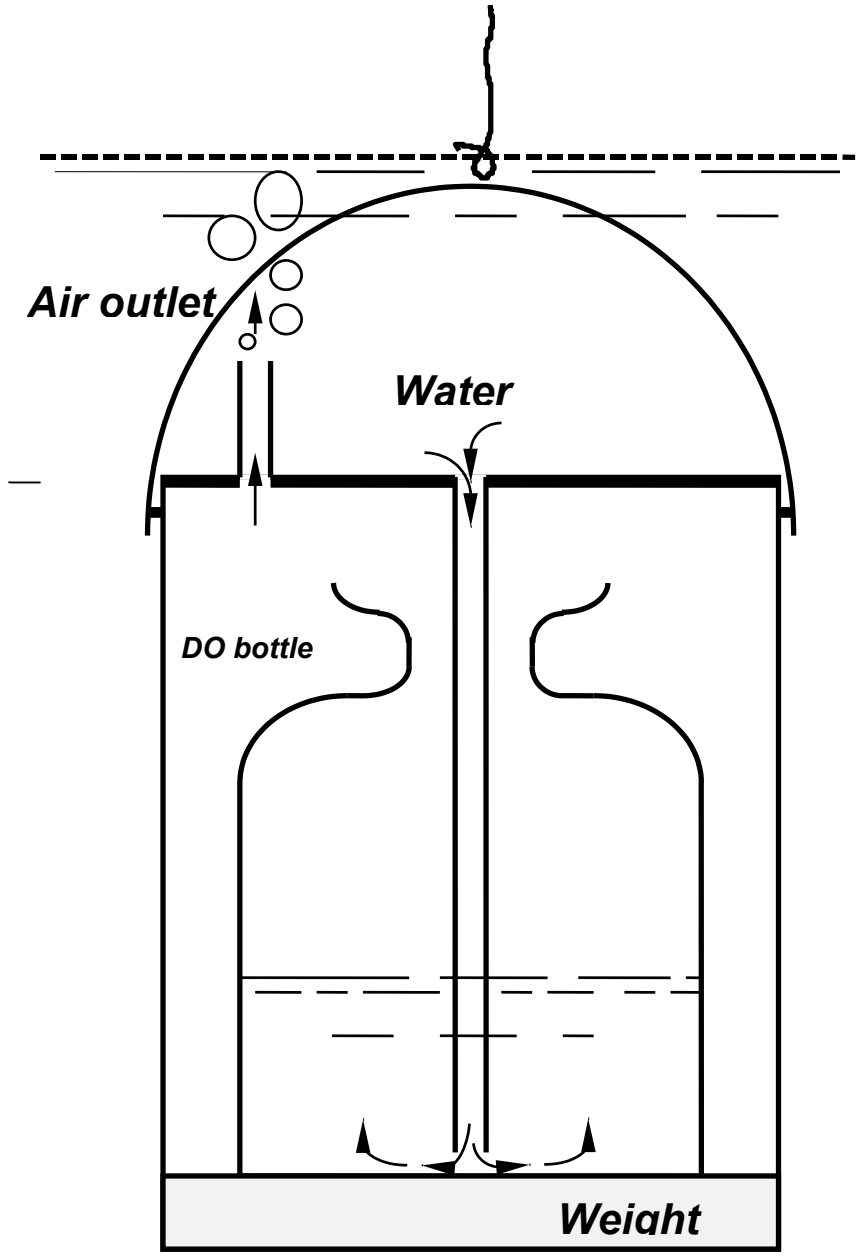
- Integrated
  - *width / depth-wise grabs at same time*
  - *large rivers, non-uniform quality*

Samplers (1)



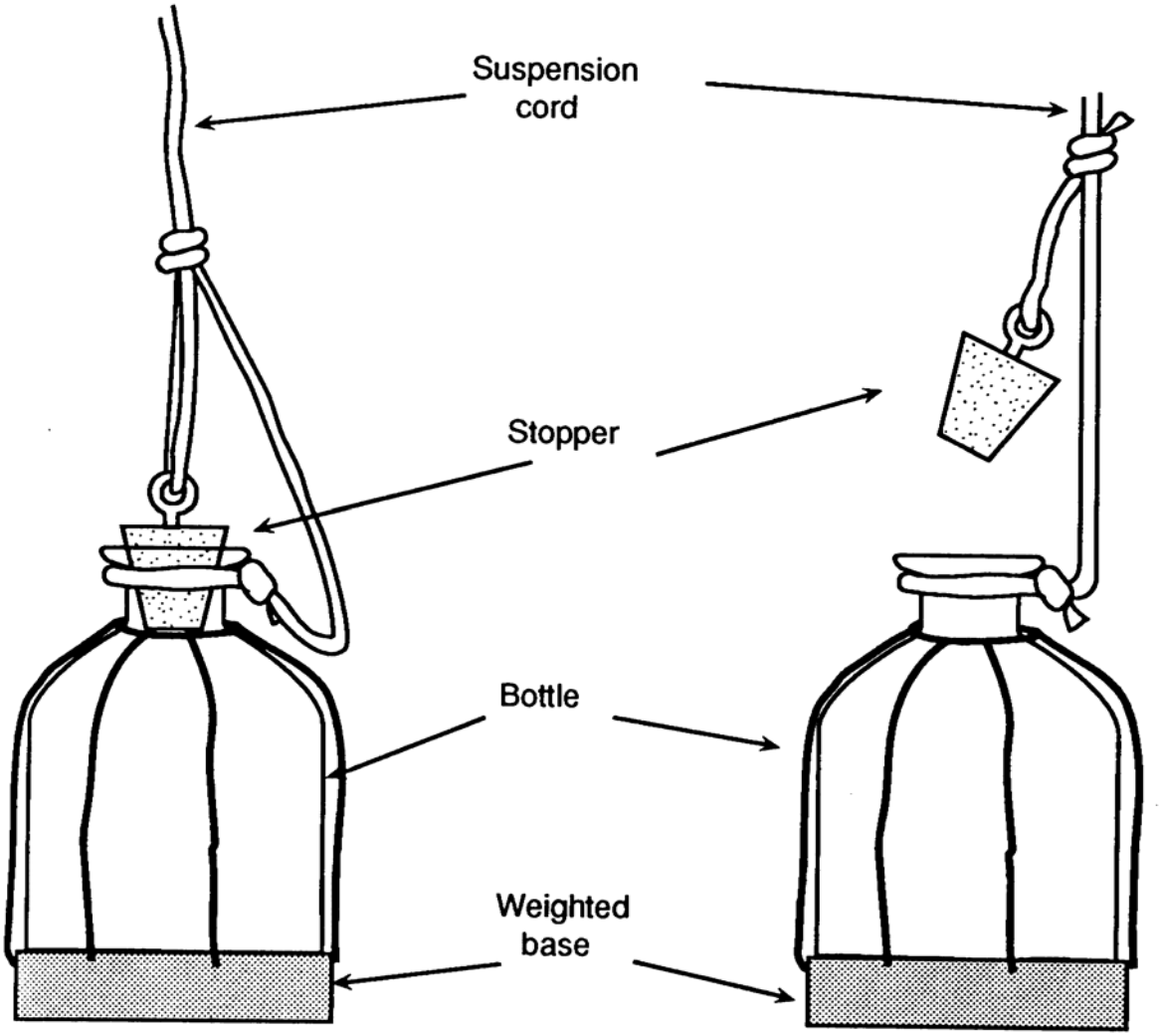
Sample bottle holder for water sampling

Samplers (2)



Dissolved oxygen sampler

Samplers (3)



Meyer's sample bottle

Sample containers

Analysis	Material
General	*Glass, PE*
Hg & P	*Glass*
Pesticide	*Glass, Teflon*
DO	*BOD bottle*
Coliforms	*Glass/ PE sterilised*

1 to 3L capacity

Sample handling

- Transfer to containers immediately
- Exclude suspended matter
- Leave minimal space, sufficient for mixing
- Separate portions for site analyses
- Preservation

Sample preservation

Analysis	Preservation
BOD	*4 ^{o}C, dark*
COD, NH_3, NO^-_2, NO^-_3	*< pH 2, H_2SO_4*
Coliforms	*4 ^{o}C, dark*
DO	*DO fixing chemicals, dark*
Heavy metals	*< pH 2, HNO_3*
Pesticides	*4^{o}C*

Sample identification

Sample code											
Observer					Agency			Project			
Date Time					Station code						
Parameter code	**Container**				**Preservation**				**Treatment**		
	Glass	**PVC**	**PE**	**Metal**	**None**	**Cool**	**Acid**	**Other**	**None**	**Decant**	**Filter**
O Gen											
O Bact											
O BOD											
O H Metals											
O Tr Organics											

Source of sample				
Waterbody	***Point***	***Approach***	***Medium***	***Matrix***
o River o Drain o Canal o Reservoir o Rainwater o Field blank	o Main current o Right bank o Left bank	o Bridge o Boat o Wading	o Water o Susp matter o Biota o Sediment	o Fresh o Brackish o Salt o Effluent
Sample type	o Grab o Time-comp o Flow-comp o Depth-integ o Width-integ			
Sample device	o Weighted bottle o Pump o Depth sampler			

Figure 4 Form for sample identification

Field Observations

Field determinations				
Temp °C	**pH**	**EC µS/cm**	**DO mg/L**	**Colour units**
Odour	o Odour free o Rotten eggs o Burnt sugar o Soapy o Fishy		o Septic o Aromatic o Chlorinous o Alcoholic o Unpleasant	

Remarks	
Weather	o Sunny o Cloudy o Rainy **o** Windy
Water vel. m/s	o High (> 0.5) o Medium (0.1-0.5) o Low (< 0.1) o Standing
Bank use	o None o Cultivation o Bathing & washing o Cattle washing o Melon/vegetable farming in river bed

Summary guidelines

- Correct location
- Decant
- Transfer to appropriate container(s)
- Small headspace
- Preservatives
- Site analyses

5. Evaluation sheets

6. Handout

Sampling of surface waters

- Sampling sites
- Types of sample
- Samplers
- Sample containers
- Sample handling
- Guidelines

Sampling site

- Well defined
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Types of sample

- Integrated
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Sample containers

Analysis	Material
General	*Glass, PE*
Hg & P	*Glass*
Pesticide	*Glass, Teflon*
DO	*BOD bottle*
Coliforms	*Glass/ PE sterilised*

1 to 3L capacity

Sample handling

- Transfer to containers immediately
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- Preservation

Sample preservation

Analysis	Preservation
BOD	*4 ^{o}C, dark*
COD, NH_3, NO^-_2, NO^-_3	*< pH 2, H_2SO_4*
Coliforms	*4 ^{o}C, dark*
DO	*DO fixing chemicals, dark*
Heavy metals	*< pH 2, HNO_3*
Pesticides	*4^{o}C*

Sample identification

- See Figure 4 of main text
  - *Sample code*
  - *Station code*
  - *Parameter code*
  - *Source*
  - *Sample type and device*
  - *Field determinations*

Summary guidelines

- Correct location
- Decant
- Transfer to appropriate container(s)
- Small headspace
- Preservatives
- Site analyses

7. Additional handout

These handouts are distributed during delivery and contain test questions, answers to questions, special worksheets, optional information, and other matters you would not like to be seen in the regular handouts.

It is a good practice to pre-punch these additional handouts, so the participants can easily insert them in the main handout folder.

8. Main text

Contents

How to sample surface waters for water quality analysis

1. General

The results of any water quality test can be no better than the sample on which it is performed. The objective of sampling is to collect a portion of the water in the waterbody, small enough in volume to be collected and transported conveniently and meet the requirements of various analyses, while still representing the water in the waterbody. This implies that the sample is representative in which the concentration of all pertinent constituents is the same as in the source.

The sampling sites should be precisely described; it should be safe and easily accessible. Only if the samples can be taken consistently from the same locations, changes in water quality variable with time can be interpreted with confidence. The waterbody at the sampling site should be representative of that river reach.

Bridges are ideal for collection of samples. The main current can be accessed easily and safely.

In the absence of bridges, boats or wading are the only alternatives. Use of boats is time consuming. On the other hand, sampling from the bank may not be representative.

The sample should be handled in such a way that no significant change in the parameter(s) of interest occurs before it is analysed. Samples for analysis of different parameters may require different treatment and handling.

2. Types of samples

Three different types of samples may be collected:

Grab sample: It is a sample taken at a selected location and time. Rivers and streams, in general, are well mixed vertically. Therefore, if the sample is collected from the main current, 20 to 30 cm below the surface to avoid collection of scum, the sample may be taken to represent the water quality of the source.

Shoreline discharge of wastewaters has a tendency to keep flowing along the shore with limited transverse mixing. This aspect should be kept in mind when locating a site for sample collection. If the objective of the monitoring programme is to obtain information regarding the general quality of the water, the sampling point should be moved upstream of the discharge point or sufficiently downstream when mixing has taken place.

Composite sample: In most cases, it is a combination of equal volumes of a number of grab samples collected at the same location at different times. The volumes of the individual grab samples making the composite sample may also be varied in proportion to the flow in the river at the time of sampling. In such a case it is called a flow weighted composite sample.

Composite samples may be required only in special cases for calculation of mass flux in rivers when the quality of water is suspected to change over short periods of time. It is however a routine practice when wastewater streams are to be characterised.

Integrated samples: It is a mixture of grab samples collected simultaneously at different locations across the width of the river and/or at different depths. The need for an integrated sample may occur for very wide and deep rivers where the quality of water may vary across its width and depth.

3. Samplers and sample containers

One to three litres of sample should suffice for most physical and chemical analyses. The simplest form of a water sampling device is a bottle attached to a string. To lower a plastic or glass bottle in a body of water it is necessary to use a bracket or holder of sufficient weight to overcome the buoyancy of the bottle and allow it to sink as rapidly as desired to the required depth. Such a holder designed to contain a one or two litre bottle is shown in Figure 1.

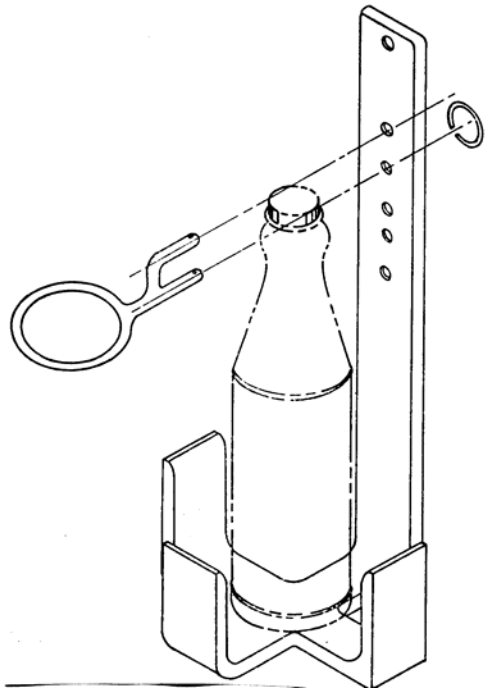

Figure 1 Sample bottle holder for sampling

Where feasible a sample may be collected by holding the sample bottle in hand and submerging it to a depth of about 20 cm. Holding the mouth slightly downwards and then turning the bottle upright to fill it.

For samples for dissolved oxygen measurement use a DO sampler shown in Figure 2. It is described in the training module “Understanding the chemistry of dissolved oxygen measurement”.

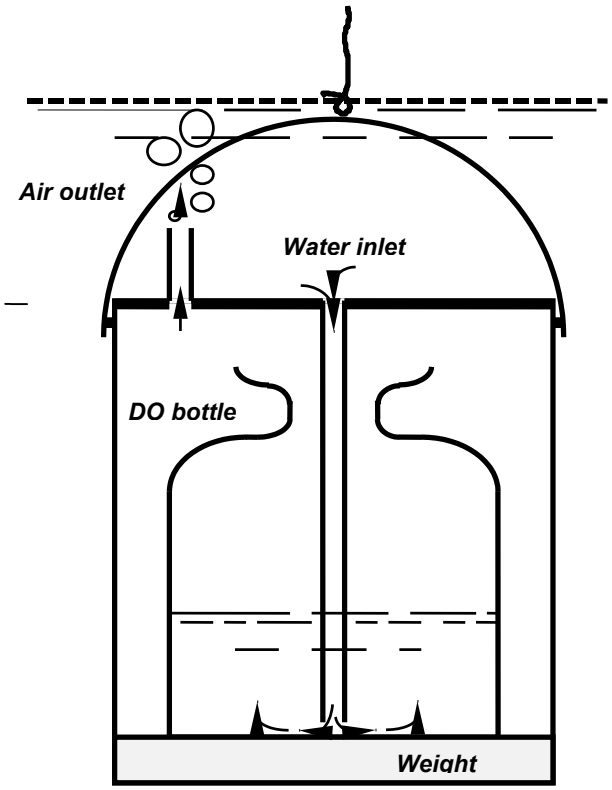

Figure 2 Dissolved oxygen sampler

When water from a particular depth is to be collected an arrangement like Meyer's sample bottle may be used, Figure 3. After the bottle is lowered to the desired depth a slight tug removes the stopper.

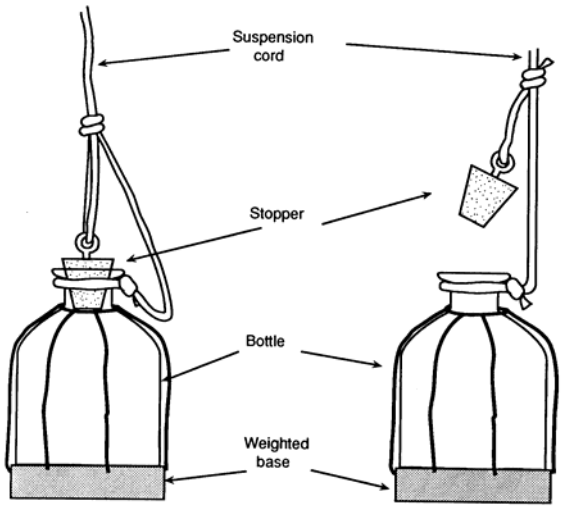

Figure3 Meyer's sample bottle

Alternatively, the DO sampler may be used. If lowered quickly to the desired depth it will collect sample which would be representative of the water at that depth. Small amount of water which gets in the bottle from other depths while the sampler is being lowered is likely to be expelled when the bottle overflows into the sampler.

In order to cover the range of parameters which need to be sampled and analysed a variety of sample containers are required as discussed below:

- 1000 millilitre glass (or Teflon) bottles with Teflon lined caps - for pesticides and phenols
- 500 millilitre polyethylene bottles - for metals (except mercury)
- 100 millilitre glass bottles - for mercury and phosphorus
- 1000 millilitre polyethylene bottles for all other chemical parameters
- BOD bottles, with ground glass stoppers, of a volume consistent with the dissolved oxygen samplers (possibly 300 millilitre)
- Strong thick-walled glass bottles of at least 300 millilitre capacity for microbiological analysis.

Bottles, which are to be used for collecting microbiological samples, must be thoroughly washed and sterilised beforehand. This can be carried out by placing them in an oven at 170°C for at least two hours.

4. Sampling record, labelling and preservation

Local conditions, such as weather, human activity on the banks, state of waterbody, etc., at the sampling site should be recorded at the time of sampling. Such information may be useful in analysis of data.

Immediately after sampling, the sample bottles should be labelled and given a unique code number. Information on the label should include:

- sample code number
- date and time of sampling
- source and type of sample
- pre-treatment or preservation carried out on the sample
- any special notes for the analyst
- sampler's name

Forms for identifying the sample and recording the field measurements and site conditions is given in Figures 4 and 5.

Samples for BOD and bacteriological analyses should be stored at a temperature below 4°C and in the dark as soon as possible after sampling. In the field this usually means placing them in an insulated cool box together with ice or cold packs. Once in the laboratory, samples should be transferred as soon as possible to a refrigerator.

Samples for DO measurement should be chemically fixed as described in the training module on dissolved oxygen measurement.

If samples collected for chemical oxygen demand (COD) analysis cannot be determined on the day of collection they should be preserved below pH 2 by addition of concentrated sulphuric acid. This procedure should also be followed for samples for ammoniac nitrogen, total oxidised nitrogen and phenol analysis.

Samples, which are to be analysed for the presence of metals, should be acidified to below pH 2 with concentrated nitric acid. Such samples can then be kept up to six months before they need to be analysed; mercury determinations should be carried out within five weeks, however.

The labels on the sample containers should include the sample code and the parameter code described in Figure 4. Following labelling, the samples should be placed in a purpose-built bottle carrier for transportation.

5. Guidelines

- Make sure that you are at the correct location. If sample is collected from a boat, identify the location by the intersection of lines between landmarks on the shore.
- In general separate any significant amount of suspended matter by decantation. GEMS/WATER monitoring programme sets the upper size limit of particulate matter at 0.063 mm.
- Sampling depth is measured from the water surface to the middle of the sampler.
- Samples should be transferred to sample bottle immediately after collection.
- A bottle that is to be used for transport and storage of the sample should be rinsed three times with portions of the sample before being filled. This does not apply if the bottle contains a preservative.
- Leave a small air space in the bottle to allow mixing of the sample before analysis.
- The temperature of the sample should be measured immediately after collection.
- If the sample is to be measured for DO, immediately add the DO fixing chemicals as described in the module on DO measurement.
- Separate portions of samples should be set aside for EC and pH measurements.
- The field analyses should be started as soon as possible.

Figure 4 Form for sample identification

Sample code											
Observer					Agency			Project			
Date Time					Station code						
Parameter code	**Container**				**Preservation**				**Treatment**		
	Glass	**PVC**	**PE**	**Metal**	**None**	**Cool**	**Acid**	**Other**	**None**	**Decant**	**Filter**
O Gen											
O Bact											
O BOD											
O H Metals											
O Tr Organics											

Source of sample				
Waterbody	***Point***	***Approach***	***Medium***	***Matrix***
o River o Drain o Canal o Reservoir o Rainwater o Field blank	o Main current o Right bank o Left bank	o Bridge o Boat o Wading	o Water o Susp matter o Biota o Sediment	o Fresh o Brackish o Salt o Effluent
Sample type	o Grab o Time-comp o Flow-comp o Depth-integ o Width-integ			
Sample device	o Weighted bottle o Pump o Depth sampler			

Figure 5 Form for field observations

Field determinations				
Temp °C	**pH**	**EC µS/cm**	**DO mg/L**	**Colour units**
Odour	o Odour free o Rotten eggs o Burnt sugar o Soapy o Fishy		o Septic o Aromatic o Chlorinous o Alcoholic o Unpleasant	
Remarks				
Weather	o Sunny o Cloudy o Rainy **o** Windy			
Water vel. m/s	o High (> 0.5) o Medium (0.1-0.5) o Low (< 0.1) o Standing			
Bank use	o None o Cultivation o Bathing & washing o Cattle washing o Melon/vegetable farming in river bed			