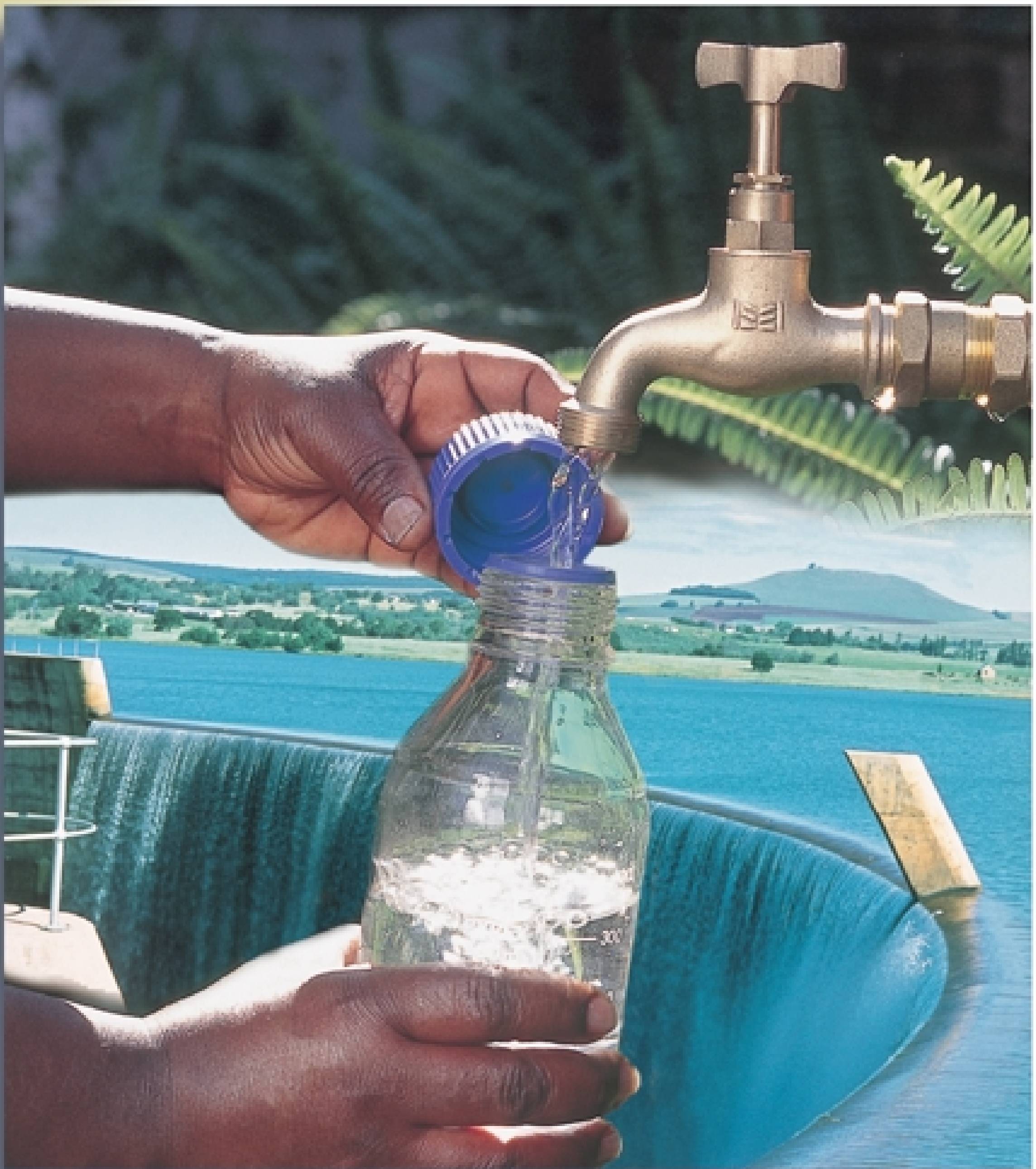
Quality of Domestic Water Supplies

Volume 2: Sampling Guide



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The Department of Health

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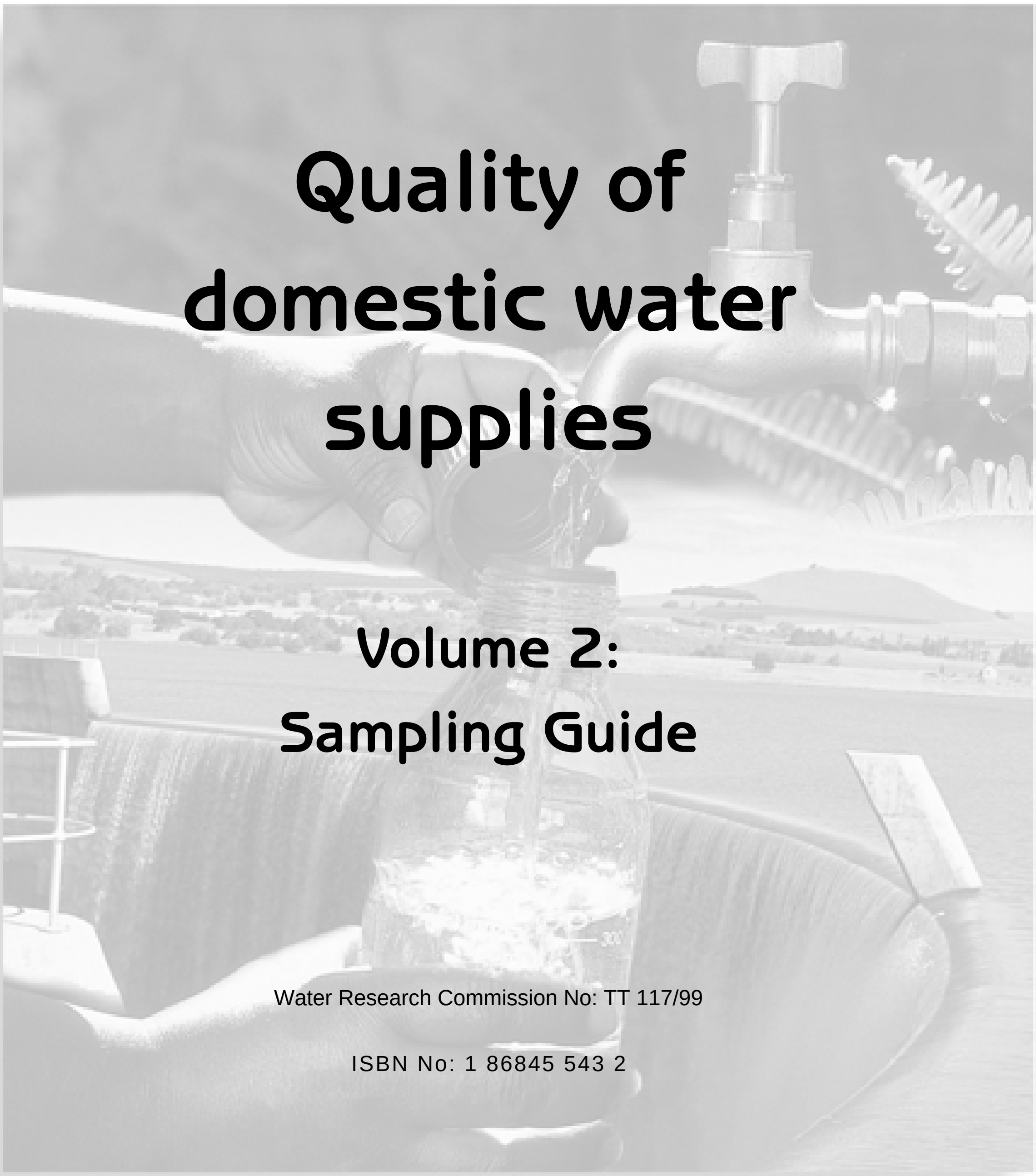

Quality of domestic water supplies

Volume 2: Sampling Guide

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OTHER REPORTS IN THIS SERIES

This Sampling Guide forms part of a series which is intended to provide water supply agencies, water resource managers, workers in the field as well as communities throughout South Africa, with the information they need to sample, analyse, assess and interpret the quality of domestic water supplies. An additional guide which will provide further information on the management of domestic water supplies is also planned.

The following documents form the series:

Quality of domestic water supplies -
Volume 1 Assessment Guide

Quality of domestic water supplies -
Volume 2 Sampling Guide

Quality of domestic water supplies -
Volume 3 Analysis Guide*

Quality of domestic water supplies -
Volume 4 Treatment Guide*

Quality of domestic water supplies -
Volume 5 Management Guide*

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*Still under preparation

FOREWORD

In search of better health for all South Africa's people, the following three objectives are of primary importance: Water resource management, waste treatment and a safe public water supply. These objectives are corner-stones of the South African Constitution and are supported by a sound legal framework in terms of the National Water Act (Act No 36 of 1998), the Water Services Act, (Act No 108 of 1997) as well as the Health Act (Act No 63 of 1977).

However, the laudable goal of ensuring that all citizens have access to a safe potable water supply will only be achievable if reliable and timely information is made available to effectively manage the relevant water supply systems.

With this aim in mind the Department of Health and the Department of Water Affairs and Forestry, in partnership with the Water Research Commission, have embarked on a venture to produce a series of user-friendly guidelines. The aim of these guidelines is to provide water supply agencies, water resource managers, workers in the health-related fields, as well as consumers, with the information they need to sample, analyse, assess and interpret the quality of domestic water supplies.

This Guide is the second in the series and is specifically aimed at explaining the concepts related to correct sampling techniques. As in the case of Volume 1 *(Quality of Domestic Water Supplies: Assessment Guide)*, particular attention has been paid to the user-friendliness of the document.

It is hoped that this guide will contribute substantially towards building the necessary capacity to monitor and assess the quality of domestic water supplies, and thereby provide another stepping stone towards achieving the goal of providing safe water to all South Africans.

Mr Ronnie Kasrils
Minister of Water Affairs and Forestry

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STRUCTURE OF THIS GUIDE

The Sampling Guide is divided into four parts

Part 1

General information on the objectives and concepts of domestic water quality sampling

Part 2

Planning of the sampling programme

Part 3

Preparing for the sampling exercise

Part 4

Sample collection

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PURPOSE OF THE SAMPLING GUIDE

What is the purpose of this Sampling Guide?

The purpose of this Sampling Guide is to provide information on the correct procedure that must be followed to collect a representative water quality sample from a water supply intended for domestic use.

Information is given in the guide on why, where and how to take a sample. Guidance is also given on how to plan a sampling programme.

Who should use this Sampling Guide?

The Sampling Guide is intended for use by -

- ***environmental health officers*** - who must collect samples to assess the safety of domestic water supplies;
- ***water supply agencies*** - who must determine if the water they supply is fit for use, or if their treatment process needs to be adjusted;
- ***water resource developers*** - to assess whether a raw water source is suitable for supply or what treatment is required;
- ***educators*** - to build an understanding of the importance of collecting water samples in the correct manner; and
- ***the public*** - to provide the information they need on how to collect a water sample in the correct manner if they want to have the sample analysed in order to determine the quality of their water supply.

PART 1

General information on the objectives and concepts of domestic water quality sampling

PART 1

General information on the objectives and concepts of domestic water quality sampling

Familiarise yourself with the objectives and concepts of water quality sampling

YOU ARE HERE

PART 2

Planning of the sampling programme

PART 3

Preparing for the sampling exercise

PART 4

Sample collection

Before embarking on a water quality sampling exercise it is important to clearly understand what needs to be sampled as well as the concepts related to the correct water quality sampling techniques.

Familiarise yourself with the objectives and concepts of domestic water quality sampling

The objectives of any water quality sampling programme should be clearly formulated before water samples are collected and analysed. For domestic water supplies the sampling objectives are determined by the information that is required such as -

- the level of treatment required to ensure that a water supply is suitable for domestic use;
- the efficiency of the water treatment;
- possible contamination of the water in the distribution system;
- the water quality at the point of use (this may include the quality of the water used by street vendors for food preparation or at a tap in a house); and
- the corrosivity of the water.

The objectives of the sampling programme in turn determine issues such as –

- which substances in the water are of interest;
- where and when are samples to be taken;
- how are samples to be taken;
- which analytical methods are to be used;
- how results are to be reported; and
- what is to be done with the reported results.

Sampling can thus not be done in isolation, but needs to be integrated into the other steps necessary to manage the quality of domestic water supplies. Communication between the various role players within the water quality management cycle is crucial to ensure that the water quality information that is generated is meaningful and correct.

Figure 1 shows the main elements of the water quality management cycle namely –

- sampling;
- analysis of the sample;
- data assessment;
- water treatment; and
- management of the resource and supply.

This document (Volume 2 of the series) deals specifically with the sampling aspects of the water quality management cycle. The following concepts related to correct water quality sampling are addressed:

- Why do we need to collect a water sample?
- What is meant by water quality?
- What substances must be analysed to determine the water quality?
- Why is it important to know how to collect water samples?

- What is a representative water sample?
- Where must water samples be collected?
- How often must water samples be taken?
- How do the differences between ground- and surface water sources affect sampling?

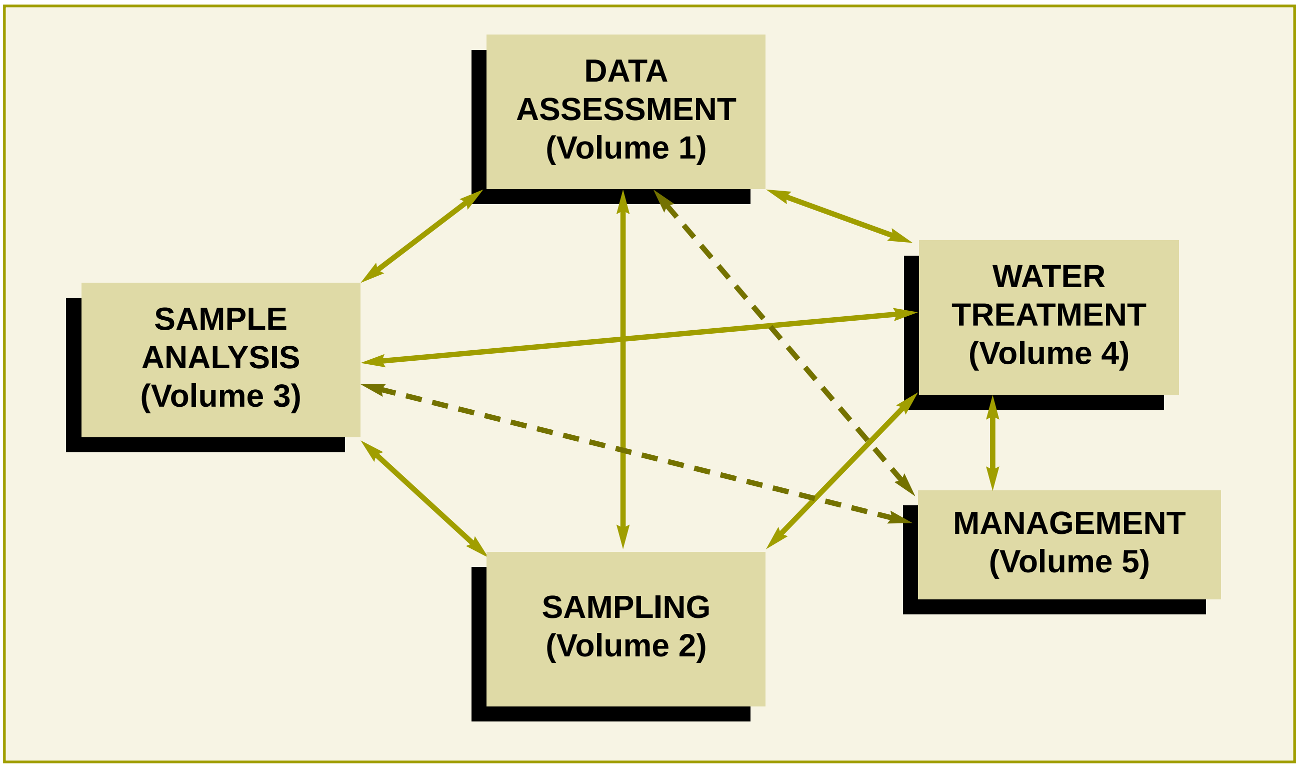


Figure 1: The five main elements in the water quality management cycle of domestic water supplies

Volume 1 = Assessment Guide
Volume 2 = Sampling Guide
Volume 3 = Analysis Guide
Volume 4 = Treatment Guide
Volume 5 = Management Guide

Why do we need to collect a water sample?

Most water quality analyses cannot be done on site (i.e. in situ). Therefore, a representative volume of water at a specific point of interest has to be collected for analysis in a laboratory.

What is meant by water quality?

The term water quality is generally used to describe the microbiological, physical and chemical properties of water that determine the fitness for use of a specific water source.

Microbiological quality: Refers to the presence of organisms that cannot be individually seen by the naked eye, such as protozoa, bacteria and viruses. Many of these microbes are associated with the transmission of infectious water-borne diseases such as gastroenteritis and cholera.

Faecal and total coliform bacteria are commonly used as indicator organisms to determine the microbiological status and safety of water supplies.

Physical quality: Refers to water quality properties (such as conductivity, pH and turbidity) that may be determined by physical methods. The physical quality mainly affects the aesthetic quality (taste, odour and appearance) of water.

Chemical quality: Refers to the nature and concentration of dissolved substances (such as organic and inorganic chemicals including metals). Many chemicals in water are essential as part of a person's daily nutritional requirements, but unfortunately above a certain concentration most chemicals (e.g. zinc, copper, manganese) may have negative health effects.

What substances must be analysed to determine the water quality?

A large number of substances are found in water. However, only a few commonly occur in concentrations that cause adverse health, aesthetic or other problems of concern to domestic users.

Table 1 gives information on those substances that are most relevant to the domestic user.

Why is it important to know how to collect water samples?

Wrong sampling procedures and methods will affect the accuracy and reliability of analytical results and lead to misleading conclusions on the quality of the water supply.

It is also important to remember that, once a water sample is taken, the substances in the sample may deteriorate or the sample may become contaminated before it reaches the laboratory. To avoid this the sampler must know all the correct sampling requirements and preservation methods beforehand.

What is a representative water sample?

A representative water sample can be described as a sample that meets the objectives of sampling, and that has been collected at a place that truly represents the water at the point of concern in the water supply system (see Figure 2).

Where must water samples be collected?

The actual sampling point in the system is determined by the objective of the sampling programme, for example (see Figure 2) –

- the source (if the objective is to determine whether a water source is suitable for domestic purposes, or what level of treatment is required);
- the outflow from the water treatment works (if the objective is to determine operational control and product quality);
- a distribution system (if the objective is to determine whether any changes in water quality occur in the distribution system); and
- a point of use (to determine if the water is fit for use).

How often must water samples be taken?

The sampling frequency depends primarily on the purpose of sampling, but also on the number of people being supplied with water and the nature of the water source as well as the substance of concern.

The quality of a water source can change within minutes or it can remain stable for a long period of time. Determining the correct sampling frequency is therefore a crucial water quality monitoring step (see Part 2 of this guide for more information). If the frequency of sampling is too low, then results would not reflect the correct variations in water quality at a specific point. On the other hand, if the sampling frequency is too high, then money would be wasted on unnecessary sample analyses, and the results obtained would not reveal new information, but would only confirm existing results.

Table 1: Water quality substances of key relevance to the domestic user

KEY SUBSTANCES	RELEVANCE TO THE DOMESTIC USER
Microbiological quality	
Faecal coliforms	Indicates recent faecal pollution, and the potential risk of contracting infectious diseases
Total coliforms	Indicates the general hygienic quality of the water
Free residual chlorine	Indicates the adequacy of disinfection using chlorine
Physical quality	
Electrical conductivity Total dissolved salts	Serves as a general indicator of change in water quality and affects the taste and "freshness" of the water
pH	Affects the taste and corrosivity of the water
Turbidity	Indicates the cloudiness of the water, and affects the risk of infectious disease transmission
Chemical quality	
Arsenic	Excessive amounts can make the water poisonous and may also cause cancer
Cadmium	May affect the toxicity of the water
Calcium	Causes scaling in pipes; affects taste of water
Sodium and chloride	May impart a salty taste to the water
Fluoride	Excessive amounts stain teeth and cause crippling skeletal deformities
Iron and manganese	May discolour water; excessive amounts may be toxic
Total hardness	Affects the scaling and foaming quality of the water
Magnesium	Excessive amounts make water bitter and may cause diarrhoea
Nitrate and nitrite	May be toxic to infants
Potassium	Imparts a bitter taste; toxic in large amounts
Zinc	May affect the taste of water - makes the water bitter
Please note the list is by no means comprehensive and site-specific conditions may necessitate a more comprehensive list of substances to be analysed.	

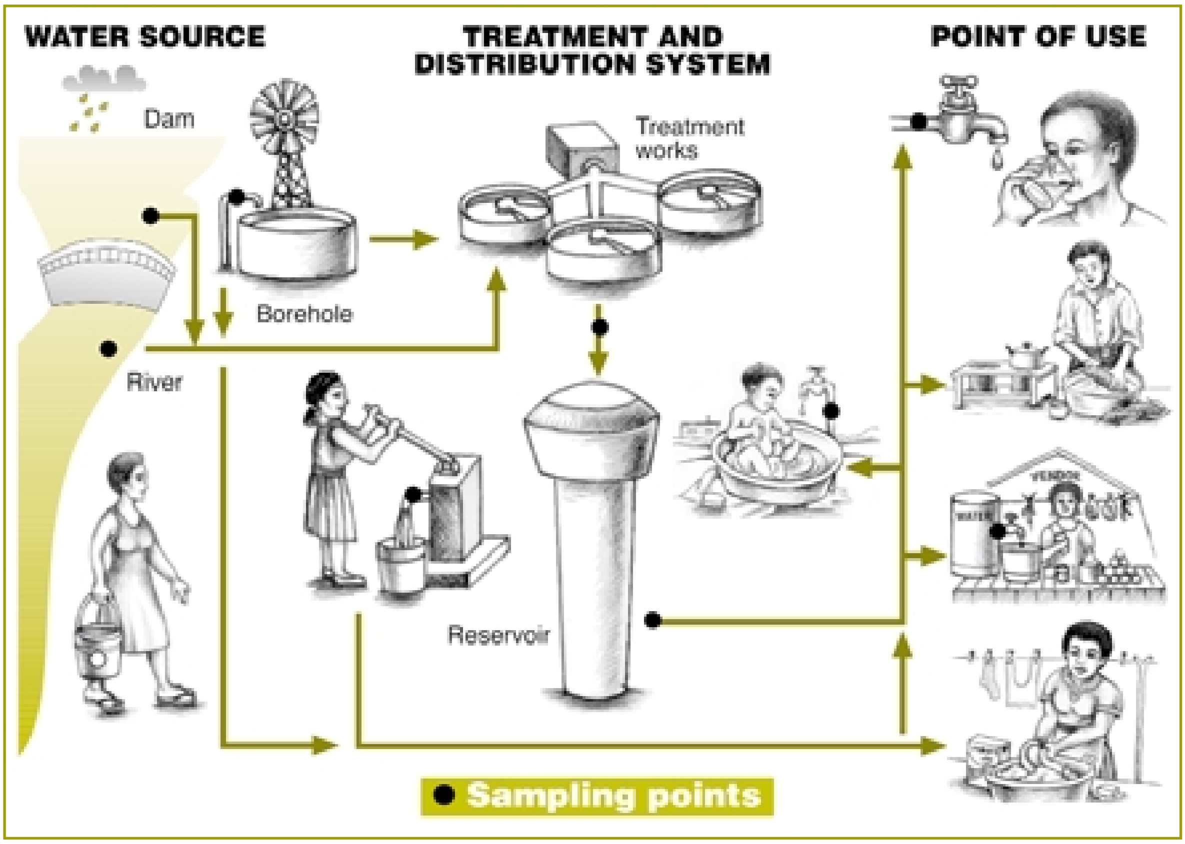


Figure 2 shows the water supply system with all possible points where water samples should be collected to assess domestic water quality.

How do the differences between ground- and surface water sources affect sampling?

Generally the quality of surface water is more variable than the quality of groundwater. Therefore, the surface water should be sampled more frequently (see Table 2 on p 11).

In the case of flowing surface water the quality may vary drastically over time, particularly during rainstorm events or in relation to effluent discharges. The choice of the time and date of sampling, therefore, has a critical effect on the representivity of the sample.

In the case of groundwater, the quality of the aquifer is typically reasonably constant over time. Local land-use activities may have a significant impact on the groundwater quality. If it is the purpose to obtain a representative sample from the groundwater aquifer the stagnant water must first be displaced (or purged*). However, if the actual quality of the borehole water (the water that is directly used by the community) needs to be determined, then purging is not required. In other words the objective of the sampling exercise must be taken into account when collecting the water sample.

NOTE

*Purging of the borehole involves the removal of sufficient water until the general quality, as measured by the pH and electrical conductivity, is stable. (Also see: Weaver, J M C 1992, Groundwater Sampling: A Comprehensive Guide for Sampling Methods. WRC Project No. 339, TT 54/92.

PART 2

Planning of the sampling programme

PART 1

General information on the objectives and concepts of domestic water quality sampling

PART 2

Planning of the sampling programme

Define the objectives of the sampling exercise

Select the sampling points in the water supply system

Describe the sampling point

Choose the analytical laboratory

Select the key substances

Determine the sampling frequency

YOU ARE HERE

PART 3

Preparing for the sampling exercise

PART 4

Sample collection

The previous section provided a background to the concept of water quality sampling and informed the reader why it is important to collect water samples correctly. At this stage it should be clear that the sampling exercise is an integral part of the total water quality assessment process. The accuracy of water quality results obtained in the laboratory is just as dependent on the correctness of the sampling technique as it is dependent on the accuracy of the analytical procedures. Therefore the sampling exercise requires careful planning beforehand.

Part 2 of the Sampling Guide will help the sampler to plan the sampling exercise.

Define the objectives of the sampling exercise

Before any sampling programme is started it is important to define clearly the objectives of the sampling programme as this will dictate issues such as -

- the substances to be sampled and analysed;
- the frequency of sampling;
- the choice of preparatory steps prior to analyses; and
- the appropriate guidelines to evaluate the results.

Objectives or purpose for sampling may include options such as -

- assessment of the fitness for use;
- evaluation of the water treatment process to determine if disinfection of the water is adequate;
- evaluation of water in a distribution system to determine whether the water is adequately stabilised; and
- evaluation of water quality at a tap in a house to determine if the water is safe to drink.

Select the sampling points in the water supply system

The point where the water sample in the water supply system will be taken depends largely on the objectives of the sampling exercise. The sampling points could thus be located at -

- the raw water source (i.e. a river, stream, dam, lake or borehole);
- the water treatment system;
- the distribution system; or
- the point of use (which can be a tap in the house, bucket in the house, or the container the vendor uses on the street).

Raw water source

River, stream, dam or lake

Surface water refers to water that is found at a source on the surface of the earth, such as a river, stream, dam or lake. It is important to remember that if a water sample is collected from one of these sources, the point where the sample is collected must be as near to the point of abstraction as possible. (Revisit definition of representative water sample on page 4).

Groundwater

The objective of the sampling exercise is very important when selecting sampling points for groundwater sources.

If the aim is to evaluate the water quality of the aquifer then the borehole must first be purged before the sample can be collected.

If the aim is to determine the quality of the water supply from the borehole then the borehole does not need to be purged. The sampling point may then be placed at the first tap (or line-opening) in the system after the borehole.

Treatment and distribution system

Water samples are taken at the outlet of treatment works to check the treatment processes and/or the quality of the water supplied to the consumer. Water within a distribution system is normally sampled to evaluate and check whether the distribution system performs correctly. If overall performance of the distribution system needs to be evaluated it is better to take the sample from a pipe with significant flow, rather than from a stagnant section of the distribution system. For contamination, monitoring samples must be collected down-flow of the (suspected) point of contamination in the distribution system.

Point of use

This is a very important sampling point as it represents the water that is actually used for domestic purposes. To obtain the quality of this water, the sampler can collect the water at the following points:

- From a tap that is used regularly outside or inside the house, shop or in the garden.
- In the case of vendors, samples must be taken directly from the vendor's water containers.

Description of the sampling point

A description of a sampling point is necessary in order to make revisits and reporting on specific sampling points easier. This applies to points in remote as well as residential areas.

The position of a sampling point can be determined by making use of -

- maps;
- street addresses;
- land surveyors to determine the geographic location in terms of coordinates (latitude and longitude);
- global positioning systems (GPS) to determine the coordinates; or
- photographs.

Maps

When water quality data are stored in a database, the location and identification of a sampling point (for example, sampling points in rivers, dams or dug-wells) can be marked on a large-scale map. A 1:10 000 map (orthophoto) is very useful in this regard.

Street addresses

Where the sampling points are situated within residential areas the name and telephone number of the owner and street address of the premises where the water sample was collected can indicate the position of the point. This is useful for routine as well as investigation-specific sampling.

Land surveyors/global positioning systems (GPS)

Other methods of documenting the exact geographical location of the sampling point position in terms of coordinates (latitudes and longitudes) are probably more expensive but the results obtained are often more accurate. The first is to hire a land surveyor, the second is to digitise the locations from a map using geographical information systems (GIS) and the third is by using a portable GPS device.

Photograph

It is always useful to have a photo record of a specific site. In this way visual identification of the site at a later stage is much easier. Another advantage of having a photo record is that physical changes can easily be detected by comparing two photographs of the same site taken on different dates.

Choose the analytical laboratory

The choice of the analytical laboratory that will conduct the water quality analyses is a crucial step in the planning process. It is important for the sampler to know the locations of the closest analytical laboratories in the area as certain of the substances have a maximum period within which they have to be analysed (for example microbiological samples). If the closest analytical laboratory can only be accessed within 48 hours, then special precautions will need to be taken with regard to the samples that have to be analysed within a short time period. It is important to contact the laboratory well in advance to determine any special requirements the laboratory may have with regard to sample handling and transport. For example, some laboratories prefer receiving microbiological samples only between Monday and Thursday, while others prefer receiving samples before 10:00 in the morning.

NOTE

The sampler must be well aware of the requirements of the laboratory that will conduct the analyses before the sample is taken.

Select the key substances

A number of factors influence the choice of substances that should be included in a domestic water quality assessment (see Table 1 on page 5). These are -

- the objectives of the sampling exercise;
- where in the water supply system the water is assessed (i.e. at the source, the treatment works, or at the point of use);
- the source of the water (i.e. river, stream, dam or rain-water tank);
- the type of pollution problems that may occur in the area;
- environmental problems that have been experienced with similar water sources in the vicinity; and
- the opinion of the analytical laboratory.

NOTE

Table 1 (on page 5) does not list all constituents that can be problematic at a site. Those not listed are normally substances that are very site-specific. For example:

- If the water source is near an industrial area, then, depending on the type of industry, organic compounds and/or metals must be included on the list of variables to be determined.
- If the water source is in an agricultural area then the possible presence of herbicides, pesticides and fertilisers must also be determined.

In these instances it is again important to consult with the analytical laboratory on special precautions that need to be taken before conducting a sampling survey.

Determine the sampling frequency

The sampling frequency is dictated by the characteristics of the water source and the number of people supplied with water.

Table 2 gives information on the minimum and recommended number of samples and sampling frequencies for different points in the water supply system.

Table 2: The minimum and recommended number of samples and sampling frequencies for different points in the water supply system

SAMPLING POINT		MINIMUM PER POINT		RECOMMENDED PER POINT*	
		Number of samples per year	Sampling frequency	Number of samples per year	Sampling frequency
SOURCE	River/stream/spring/dug-well	4	3-monthly	26	2-weekly
SOURCE	Dam	2	6-monthly	12	2-monthly
SOURCE	Borehole	1	-	2	6-monthly
Treatment works		4	3-monthly	12/52/365	Monthly/weekly/daily**
Point of use		4	3-monthly	12/52/365	Monthly/weekly/daily**

** Also refer to SABS Code of Practice, *South African Bureau of Standards: Drinking Water Specifications. SABS 241-1999*

** Depends on size of treatment works, the variability in the water quality, and the number of people supplied with water.

NOTE

It is the goal to collect the optimal number of samples that would provide reliable results.

If the frequency of sampling is too low, then results would not reflect the correct variations in water quality changes at a specific site. On the other hand, if the sampling frequency is too high, then money would be wasted on unnecessary sampling and analyses and the results obtained would not reveal new information, but would only confirm existing results.

Sampling frequency for surface and groundwater sources

Surface water

Surface water sources are divided into flowing and standing water. The sampling frequency at these two types of water resources differs. Rivers and streams are more susceptible to sudden water quality changes than lakes and dams. Thus, more frequent samples are needed from a river or stream than from a lake or dam. In general, bi-weekly samples from a river or stream are adequate (i.e. 26 samples per year) while monthly samples from a lake or dam (i.e. 12 samples per year) should be sufficient to determine if the source is suitable for domestic use (see Volume 1 of this series). In the event of non-compliance with water quality guidelines, sampling frequency should be increased (for example to 4 samples per month).

NOTE

NON-COMPLIANCE: when the quality of a water sample is above or below the recommended quality suitable for domestic use.

Groundwater

It is generally accepted that the quality of groundwater sources is more stable than surface water sources. For this reason two groundwater samples per year per borehole should be sufficient. However, if water quality changes are detected, the frequency should be increased to weekly sampling and maintained until the problem causing the change in water quality has been solved.

Sampling frequency for a treatment works

The sampling of water in treatment works normally needs to be conducted to -

- determine whether the water treatment works is supplying water of an acceptable quality; and
- assess the operational performance of the water treatment works.

In order to determine the adequacy of the water treatment works, four samples per year are the absolute minimum, with a recommended sampling frequency of 12 (monthly), 52 (weekly) or 365 (daily) samples per year depending on the size of the treatment works (see Table 2 for reference).

Sampling frequency for a distribution system

If any changes in water quality are detected after the water has been through the treatment works, (see Figure 2) then the cause should be investigated. The sampling frequency should be increased until such time that the problem has been found and solved. It is proposed that the quality of the water in the distribution system and reticulation network be measured on a monthly basis, and increased to weekly samples if a water quality problem is found.

Sampling frequency at the point of use

Sampling at the point of use can range from an infrequent spot-check at a street vendor's water container, to more regular routine monitoring of the distribution system.

SPECIAL NOTES ON THE SAMPLING FREQUENCY FOR MICROBIOLOGICAL SAMPLES:

The microbiological quality of water is usually sampled at a higher frequency than the chemical quality of the water. The recommended frequency of sampling is -

- weekly samples for surface water;
- weekly samples in distribution systems; and
- two samples per year for boreholes. In the event of a sewage spill into surface or borehole water near the point of abstraction, the sampling frequency should be increased to daily samples until the problem has been rectified.

PART 3

Preparing for the sampling programme

PART 1

General information on the objectives and concepts of domestic water quality sampling

PART 2

Planning of the sampling programme

PART 3

Preparing for the sampling exercise ◄ YOU ARE HERE

- Familiarise yourself with safety precautions
- Prepare sample equipment
- Familiarise yourself with sample preservation and transport

↓

PART 4

Sample collection

This part of the document deals with the preparation the sampler has to do before embarking on a water quality sampling trip.

Familiarise yourself with safety precautions

While safety is often not considered an integral part of the sampling programme, the sampler must be aware of possible unsafe working conditions, hazards associated with the operation of sampling gear, and other risks.

Basic good practice should be followed in the field. Always keep the following points in mind –

- If samples are collected from a river or dam, waders should preferably be worn with a belt to prevent the waders from filling with water in the case of a fall. (Not necessary for shallow water).
- Never drink the water you are about to sample unless you are very sure about the quality and safety of the water.
- Many hazards lie out of sight on the bottom of dams, rivers and streams. Broken glass or sharp pieces of metal embedded into the substrate can cause serious injury if care is not exercised when working in such environments.

Prepare sample equipment

Assemble and check sample equipment and instruments

The sampling of water to determine domestic water quality does not mean that the sampler only needs a sample bottle. Other types of equipment may also be needed. Field instruments such as conductivity and pH meters are all part of sampling equipment. It is important for the sampler to be well prepared when going out on a sampling trip as sampling is often conducted far from the office, which makes it difficult to replenish supplies or pick up forgotten items.

A water quality sampling equipment checklist should be drawn up by the sampler and checked before every sampling survey. (See Table 3 for an example of such a checklist. Appendix B contains a copy of the checklist for easy photocopying).

Calibrate the field instruments

Field instruments required are normally those used to determine the physical constituents, namely –

- pH;
- electrical conductivity (EC); and
- turbidity.

Field instruments used to determine physical parameters must be calibrated before any water sample is collected. Because a wide variety of instruments is available to determine the physical quality of the water it is not within the scope of this document to provide calibration instructions for any of them. It is, however, recommended that the sampler reads the manufacturer's manual and instructions carefully before using any of the equipment.

NOTE

If the manufacturer prescribes the use of distilled water and it is not readily available it can be obtained from the local pharmacy or health clinic.

Table 3: Domestic water quality sampling equipment checklist

Sampling Equipment	Tick
Stopwatch (if required for flow measurements)	
pH meter and buffers or pH indicator strips	
Turbidity meter	
Temperature meter	
Additional batteries for field apparatus	
Electrical conductivity meter	
Copies of manufacturers' manuals for calibrating field instruments	
Map indicating all sampling locations	
Field notebook	
Waterproof pens, markers and pencils	
Field data forms and data labels	
Containers for purging the borehole (if no pumps are available)	
Electric generator (if necessary)	
Calibrated bucket	
Sealed cooler bags	
Glass sample bottles (sterile glass bottles for microbiological sampling)	
Plastic sample bottles	
Bags of ice or freezer ice packs	
Paper towels	
Disposable latex gloves (if required)	

Sample bottles

Obtaining a representative water sample also means being careful in the choice of sample bottles. For example if the water sample is being collected to determine the presence of trace metals (e.g. copper or zinc) in the water, do not use sample bottles with metal components (e.g. metal caps). When sampling for organics, avoid using sample bottles with plastic components, as the plasticizers may leach and contaminate the samples.

Table 4 gives an indication of the size and type of sample bottles needed to sample domestic water supplies. **It is however recommended that the sampler informs the laboratory beforehand on the type of water samples that is going to be collected. They will then also give advice on the desired type of sample bottle.**

NOTE: What to do if sample bottles are not available?

In the case of an **emergency**, when the sample must be taken as a matter of urgency, the following sample bottles can be used:

- 1l glass cold drink bottles
- 2l plastic cold drink bottles

It is very important that these bottles, together with their respective caps, be properly cleaned before the water sample is taken. This can be achieved by rinsing the substitute water sample bottle at least five times with the water to be sampled. A good indication of whether the sample bottle and its cap are clean enough for sampling purposes is to smell the inside of the bottle after it has been rinsed. If it still has the smell of the original contents then rinse the bottle a few more times and repeat the smell-test.

If a sufficient number of sample bottles is not available and additional bottles are needed, sample bottles as indicated above can be used. However, clean the bottles and caps thoroughly with hot water. Let the bottles air-dry with the top of the bottle facing downwards. This will prevent dust or other particles collecting in the bottle. After all the bottles are dry replace the caps and store with other sample bottles.

Sample labels

It is crucial for each sample bottle to have a clearly identifiable label when arriving at the laboratory. Labels printed on special water-resistant paper should preferably be used. The label should be completed with a waterproof pen immediately after the sample is taken and tied to the neck of the bottle with a piece of string with the following information written on the label –

- An unique sample number and description.
- The date and time of sampling (Remember day/month/year).
- The name of the sampler.

Consult with the local analytical laboratory for more information on these sample labels and how to obtain them.

Data sheets

Data sheets (see Appendix A) make provision for recording the physical and environmental information of the sampling point. This information is needed to interpret water quality at a site especially if the water quality results obtained from the laboratory indicate a sudden change. The information on the data sheet must be handed in with the sample bottles at the laboratory. (The sampler must also make a copy for his or her own filing purposes).

Table 4: Type of sample bottles required for domestic water quality sampling

Substance	Type of sample bottle to be used		Minimum sample size required (mℓ)	Special remarks
	Glass	Plastic		
Biological quality				
Faecal coliforms	✔	✔	500	Sample bottles must be sterilised
Total coliforms	✔	✔	500	Sample bottles must be sterilised
Free residual chlorine (residual)	✔	✔	500	Measured on site
Physical quality				
Electrical conductivity/ total dissolved salts	✔	✔	300	Should preferably be measured immediately at site
pH	✔	✔	50	Should preferably be measured immediately at site
Turbidity	✔	✔	300	
Chemical quality				
Arsenic		✔	300	
Cadmium		✔	300	
Calcium	✔	✔	300	Use borosilicate glass bottles Ask laboratory for more information
Sodium		✔	300	
Chloride	✔	✔	300	
Fluoride		✔	300	
Iron		✔	300	
Manganese		✔	300	
Total hardness	✔	✔	100	
Magnesium	✔	✔	300	Use borosilicate glass bottles Ask laboratory for more information
Nitrate	✔	✔	300	
Nitrite	✔	✔	300	
Potassium		✔	300	
Zinc		✔	300	

Please note the minimum sample size required is only adequate for determining the concentration of that specific substance. In practice a 1000 mℓ (or 1 ℓ) sample is normally collected to determine the concentration of a range of substances in the sample. Consult the laboratory on the type of sample bottle(s) required for the different types of substance(s) to be analysed.

Familiarise yourself with sample preservation and transport

Sample handling and sample transport are important aspects of water quality sampling that are often neglected.

As soon as the water sample has been collected some of the chemical characteristics of the water start to change. For this reason some samples must be preserved to keep the quality of the water sample as stable as possible until the analysis can be carried out. **It must, however, be kept in mind that the preservation technique only retards chemical and biological changes that continue after sample collection and will not stop quality changes altogether.**

The following preservation techniques are recommended:

- To minimise water quality changes between sampling and analysis it is important to keep the samples as cool as possible, without freezing them. In general, the shorter the time between collection of a sample and its analysis, the more reliable the results.
- Preferably pack water samples in crushed or cubed ice during transportation (only applicable if samples will be delivered to the laboratory within 6 hours, as the ice will melt after longer periods). This specifically applies to microbiological and nutrient samples.
- Avoid using dry ice as it will freeze the samples and may cause glass containers to break. Dry ice may also effect a pH change in samples.
- As was mentioned earlier, this manual does not prescribe the use of any specific preservatives to preserve chemical samples as it is expected that the chemical samples will be kept cool and analysed at a laboratory within 7 days of sampling. This technique excludes the physical measurements that are taken on site, and microbiological samples that must be analysed within 6 hours of sampling if not cooled, and within 24 hours if cooled.

NOTE

Preservation is normally recommended only when the water sample cannot be delivered to the laboratory within 24 hours (1 day) after sampling. As a rule of thumb always ensure that the laboratory has been notified of the expected time of sample delivery and ask their advice on the preservation of the samples.

NOTE

If bacteriological samples are to be analysed after more than 6 hours from the time of sampling (24 hours for cooled samples), examination can still be carried out. It must then be stated in the report that, because of the delay, the examination does not comply with the requirements for analysis and results should be evaluated accordingly.

Sample collection

PART 1

General information on the objectives and concepts of domestic water quality sampling

↓

PART 2

Planning of the sampling programme

↓

PART3

Preparing for the sampling exercise

↓

PART 4

- Sample collection
- Equipment needed
- Special precautions
- Sampling techniques

↓

← YOU ARE HERE

When all the requirements outlined in Part 1, 2 and 3 have been met, collection of the water samples can commence.

NOTE
Three major aspects must be kept in mind at all times during sample collection:

i. Personal health and safety
ii. Representative sample collection
iii. Record of all samples collected

Equipment needed

Equipment to collect microbiological samples

- Sterile sample bottles (see Table 4 for the type of sample bottle needed)
- Sealed container or cool box which can be kept cool (preferably with ice)

Equipment for recording physical measurements

- Clean laboratory glass beaker or any well cleaned container large enough in volume for the probes of the instruments to be lowered in (at least 250 ml in volume)
- Electrical conductivity meter
- pH field instrument
- pH test-paper as an optional method to the pH field instrument
- Nephelometric turbidity meter (if required)
- Temperature meter - electronic or field thermometer (if required)
- Distilled water for cleaning the probes
- Field notebook/data sheet

Equipment to collect chemical samples

- Correct sample bottles (see Table 4 for the different types of sample bottles required)
- Cooler box with ice (if necessary)

Special precautions

Microbiological water samples

- If the water sampled contains residual chlorine then add 1 ml of a 10% sodium thiosulphate solution for every litre of sample taken. (See *Standard Methods*, AWWA (1995) or consult with the laboratory).
- Keep sample bottle closed and in a clean condition up to the point where it has to be filled with the water to be sampled.
- Do not rinse bottle with any water prior to sampling.
- When samples for chemical and microbiological analysis are to be collected from the same location, the microbiological sample should be collected first to avoid the danger of microbiological contamination of the sampling point.
- If the tap cleanliness of the tap at home or in a distribution system is questionable, clean the

tap with a solution of sodium hypochlorite (100 mg/l NaOCl) before sampling (Ask laboratory for more detail). Let the water run for 2 to 3 minutes afterwards.

- The sampler (person taking the sample) should wear gloves (if possible) or wash his/her hands thoroughly before taking each sample. Avoid hand contact with the neck of the sampling bottle.

NOTE

If the sample can only be analysed more than 6 hours after the time of sampling (24 hours for cooled samples) the examination can still be carried out, but then this must be stated on the sample sheet accompanying the sample. The delay does not comply with the requirements for analyses, and results should be evaluated accordingly.

Physical quality of the water

- Field apparatus (for example the pH and electrical conductivity probes) must be cleaned thoroughly as well as being calibrated according to the manufacturer's specifications before any physical measurement is taken.
- Never take the reading immediately after the probe was put into the water sample; always allow sufficient time for the instrument to stabilise before taking the reading.
- After taking a measurement the probe must be rinsed in distilled water and covered in its protective sleeve, or follow instructions in the manufacturer's manual for caring of the specific probe.
- Try to avoid using the same water sample for determining all field measurements; rather split the water sample for each physical measurement.

Chemical water samples

- Some plastic caps or cap liners may cause metal contamination of the water sample. Please consult with the laboratory on the correct use of bottle caps.
- Keep sample bottle closed and in a clean condition up to the point where it has to be filled with the water to be analysed.
- Never leave the sample bottles (empty or filled with the water sample) unprotected in the sun.
- After the sample has been collected the sample bottle should be placed directly in a cooled container (e.g. portable cooler box). Try and keep cooled container dust-free.

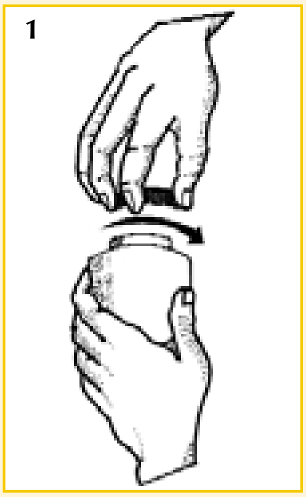
Sampling techniques

The following procedures should be followed when taking water samples in:

River, stream, lake dam or reservoir

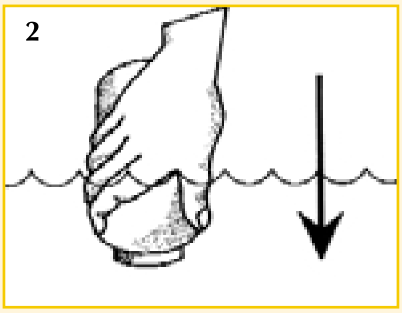
Step 1

- At the sampling point remove cap of sample bottle but do not contaminate inner surface of cap and neck of sample bottle with hands.



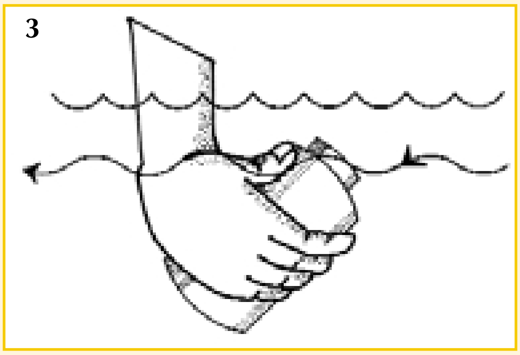
Step 2

- Take samples by holding bottle with hand near base and plunge the sample bottle, neck downward, below the water surface (wear gloves to protect your hands from contact with the water).



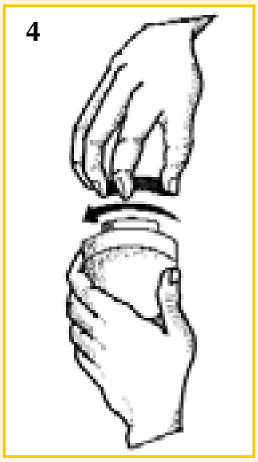
Step 3

- Turn bottle until neck points slightly upward and mouth is directed toward the current (can also be created artificially by pushing bottle forward horizontally in a direction away from the hand).



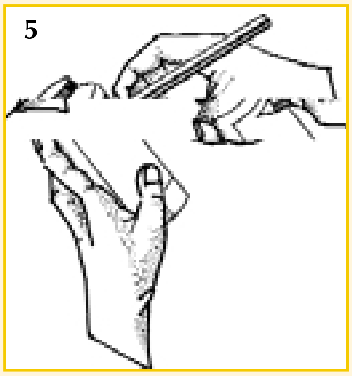
Step 4

- Fill sample bottle without rinsing and replace cap immediately.
- Before closing the sample bottle leave ample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking before examination.



Step 5

- Complete label and sample sheet



Borehole

Purging of borehole

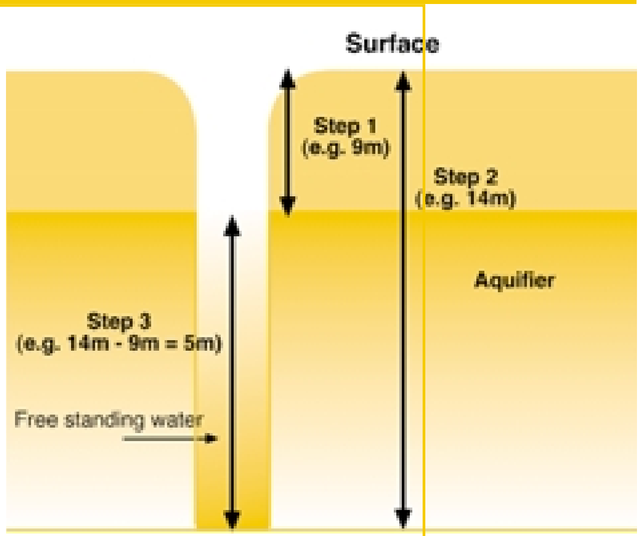
If a borehole needs to be purged (see p 6) it can be done in the following ways:

- With a portable pump
- With an already installed submersible pump
- By treating the borehole as a hand dug-well and by lowering a small bucket on a rope into the borehole

NOTE

- Before opening any borehole first check for any possible trapped vapours, especially at landfill and fuel-spilled areas.
- When arriving at the borehole or well to collect a water sample the first measurement that must be taken is the water level and the second is the depth of the **borehole**. If the **borehole** has been sampled before, the depth measurement will indicate whether borehole collapse or silting has occurred.
- When samples for chemical and microbiological analyses are collected from the same borehole the sample for microbiological examination should be collected first. This precautionary measure is to avoid the danger of contamination of the water at the sampling point.

Step 1:	Measure the water level (m)
Step 2:	Measure the borehole depth (m)
Step 3:	Calculate the height of water column (m) by subtracting the depth of the water level (1) from the borehole depth (see#2)
Step 4:	Calculate the standing volume of water in litres by substituting in the following formula: Volume of standing water $= \pi r^2 \times h \times 1000$ r = radius of borehole in metres h = height of water column in metres
Step 5:	Using the calculated volume of Step 4, calculate the pumping time needed to remove three volumes (if a pump is used)
Step 6:	While removing the stagnant water from the borehole take continuous readings of EC and pH until the readings are stable
Step 7:	Once the borehole has been purged, try to collect the water sample at least 0.5 m (500 cm) below the water surface



Borehole (continued)

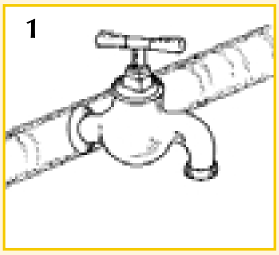
Sampling of borehole without pump	
Step 1	Secure a weight under the sample bottle and lower a plastic sample bottle in borehole until the bottle is submerged in the water.
Step 2	Fill bottle with groundwater.
Step 3	When raising the bottle to the surface ensure that the sample bottle does not get contaminated as a result of touching the inner walls of the borehole.
Step 4	Keep sample container closed and in a clean condition up to the point where it has to be filled with the water to be tested.
Step 5	At sampling point remove cap but do not contaminate inner surface of cap and neck of sample bottle with hands.
Step 6	Do not rinse the bottle.
Step 7	Fill sample with groundwater and replace the cap immediately.
Step 8	Leave ample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking, before examination.
Step 9	Place sample bottle in a cooled container (e.g. cool box) directly after collection. Try and keep cooled container dust-free and out of any direct sunlight.

Sampling of borehole with pump	
Step 1	Find the nearest tap on the line where you must collect the water quality sample.
Step 2	Open the tap and let water run to waste for at least 3 minutes. At the sampling point remove cap but do not contaminate inner surface of cap and neck of sample bottle with hands.
Step 3	Remove cap of sample bottle, but do not contaminate inner surface of cap and neck of sample bottle with hands.
Step 4	Fill sample bottle without rinsing.
Step 5	Replace the cap immediately.
Step 6	When the sample is collected leave ample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking before examination.
Step 7	Place sample bottle in a cooled container (e.g. cool box) directly after collection. Try and keep cooled container dust-free and out of any direct sunlight.
Step 8	It may sometimes be necessary, although less desirable, to install a temporary sampling point in the discharge pipe to obtain a sample. This is accomplished by drilling and threading a hole in the discharge pipe and installing a faucet or valve.

Treatment and distribution system

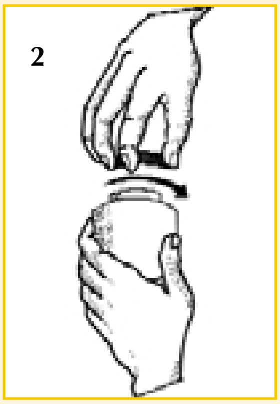
Step 1

- Open tap or valve and let water run to waste for at least 3 minutes.



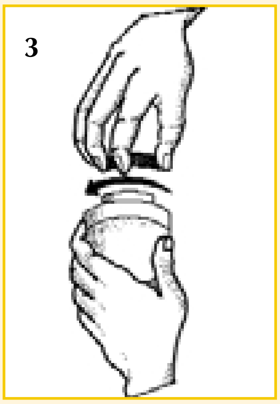
Step 2

- Remove cap of sample bottle, but do not contaminate inner surface of cap and neck of sample bottle with hands.



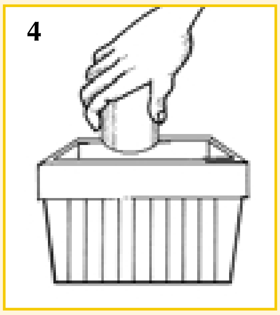
Step 3

- Fill sample bottle without rinsing and replace cap immediately. When the sample is collected leave ample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking before analysis.



Step 4

- Place sample bottle in a cooled container (e.g. cool box) directly after collection.

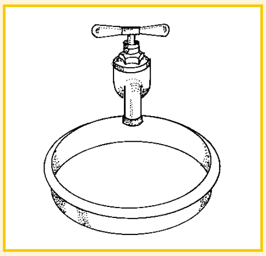


Step 5

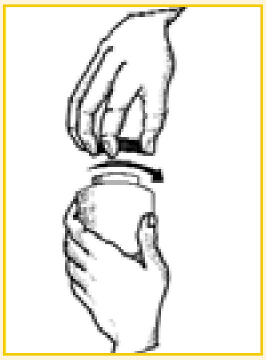
- Remember to close the tap!

Point of use

Step 1
- Open tap or valve.



Step 2
- Remove cap of sample bottle, but do not contaminate inner surface of cap and neck of sample bottle with hands.



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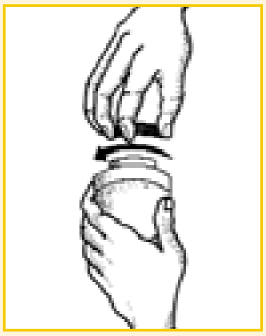
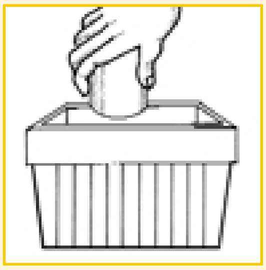


Step 4
- Place sample bottle in a cooled container (e.g. cool box) directly after collection.



Step 5
- Remember to close the tap!

NOTE
- The important aspect to keep in mind with regard to sampling at the point of use is that the sampler must collect a sample representative of the water that is being consumed by the community. In other words, not the water that is in the reservoir or distribution line, but the water you drink the moment the tap is opened.

Information requirements for data sheets

NOTE: Station number and date of sampling must be indicated on sample bottle

Station number ....

Coordinates latitude ☐☐☐

longitude ☐☐☐

Date of sampling day ☐ month ☐ year ☐

Time of sampling hour ☐ minute ☐

Contact person ....

Telephone number ....

Purpose of sampling* ....

....

....

Water body Borehole ☐

Flowing water ☐

Standing water ☐

Distribution system ☐

If flowing water:

Stream ☐

River ☐

If standing water:

Reservoir ☐

Stream ☐

Lake ☐

Dam ☐

Analyses required Metals: trace ☐

Major inorganic ions ☐

Microbiological ☐

Organic ☐

Other ☐

(specify) ....

Sample depth below surface (only for surface water supply) ....

On-site observations

Odour Present ☐

Absent ☐

Colour Normal ☐

Abnormal ☐

Appearance of water ....

Temperature of water (if required) .... °C

pH of water .... pH units

Conductivity of water .... mS/m

Preservation added yes ☐ no ☐

If so, what preservative ....

NON-COMPULSORY INFORMATION

Water flowing yes ☐ no ☐

Flow measurement (if flow is available)

Rainfall figures (if available)

Weather sun ☐ rain ☐ clouds ☐ wind

General notes/other observations

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* refer to p 16 purpose of sampling

Domestic water quality sampling equipment checklist

Sampling equipment	Tick
Stopwatch (if required for flow measurements)	
pH meter and buffers or pH indicator strips	
Turbidity meter	
Temperature meter	
Additional batteries for field apparatus	
Conductivity meter	
Copies of manufacturers’ manuals for field instruments	
Map indicating all sampling locations	
Field notebook	
Waterproof pens, markers and pencils	
Field data forms and data labels	
Containers for purging the borehole (if no pumps are available)	
Electric generator (if necessary)	
Calibrated bucket	
Sealed cooler bags	
Glass sample bottles (sterile glass bottles for microbiological sampling)	
Plastic sample bottles	
Bags of ice or freezer ice packs	
Paper towels	
Disposable latex gloves (if required)	